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Supporting Documentation for the SPS-Prospec Case Study

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Technical Report -UTEP-CS-05-14
Supporting Documentation for the SPS-Prospect Case Study

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1. Introduction

In spring of 2005 a case study was conducted to compare the correctness of the LTL formulas generated by the *Prospect tool* [1] and the Specification Pattern System (SPS) [2]. The objective of the case study was to discover any inconsistencies in the semantics of the generated LTL formulas for pattern/scope combinations [2], and the natural language description provided by Prospect and SPS.

The purpose of this document is to present the material that was used during the case study, and to document how the classification of the patterns and scopes of each trial was validated.

Along with this introductory Section, this document consists of two more sections in addition to the references. Section 2 provides the methodology of the case study along with all the testing material. Section 3 provides screenshot description of testing LTL formulas using Xspin; the graphical interface to Spin.

2. Methodology

The semantics of the LTL formulas were verified using the SPIN model checker.

There is a test suite for the following patterns: universality, absence, existence,

response, and precedence. Each test suite includes several tests for each of the scopes associated to a given pattern. Tables 1-8 provide the equivalence class and boundary value analysis testing of some of the pattern/scope combinations considered in this case study. Table 9 describes the elements considered in the test suite documentation. Figure 1 presents the Promela code used in testing the LTL formulas in Spin. The remaining tables show the actual test cases and actual results returned by Spin. Note that for the sake of consistency, the proposition Q in SPS was replaced by L, and similarly, the proposition S was replaced by Q in the test cases.

```
#define limit 20

byte i = 0;

proctype seq( )
{
  do
  :: (i < limit) -> i = i+1;
  :: (i == limit) -> break;
  od;
}
init
{
  run seq()
}
```

Figure 1. Promela Code Used in the Case Study

Table 1: Absence-Global

EQUIVALENCE CLASSES ON P	TEST CASES WITH BOUNDARY	EXPECTED RESULTS
P does not hold in any state	1. -----	1. Valid
P holds in some states	2. P----- 3. -----P	2. Not valid 3. Not valid

4. -----P-----	4. Not valid
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Table 2: Absence-Before R

EQUIVALENCE CLASSES ON P	TEST CASES WITH BOUNDARY ANALYSIS AND EQUIVALENCE CLASSES ON R	EXPECTED RESULTS
P does not hold in any state of the interval	1. R holds in first state: a) R----- b) R----- P 2. R holds in last state: a) -----R b) -----R P 3. R holds in other states: a) -----R----- b) -----R----- P c) ---R-----PR----- 4. Interval is not built a) ----- b) -----P-----P-----	1a. Valid 1b. Valid 2a. Valid 2b. Valid 3a. Valid 3b. Valid 3c. Valid 4a. Valid 4b. Valid
P holds in some state of the interval	5. R holds in first state: a) R----P----- b) RP----- 6. R holds in last state: a) -----P-----R b) -----PR 7. R holds in other states: a) -----PR----- b) -----RP-----	5a. Valid 5b. Valid 6a. Not valid 6b. Not valid 7a. Not valid 7b. Valid

Table 4: Absence-After L

EQUIVALENCE CLASSES ON P	TEST CASES WITH BOUNDARY ANALYSIS AND EQUIVALENCE CLASSES ON L	EXPECTED RESULTS
P does not hold in any state	1. L holds in first state: L----- 2. L holds in last state: -----L 3. L holds in other states: -----L----- 4. L does not occur: -----	1. Valid 2. Valid 3. Valid 4. Valid
P holds in some	5. L holds in first state:	

states	a) L----P----- b) L----- P c) LP----- 6. L holds in last state: a) -----P-----L b) -----PL c) -----L P 7. L holds in other states: a) -----PL----- b) -----L----- P c) -----LP----- 8. L holds in multiple states: ---L---P---L----- 9. L does not occur: -----P-----P-----	5a. Not valid 5b. Not valid 5c. Not valid 6a. Valid 6b. Valid 6c. Not valid 7a. Valid 7b. Not valid 7c. Not valid 8. Not valid 9. Not valid
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Table 5: Absence-Between L-R

EQUIVALENCE CLASSES ON P	TEST CASES WITH BOUNDARY ANALYSIS AND EQUIVALENCE CLASSES ON L-R	EXPECTED RESULTS
P does not hold in any state	1. The interval is not made: a) L----- b) R-----L----- c) -----R d) ---L----- R e) ----- 2. A single interval is made: a) L holds in first state: L-----R----- b) R holds in last state: -----L-----R c) L-R hold in other states: ---L---R--- 3. Multiple intervals are made: L---R-----L---R---L---R 4. Nested intervals are made: a) -----L-----L-----R----- b) -----L-----L---R---R-----	1a. Valid 1b. Valid 1c. Valid 1d. Valid 1e. Valid 2a. Valid 2b. Valid 2c. Valid 3. Valid 4a. Valid 4b. Valid
P holds in some states	5. The interval is not made: a) L----P----- b) R----P---L----P---- c) -----P-----R	5a. Valid 5b. Valid 5c. Valid

	<p>d) ---L----- R P</p> <p>e) -----P-----</p> <p>6. A single interval is made:</p> <p>a) L holds in first state:</p> <p>i. LP---R----- ii. L---R----- P iii. L---PR----- iv. L---R----- P v. L---RP----- vi. L---R--L--P--</p> <p>b) R holds in last state:</p> <p>i. -----LP---R ii. ----- L---R P iii. -----PL-----R iv. -----L---PR v. -----L---R P</p> <p>c) L-R hold in other states:</p> <p>i. -----LP---R--- ii. ----- L---R--- P iii. PL-----R----- iv. -----L---PR----- v. -----L---R----- P vi. -----L---RP</p> <p>7. Multiple intervals are made:</p> <p>a) L---R---L---R---L-P-R b) L---R--P--L---R---L---R</p> <p>8. Nested intervals are made:</p> <p>a) -----L---P--L-----R----- b) -----L-----L---P--R----- c) -----L-----L-----R---P-- d) ---P-L-----L-----R----- e) -----L-----L---R--P--R---</p>	<p>5d. Valid</p> <p>5e. Valid</p> <p>6ai. Not valid 6aia. Not valid</p> <p>6aiii. Not valid 6aiv. Valid</p> <p>6av. Valid 6avi. Valid</p> <p>6bi. Not valid 6bii. Not valid</p> <p>6biii. Valid 6biv. Not valid 6bv. Valid</p> <p>6ci. Not valid 6cii. Not valid</p> <p>6ciii. Valid 6civ. Not valid 6cv. Valid</p> <p>6cvi. Valid</p> <p>7a. Not valid 7b. Valid</p> <p>8a. Not valid 8b. Not valid 8c. Valid 8d. Valid 8e. Valid</p>
P holds in some states	<p>5. The interval is not made:</p> <p>a) L-----P----- b) R-----P---L-----P----- c) -----P-----R</p>	<p>5a. Valid 5b. Valid 5c. Valid</p>

	<p>d) ---L----- R P</p> <p>e) -----P-----</p> <p>6. A single interval is made:</p> <p>a) L holds in first state:</p> <p>i. LP---R----- ii. L---R----- P iii. L---PR----- iv. L---R----- P v. L---RP----- vi. L---R--L--P--</p> <p>b) R holds in last state:</p> <p>i. -----LP---R ii. -----L---R P iii. -----PL-----R iv. -----L---PR v. -----L---R P</p> <p>c) L-R hold in other states:</p> <p>i. -----LP---R--- ii. -----L---R--- P iii. PL-----R----- iv. -----L---PR----- v. -----L---R----- P vi. -----L---RP</p> <p>7. Multiple intervals are made:</p> <p>a) L---R---L---R---L-P-R b) L---R--P--L---R---L---R</p> <p>8. Nested intervals are made:</p> <p>a) -----L---P--L-----R----- b) -----L-----L---P--R----- c) -----L-----L-----R---P-- d) ---P-L-----L-----R----- e) -----L-----L---R--P--R---</p>	<p>5d. Valid</p> <p>5e. Valid</p> <p>6ai. Not valid 6aii. Not valid</p> <p>6aiii. Not valid 6aiv. Valid</p> <p>6av. Valid 6avi. Valid</p> <p>6bi. Not valid 6bii. Not valid</p> <p>6biii. Valid 6biv. Not valid 6bv. Valid</p> <p>6ci. Not valid 6cii. Not valid</p> <p>6ciii. Valid 6civ. Not valid 6cv. Valid</p> <p>6cvi. Valid</p> <p>7a. Not valid 7b. Valid</p> <p>8a. Not valid 8b. Not valid 8c. Valid 8d. Valid 8e. Valid</p>
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Table 6: Existence- After L Until R

EQUIVALENCE CLASSES ON P	TEST CASES WITH BOUNDARY ANALYSIS AND EQUIVALENCE CLASSES ON L-R	EXPECTED RESULTS
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<p>P does not hold in any state of the interval</p>	<p>1. The interval is not made: a) -----R b) ---L----- R c) -----</p> <p>2. A single interval is made: a) L holds in first state: i. L-----R----- ii. L---R----- P iii. L---RP----- iv. L-----</p> <p>b) R holds in last state: i. -----PL-----R ii. -----L---R P</p> <p>c) L-R hold in other states: R-----P---L-----</p> <p>3. Multiple intervals are made: a) L---R-----L---R---L--- b) L---R--P--L---R---L---</p> <p>4. Nested intervals are made: a) -----L-----L-----R----P-- b) ---P-L-----L-----R----- c) -----L-----L---R--P--R---</p>	<p>1a. Valid 1b. Valid 1c. Valid</p> <p>2ai. Not valid 2aii. Not valid 2aiii. Not valid 2aiv. Not valid</p> <p>2bi. Not valid 2bii. Not valid 2c. Not valid</p> <p>3a. Not valid 3b. Not valid</p> <p>4a. Not valid 4b. Not valid 4c. Not valid</p>
<p>P holds in the interval</p>	<p>5. A single interval is made: a) L holds in first state: i. LP---R----- ii. L---R----- P iii. L---PR----- iv. L-----P-----</p> <p>b) R holds in last state: i. -----LP---R ii. -----L---R P iii. -----L---PR</p> <p>c) L-R hold in other states: i. -----LP---R--- ii. -----L---R--- P iii. -----L---PR-----</p> <p>6. Multiple intervals are made: a. L--P---R-----L---R---L--- c. L--P--R--L--P--R---L-P--</p>	<p>5ai. Valid 5aii. Valid 5aiii. Valid 5aiv. Valid</p> <p>5bi. Valid 5bii. Valid 5biii. Valid</p> <p>5ci. Valid 5cii. Valid 5ciiii. Valid</p> <p>6a. Not valid 6b. Valid</p>

	<p>7. Nested intervals are made:</p> <p>a) -----L---P---L-----R-----</p> <p>b) -----L-----L---P-----</p>	<p>7a. Not valid (Prospec) Valid (SPS)</p> <p>7b. Valid</p>
--	--	---

Table 7: Precedence (T precedes P)- Between L and R

EQUIVALENCE CLASSES ON P	TEST CASES WITH BOUNDARY ANALYSIS AND EQUIVALENCE CLASSES ON L-R	EXPECTED RESULTS
T does not precede P in any state of the interval	<p>1. The interval is not made:</p> <p>a) -----P-----R</p> <p>b) ---L----- R P</p> <p>c) ---L-----P-----</p> <p>d) -----P-----</p> <p>e) R-----P---L-----</p> <p>2. A single interval is made:</p> <p>a) L holds in first state:</p> <p>i. L---P---R-----</p> <p>ii. L---T---R-----</p> <p>iii. L---P--T--R-----</p> <p>iv. L---R----- P</p> <p>v. L----RP-----</p> <p>vi. L---P---R----- T</p> <p>b) R holds in last state:</p> <p>i. -----PL-----R</p> <p>ii. -----L---R P</p> <p>iii. -----L--P---R</p> <p>iv. -----L--P--T--R</p> <p>v. -----L--T---R</p> <p>3. Multiple intervals are made:</p> <p>a) L----R-----L--P--R-----</p> <p>b) L----R--P--L----R-----</p> <p>4. Nested intervals are made:</p> <p>a) -----L-----L--P---R-----</p> <p>b) -----L---P---L-----R-----</p> <p>c) -----L-----L----R--P--R-----</p> <p>d) -----L---T-L---P-----R-----</p>	<p>1a. Valid</p> <p>1b. Valid</p> <p>1c. Valid</p> <p>1d. Valid</p> <p>1e. Valid</p> <p>2ai. Not valid</p> <p>2aai. Valid</p> <p>2aiii. Not valid</p> <p>2aiv. Valid</p> <p>2av. Valid</p> <p>2avi. Not valid</p> <p>2bi. Valid</p> <p>2bii. Valid</p> <p>2biii. Not valid</p> <p>2biv. Not valid</p> <p>2bv. Valid</p> <p>3a. Not valid</p> <p>3b. Valid</p> <p>4a. Not valid</p> <p>4b. Not valid</p> <p>4c. Valid</p> <p>4d. Valid (in SPS)</p>

		Not valid (in Prospec)
P precedes Q in the interval	<p>5. A single interval is made:</p> <p>a) L holds in first state:</p> <p>i. LT-P---R-----</p> <p>ii. LP---R-----</p> <p style="padding-left: 40px;">T</p> <p>iii. L---TPR-----</p> <p>b) R holds in last state:</p> <p>i. -----LTP---R</p> <p>ii. -----LP---R</p> <p style="padding-left: 40px;">T</p> <p>iii.. -----L--T-PR</p> <p>c) L-R hold in other states:</p> <p>i. -----L--T--P--R-----</p> <p>iii. -----L--T--P--R-----</p> <p>6. Multiple intervals are made:</p> <p>a. L-T-P---R-----L---R---LPR</p> <p>c. L-TP---R---L--T-P---R---L-P--</p> <p>7. Nested intervals are made:</p> <p>a) -----L---P---L-----R-----</p> <p>b) -----L-----L---P-----</p> <p>c) -----L---T--L---P-----R-----</p>	<p>5ai. Valid</p> <p>5aai. Valid</p> <p>5aaiii. Valid</p> <p>5bi. Valid</p> <p>5bii. Valid</p> <p>5biii. Valid</p> <p>5ci. Valid</p> <p>5cii. Valid</p> <p>5ciii. Valid</p> <p>6a. Not valid</p> <p>6b. Valid</p> <p>7a. Not valid</p> <p>7b. Valid</p> <p>7c. Valid in SPS</p> <p>7c. Not valid in Prospec</p>

Table 8: - Existence of P Between L and R

EQUIVALENCE CLASSES ON P	TEST CASES WITH BOUNDARY ANALYSIS AND EQUIVALENCE CLASSES ON L-R	EXPECTED RESULTS
P does not hold in any state of the interval	<p>1. The interval is not made:</p> <p>a) -----R</p> <p>b) ---L-----</p> <p style="padding-left: 40px;">R</p> <p>c) -----</p> <p>2. A single interval is made:</p> <p>a) L holds in first state:</p> <p>i. L-----R-----</p> <p>ii . L---R-----</p> <p style="padding-left: 40px;">P</p> <p>iii. L---RP-----</p> <p>iv. L-----</p> <p>b) R holds in last state:</p>	<p>1a. Valid</p> <p>1b. Valid</p> <p>1c. Valid</p> <p>2ai. Not valid</p> <p>2aai. Not valid</p> <p>2aaiii. Not valid</p> <p>2aiv. Not valid</p>

	<p>i. -----PL-----R ii. -----L----R P c) L-R hold in other states: R-----P---L-----</p> <p>3. Multiple intervals are made: a) L----R-----L----R---L--- b) L----R--P--L----R---L---</p> <p>4. Nested intervals are made: a) -----L-----L-----R----P-- b) ---P-L-----L-----R----- c) -----L-----L----R--P--R---</p>	<p>2bi. Not valid 2bii. Not valid 2 c. Not valid</p> <p>3a. Not valid 3b. Not valid</p> <p>4a. Not valid 4b. Not valid 4c. Not valid</p>
<p>P holds in some state of the interval</p>	<p>5. A single interval is made: a) L holds in first state: i. LP---R----- ii. L---R----- P iii. L---PR----- iv. L-----P-----</p> <p>b) R holds in last state: i. -----LP---R ii. ----- L---R P iii.. -----L---PR</p> <p>c) L-R hold in other states: i. -----LP---R---- ii. ----- L---R---- P iii. -----L---PR-----</p> <p>6. Multiple intervals are made: a. L--P--R-----L---R---L--- c. L--P--R--L--P--R---L-P--</p> <p>7. Nested intervals are made: a) -----L---P--L-----R----- b) -----L-----L----P-----</p>	<p>5ai. Valid 5aii. Valid 5aiii. Valid 5aiv. Valid</p> <p>5bi. Valid 5bii. Valid</p> <p>5biii. Valid</p> <p>5ci. Valid 5cii. Valid 5ciiii. Valid</p> <p>6a. Not valid 6b. Valid</p> <p>7a. Not valid 7b. Valid</p>

Table 9: Test Cases Description

ELEMENT	DESCRIPTION
TEST #	The test number in the test suite. Additionally, it describes the trace of computation to be tested. The trace is read as follows. A dash (-) implies that none of the propositions is <i>true</i> at that state. A letter symbol implies that the proposition is valid at that state. Displaying two letters (one on top of the other) implies that both propositions are valid at that state. For instance, in trace : - - p - - r - <div style="text-align: center;">t</div> no proposition is valid on states 0, 1, 3, 4, and 6. Let <i>p</i> , <i>t</i> , and <i>r</i> denote propositions, then <i>p</i> holds in state 2 and <i>r</i> and <i>t</i> hold in state 5.
PATTERN	Names the pattern being tested, e.g., <i>Absence of (p)</i> , <i>Existence of (p)</i> , <i>Universality of (p)</i> , <i>Precedence (t precedes p)</i> , <i>Response (t responds to p)</i> .
SCOPE	Names the pattern being tested, e.g., Global, Before <i>R</i> , After <i>L</i> , Between <i>L</i> and <i>R</i> , After <i>L</i> until <i>R</i> .
FORMULA	The LTL formula describing the pattern and scope. This formula was tested by the SPIN model checker. Because SPIN does not support the <i>weak until (W)</i> operator, the LTL equivalence was used instead.
P, T, L, R	Provides a description of the propositions as they were entered in the SPIN LTL property panel. For example <i>P: (i = 0)</i> asserts that <i>P</i> is <i>true</i> when program variable <i>i</i> is equal to 0. Depending on the pattern and scope, some of these propositions might not be used in the test case. For example, in a <i>response</i> pattern with a <i>global</i> scope, only <i>P</i> and <i>T</i> are present.
INTERVAL	Specifies whether the interval defined by the scope can be built in the trace of computation given by the test case. Consider the scope Between <i>L</i> and <i>R</i> . For trace - - <i>L</i> - <i>P</i> - <i>R</i> -, the interval is built and for trace - <i>L</i> - <i>P</i> - -, the interval is not built.
EXPECTED RESULT	Result expected by visual inspection.
ACTUAL RESULT	Result returned by the SPIN model checker.

Table1. Test suite for the *absence* pattern in Prospec.

Test #1 : ----- Pattern : Absence (p) Scope : Global Formula : $\neg (\diamond P)$ P : (<i>i</i> > limit + 1) Interval : Yes Expected Result : No violation Actual Result : No violation	Test #2 : P P P P P P P P P P Pattern : Absence (p) Scope : Global Formula : $\neg (\diamond P)$ P : (<i>i</i> <= limit) Interval : Yes Expected Result : Violation Actual Result : Violation
Test #3 : ----- P Pattern : Absence (p)	Test #4 : P ----- Pattern : Absence (p)

<p>Scope : Global Formula: $\neg (\diamond P)$ P : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Scope : Global Formula: $\neg (\diamond P)$ P : (i = 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #5 : ----- R Pattern : Absence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg (\neg R U P))$ P : (i < 0) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #6 : P ----- R Pattern : Absence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg (\neg R U P))$ P : (i == 0) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #7 : --- P -- R --- Pattern : Absence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg (\neg R U P))$ P : (i == 3) R : (i == 6) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #8 : ----- Pattern : Absence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg (\neg R U P))$ P : (i < 0) R : (i > limit + 1) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #9 : --- R P P P P P P Pattern : Absence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg (\neg R U P))$ P : (i > 3) R : (i == 3) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #10 : --- R P P P P P P P Pattern : Absence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg (\neg R U P))$ P : (i >= 3) R : (i == 3) Interval: Yes Expected Result: No violation Actual Result: Violation</p>
<p>Test #10 : --- R -- P --- R Pattern : Absence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg (\neg R U P))$ P : (i == 6) R : (i == 3 i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	
<p>Test #11 : R ----- Pattern : Absence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg (\neg R U P))$ P : (i < 0) R : (i = 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #12 : L ----- Pattern : Absence (p) Scope : After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P : (i < 0) L : (i = 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #13 : P ----- L</p>	<p>Test #14 : P P P ----- L</p>

<p>Pattern : Absence (p) Scope : After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P : (i == 0) L : (i == 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Pattern : Absence (p) Scope : After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P : (i <= 2) L : (i == 2) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #15 : P P L ----- Pattern : Absence (p) Scope : After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P : (i <= 1) L : (i == 2) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #16 : - L P ----- Pattern : Absence (p) Scope : After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P : (i == 2) L : (i == 1) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #17 : P P P P P P P P Pattern : Absence (p) Scope : After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P : (i >= 0) L : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #18 : ----- Pattern : Absence (p) Scope : After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P : (i < 0) L : (i > limit + 1) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #19 : ----- Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i < 0) L : (i > limit + 1) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #20 : R P P P P --- L Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i > 0) && (i < 5) L : (i == limit) R : (i == 0) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #21 : - L - - P ----- Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 4) L : (i == 1) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #22 : L ----- P R Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 0) L : (i == 0) R : (i == 0) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #23 : L - P - R ----- Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$</p>	<p>Test #24 : L ----- R P Pattern : Absence (p) Scope : Between L - R</p>

<p>P : (i == 2) L : (i == 0) R : (i == 4) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 0) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #25 : L - - - - - R Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i < 0) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #26 : - - - L - R - - - - - P Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 5) L : (i == 3) R : (i == 5) Interval: Yes Expected Result: No violation Actual Result: Violation</p>
<p>Test #27 : - - L - - R - L - P - Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == limit - 1) L : (i == 2) (i == 7) R : (i == 5) Interval: Yes ... No Expected Result: No violation Actual Result: No violation</p>	<p>Test #28 : - L - - R - L P - R Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i = 7) L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #30 : - L - - R - L - - R Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : ((i > i)) L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #31 : - L - - R - L - - R P P Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : ((i == 4) (i == limit)) L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: No violation Actual Result: Violation</p>
<p>Test #32 : - L - - R - L - - R P Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 4) L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: No violation Actual Result: Violation</p>	<p>Test #32 : - L - - R - L - - R P Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == limit) L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: No violation Actual Result: Violation</p>
<p>Test #33 : - - - - - Pattern : Absence (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(\neg R U P)))$</p>	<p>Test #34 : - - P - - - R - - Pattern : Absence (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(\neg R U P)))$</p>

<p>P : (i > limit + 1) L : (i == limit + 2) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>P : (i == 2) L : (i == limit + 2) R : (i == 7) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #35 : P P P P P P P P P Pattern : Absence (p) Scope : After L – Until R Formula: $(L \wedge \neg (R) \rightarrow (\neg (\neg R U P)))$ P : (i >= 0) L : (i == limit + 2) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #36 : - L - - - - - R P Pattern : Absence (p) Scope : After L – Until R Formula: $(L \wedge \neg (R) \rightarrow (\neg (\neg R U P)))$ P : (i == 0) L : (i == 1) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #37 : - L - - - - - R P Pattern : Absence (p) Scope : After L – Until R Formula: $(L \wedge \neg (R) \rightarrow (\neg (\neg R U P)))$ P : (i == 1) L : (i == 1) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #38 : L - - - - - R Pattern : Absence (p) Scope : After L – Until R Formula: $(L \wedge \neg (R) \rightarrow (\neg (\neg R U P)))$ P : (i < 0) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #39 : - L - - - - - P R Pattern : Absence (p) Scope : After L – Until R Formula: $(L \wedge \neg (R) \rightarrow (\neg (\neg R U P)))$ P : (i == limit - 1) L : (i == 1) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #40 : - L R - - - - - P Pattern : Absence (p) Scope : After L – Until R Formula: $(L \wedge \neg (R) \rightarrow (\neg (\neg R U P)))$ P : (i == 1) L : (i == 1) R : (i == 2) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #41 : - L R - - - - - P Pattern : Absence (p) Scope : After L – Until R Formula: $(L \wedge \neg (R) \rightarrow (\neg (\neg R U P)))$ P : (i == 2) L : (i == 1) R : (i == 2) Interval: Yes Expected Result: No violation Actual Result: Violation</p>	<p>Test #42 : L - - - - - P Pattern : Absence (p) Scope : After L – Until R Formula: $(L \wedge \neg (R) \rightarrow (\neg (\neg R U P)))$ P : (i == limit) L : (i == 0) R : (i < 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #43 : L - - - - - Pattern : Absence (p) Scope : After L – Until R Formula: $(L \wedge \neg (R) \rightarrow (\neg (\neg R U P)))$</p>	<p>Test #44 : L - - R - L - P P - Pattern : Absence (p) Scope : After L – Until R</p>

<p>P : (i < 0) L : (i == 0) R : (i > i) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Formula: $(L \wedge \neg(R) \rightarrow (\neg(\neg R U P)))$ P : (i == 7) (i == 8) L : ((i == 0) (i == 5)) R : (i == 3)) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #45 : L - - R - L - - - - Pattern : Absence (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(\neg R U P)))$ P : (i < 0) L : ((i == 0) (i == 5)) R : (i == 3)) Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #46 : L - - R - L - - - R Pattern : Absence (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(\neg R U P)))$ P : (i < 0) L : ((i == 0) (i == 5)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #47 : L - - R - - L - - - R P P Pattern : Absence (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(\neg R U P)))$ P : (i == 0 i == 6) L : ((i == 0) (i == 6)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #47 : L - - R - - L - - - R P P Pattern : Absence (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(\neg R U P)))$ P : (i == 0) L : ((i == 0) (i == 5)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #48 : L - - R - - L - - - R P P Pattern : Absence (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(\neg R U P)))$ P : (i == 6) L : ((i == 0) (i == 6)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #50 : L - - R - - L - - - R P P P Pattern : Absence (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(\neg R U P)))$ P : (i == 3 i == limit) L : ((i == 0) (i == 6)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: No violation Actual Result: Violation</p>
<p>Test #51 : L - - R - - L - - - R P P Pattern : Absence (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(\neg R U P)))$ P : (i == 3) L : ((i == 0) (i == 6)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: No violation Actual Result: Violation</p>	<p>Test #52 : L - - R - - L - - - R P P Pattern : Absence (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(\neg R U P)))$ P : (i == limit) L : ((i == 0) (i == 6)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: No violation Actual Result: Violation</p>
<p>Test #4 : - - - - - P - - - - - Pattern : Absence (p) Scope : Global Formula: $\neg(\diamond P)$</p>	<p>Test #3 : - - - - - R - - - - - Pattern : Absence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg(\neg R U P))$</p>

<p>P: (i == 5) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>P: (i == 600) R: (i == 6) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #5a: R - - - P - - - - - Pattern: Absence (p) Scope: Before R Formula: $\diamond R \rightarrow (\neg(\neg R U P))$ P: (i == 4) R: (i == 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #5b: R - - - - - P Pattern: Absence (p) Scope: Before R Formula: $\diamond R \rightarrow (\neg(\neg R U P))$ P: (i == 0) R: (i == 0) Interval: Yes Expected Result: No violation Actual Result: Violation</p>
<p>Test #5c: R P - - - - - Pattern: Absence (p) Scope: Before R Formula: $\diamond R \rightarrow (\neg(\neg R U P))$ P: (i == 1) R: (i == 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #6b: - - - - - - - - - PR Pattern: Absence (p) Scope: Before R Formula: $\diamond R \rightarrow (\neg(\neg R U P))$ P: (i == limit - 1) R: (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #6c: - - - - - - - - - R P Pattern: Absence (p) Scope: Before R Formula: $\diamond R \rightarrow (\neg(\neg R U P))$ P: (i == limit) R: (i == limit) Interval: Yes Expected Result: No violation Actual Result: Violation</p>	<p>Test #9: - - - - - P - - - P - - - Pattern: Absence (p) Scope: Before R Formula: $\diamond R \rightarrow (\neg(\neg R U P))$ P: (i == limit) R: (i == limit) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #2: - - - - - - - - - L Pattern: Absence (p) Scope: After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P: (i < 0) L: (i == Limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #3: - - - - - L - - - - - Pattern: Absence (p) Scope: After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P: (i < 0) L: (i == 6) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #4: - - - - - - - - - Pattern: Absence (p) Scope: After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P: (i < 0) L: (i > limit + 1) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #5a: L - - - - - P - - - - - Pattern: Absence (p) Scope: After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P: (i == 5) L: (i == 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #5a: LP - - - - - - - - -</p>	<p>Test #6a: - - - - - P - - - - - L</p>

<p>Pattern : Absence (p) Scope : After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P : (i == 1) L: (i == 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Pattern : Absence (p) Scope : After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P : (i == 5) L: (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #6a : -----PL Pattern : Absence (p) Scope : After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P : (i == limit - 1) L: (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #6c : -----L P Pattern : Absence (p) Scope : After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P : (i == limit) L: (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #8 : --L--P-----L Pattern : Absence (p) Scope : After L Formula: $\neg(L) W (L \wedge \neg(\diamond P))$ Formula: $\neg L \parallel (\neg L U (L \wedge \neg(\diamond P)))$ P : (i == 5) L: (i == limit i == 2) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #1a : L----- Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 100) L : (i == 0) R : (i == limit+2) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #1d : --L----- R Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 100) L : (i == 2) R : (i == 2) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #2c : --L----R---- Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 100) L : (i == 2) R : (i == 7) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #4a : --L---L---R-- Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 100) L : (i == 2 i == 6) R : (i == 10) Interval: Yes..Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #4b : --L---L---R--R Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 100) L : (i == 2 i == 6) R : (i == 10 i == limit) Interval: Yes..Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #5c : -----P----R Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$</p>	<p>Test #5e : -----P---- Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$</p>

<p>P : (i == 5) L : (i == 200) R : (i == limit) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>P : (i == 5) L : (i == 200) R : (i == limit+3) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #6aiii : L - - - - - PR - - - - - Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 5) L : (i == 0) R : (i == 6) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #6av : L - - - - - RP - - - - - Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 6) L : (i == 0) R : (i == 5) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #6bi : - - - - - LP - - - - -R Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 6) L : (i == 5) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #6bii : - - - - - L - - - - -R P Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 5) L : (i == 5) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #6biii : - - - - - PL - - - - -R Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 5) L : (i == 6) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #6biv : - - - - - L - - - - -PR Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == limit - 1) L : (i == 5) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #6bv : - - - - - L - - - - -R P Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == limit) L : (i == 5) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: Violation</p>	<p>Test #6ci : - - - - - LP - - - - -R - - - - - Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 6) L : (i == 5) R : (i == 11) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #6cii : - - - - - L - - - - -R - - - - - P Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 5) L : (i == 5)</p>	<p>Test #6ciii : PL - - - - - R - - - - - Pattern : Absence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 0) L : (i == 1) R : (i == 7)</p>

R : (i == 11) Interval : Yes Expected Result : Violation Actual Result : Violation	Interval : Yes Expected Result : No violation Actual Result : No violation
Test #6civ :- - - L - - - - - PR - - - - - Pattern : Absence (p) Scope : Between L - R Formula : $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 9) L : (i == 3) R : (i == 10) Interval : Yes Expected Result : Violation Actual Result : Violation	Test #6cvi :- - - - - L - - - - - RP Pattern : Absence (p) Scope : Between L - R Formula : $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == limit) L : (i == 6) R : (i == limit- 1) Interval : Yes Expected Result : No violation Actual Result : No violation
Test #7b :L - -R- P - L - R - - L - - - R Pattern : Absence (p) Scope : Between L - R Formula : $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(\neg R U P)))$ P : (i == 5) L : (i == 0 i == 7 i == 12) R : (i == 3 i == 9 i == limit) Interval : Yes..yes..yes Expected Result : No violation Actual Result : No violation	

Table2. Test suite for the *existence* pattern in Prospec.

Test #1 : - - - - - Pattern : Existence (p) Scope : Global Formula : $\diamond P$ P : (i > limit + 1) Interval : Yes Expected Result : Violation Actual Result : Violation	Test #2 : - - - - - P - - - - - Pattern : Existence (p) Scope : Global Formula : $\diamond P$ P : (i == 5) Interval : Yes Expected Result : No violation Actual Result : No violation
Test #3 : - - - - - P Pattern : Existence (p) Scope : Global Formula : $\diamond P$ P : (i == limit) Interval : Yes Expected Result : No violation Actual Result : No violation	Test #4 : P - - - - - Pattern : Existence (p) Scope : Global Formula : $\diamond P$ P : (i == 0) Interval : Yes Expected Result : No violation Actual Result : No violation
Test #5 : - - - - - P - - - - - R Pattern : Existence (p) Scope : Before R Formula : $\diamond R \rightarrow (\neg(R) U (P \& \neg R))$ P : (i == 4) R : (i == limit) Interval : Yes Expected Result : No violation Actual Result : No violation	Test #6 : - - - - - R P - - - - - Pattern : Existence (p) Scope : Before R Formula : $\diamond R \rightarrow (\neg(R) U (P \& \neg R))$ P : (i == 5) R : (i == 4) Interval : Yes Expected Result : Violation Actual Result : Violation

<p>Test #7 : --- P ----- R Pattern : Existence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg(R)U (P \& \neg R))$ P : (i == 3) R : (i == 3) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #8 : P P P P P P P P Pattern : Existence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg(R) (P U \neg R))$ P : (i >= 0) R : (i > limit + 1) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #9 : ----- Pattern : Existence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg(R) U (P \& \neg R))$ P : (i > i) R : (i > limit + 1) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #10 : P ----- R Pattern : Existence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg(R)U (P \& \neg R))$ P : (i == 0) R : (i == 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #11 : R ----- Pattern : Existence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg(R)U (P \& \neg R))$ P : (i == i + 1) R : (i == 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #12 : R P P P P P P P P Pattern : Existence (p) Scope : Before R Formula: $\diamond R \rightarrow (\neg(R) (P U \neg R))$ P : (i > 0) R : (i = 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #13 : L P P P P P P P P Pattern : Existence (p) Scope : After L Formula: $\neg(L) W (L \wedge \diamond P)$ Formula: $\neg L \parallel (\neg L U (L \wedge \diamond P))$ P : (i > 0) L : (i == 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #14 : ----- L Pattern : Existence (p) Scope : After L Formula: $\neg(L) W (L \wedge \diamond P)$ Formula: $\neg L \parallel (\neg L U (L \wedge \diamond P))$ P : (i < 0) L : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #15 : P P P P L ----- Pattern : Existence (p) Scope : After L Formula: $\neg(L) W (L \wedge \diamond P)$ Formula: $\neg L \parallel (\neg L U (L \wedge \diamond P))$ P : (i <= 3) L : (i == 4) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #16 : --- -P ----- L Pattern : Existence (p) Scope : After L Formula: $\neg(L) W (L \wedge \diamond P)$ Formula: $\neg L \parallel (\neg L U (L \wedge \diamond P))$ P : (i == 3) L : (i == 3) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #17 : - L P ----- Pattern : Existence (p) Scope : After L Formula: $\neg(L) W (L \wedge \diamond P)$ Formula: $\neg L \parallel (\neg L U (L \wedge \diamond P))$</p>	<p>Test #18 : - - L - P ----- Pattern : Existence (p) Scope : After L Formula: $\neg(L) W (L \wedge \diamond P)$ Formula: $\neg L \parallel (\neg L U (L \wedge \diamond P))$</p>

<p>P : (i == 2) L : (i == 1) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>P : (i == 4) L : (i == 2) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #19 : P P P P P P P P P Pattern : Existence (p) Scope : After L Formula: $\neg(L) W (L \wedge \diamond P)$ Formula: $\neg L \parallel (\neg L U (L \wedge \diamond P))$ P : (i >= 0) L : (i < 0) Interval: No Expected Result: No violation Actual Result: No Violation</p>	<p>Test #20 : - - - - - Pattern : Existence (p) Scope : After L Formula: $\neg(L) W (L \wedge \diamond P)$ Formula: $\neg L \parallel (\neg L U (L \wedge \diamond P))$ P : (i < 0) L : (i > limit + 1) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #21 : - L - - P - - L - - - - Pattern : Existence (p) Scope : After L Formula: $\neg(L) W (L \wedge \diamond P)$ Formula: $\neg L \parallel (\neg L U (L \wedge \diamond P))$ P : (i == 4) L : (i == 1 i == 7) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #22 : P P P P P P P P P Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i >= 0) L : (i > limit + 1) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #23 : - - - - - Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i < 0) L : (i > limit + 1) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #24 : R - - - - - L Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i < 0) L : (i == limit) R : (i == 0) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #25 : - L - - - - - Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i < i) L : (i == 1) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #26 : L - - - - - R Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i < 0) L : (i == 0) R : (i == 0) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #27 : L - - - R - - - - - Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i < 0) L : (i == 0) R : (i == 4) Interval: Yes Expected Result: Violation</p>	<p>Test #28 : L - - - - P - - - - R Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 5) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: No violation</p>

<p>Actual Result: Violation</p> <p>Test #29 : P - - - - - R L</p> <p>Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 0) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Actual Result: No violation</p> <p>Test #30 : - - - L R - - - - P</p> <p>Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 4) L : (i == 3) R : (i == 4) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #30 : - - - L - - - L - - - R - - P</p> <p>Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 5) L : (i == 3 i == 8) R : (i == 13) Interval: Yes.. Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #31 : - - - L R - - - - - P</p> <p>Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 3) L : (i == 3) R : (i == 4) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #32 : - - L - P R - L - - P</p> <p>Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 4) L : (i == 2) (i == 7) R : (i == 5) Interval: Yes ... No Expected Result: No violation Actual Result: No violation</p>	<p>Test #33 : - L P P R - L - - P L - - - - R P</p> <p>Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (((i >= 1) && (i < 4)) i == 9) L : ((i == 1) (i == 6) i == 10) R : (i == limit) (i == 4) Interval: Yes ... Yes .. Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #34 : - L P P R - L - - R P</p> <p>Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (((i >= 1) && (i < 4)) L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #35 : - L P - R - L P - R P</p> <p>Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 2 i == 7) L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #29 : - L - - R - L - - R P P</p> <p>Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 4 i == limit) L : ((i == 1) (i == 6)) R : (i == limit (i == 4) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #30 : - L - - R - L P - R P</p> <p>Pattern : Existence (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 4 i == 7) L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>

<p>Test #31 : ----- Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i > limit + 1) L : (i == limit + 2) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #32 : ----- R ----- Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i > i) L : (i == limit + 2) R : (i == 7) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #33 : P P P P P P P P Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i >= 0) L : (i == limit + 2) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #34 : - L P P P P P P R Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i > 1) && (i < limit) L : (i == 1) R : (i = limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #35 : P- ----- R L Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 0) L : (i == 0) R : (i = limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #36 : P P L ----- R Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i <= 1) L : (i == 2) R : (i = limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #37 : - L R ----- P Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 1) L : (i == 1) R : (i == 2) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #38 : - L R ----- P Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 2) L : (i == 1) R : (i == 2) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #39 : P ----- L Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 0) L : (i == 0) R : (i < 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #40 : L - P ----- Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 2) L : (i == 0) R : (i < 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #41 : L P - R - L ----- Pattern : Existence (p)</p>	<p>Test #42 : L P - R - L --- P</p>

<p>Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 1) L : ((i == 0) (i == 5)) R : (i == 3)) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : ((i == 1) (i == limit)) L : ((i == 0) (i == 5)) R : (i == 3)) Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #43 : L - P R - L - - P R Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : ((i == 2) (i == limit - 1)) L : ((i == 0) (i == 5)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #44 : L P - R - L - - - R Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 1) L : ((i == 0) (i == 5)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #43 : L - - L - R P Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ L : (i == 0 i == 3) P : ((i == 2) R : (i == limit) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #44 : L - - - - - Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == i + 1) L : (i == 0) R : (i == limit + 1) Interval: Yes Expected Result: Violation Actual Result: Violation</p>

Table3. Test suite for the *universality* pattern for Prospec.

<p>Test #1 : - - - - - Pattern : Universality (p) Scope : Global Formula: P P: (i > limit + 1) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #2 : P P P P P P P P P Pattern : Universality (p) Scope : Global Formula: P P: (i <= limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #3 : - P P P - - - - P Pattern : Universality (p) Scope : Global Formula: P P : (((i > 0) && (i < 4)) (i == limit)) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #4 : - P P P P P P P P - Pattern : Universality (p) Scope : Global Formula: P P : ((i != 0) && (i != limit)) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #5 : P P P P P P P P R</p>	<p>Test #6 : - P P P P P P P R</p>

<p>Pattern : Universality (p) Scope : Before R Formula: $\diamond R \rightarrow (P \cup R)$ P : (i < Limit) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Pattern : Universality (p) Scope : Before R Formula: $\diamond R \rightarrow (P \cup R)$ P : (i < Limit) && (i > 0) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #7 : ----- Pattern : Universality (p) Scope : Before R Formula: $\diamond R \rightarrow (P \cup R)$ P : (i < 0); R : (i > limit + 1) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #8 : P P P P P P P P Pattern : Universality (p) Scope : Before R Formula: $\diamond R \rightarrow (P \cup R)$ P : (i >= 0); R : (i > limit + 1) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #5 : P P P R - - - - R Pattern : Universality (p) Scope : Before R Formula: $\diamond R \rightarrow (P \cup R)$ P : (i <= 2) R : (i == 2 i == limit) Interval: Yes..Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #5 : - - - - R P P P P R P P Pattern : Universality (p) Scope : Before R Formula: $\diamond R \rightarrow (P \cup R)$ P : (i < 4) R : (i == 5 i == limit) Interval: Yes..Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #9 : R - - - - - Pattern : Universality (p) Scope : Before R Formula: $\diamond R \rightarrow (P \cup R)$ P : (i < 0) R : (i == 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #10 : R P P P P P P P P Pattern : Universality (p) Scope : Before R Formula: $\diamond R \rightarrow (P \cup R)$ P : (i > 0) R : (i == 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #11 : L P P P P P P P P Pattern : Universality (p) Scope : After L Formula: $\neg(L) W (L \wedge P)$ Formula: $\neg L \parallel (\neg L U (L \wedge P))$ P : (i > 0) L : (i == 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #12 : P P P P P P P P P L Pattern : Universality (p) Scope : After L Formula: $\neg(L) W (L \wedge P)$ Formula: $\neg L \parallel (\neg L U (L \wedge P))$ P : (i >= 0) L : (i == 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #13 : P P P P P P P P P L Pattern : Universality (p) Scope : After L Formula: $\neg(L) W (L \wedge P)$ Formula: $\neg L \parallel (\neg L U (L \wedge P))$ P : (i >= 0) L : (i == 2)</p>	<p>Test #14 : P P P P P P - - P L Pattern : Universality (p) Scope : After L Formula: $\neg(L) W (L \wedge P)$ Formula: $\neg L \parallel (\neg L U (L \wedge P))$ P : ((i < 7) (i == limit)) L : (i == 2)</p>

<p>Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #15 : - - P P P P P P P P L Pattern : Universality (p) Scope : After L Formula: $\neg(L) W (L \wedge P)$ Formula: $\neg L \parallel (\neg L U (L \wedge P))$ P : (i >= 2) L : (i == 2) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #16 : - - L P P P P P P P Pattern : Universality (p) Scope : After L Formula: $\neg(L) W (L \wedge P)$ Formula: $\neg L \parallel (\neg L U (L \wedge P))$ P : (i > 2) L : (i == 2) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #15 : - - P P P P - - - - - L L Pattern : Universality (p) Scope : After L Formula: $\neg(L) W (L \wedge P)$ Formula: $\neg L \parallel (\neg L U (L \wedge P))$ P : (i => 2 && i <= 5) L : (i == 2 i == 8) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #15 : - - P P P P - - - - - L L Pattern : Universality (p) Scope : After L Formula: $\neg(L) W (L \wedge P)$ Formula: $\neg L \parallel (\neg L U (L \wedge P))$ P : (i => 2 && i <= 5) L : (i == 2 i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #17 : - - L P - - - - - Pattern : Universality (p) Scope : After L Formula: $\neg(L) W (L \wedge P)$ Formula: $\neg L \parallel (\neg L U (L \wedge P))$ P : (i == 2) L : (i == 1) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #18 : - - L - P - - - - - Pattern : Universality (p) Scope : After L Formula: $\neg(L) W (L \wedge P)$ Formula: $\neg L \parallel (\neg L U (L \wedge P))$ P : (i == 4) L : (i == 2) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #19 : P P P P P P P P P P Pattern : Universality (p) Scope : After L Formula: $\neg(L) W (L \wedge P)$ Formula: $\neg L \parallel (\neg L U (L \wedge P))$ P : (i >= 0) L : (i < 0) Interval: No Expected Result: No violation Actual Result: Violation</p>	<p>Test #20 : - - - - - Pattern : Universality (p) Scope : After L Formula: $\neg(L) W (L \wedge P)$ Formula: $\neg L \parallel (\neg L U (L \wedge P))$ P : (i < 0) L : (i > limit + 1) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #21 : - - - - - Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i < 0) L : (i > limit + 1) R : (i < 0) Interval: No</p>	<p>Test #22 : R P P P P - - - L Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i > 0) && (i < 6) L : (i == limit) R : (i == 0) Interval: No</p>

<p>Expected Result: No violation Actual Result: No violation</p>	<p>Expected Result: No violation Actual Result: No violation</p>
<p>Test #23 : - L - - P - - - - - Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i == 4) L : (i == 1) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #24 : L - - - - - R Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i < 0) L : (i == 0) R : (i == 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>

<p>Test #25 : L - - - R - - - - - Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i < 0) L : (i == 0) R : (i == 4) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #26 : L P P P P P P P R Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i > 0) && (i < limit) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #27 : P P P P P P P P R L Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i >= 0) && (i < limit) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #28 : - - - L R - - - - - P Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i == 4) L : (i == 3) R : (i == 4) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #29 : - - - L R - - - - - P Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i == 3) L : (i == 3) R : (i == 4) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #30 : - - L P P R - L - - P Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i > 1) && (i < 4) L : (i == 2) (i == 7) R : (i == 4) Interval: Yes ... No Expected Result: No violation Actual Result: No violation</p>
<p>Test #31 : - L P P R - L P - R P Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (((i >= 1) && (i < 4)) (i = 7))</p>	<p>Test #32 : - L P P R - L P P R P P Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : ((i >= 1) && (i < 4)) ((i = 7) && (i <</p>

<p>L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>limit)) L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #33 : ----- Pattern : Universality (p) Scope : After L – Until R Formula: (L ∧ ¬(R) → (P W R)) Formula: ((L ∧ ¬(R)) → (P (P U R))) P : (i > limit + 1) L : (i == limit + 2) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #34 : - - P - - - - R - - Pattern : Universality (p) Scope : After L – Until R Formula: (L ∧ ¬(R) → (P W R)) Formula: ((L ∧ ¬(R)) → (P (P U R))) P : (i == 2) L : (i == limit + 2) R : (i == 7) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #35 : P P P P P P P P P P Pattern : Universality (p) Scope : After L – Until R Formula: (L ∧ ¬(R) → (P W R)) Formula: ((L ∧ ¬(R)) → (P (P U R))) P : (i >= 0) L : (i == limit + 2) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #36 : - L P P P P P P P R Pattern : Universality (p) Scope : After L – Until R Formula: (L ∧ ¬(R) → (P W R)) Formula: ((L ∧ ¬(R)) → (P (P U R))) P : (i > 1) && (i < limit) L : (i == 1) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #37 : P P P P P P P P R L Pattern : Universality (p) Scope : After L – Until R Formula: (L ∧ ¬(R) → (P W R)) Formula: ((L ∧ ¬(R)) → (P (P U R))) P: (i >= 0) && (i < limit) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #38 : - L P P P P P P - R Pattern : Universality (p) Scope : After L – Until R Formula: (L ∧ ¬(R) → (P W R)) Formula: ((L ∧ ¬(R)) → (P (P U R))) P : (i > 1) && (i < limit - 1) L : (i == 1) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #39 : - L R - - - - - P Pattern : Universality (p) Scope : After L – Until R Formula: (L ∧ ¬(R) → (P W R)) Formula: ((L ∧ ¬(R)) → (P (P U R))) P: (i == 1) L : (i == 1) R : (i == 2) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #40 : - L R - - - - - P Pattern : Universality (p) Scope : After L – Until R Formula: (L ∧ ¬(R) → (P W R)) Formula: ((L ∧ ¬(R)) → (P (P U R))) P : (i == 2) L : (i == 1) R : (i == 2) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #41 : P P P P P P P P - - L Pattern : Universality (p)</p>	<p>Test #42 : P P P P P P P P P P L Pattern : Universality (p)</p>

<p>Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W \ R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U \ R)))$ P: $(i \geq 0) \ \&\& \ (i < \text{limit} - 1)$ L: $(i == 0)$ R: $(i < 0)$ Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W \ R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U \ R)))$ P: $(i \geq 0)$ L: $(i == 0)$ R: $(i < 0)$ Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #43 : L P P R – L P – P P</p> <p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W \ R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U \ R)))$ P: $((i \geq 0) \ \&\& \ (i < 3)) \parallel (i == 6) \parallel (i == \text{limit})$ L: $((i == 0) \parallel (i == 5))$ R: $(i == 3)$ Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #44 : L P P R – L P P P P P P</p> <p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W \ R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U \ R)))$ P: $((i \geq 0) \ \&\& \ (i < 3)) \parallel (i \geq 5)$ L: $((i == 0) \parallel (i == 5))$ R: $(i == 3)$ Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #47 : L P P R – L P P P R P P</p> <p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W \ R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U \ R)))$ P: $((i \geq 0) \ \&\& \ (i < 3)) \parallel ((i \geq 5) \ \&\& \ (i < \text{limit}))$ L: $((i == 0) \parallel (i == 5))$ R: $(i == 3) \parallel (i == \text{limit})$ Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #48 : L P P R – L P P P R P</p> <p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W \ R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U \ R)))$ P: $((i \geq 0) \ \&\& \ (i < 3)) \parallel ((i > 5) \ \&\& \ (i < \text{limit}))$ L: $((i == 0) \parallel (i == 5))$ R: $(i == 3) \parallel (i == \text{limit})$ Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>

Table4. Test suite for the *precedence* pattern for Prospec.

<p>Test #1 : ----- Pattern : Precedence : (T) Precedes (P) Scope : Global Formula: $\neg(P) \ W \ (T \wedge \neg(P))$ Formula: $(\neg(P)) \vee ((\neg P) \ U \ (T \wedge \neg P))$ P: $(i > \text{limit} + 1)$ T: $(i < 0)$ Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #2 : --- T ----- Pattern : Precedence : (T) Precedes (P) Scope : Global Formula: $\neg(P) \ W \ (T \wedge \neg(P))$ Formula: $(\neg(P)) \vee ((\neg P) \ U \ (T \wedge \neg P))$ P: $(i > \text{limit} + 1)$ T: $(i == 3)$ Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #3 : P----- Pattern : Precedence : (T) Precedes (P) Scope : Global Formula: $\neg(P) \ W \ (T \wedge \neg(P))$ Formula: $(\neg(P)) \vee ((\neg P) \ U \ (T \wedge \neg P))$</p>	<p>Test #4 : ---T ----- P Pattern : Precedence : (T) Precedes (P) Scope : Global Formula: $\neg(P) \ W \ (T \wedge \neg(P))$</p>

<p>P: (i == 0) T: (i > limit + 1) Interval: Built Expected Result: Not valid Actual Result: Not Valid</p>	<p>Formula: ($\neg(P)$) \vee ($(\neg P) U (T \wedge \neg P)$) P: (i == 3) T: (i == 3) Interval: Built Expected Result: Not valid Actual Result: Not valid</p>
<p>Test #5 : - - - P - - - - - Pattern : Precedence : (T) Precedes (P) Scope : Global Formula: $\neg(P) W (T \wedge \neg(P))$ Formula: ($\neg(P)$) \vee ($(\neg P) U (T \wedge \neg P)$) P: (i == 3) T: (i > limit + 1) Interval: Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #6 : - P - T - - - - - Pattern : Precedence : (T) Precedes (P) Scope : Global Formula: $\neg(P) W (T \wedge \neg(P))$ Formula: ($\neg(P)$) \vee ($(\neg P) U (T \wedge \neg P)$) P: (i == 1) T: (i == 3) Interval: Built Expected Result: Not valid Actual Result: Not valid</p>
<p>Test #7 : - - - - - Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: $\diamond R \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i > limit + 1) T: (i < 0); R: (i < 0) Interval: Not built Expected Result: Valid Actual Result: Valid</p>	<p>Test #8 : - - - - - P - - - - - Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: $\diamond R \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i == 5) T: (i < 0); R: (i > limit + 1) Interval: Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #9 : - - - - - R - - - - - Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: $\diamond R \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i > limit + 1) T: (i < 0); R: (i == 6) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #10 : - - - - - R - P - - - - - Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: $\diamond R \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i == 8) T: (i < 0); R: (i == 6) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #9 : - - - R - - P - R - - - Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: $\diamond R \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i == 6) T: (i < 0); R: (i == 3 i == 8) Interval: Built Expected Result: Violation Actual Result: Violation</p>	<p>Test #9 : - - - - - P - - - - - Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: $\diamond R \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i == 6) T: (i < 0); R: (i == 6) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #11 : - - - P - - R - - Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: $\diamond R \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i == 3) T: (i < 0) R: (i == 6) Interval: Built Expected Result: Not Valid Actual Result: Not valid</p>	<p>Test #12 : R - - - - - Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: $\diamond R \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i > limit + 1) T: (i < 0) R: (i == 0) Interval: Built Expected Result: Valid Actual Result: Valid</p>

<p>Test #13 : - T - - P - - R - - Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: $\diamond R \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i == 4) T: (i == 1) R: (i == 7) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #14 : - - - P - - R - - T Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: $\diamond R \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i == 3) T: (i == 3) R: (i == 7) Interval: Built Expected Result: Not valid Actual Result: Not valid</p>
<p>Test #15 : - - - P - - - - - R T Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: $\diamond R \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i == 3) T: (i == 3) R: (i == 3) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #16 : - - - - - - - - - - Pattern : Precedence : (T) Precedes (P) Scope : After L Formula: $\neg (L) W (L \wedge (\neg P W (T \wedge \neg P)))$ Formula: $(\neg L) \vee \neg L U (L \wedge (\neg P \vee \neg P U (T \wedge \neg P)))$ P: (i < 0) T: (i > limit + 1) L: (i > i) Interval: Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #17 : - - - L - - - - - Pattern : Precedence : (T) Precedes (P) Scope : After L Formula: $\neg (L) W (L \wedge (\neg P W (T \wedge \neg P)))$ Formula: $(\neg L) \vee \neg L U (L \wedge (\neg P \vee \neg P U (T \wedge \neg P)))$ P: (i < 0) T: (i > limit + 1) L: (i == 3) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #18 : - P - L - - - - - Pattern : Precedence : (T) Precedes (P) Scope : After L Formula: $\neg (L) W (L \wedge (\neg P W (T \wedge \neg P)))$ Formula: $(\neg L) \vee \neg L U (L \wedge (\neg P \vee \neg P U (T \wedge \neg P)))$ P: (i == 2) T: (i > limit + 1) L: (i == 3) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #18 : L - - T - L - P - Pattern : Precedence : (T) Precedes (P) Scope : After L Formula: $\neg (L) W (L \wedge (\neg P W (T \wedge \neg P)))$ Formula: $(\neg L) \vee \neg L U (L \wedge (\neg P \vee \neg P U (T \wedge \neg P)))$ P: (i == limit - 1) T: (i == 3) L: (i == 0 i == 5) Interval: Built Expected Result: Violation Actual Result: Violation</p>	<p>Test #18 : L - - T - L - Pattern : Precedence : (T) Precedes (P) Scope : After L Formula: $\neg (L) W (L \wedge (\neg P W (T \wedge \neg P)))$ Formula: $(\neg L) \vee \neg L U (L \wedge (\neg P \vee \neg P U (T \wedge \neg P)))$ P: (i == limit - 1) T: (i == 3) L: (i == 0 i == 5) Interval: Built Expected Result: Violation Actual Result: Violation</p>
<p>Test #19 : - - - L - - - - - P T Pattern : Precedence : (T) Precedes (P) Scope : After L Formula: $\neg (L) W (L \wedge (\neg P W (T \wedge \neg P)))$ Formula: $(\neg L) \vee \neg L U (L \wedge (\neg P \vee \neg P U (T \wedge \neg P)))$</p>	<p>Test #20 : - - L - - P - T - - - Pattern : Precedence : (T) Precedes (P) Scope : After L Formula: $\neg (L) W (L \wedge (\neg P W (T \wedge \neg P)))$ Formula: $(\neg L) \vee \neg L U (L \wedge (\neg P \vee \neg P U (T \wedge \neg P)))$ P: (i == 5)</p>

<p>P: (i == 3) T: (i == 3) L: (i == 3) Interval: Built Expected Result: Not valid Actual Result: Not valid</p>	<p>T: (i == 7) L: (i == 2) Interval: Built Expected Result: Not Valid Actual Result: Not valid</p>
<p>Test #21 : - L -- T - - P - - Pattern : Precedence : (T) Precedes (P) Scope : After L Formula: $\neg(L) W (L \wedge (\neg P W (T \wedge \neg P)))$ Formula: $(\neg L) \vee \neg L U (L \wedge (\neg P \vee \neg P U (T \wedge \neg P)))$ P: (i == 7) T: (i == 4) L: (i == 1) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #22 : - - L - - P - - - - T Pattern : Precedence : (T) Precedes (P) Scope : After L Formula: $\neg(L) W (L \wedge (\neg P W (T \wedge \neg P)))$ Formula: $(\neg L) \vee \neg L U (L \wedge (\neg P \vee \neg P U (T \wedge \neg P)))$ P: (i == 5); T: (i == 5) L: (i == 2) Interval: Built Expected Result: Not valid Actual Result: Not valid</p>
<p>Test #23 : - - - - - - - - - - Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i > limit + 1) T: (i < 0) L: (i < i) R: (i > i) Interval: Not built Expected Result: Valid Actual Result: Valid</p>	<p>Test #24: - - - P - - - - - - - - Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i == 3) T: (i < 0) L: (i < i) R: (i > i) Interval: Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #25 : - - - R - - - P - - L - Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i == 7) T: (i < 0) L: (i == 10) R: (i == 3) Interval: Not Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #26 : - L - - P - T - - R - Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i == 4) T: (i == 6) L: (i == 1) R: (i == 9) Interval: Built Expected Result: Not valid Actual Result: Not valid</p>
<p>Test #26 : - L - - T - - L - P - R - Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i == 9) T: (i == 4) L: (i == 1 i == 7) R: (i == limit - 1) Interval: Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #26 : - L - - P - T - - - - - Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (\neg P U ((T \wedge \neg P) \vee R))$ P: (i == 4) T: (i == 6) L: (i == 1) R: (i == 900) Interval: No Expected Result: Valid</p>

	Actual Result: Valid
Test #27 : --- R - L - P -- Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \hat{O}R) \rightarrow (\neg P U ((T \wedge \neg P) \vee R)))$ P: (i == 7) T: (i < 0) L: (i == 5) R: (i == 3) Interval: Not built Expected Result: Valid Actual Result: Valid	Test #28 : -- R - P - -L - - T Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \hat{O}R) \rightarrow (\neg P U ((T \wedge \neg P) \vee R)))$ P: (i == 4); T: (i == 4) L: (i == 7); R: (i == 2) Interval: Not built Expected Result: Valid Actual Result: Valid
Test #29 : -- L - P - -R -- T Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \hat{O}R) \rightarrow (\neg P U ((T \wedge \neg P) \vee R)))$ P: (i == 4) T: (i == 4) L: (i == 2) R: (i == 7) Interval: Built Expected Result: Not valid Actual Result: Not valid	Test #30 : - L T - P R - L - P Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \hat{O}R) \rightarrow (\neg P U ((T \wedge \neg P) \vee R)))$ P: (i == 4 i == 9) T: (i == 2) L: (i == 1 i == 7) R: (i == 5) Interval: Built ... Not built Expected Result: Valid Actual Result: Valid
Test #31 : - L T - P R - L - P -R Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \hat{O}R) \rightarrow (\neg P U ((T \wedge \neg P) \vee R)))$ P: (i == 4 i == 9) T: (i == 2) L: (i == 1 i == 7) R: (i == 5 i == 11) Interval: Built ... Built Expected Result: Not valid Actual Result: Not valid	Test #32 : - L T - P R - L T P -R Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \hat{O}R) \neg (\neg P U ((T \wedge \neg P) \vee R)))$ P: (i == 4 i == 9) T: (i == 2 i == 8) L: (i == 1 i == 7) R: (i == 5 i == 11) Interval: Built ... Built Expected Result: Valid Actual Result: Valid
Test #33 : ----- Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: $(L \wedge \neg R \rightarrow (\neg P W ((T \wedge \neg P) \vee R)))$ Formula: $(L \wedge \neg R \rightarrow (\neg P \vee (\neg P U ((T \wedge \neg P) \vee R))))$ P: (i < 0) T: (i < i) L: (i > i) R: (i > limit + 1) Interval: Not built Expected Result: Valid Actual Result: Valid	Test #34 : ---P - -L ----- Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: $(L \wedge \neg R \rightarrow (\neg P W ((T \wedge \neg P) \vee R)))$ Formula: $(L \wedge \neg R \rightarrow (\neg P \vee (\neg P U ((T \wedge \neg P) \vee R))))$ P: (i == 3) T: (i < i) L: (i == 6) R: (i > limit + 1) Interval: Built Expected Result: Valid Actual Result: Valid
Test #35 : - -L - P T - - R ----- Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: $(L \wedge \neg R \rightarrow (\neg P W ((T \wedge \neg P) \vee R)))$	Test #36 : - -L - T - P - R ----- Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: $(L \wedge \neg R \rightarrow (\neg P W ((T \wedge \neg P) \vee R)))$

<p>Formula: $(L \wedge \neg R \rightarrow (\neg P \vee (\neg P U ((T \wedge \neg P) \vee R))))$ P: (i == 4); T: (i == 5) L: (i == 2); R: (i == 8) Interval: Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Formula: $(L \wedge \neg R \rightarrow (\neg P \vee (\neg P U ((T \wedge \neg P) \vee R))))$ P: (i == 6); T: (i == 4) L: (i == 2); R: (i == 8) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #37: - - L - T - R - - - - P Pattern: Precedence : (T) Precedes (P) Scope: After L Until R Formula: $(L \wedge \neg R \rightarrow (\neg P W ((T \wedge \neg P) \vee R)))$ Formula: $(L \wedge \neg R \rightarrow (\neg P \vee (\neg P U ((T \wedge \neg P) \vee R))))$ P: (i == 6); T: (i == 6) L: (i == 2); R: (i == 8) Interval: Built Expected Result: Not valid Actual Result:</p>	<p>Test #38: - - L - R - - P - - - - Pattern: Precedence : (T) Precedes (P) Scope: After L Until R Formula: $(L \wedge \neg R \rightarrow (\neg P W ((T \wedge \neg P) \vee R)))$ Formula: $(L \wedge \neg R \rightarrow (\neg P \vee (\neg P U ((T \wedge \neg P) \vee R))))$ P: (i == 7); T: (i > i) L: (i == 2); R: (i == 4) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #39: - L T P R - - L - - P - Pattern: Precedence : (T) Precedes (P) Scope: After L Until R Formula: $(L \wedge \neg R \rightarrow (\neg P W ((T \wedge \neg P) \vee R)))$ Formula: $(L \wedge \neg R \rightarrow (\neg P \vee (\neg P U ((T \wedge \neg P) \vee R))))$ P: (i == 3 i == 10) T: (i == 2) L: (i == 1 i == 7) R: (i == 4) Interval: Built ... Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #40: - L T P R - - L T - P - Pattern: Precedence : (T) Precedes (P) Scope: After L Until R Formula: $(L \wedge \neg R \rightarrow (\neg P W ((T \wedge \neg P) \vee R)))$ Formula: $(L \wedge \neg R \rightarrow (\neg P \vee (\neg P U ((T \wedge \neg P) \vee R))))$ P: (i == 3 i == 10) T: (i == 2 i == 8) L: (i == 1 i == 7) R: (i == 4) Interval: Built ... Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #41: - L T P R - - L T - P R Pattern: Precedence : (T) Precedes (P) Scope: After L Until R Formula: $(L \wedge \neg R \rightarrow (\neg P W ((T \wedge \neg P) \vee R)))$ Formula: $(L \wedge \neg R \rightarrow (\neg P \vee (\neg P U ((T \wedge \neg P) \vee R))))$ P: (i == 3 i == 10) T: (i == 2 i == 8) L: (i == 1 i == 7) R: (i == 4 i == 11) Interval: Built ... Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #42: - L T P R - - L - - P R Pattern: Precedence : (T) Precedes (P) Scope: After L Until R Formula: $(L \wedge \neg R \rightarrow (\neg P W ((T \wedge \neg P) \vee R)))$ Formula: $(L \wedge \neg R \rightarrow (\neg P \vee (\neg P U ((T \wedge \neg P) \vee R))))$ P: (i == 3 i == 10) T: (i == 2) L: (i == 1 i == 7) R: (i == 4 i == 11) Interval: Built ... Built Expected Result: Not valid Actual Result: Not valid</p>
<p>Test #41: - L - - T - L - P R Pattern: Precedence : (T) Precedes (P) Scope: After L Until R Formula: $(L \wedge \neg R \rightarrow (\neg P W ((T \wedge \neg P) \vee R)))$ Formula: $(L \wedge \neg R \rightarrow (\neg P \vee (\neg P U ((T \wedge \neg P) \vee R))))$ P: (i == 8) T: (i == 4) L: (i == 1 i == 6) R: (i == limit) Interval: Built ... Built Expected Result: Not Valid</p>	

Actual Result: Not Valid	
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Table5. Test suite for the *response* pattern for Prospec.

Test #1 : ----- Pattern : Response: (T) Responds to (P) Scope : Global Formula : $(P \rightarrow \diamond T)$ P : $(i > \text{limit} + 1)$ T : $(i < 0)$ Interval : Built Expected Result : Valid Actual Result : Valid	Test #2 : --- T ----- Pattern : Response: (T) Responds to (P) Scope : Global Formula : $(P \rightarrow \diamond T)$ P : $(i > \text{limit} + 1)$ T : $(i == 3)$ Interval : Built Expected Result : Valid Actual Result : Valid
Test #3 : ----- P Pattern : Response: (T) Responds to (P) Scope : Global Formula : $(P \rightarrow \diamond T)$ P : $(i == \text{limit})$ T : $(i > \text{limit} + 1)$ Interval : Built Expected Result : Not valid Actual Result : Not valid	Test #4 : --- T ----- P Pattern : Response: (T) Responds to (P) Scope : Global Formula : $(P \rightarrow \diamond T)$ P : $(i == 3)$ T : $(i == 3)$ Interval : Built Expected Result : Valid Actual Result : Valid
Test #5 : --- P ----- Pattern : Response: (T) Responds to (P) Scope : Global Formula : $(P \rightarrow \diamond T)$ P : $(i == 3)$ T : $(i > \text{limit} + 1)$ Interval : Built Expected Result : Not valid Actual Result : Not valid	Test #6 : - P - T ----- Pattern : Response: (T) Responds to (P) Scope : Global Formula : $(P \rightarrow \diamond T)$ P : $(i == 1)$ T : $(i == 3)$ Interval : Built Expected Result : Valid Actual Result : Valid
Test #7 : ----- Pattern : Response: (T) Responds to (P) Scope : Before R Formula : $\diamond R \rightarrow ((P \rightarrow ((\neg R) U (T \wedge \neg R)))) U R)$ P : $(i > \text{limit} + 1)$ T : $(i < 0)$ R : $(i < 0)$ Interval : Not built Expected Result : Valid Actual Result : Valid	Test #8 : ----- P ----- Pattern : Response: (T) Responds to (P) Scope : Before R Formula : $\diamond R \rightarrow ((P \rightarrow ((\neg R) U (T \wedge \neg R)))) U R)$ P : $(i == 5)$ T : $(i < 0)$ R : $(i > \text{limit} + 1)$ Interval : Not built Expected Result : Valid Actual Result : Valid
Test #8 : --- -R --- P - -R Pattern : Response: (T) Responds to (P) Scope : Before R Formula : $\diamond R \rightarrow ((P \rightarrow ((\neg R) U (T \wedge \neg R)))) U R)$ P : $(i == 10)$ T : $(i < 0)$ R : $(i == 4 \parallel i == \text{limit})$ Interval : Not built	Test #8 : -- P - -R ----- -R Pattern : Response: (T) Responds to (P) Scope : Before R Formula : $\diamond R \rightarrow ((P \rightarrow ((\neg R) U (T \wedge \neg R)))) U R)$ P : $(i == 2)$ T : $(i < 0)$ R : $(i == 4 \parallel i == \text{limit})$ Interval : Not built

<p>Expected Result: Not Valid Actual Result: Not Valid</p>	<p>Expected Result: Not Valid Actual Result: Not Valid</p>
<p>Test #9 : - - - - - R - - - Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) U (T \wedge \neg R))) U R$ P: (i > limit + 1) T: (i < 0) R: (i == 6) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #10 : - - - - - R - P - Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) U (T \wedge \neg R))) U R$ P: (i == 8) T: (i < 0) R: (i == 6) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #11 : - - - P - - R - - Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) U (T \wedge \neg R))) U R$ P: (i == 3) T: (i < 0) R: (i == 6) Interval: Built Expected Result: Not Valid Actual Result: Not valid</p>	<p>Test #12 : R - - - - - Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) U (T \wedge \neg R))) U R$ P: (i > limit + 1) T: (i < 0) R: (i == 0) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #13 : - P - - T - - R - - Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) U (T \wedge \neg R))) U R$ P: (i == 1) T: (i == 4) R: (i == 7) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #14 : - - - P - - R - - T Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) U (T \wedge \neg R))) U R$ P: (i == 3) T: (i == 3) R: (i == 7) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #15 : - - - P - - - - - R Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) U (T \wedge \neg R))) U R$ P: (i == 3) T: (i > i) R: (i == 3) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #16 : - - - - - Pattern : Response: (T) Responds to (P) Scope : After L Formula: $\neg(L) W (L \wedge (P \rightarrow \diamond T))$ Formula: $(\neg L) \vee (\neg L U (L \wedge (P \rightarrow \diamond T)))$ P: (i < 0) T: (i > limit + 1) L: (i > i) Interval: Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #17 : - - - L - - - - - Pattern : Response: (T) Responds to (P) Scope : After L Formula: $\neg(L) W (L \wedge (P \rightarrow \diamond T))$ Formula: $(\neg L) \vee (\neg L U (L \wedge (P \rightarrow \diamond T)))$ P: (i < 0) T: (i > limit + 1)</p>	<p>Test #18 : - T - L - - - - - Pattern : Response: (T) Responds to (P) Scope : After L Formula: $\neg(L) W (L \wedge (P \rightarrow \diamond T))$ Formula: $(\neg L) \vee (\neg L U (L \wedge (P \rightarrow \diamond T)))$ P: (i < 0) T: (i == 1)</p>

<p>L: (i == 3) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>L: (i == 3) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #19 : --- L ----- P T Pattern : Response: (T) Responds to (P) Scope : After L Formula: $\neg(L) W (L \wedge (P \rightarrow \diamond T))$ Formula: $(\neg L) \vee (\neg L U (L \wedge (P \rightarrow \diamond T)))$ P: (i == 3) T: (i == 3) L: (i == 3) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #20 : -- L -- T - P - - - Pattern : Response: (T) Responds to (P) Scope : After L Formula: $\neg(L) W (L \wedge (P \rightarrow \diamond T))$ Formula: $(\neg L) \vee (\neg L U (L \wedge (P \rightarrow \diamond T)))$ P: (i == 7) T: (i == 5) L: (i == 2) Interval: Built Expected Result: Not Valid Actual Result: Not valid</p>
<p>Test #21 : - L - - P - - T - - Pattern : Response: (T) Responds to (P) Scope : After L Formula: $\neg(L) W (L \wedge (P \rightarrow \diamond T))$ Formula: $(\neg L) \vee (\neg L U (L \wedge (P \rightarrow \diamond T)))$ P: (i == 4) T: (i == 7) L: (i == 1) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #22 : - - L - - P - - - - T Pattern : Response: (T) Responds to (P) Scope : After L Formula: $\neg(L) W (L \wedge (P \rightarrow \diamond T))$ Formula: $(\neg L) \vee (\neg L U (L \wedge (P \rightarrow \diamond T)))$ P: (i == 5) T: (i == 5) L: (i == 2) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #23 : ----- Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$ P: (i > limit + 1) T: (i < 0) L: (i < i) R: (i > i) Interval: Not built Expected Result: Valid Actual Result: Valid</p>	<p>Test #24: --- P ----- Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$ P: (i == 3) T: (i < 0) L: (i < i) R: (i > i) Interval: Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #25 : --- R - - - P - - L - Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$ P: (i == 7) T: (i < 0) L: (i == 10) R: (i == 3) Interval: Not Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #26 : - L - - P - T - - R - Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$ P: (i == 4) T: (i == 6) L: (i == 1) R: (i == 9) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #27 : --- R - L - P - - Pattern : Response: (T) Responds to (P) Scope : Between L and R</p>	<p>Test #28 : - - R - P - - L - - T Pattern : Response: (T) Responds to (P)</p>

<p>Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$</p> <p>P: (i == 7) T: (i < 0) L: (i == 5) R: (i == 3) Interval: Not built Expected Result: Valid Actual Result: Valid</p>	<p>Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$ P: (i == 4) T: (i == 4) L: (i == 7) R: (i == 2) Interval: Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #29 : - - L - P - - R - - T</p> <p>Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$</p> <p>P: (i == 4); T: (i == 4) L: (i == 2); R: (i == 7) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #30 : - L P - T R - L - P Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$ P: (i == 2 i == 9) T: (i == 4) L: (i == 1 i == 7) R: (i == 5) Interval: Built ... Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #31 : - L P - T R - L - P - R Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$</p> <p>P: (i == 2 i == 9) T: (i == 4) L: (i == 1 i == 7) R: (i == 5 i == 11) Interval: Built ... Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #32 : - L P - T R - L P T - R Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$ P: (i == 2 i == 8) T: (i == 4 i == 9) L: (i == 1 i == 7) R: (i == 5 i == 11) Interval: Built ... Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #33 : - - - - - Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) W R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$</p> <p>P: (i < 0) T: (i < i) L: (i > i) R: (i > limit + 1) Interval: Not built Expected Result: Valid Actual Result: Valid</p>	<p>Test #34 : - - - P - - L - - - - Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) W R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$</p> <p>P: (i == 3) T: (i < i) L: (i == 6) R: (i > limit + 1) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #35 : - - L - T P - - R - - - - Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) W R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$</p> <p>P: (i == 5) T: (i == 4) L: (i == 2) R: (i == 8) Interval: Built</p>	<p>Test #36 : - - L - P - T - R - - - - Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) W R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$</p> <p>P: (i == 4) T: (i == 6) L: (i == 2) R: (i == 8) Interval: Built</p>

<p>Expected Result: Not valid Actual Result: Not valid</p>	<p>Expected Result: Valid Actual Result: Valid</p>
<p>Test #37 : --L - T - R - - - - P Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \vee R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \vee R)$ P: (i == 6) T: (i == 6) L: (i == 2) R: (i == 8) Interval: Built Expected Result: Valid Actual Result:</p>	<p>Test #38 : --L - R - - P - - - - Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \vee R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \vee R)$ P: (i == 7) T: (i > i) L: (i == 2) R: (i == 4) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #39 : - L P T R - - L - - P - Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \vee R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \vee R)$ P: (i == 2 i == 10) T: (i == 3) L: (i == 1 i == 7) R: (i == 4) Interval: Built ... Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #40 : - L P T R - - L P - T - Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \vee R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \vee R)$ P: (i == 2 i == 8) T: (i == 3 i == 10) L: (i == 1 i == 7) R: (i == 4) Interval: Built ... Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #41 : - L P T R - - L P - T R Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \vee R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \vee R)$ P: (i == 2 i == 8) T: (i == 3 i == 10) L: (i == 1 i == 7) R: (i == 4 i == 11) Interval: Built ... Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #42 : - L P T R - - L - - P R Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \vee R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R \vee (T \wedge \neg R)))) \vee R)$ P: (i == 2 i == 10) T: (i == 3) L: (i == 1 i == 7) R: (i == 4 i == 11) Interval: Built ... Built Expected Result: Not valid Actual Result: Not valid</p>

Table6. Test suite for the *absence* pattern in SPS.

<p>Test #1 : ----- Pattern : Absence (p) Scope : Global Formula: [] !P P: (i > limit + 1) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #2 : P P P P P P P P P P Pattern : Absence (p) Scope : Global Formula: [] !P P: (i <= limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #3 : ----- P Pattern : Absence (p) Scope : Global Formula: [] !P P : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #4 : P ----- Pattern : Absence (p) Scope : Global Formula: [] !P P : (i = 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #5 : ----- R Pattern : Absence (p) Scope : Before R Formula: <>R -> (!P U R) P : (i < 0) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #6 : P ----- R Pattern : Absence (p) Scope : Before R Formula: <>R -> (!P U R) P : (i == 0) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #7 : --- P -- R --- Pattern : Absence (p) Scope : Before R Formula: <>R -> (!P U R) P : (i == 3) R : (i == 6) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #8 : ----- Pattern : Absence (p) Scope : Before R Formula: <>R -> (!P U R) P : (i < 0) R : (i > limit + 1) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #9 : --- R P P P P P P Pattern : Absence (p) Scope : Before R Formula: <>R -> (!P U R) P : (i > 3) R : (i == 3) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #10 : --- R P P P P P P P Pattern : Absence (p) Scope : Before R Formula: <>R -> (!P U R) P : (i >= 3) R : (i == 3) Interval: Yes Expected Result: Violation Actual Result: No violation</p>
<p>Test #10 : --- R -- P --- R Pattern : Absence (p) Scope : Before R Formula: <>R -> (!P U R) P : (i > 3) R : (i == 3 i == limit) Interval: Yes .. Yes</p>	

<p>Expected Result: No Violation Actual Result: Violation</p>	
<p>Test #11 : R ----- Pattern : Absence (p) Scope : Before R Formula<>R -> (!P U R) P : (i < 0) R : (i == 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #12 : L ----- Pattern : Absence (p) Scope : After L Formula: [] (L -> [] (!P)) P : (i < 0) L : (i == 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #13 : P ----- L Pattern : Absence (p) Scope : After L Formula[] (L -> [] (!P)) P : (i <= 0) L: (i == 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #14 : P P P ----- L Pattern : Absence (p) Scope : After L Formula[] (L -> [] (!P)) P : (i <= 2) L : (i == 2) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #15 : P P L ----- Pattern : Absence (p) Scope : After L Formula: [] (L -> [] (!P)) P : (i <= 1) L : (i == 2) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #16 : - L P ----- Pattern : Absence (p) Scope : After L Formula: [] (L -> [] (!P)) P : (i == 2) L : (i == 1) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #17 : P P P P P P P P Pattern : Absence (p) Scope : After L Formula: [] (L -> [] (!P))) P : (i >= 0) L : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #18 : ----- Pattern : Absence (p) Scope : After L Formula[] (L -> [] (!P))) P : (i < 0) L : (i > limit + 1) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #19 : ----- Pattern : Absence (p) Scope : Between L - R Formula: [] ((L & !R & <>R) -> (!PUR)) P : (i < 0) L : (i > limit + 1) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #20 : R P P P P - - - L Pattern : Absence (p) Scope : Between L - R Formula: [] ((L & !R & <>R) -> (!PUR)) P : (i > 0) && (i < 6) L : (i == limit) R: (i == 0) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #21 : - L - - P ----- Pattern : Absence (p) Scope : Between L - R Formula: [] ((L & !R & <>R) -> (!PUR)) P : (i == 4) L : (i == 1)</p>	<p>Test #22 : L ----- P R Pattern : Absence (p) Scope : Between L - R Formula[] ((L & !R & <>R) -> (!PUR))</p>

<p>R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>P : (i == 0) L : (i == 0) R : (i == 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #23 : L - P - R - - - - - Pattern : Absence (p) Scope : Between L - R Formula: [] ((L & !R & <>R) ->(!PUR) P : (i == 2) L : (i == 0) R : (i == 4) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #24 : L - - - - - - - - R P Pattern : Absence (p) Scope : Between L - R Formula [] ((L & !R & <>R) ->(!PUR) P : (i == 0) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #25 : L - - - - - - - - R Pattern : Absence (p) Scope : Between L - R Formula [] ((L & !R & <>R) ->(!PUR) P : (i < 0) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #26 : - - - L - R - - - - - P Pattern : Absence (p) Scope : Between L - R Formula [] ((L & !R & <>R) ->(!PUR) P : (i == 5) L : (i == 3) R : (i == 5) Interval: Yes Expected Result: No violation Actual Result: Violation</p>
<p>Test #27 : - - L - - R - L - P - Pattern : Absence (p) Scope : Between L - R Formula [] ((L & !R & <>R) ->(!PUR) P : (i == limit - 1) L : (i == 2) (i == 7) R : (i == 5) Interval: Yes ... No Expected Result: No violation Actual Result: No violation</p>	<p>Test #28 : - L - - R - L P - R Pattern : Absence (p) Scope : Between L - R Formula: [] ((L & !R & <>R) ->(!PUR) P : (i = 7) L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #30 : - L - - R - L - - R Pattern : Absence (p) Scope : Between L - R Formula: [] ((L & !R & <>R) ->(!PUR) P : ((i > i) L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #31 : - L - - R - L - - R P P Pattern : Absence (p) Scope : Between L - R Formula [] ((L & !R & <>R) ->(!PUR) P : ((i == 4) (i == limit)) L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: No violation Actual Result: Violation</p>
<p>Test #32 : - L - - R - L - - R P Pattern : Absence (p) Scope : Between L - R Formula: [] ((L & !R & <>R) ->(!PUR) P : (i == 4)</p>	<p>Test #32 : - L - - R - L - - R P Pattern : Absence (p) Scope : Between L - R Formula [] ((L & !R & <>R) ->(!PUR) P : (i == limit)</p>

<p>L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: No violation Actual Result: Violation</p>	<p>L : ((i == 1) (i == 6)) R : (i == limit) (i == 4) Interval: Yes ... Yes Expected Result: No violation Actual Result: Violation</p>
<p>Test #33 : ----- Pattern : Absence (p) Scope : After L – Until R Formula: (L ∧ ¬(R) → (¬(¬R U P))) P : (i > limit + 1) L : (i == limit + 2) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #34 : - - P - - - - R - - Pattern : Absence (p) Scope : After L – Until R Formula: (L ∧ ¬(R) → (¬(¬R U P))) P : (i == 2) L : (i == limit + 2) R : (i == 7) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #35 : P P P P P P P P P P Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i >= 0) L : (i == limit + 2) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #36 : - L - - - - - - - R P Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i == 0) L : (i == 1) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #37 : - L - - - - - - - R P Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i == 1) L : (i == 1) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #38 : L - - - - - - - R Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i < 0) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #39 : - L - - - - - - - P R Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i == limit - 1) L : (i == 1) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #40 : - L R - - - - - - - P Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i == 1) L : (i == 1) R : (i == 2) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #41 : - L R - - - - - - - P Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i == 2)</p>	<p>Test #42 : L - - - - - - - P Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i == limit)</p>

<p>L : (i == 1) R : (i == 2) Interval: Yes Expected Result: No violation Actual Result: Violation</p>	<p>L : (i == 0) R : (i < 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #43 : L - - - - - Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i < 0) L : (i == 0) R : (i > i) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #44 : L - - R - L - P P - Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i == 7) (i == 8) L : ((i == 0) (i == 5)) R : (i == 3)) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #45 : L - - R - L - - - - Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i < 0) L : ((i == 0) (i == 5)) R : (i == 3)) Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #46 : L - - R - L - - - R Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i < 0) L : ((i == 0) (i == 5)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #47 : L - - R - - L - - - R P P Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i == 0 i == 5) L : ((i == 0) (i == 5)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #47 : L - - R - - L - - - R P Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i == 0) L : ((i == 0) (i == 5)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #48 : L - - R - - L - - - R P Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i == 5) L : ((i == 0) (i == 5)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #50 : L - - R - - L - - - R P P Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R)) P : (i == 3 i == limit) L : ((i == 0) (i == 5)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: No violation Actual Result: Violation</p>
<p>Test #51 : L - - R - - L - - - R P Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R))</p>	<p>Test #52 : L - - R - - L - - - R P Pattern : Absence (p) Scope : After L – Until R Formula: [] (L & !R -> (!P W R))</p>

P : (i == 3) L : ((i == 0) (i == 5)) R : (i == 3) (i == limit) Interval : Yes ... Yes Expected Result : No violation Actual Result : Violation	P : (i == limit) L : ((i == 0) (i == 5)) R : (i == 3) (i == limit) Interval : Yes ... Yes Expected Result : No violation Actual Result : Violation
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Table7. Test suite for the *existence* pattern in SPS.

Test #1 : ----- Pattern : Existence (p) Scope : Global Formula : $\diamond P$ P : (i > limit + 1) Interval : Yes Expected Result : Violation Actual Result : Violation	Test #2 : ----- P ---- Pattern : Existence (p) Scope : Global Formula : $\diamond P$ P : (i == 5) Interval : Yes Expected Result : No violation Actual Result : No violation
Test #3 : ----- P Pattern : Existence (p) Scope : Global Formula : $\diamond P$ P : (i == limit) Interval : Yes Expected Result : No violation Actual Result : No violation	Test #4 : P ----- Pattern : Existence (p) Scope : Global Formula : $\diamond P$ P : (i == 0) Interval : Yes Expected Result : No violation Actual Result : No violation
Test #5 : ----- P --- R Pattern : Existence (p) Scope : Before R Formula : $\neg R \ W \ (P \ \& \ \neg R)$ P : (i == 4) R : (i == limit) Interval : Yes Expected Result : No violation Actual Result : No violation	Test #6 : ----- R P --- Pattern : Existence (p) Scope : Before R Formula : $\neg R \ W \ (P \ \& \ \neg R)$ P : (i == 5) R : (i == 4) Interval : Yes Expected Result : Violation Actual Result : Violation
Test #7 : --- P ----- R Pattern : Existence (p) Scope : Before R Formula : $\neg R \ W \ (P \ \& \ \neg R)$ P : (i == 3) R : (i == 3) Interval : Yes Expected Result : Violation Actual Result : Violation	Test #8 : P P P P P P P P Pattern : Existence (p) Scope : Before R Formula : $\neg R \ W \ (P \ \& \ \neg R)$ P : (i >= 0) R : (i > limit + 1) Interval : No Expected Result : No violation Actual Result : No violation
Test #9 : ----- Pattern : Existence (p) Scope : Before R Formula : $\neg R \ W \ (P \ \& \ \neg R)$ P : (i > i) R : (i > limit + 1) Interval : No Expected Result : No violation	Test #10 : P ----- R Pattern : Existence (p) Scope : Before R Formula : $\neg R \ W \ (P \ \& \ \neg R)$ P : (i == 0) R : (i == 0) Interval : Yes

<p>Actual Result: No violation</p>	<p>Expected Result: Violation Actual Result: Violation</p>
<p>Test #11 : R ----- Pattern : Existence (p) Scope : Before R Formula: !R W (P & !R) P : (i == i + 1) R : (i == 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #12 : R P P P P P P P P P Pattern : Existence (p) Scope : Before R Formula: !R W (P & !R) P : (i > 0) R : (i == 0) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #13 : L P P P P P P P P Pattern : Existence (p) Scope : After L Formula: [] (!L) <>(L & <>P) P : (i > 0) L : (i == 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #14 : ----- L Pattern : Existence (p) Scope : After L Formula: [] (!L) <>(L & <>P) P : (i < 0) L : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #15 : P P P P L ---- Pattern : Existence (p) Scope : After L Formula: [] (!L) <>(L & <>P) P : (i <= 3) L : (i == 4) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #16 : ---P ----- L Pattern : Existence (p) Scope : After L Formula: [] (!L) <>(L & <>P) P : (i == 3) L : (i == 3) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #17 : - L P ----- Pattern : Existence (p) Scope : After L Formula: [] (!L) <>(L & <>P) P : (i == 2) L : (i == 1) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #18 : - - L - P ----- Pattern : Existence (p) Scope : After L Formula: [] (!L) <>(L & <>P) P : (i == 4) L : (i == 2) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #19 : P P P P P P P P P P Pattern : Existence (p) Scope : After L Formula: [] (!L) <>(L & <>P) P : (i >= 0) L : (i < 0) Interval: No Expected Result: No violation Actual Result: No Violation</p>	<p>Test #20 : ----- Pattern : Existence (p) Scope : After L Formula: [] (!L) <>(L & <>P) P : (i < 0) L : (i > limit + 1) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #21 : - L - - P- -L ---- Pattern : Existence (p) Scope : After L Formula: [] (!L) <>(L & <>P) P : (i == 7) L : (i == 1 i == 10) Interval: Yes .. Yes</p>	<p>Test #22 : P P P P P P P P P P Pattern : Existence (p) Scope : Between L - R Formula: [(L & !R -> (!R W (P & !R))) P : (i >= 0) L : (i > limit + 1) R : (i < 0)</p>

<p>Expected Result: No Violation Actual Result: Violation</p>	<p>Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #23 : - - - - - Pattern : Existence (p) Scope : Between L - R Formula: [(L & !R -> (!R W (P& !R))) P : (i < 0) L : (i > limit + 1) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #24 : R - - - - - L Pattern : Existence (p) Scope : Between L - R Formula: [(L & !R -> (!R W (P& !R))) P : (i < 0) L : (i == limit) R : (i == 0) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #25 : - L - - - - - Pattern : Existence (p) Scope : Between L - R Formula: [(L & !R -> (!R W (P& !R))) P : (i < i) L : (i == 1) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #26 : L - - - - - R Pattern : Existence (p) Scope : Between L - R Formula: [(L & !R -> (!R W (P& !R))) P : (i < 0) L : (i == 0) R : (i == 0) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #27 : L - - - R - - - - Pattern : Existence (p) Scope : Between L - R Formula: [(L & !R -> (!R W (P& !R))) P : (i < 0) L : (i == 0) R : (i == 4) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #28 : L - - - -P - - - - R Pattern : Existence (p) Scope : Between L - R Formula: [(L & !R -> (!R W (P& !R))) P : (i == 4) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #29 : P - - - - - R L Pattern : Existence (p) Scope : Between L - R Formula: [(L & !R -> (!R W (P& !R))) P : (i == 0) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #30 : - - - L R - - - - P Pattern : Existence (p) Scope : Between L - R Formula: [(L & !R -> (!R W (P& !R))) P : (i == 4) L : (i == 3) R : (i == 4) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #30 : - - - L - - - -L - - - -R - - - - P Pattern : Existence (p) Scope : Between L - R Formula: [(L & !R -> (!R W (P& !R))) P : (i == 5) L : (i == 3 i == 7) R : (i == 9) Interval: Yes.. Yes Expected Result: No Violation Actual Result: Violation</p>	<p>Test #31 : - - - L R - - - - P Pattern : Existence (p) Scope : Between L - R Formula: [(L & !R -> (!R W (P& !R))) P : (i == 3) L : (i == 3) R : (i == 4) Interval: Yes Expected Result: No violation Actual Result: No violation</p>

<p>Test #32 : - - L - P R - L - - Pattern : Existence (p) Scope : Between L - R Formula: $[(L \ \& \ !R \ \rightarrow \ (!R \ W \ (P \ \& \ !R)))]$ P : (i == 4) L : (i == 2) \parallel (i == 7) R : (i == 5) Interval: Yes ... No Expected Result: No violation Actual Result: No violation</p>	<p>Test #33 : - L P P R - L - - P L - R Pattern : Existence (p) Scope : Between L - R Formula: $[(L \ \& \ !R \ \rightarrow \ (!R \ W \ (P \ \& \ !R)))]$ P : (((i >= 1) $\&\&$ (i < 4)) \parallel i == 9) L : ((i == 1) \parallel (i == 6)) R : (i == limit) \parallel (i == 4) Interval: Yes ... Yes .. Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #34 : - L P P R - L - - R Pattern : Existence (p) Scope : Between L - R Formula: $[(L \ \& \ !R \ \rightarrow \ (!R \ W \ (P \ \& \ !R)))]$ P : (((i >= 1) $\&\&$ (i < 4)) L : ((i == 1) \parallel (i == 6)) R : (i == limit) \parallel (i == 4) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #35 : - L P - R - L P - R Pattern : Existence (p) Scope : Between L - R Formula: $[(L \ \& \ !R \ \rightarrow \ (!R \ W \ (P \ \& \ !R)))]$ P : (i == 2 \parallel i == 7)) L : ((i == 1) \parallel (i == 6)) R : (i == limit) \parallel (i == 4) Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #29 : - L - - R - L - - R P P Pattern : Existence (p) Scope : Between L - R Formula: $[(L \ \& \ !R \ \rightarrow \ (!R \ W \ (P \ \& \ !R)))]$ P : (((i >= 1) $\&\&$ (i < 4)) L : ((i == 1) \parallel (i == 6)) R : (i == limit) \parallel (i == 4) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #30 : - L - - R - L P - R P Pattern : Existence (p) Scope : Between L - R Formula: $[(L \ \& \ !R \ \rightarrow \ (!R \ W \ (P \ \& \ !R)))]$ P : (i == 2 \parallel i == 7)) L : ((i == 1) \parallel (i == 6)) R : (i == limit) \parallel (i == 4) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #31 : - - - - - Pattern : Existence (p) Scope : After L - Until R Formula: $(L \ \wedge \ \neg \ (R) \ \rightarrow \ (\neg \ (R) \ U \ (P \ \wedge \ \neg \ (R))))$ P : (i > limit + 1) L : (i == limit + 2) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #32 : - - - - - R - - Pattern : Existence (p) Scope : After L - Until R Formula: $(L \ \wedge \ \neg \ (R) \ \rightarrow \ (\neg \ (R) \ U \ (P \ \wedge \ \neg \ (R))))$ P : (i > i) L : (i == limit + 2) R : (i == 7) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #33 : P P P P P P P P Pattern : Existence (p) Scope : After L - Until R Formula: $(L \ \wedge \ \neg \ (R) \ \rightarrow \ (\neg \ (R) \ U \ (P \ \wedge \ \neg \ (R))))$ P : (i >= 0) L : (i == limit + 2) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #34 : - L P P P P P P R Pattern : Existence (p) Scope : After L - Until R Formula: $(L \ \wedge \ \neg \ (R) \ \rightarrow \ (\neg \ (R) \ U \ (P \ \wedge \ \neg \ (R))))$ P : (i > 1) $\&\&$ (i < limit) L : (i == 1) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #35 : P - - - - - R L</p>	<p>Test #36 : P P L - - - - R Pattern : Existence (p)</p>

<p>Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P: (i == 0) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i <= 1) L : (i == 2) R : (i = =limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #37 : - L R - - - - - P</p> <p>Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P: (i == 1) L : (i == 1) R : (i == 2) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #38 : - L R - - - - - P</p> <p>Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i ==2) L : (i == 1) R : (i == 2) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #39 : P - - - - - L</p> <p>Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P: (i == 0) L : (i == 0) R : (i < 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #40 : L - P - - - - -</p> <p>Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 2) L : (i == 0) R : (i < 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #41 : L P - R - L - - - -</p> <p>Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 1) L : ((i == 0) (i == 5)) R : (i == 3)) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #42 : L P - R - L - - - P</p> <p>Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : ((i == 1) (i == 5)) L : ((i == 0) (i == 5)) R : (i == 3)) Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #43 : L - P R - L - - P R</p> <p>Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : ((i == 2) (i == limit - 1)) L : ((i == 0) (i == 5)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #44 : L P - R - L - - - R</p> <p>Pattern : Existence (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : (i == 1) L : ((i == 0) (i == 5)) R : (i == 3)) (i == limit) Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #43 : L - - L - R P</p>	<p>Test #44 : L - - - - - Pattern : Existence (p)</p>

Pattern : Existence (p) Scope : After L – Until R Formula : $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : $((i == 2)$ R : $(i == 3) \parallel (i == \text{limit})$ Interval : Yes ... Yes Expected Result : No Violation Actual Result : Violation	Scope : After L – Until R Formula : $(L \wedge \neg(R) \rightarrow (\neg(R) U (P \wedge \neg(R))))$ P : $(i == i + 1)$ L : $(i == 0)$ R : $(i == \text{limit} + 1)$ Interval : Yes Expected Result : Violation Actual Result : Violation
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Table8. Test suite for the *universality* pattern for SPS.

Test #1 : ----- Pattern : Universality (p) Scope : Global Formula : P P : $(i > \text{limit} + 1)$ Interval : Yes Expected Result : Violation Actual Result : Violation	Test #2 : P P P P P P P P P P Pattern : Universality (p) Scope : Global Formula : P P : $(i \leq \text{limit})$ Interval : Yes Expected Result : No violation Actual Result : No violation
Test #3 : - P P P ----- P Pattern : Universality (p) Scope : Global Formula : P P : $((i > 0) \ \&\& \ (i < 4)) \parallel (i == \text{limit})$ Interval : Yes Expected Result : Violation Actual Result : Violation	Test #4 : - P P P P P P P P - Pattern : Universality (p) Scope : Global Formula : P P : $((i != 0) \ \&\& \ (i != \text{limit}))$ Interval : Yes Expected Result : Violation Actual Result : Violation
Test #5 : P P P P P P P P P R Pattern : Universality (p) Scope : Before R Formula : $\diamond R \rightarrow (P U R)$ P : $(i < \text{Limit})$ R : $(i = \text{limit})$ Interval : Yes Expected Result : No violation Actual Result : No violation	Test #6 : - P P P P P P P P R Pattern : Universality (p) Scope : Before R Formula : $\diamond R \rightarrow (P U R)$ P : $(i < \text{Limit}) \ \&\& \ (i > 0)$ R : $(i = \text{limit})$ Interval : Yes Expected Result : Violation Actual Result : Violation
Test #7 : ----- Pattern : Universality (p) Scope : Before R Formula : $\diamond R \rightarrow (P U R)$ P : $(i < 0)$; R : $(i > \text{limit} + 1)$ Interval : No Expected Result : No violation Actual Result : No violation	Test #8 : P P P P P P P P P Pattern : Universality (p) Scope : Before R Formula : $\diamond R \rightarrow (P U R)$ P : $(i \geq 0)$; R : $(i > \text{limit} + 1)$ Interval : No Expected Result : No violation Actual Result : No violation
Test #5 : P P P R - - - -R Pattern : Universality (p) Scope : Before R Formula : $\diamond R \rightarrow (P U R)$ P : $(i \leq 2)$ R : $(i = 2 \parallel i == \text{limit})$ Interval : Yes..Yes	Test #5 : - - - -R P P P P R P P Pattern : Universality (p) Scope : Before R Formula : $\diamond R \rightarrow (P U R)$ P : $(i < 4)$ R : $(i = 5 \parallel i == \text{limit})$

<p>Expected Result: No Violation</p> <p>Actual Result: Violation</p>	<p>Interval: Yes..Yes</p> <p>Expected Result: Violation</p> <p>Actual Result: Violation</p>
<p>Test #9 : R - - - - -</p> <p>Pattern : Universality (p)</p> <p>Scope : Before R</p> <p>Formula: $\diamond R \rightarrow (P U R)$</p> <p>P : (i < 0)</p> <p>R : (i = 0)</p> <p>Interval: Yes</p> <p>Expected Result: No violation</p> <p>Actual Result: No violation</p>	<p>Test #10 : R P P P P P P P P</p> <p>Pattern : Universality (p)</p> <p>Scope : Before R</p> <p>Formula: $\diamond R \rightarrow (P U R)$</p> <p>P : (i > 0)</p> <p>R : (i = 0)</p> <p>Interval: Yes</p> <p>Expected Result: No violation</p> <p>Actual Result: No violation</p>
<p>Test #11 : L P P P P P P P</p> <p>Pattern : Universality (p)</p> <p>Scope : After L</p> <p>Formula: $[] (L \rightarrow []) (P)$</p> <p>P : (i > 0)</p> <p>L : (i = 0)</p> <p>Interval: Yes</p> <p>Expected Result: Violation</p> <p>Actual Result: Violation</p>	<p>Test #12 : P P P P P P P P P L</p> <p>Pattern : Universality (p)</p> <p>Scope : After L</p> <p>Formula: $[] (L \rightarrow []) (P)$</p> <p>P : (i >= 0)</p> <p>L : (i = 0)</p> <p>Interval: Yes</p> <p>Expected Result: No violation</p> <p>Actual Result: No violation</p>
<p>Test #13 : P P P P P P P P P L</p> <p>Pattern : Universality (p)</p> <p>Scope : After L</p> <p>Formula: $[] (L \rightarrow []) (P)$</p> <p>P : (i >= 0)</p> <p>L : (i = 2)</p> <p>Interval: Yes</p> <p>Expected Result: No violation</p> <p>Actual Result: No violation</p>	<p>Test #14 : P P P P P P - - P L</p> <p>Pattern : Universality (p)</p> <p>Scope : After L</p> <p>Formula: $[] (L \rightarrow []) (P)$</p> <p>P : ((i < 7) (i == limit))</p> <p>L : (i = 2)</p> <p>Interval: Yes</p> <p>Expected Result: Violation</p> <p>Actual Result: Violation</p>
<p>Test #15 : - - P P P P P P P P L</p> <p>Pattern : Universality (p)</p> <p>Scope : After L</p> <p>Formula: $[] (L \rightarrow []) (P)$</p> <p>P : (i >= 2)</p> <p>L : (i = 2)</p> <p>Interval: Yes</p> <p>Expected Result: No violation</p> <p>Actual Result: No violation</p>	<p>Test #16 : - - L P P P P P P P L</p> <p>Pattern : Universality (p)</p> <p>Scope : After L</p> <p>Formula: $[] (L \rightarrow []) (P)$</p> <p>P : (i > 2)</p> <p>L : (i = 2)</p> <p>Interval: Yes</p> <p>Expected Result: Violation</p> <p>Actual Result: Violation</p>
<p>Test #15 : - - P P P P - - - - - L L</p> <p>Pattern : Universality (p)</p> <p>Scope : After L</p> <p>Formula: $[] (L \rightarrow []) (P)$</p> <p>P : (i == 2 && i <= 5)</p> <p>L : (i == 2 i == 8)</p> <p>Interval: Yes</p> <p>Expected Result: Violation</p> <p>Actual Result: Violation</p>	<p>Test #15 : - - P P P P - - - - - L L</p> <p>Pattern : Universality (p)</p> <p>Scope : After L</p> <p>Formula: $[] (L \rightarrow []) (P)$</p> <p>P : (i == 2 && i <= 5)</p> <p>L : (i == 2 i == limit)</p> <p>Interval: Yes</p> <p>Expected Result: Violation</p> <p>Actual Result: Violation</p>

<p>Test #17 : - L P ----- Pattern : Universality (p) Scope : After L Formula: $[\] (L \rightarrow [\] (P))$ P : (i == 2) L : (i == 1) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #18 : - - L - P ----- Pattern : Universality (p) Scope : After L Formula: $[\] (L \rightarrow [\] (P))$ P : (i == 4) L : (i == 2) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #19 : P P P P P P P P P P Pattern : Universality (p) Scope : After L Formula: $[\] (L \rightarrow [\] (P))$ P : (i >= 0) L : (i < 0) Interval: No Expected Result: No violation Actual Result: Violation</p>	<p>Test #20 : ----- Pattern : Universality (p) Scope : After L Formula: $[\] (L \rightarrow [\] (P))$ P : (i < 0) L : (i > limit + 1) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #21 : ----- Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i < 0) L : (i > limit + 1) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #22 : R P P P P - - - L Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i > 0) && (i < 6) L : (i == limit) R : (i == 0) Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #23 : - L - - P ----- Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i == 4) L : (i == 1) R : (i < 0) Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #24 : L ----- R Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i < 0) L : (i == 0) R : (i == 0) Interval: Yes Expected Result: No violation Actual Result: No violation</p>

<p>Test #25 : L - - - R ----- Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i < 0) L : (i == 0) R : (i == 4) Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #26 : L P P P P P P P P R Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : (i > 0) && (i < limit) L : (i == 0) R : (i == limit) Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #27 : P P P P P P P P P R L Pattern : Universality (p)</p>	<p>Test #28 : - - - L R ----- P Pattern : Universality (p)</p>

<p>Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : $(i \geq 0) \ \&\& \ (i < \text{limit})$ L : $(i == 0)$ R : $(i == \text{limit})$ Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : $(i == 4)$ L : $(i == 3)$ R : $(i == 4)$ Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #29 : - - - L R - - - - - P Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : $(i == 3)$ L : $(i == 3)$ R : $(i == 4)$ Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #30 : - - L P P R - L - - P Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : $(i > 1) \ \&\& \ (i < 4)$ L : $(i == 2) \ \parallel \ (i == 7)$ R : $(i == 4)$ Interval: Yes ... No Expected Result: No violation Actual Result: No violation</p>
<p>Test #31 : - L P P R - L P - R P Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : $((i \geq 1) \ \&\& \ (i < 4)) \ \parallel \ (i = 7)$ L : $((i == 1) \ \parallel \ (i == 6))$ R : $(i == \text{limit}) \ \parallel \ (i == 4)$ Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #32 : - L P P R - L P P R P P Pattern : Universality (p) Scope : Between L - R Formula: $((L \wedge \neg(R) \wedge \diamond R) \rightarrow (P U R))$ P : $((i \geq 1) \ \&\& \ (i < 4)) \ \parallel \ ((i = 7) \ \&\& \ (i < \text{limit}))$ L : $((i == 1) \ \parallel \ (i == 6))$ R : $(i == \text{limit}) \ \parallel \ (i == 4)$ Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #33 : - - - - - Pattern : Universality (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (P W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P U R)))$ P : $(i > \text{limit} + 1)$ L : $(i == \text{limit} + 2)$ R : $(i < 0)$ Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #34 : - - P - - - - R - - Pattern : Universality (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (P W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P U R)))$ P : $(i == 2)$ L : $(i == \text{limit} + 2)$ R : $(i = 7)$ Interval: No Expected Result: No violation Actual Result: No violation</p>
<p>Test #35 : P P P P P P P P P P Pattern : Universality (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (P W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P U R)))$ P : $(i \geq 0)$ L : $(i == \text{limit} + 2)$ R : $(i < 0)$ Interval: No Expected Result: No violation Actual Result: No violation</p>	<p>Test #36 : - L P P P P P P P R Pattern : Universality (p) Scope : After L - Until R Formula: $(L \wedge \neg(R) \rightarrow (P W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P U R)))$ P : $(i > 1) \ \&\& \ (i < \text{limit})$ L : $(i == 1)$ R : $(i = \text{limit})$ Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #37 : P P P P P P P P R</p>	<p>Test #38 : - L P P P P P P - R</p>

<p style="text-align: center;">L</p> <p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U R)))$ P: $(i \geq 0) \ \&\& \ (i < \text{limit})$ L: $(i == 0)$ R: $(i == \text{limit})$ Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U R)))$ P: $(i > 1) \ \&\& \ (i < \text{limit} - 1)$ L: $(i == 1)$ R: $(i == \text{limit})$ Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #39 : - L R - - - - - - - P</p> <p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U R)))$ P: $(i == 1)$ L: $(i == 1)$ R: $(i == 2)$ Interval: Yes Expected Result: No violation Actual Result: No violation</p>	<p>Test #40 : - L R - - - - - - - P</p> <p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U R)))$ P: $(i == 2)$ L: $(i == 1)$ R: $(i == 2)$ Interval: Yes Expected Result: Violation Actual Result: Violation</p>
<p>Test #41 : P P P P P P P P - - L</p> <p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U R)))$ P: $(i \geq 0) \ \&\& \ (i < \text{limit} - 1)$ L: $(i == 0)$ R: $(i < 0)$ Interval: Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #42 : P P P P P P P P P P L</p> <p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U R)))$ P: $(i \geq 0)$ L: $(i == 0)$ R: $(i < 0)$ Interval: Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #43 : L P P R - L P - - P P</p> <p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U R)))$ P: $((i \geq 0) \ \&\& \ (i < 3)) \parallel (i == 6) \parallel (i == \text{limit})$ L: $((i == 0) \parallel (i == 5))$ R: $(i == 3)$ Interval: Yes ... Yes Expected Result: Violation Actual Result: Violation</p>	<p>Test #44 : L P P R - L P P P P P P</p> <p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U R)))$ P: $((i \geq 0) \ \&\& \ (i < 3)) \parallel (i \geq 5)$ L: $((i == 0) \parallel (i == 5))$ R: $(i == 3)$ Interval: Yes ... Yes Expected Result: No violation Actual Result: No violation</p>
<p>Test #47 : L P P R - L P P P R P P</p> <p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U R)))$ P: $((i \geq 0) \ \&\& \ (i < 3)) \parallel ((i \geq 5) \ \&\& \ (i < \text{limit}))$ L: $((i == 0) \parallel (i == 5))$</p>	<p>Test #48 : L P P R - - L P P P R P</p> <p>Pattern : Universality (p) Scope : After L – Until R Formula: $(L \wedge \neg(R) \rightarrow (P \ W R))$ Formula: $((L \wedge \neg(R)) \rightarrow (P \parallel (P \ U R)))$ P: $((i \geq 0) \ \&\& \ (i < 3)) \parallel ((i > 5) \ \&\& \ (i < \text{limit}))$</p>

R : (i == 3) (i == limit) Interval : Yes ... Yes Expected Result : No violation Actual Result : No violation	L : ((i == 0) (i == 5)) R : (i == 3) (i == limit) Interval : Yes ... Yes Expected Result : Violation Actual Result : Violation
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Table9. Test suite for the *precedence* pattern for SPS.

Test #1 : ----- Pattern : Precedence : (T) Precedes (P) Scope : Global Formula : !P W T P : (i > limit + 1) T : (i < 0) Interval : Built Expected Result : Valid Actual Result : Valid	Test #2 : --- T ----- Pattern : Precedence : (T) Precedes (P) Scope : Global Formula : !P W T P : (i > limit + 1) T : (i == 3) Interval : Built Expected Result : Valid Actual Result : Valid
Test #3 : P----- Pattern : Precedence : (T) Precedes (P) Scope : Global Formula : !P W T P : (i == 0) T : (i > limit + 1) Interval : Built Expected Result : Not valid Actual Result : Not Valid	Test #4 : ---T----- P Pattern : Precedence : (T) Precedes (P) Scope : Global Formula : !P W T P : (i == 3) T : (i == 3) Interval : Built Expected Result : Not valid Actual Result : Not valid
Test #5 : --- P ----- Pattern : Precedence : (T) Precedes (P) Scope : Global Formula : !P W T P : (i == 3) T : (i > limit + 1) Interval : Built Expected Result : Not valid Actual Result : Not valid	Test #6 : - P - T ----- Pattern : Precedence : (T) Precedes (P) Scope : Global Formula : !P W T P : (i == 1) T : (i == 3) Interval : Built Expected Result : Not valid Actual Result : Not valid
Test #7 : ----- Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula : <>R -> (!P U (T R)) P : (i > limit + 1) T : (i < 0); R : (i < 0) Interval : Not built Expected Result : Valid Actual Result : Valid	Test #8 : ----- P ----- Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula : <>R -> (!P U (T R)) P : (i == 5) T : (i < 0); R : (i > limit + 1) Interval : Not built Expected Result : Valid Actual Result : Valid
Test #9 : ----- R --- Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula : <>R -> (!P U (T R)) P : (i > limit + 1) T : (i < 0); R : (i == 6) Interval : Built	Test #10 : ----- R - P - Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula : <>R -> (!P U (T R)) P : (i == 8) T : (i < 0); R : (i == 6) Interval : Built

<p>Expected Result: Valid Actual Result: Valid</p>	<p>Expected Result: Valid Actual Result: Valid</p>
<p>Test #9 : --- R - - P - R --- Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: <>R -> (!P U (T R)) P: (i == 6) T: (i < 0); R: (i == 3 i == 8) Interval: Built Expected Result: No Violation Actual Result: Violation</p>	<p>Test #9 : ----- P --- Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: <>R -> (!P U (T R)) P: (i == 6) T: (i < 0); R: (i == 6) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #11 : --- P - - R - - Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: <>R -> (!P U (T R)) P: (i == 3) T: (i < 0) R: (i == 6) Interval: Built Expected Result: Not Valid Actual Result: Not valid</p>	<p>Test #12 : R ----- Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: <>R -> (!P U (T R)) P: (i > limit + 1) T: (i < 0) R: (i == 0) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #13 : - T - - P - - R - - Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: <>R -> (!P U (T R)) P: (i == 4) T: (i == 1) R: (i == 7) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #14 : --- P - - R - - T Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: <>R -> (!P U (T R)) P: (i == 3) T: (i == 3) R: (i == 7) Interval: Built Expected Result: Not valid Actual Result: Not valid</p>
<p>Test #15 : --- P ----- R T Pattern : Precedence : (T) Precedes (P) Scope : Before R Formula: <>R -> (!P U (T R)) P: (i == 3) T: (i == 3) R: (i == 3) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #16 : ----- Pattern : Precedence : (T) Precedes (P) Scope : After L Formula: []!L <>(L & (!P W T)) P: (i < 0) T: (i > limit + 1) L: (i > i) Interval: Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #17 : --- L ----- Pattern : Precedence : (T) Precedes (P) Scope : After L Formula: []!Q <>(L & (!P W T)) P: (i < 0) T: (i > limit + 1) L: (i == 3) Interval: Built Expected Result: Valid</p>	<p>Test #18 : -P - L ----- Pattern : Precedence : (T) Precedes (P) Scope : After L Formula: []!L <>(L & (!P W T)) P: (i == 2) T: (i > limit + 1) L: (i == 3) Interval: Built Expected Result: Valid</p>

<p>Actual Result: Valid</p> <p>Test #18 : L--T- L- P-</p> <p>Pattern : Precedence : (T) Precedes (P)</p> <p>Scope : After L</p> <p>Formula: []!L <>(L & (!P W T))</p> <p>P: (i == limit - 1)</p> <p>T: (i == 3)</p> <p>L: (i == 0 i == 5)</p> <p>Interval: Built</p> <p>Expected Result: No Violation</p> <p>Actual Result: Violation</p>	<p>Actual Result: Valid</p> <p>Test #18 : L--T- L-</p> <p>Pattern : Precedence : (T) Precedes (P)</p> <p>Scope : After L</p> <p>Formula: []!L <>(L & (!P W T))</p> <p>P: (i == limit - 1)</p> <p>T: (i == 3)</p> <p>L: (i == 0 i == 5)</p> <p>Interval: Built</p> <p>Expected Result: Violation</p> <p>Actual Result: Violation</p>
<p>Test #19 : ---L-----</p> <p style="text-align: center;">P T</p> <p>Pattern : Precedence : (T) Precedes (P)</p> <p>Scope : After L</p> <p>Formula: []!L <>(L & (!P W T))</p> <p>P: (i == 3)</p> <p>T: (i == 3)</p> <p>L: (i == 3)</p> <p>Interval: Built</p> <p>Expected Result: Not valid</p> <p>Actual Result: Not valid</p>	<p>Test #20 : --L--P-T---</p> <p>Pattern : Precedence : (T) Precedes (P)</p> <p>Scope : After L</p> <p>Formula: []!L <>(L & (!P W T))</p> <p>P: (i == 5)</p> <p>T: (i == 7)</p> <p>L: (i == 2)</p> <p>Interval: Built</p> <p>Expected Result: Not Valid</p> <p>Actual Result: Not valid</p>
<p>Test #21 : -L--T--P--</p> <p>Pattern : Precedence : (T) Precedes (P)</p> <p>Scope : After L</p> <p>Formula: []!L <>(L & (!P W T))</p> <p>P: (i == 7)</p> <p>T: (i == 4)</p> <p>L: (i == 1)</p> <p>Interval: Built</p> <p>Expected Result: Valid</p> <p>Actual Result: Valid</p>	<p>Test #22 : --L--P----</p> <p style="text-align: center;">T</p> <p>Pattern : Precedence : (T) Precedes (P)</p> <p>Scope : After L</p> <p>Formula: []!L <>(L & (!P W T))</p> <p>P: (i == 5); T: (i == 5)</p> <p>L: (i == 2)</p> <p>Interval: Built</p> <p>Expected Result: Not valid</p> <p>Actual Result: Not valid</p>
<p>Test #23 : -----</p> <p>Pattern : Precedence : (T) Precedes (P)</p> <p>Scope : Between L and R</p> <p>Formula: [] (Q&!R& <>R)->(!PU(S v R))</p> <p>P: (i > limit + 1)</p> <p>T: (i < 0)</p> <p>L: (i < i)</p> <p>R: (i > i)</p> <p>Interval: Not built</p> <p>Expected Result: Valid</p> <p>Actual Result: Valid</p>	<p>Test #24: ---P-----</p> <p>Pattern : Precedence : (T) Precedes (P)</p> <p>Scope : Between L and R</p> <p>Formula: [] (Q&!R& <>R)->(!PU(S v R))</p> <p>P: (i == 3)</p> <p>T: (i < 0)</p> <p>L: (i < i)</p> <p>R: (i > i)</p> <p>Interval: Not built</p> <p>Expected Result: Valid</p> <p>Actual Result: Valid</p>
<p>Test #25 : ---R---P--L-</p> <p>Pattern : Precedence : (T) Precedes (P)</p> <p>Scope : Between L and R</p> <p>Formula: [] (Q&!R& <>R)->(!PU(S v R))</p> <p>P: (i == 7)</p> <p>T: (i < 0)</p> <p>L: (i == 10)</p> <p>R: (i == 3)</p> <p>Interval: Not Built</p> <p>Expected Result: Valid</p>	<p>Test #26 : -L--P-T--R-</p> <p>Pattern : Precedence : (T) Precedes (P)</p> <p>Scope : Between L and R</p> <p>Formula: [] (Q&!R& <>R)->(!PU(S v R))</p> <p>P: (i == 4)</p> <p>T: (i == 6)</p> <p>L: (i == 1)</p> <p>R: (i == 9)</p> <p>Interval: Built</p> <p>Expected Result: Not valid</p>

<p>Actual Result: Valid</p> <p>Test #26 : - L- - T- -L - P - R - Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: [] (L&!R& <>R) -> (!PU(T ∨ R)) P: (i == 9) T: (i == 4) L: (i == 1 i == 7) R: (i == limit - 1) Interval: Built Expected Result: Not valid</p> <p>Actual Result: Not valid</p>	<p>Actual Result: Not valid</p> <p>Test #26 : - L- -P - T- - - - - Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: [] (L&!R& <>R) -> (!PU(T ∨ R)) P: (i == 4) T: (i == 6) L: (i == 1) R: (i == 900) Interval: No Expected Result: Valid</p> <p>Actual Result: Valid</p>
<p>Test #27 : - - - R - L - P - - Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: [] (L&!R& <>R) -> (!PU(T ∨ R)) P: (i == 7) T: (i < 0) L: (i == 5) R: (i == 3) Interval: Not built Expected Result: Valid Actual Result: Valid</p>	<p>Test #28 : - - R - P - -L - - T Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: [] (L&!R& <>R) -> (!PU(T ∨ R)) P: (i == 4); T: (i == 4) L: (i == 7); R: (i == 2) Interval: Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #29 : - - L - P - -R - - T Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: [] (L&!R& <>R) -> (!PU(T ∨ R)) P: (i == 4) T: (i == 4) L: (i == 2) R: (i == 7) Interval: Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #30 : - L T - P R - L - P Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: [] (L&!R& <>R) -> (!PU(T ∨ R)) P: (i == 4 i == 9) T: (i == 2) L: (i == 1 i == 7) R: (i == 5) Interval: Built ... Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #31 : - L T - P R - L - P - R Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: [] (L&!R& <>R) -> (!PU(T ∨ R)) P: (i == 4 i == 9) T: (i == 2) L: (i == 1 i == 7) R: (i == 5 i == 11) Interval: Built ... Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #32 : - L T - P R - L T P - R Pattern : Precedence : (T) Precedes (P) Scope : Between L and R Formula: [] (L&!R& <>R) -> (!PU(T ∨ R)) P: (i == 4 i == 9) T: (i == 2 i == 8) L: (i == 1 i == 7) R: (i == 5 i == 11) Interval: Built ... Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #33 : - - - - - - - - - - Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: [] (L & !R -> (!P W (T ∨ R))) P: (i < 0) T: (i < i) L: (i > i)</p>	<p>Test #34 : - - - P - - L - - - - - Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: [] (L & !R -> (!P W (T ∨ R))) P: (i == 3) T: (i < i) L: (i == 6)</p>

<p>R: (i > limit + 1) Interval: Not built Expected Result: Valid Actual Result: Valid</p>	<p>R: (i > limit + 1) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #35: --L - P T -- R ----- Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: [] (L & !R -> (!P W (T v R))) P: (i == 4); T: (i == 5) L: (i == 2); R: (i == 8) Interval: Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #36: --L - T - P - R ----- Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: [] (L & !R -> (!P W (T v R))) P: (i == 6); T: (i == 4) L: (i == 2); R: (i == 8) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #37: --L - T - R ----- P Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: [] (L & !R -> (!P W (T v R))) P: (i == 6); T: (i == 6) L: (i == 2); R: (i == 8) Interval: Built Expected Result: Not valid Actual Result:</p>	<p>Test #38: --L - R -- P ---- Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: [] (L & !R -> (!P W (T v R))) P: (i == 7); T: (i > i) L: (i == 2); R: (i == 4) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #39: - L T P R -- L -- P - Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: [] (L & !R -> (!P W (T v R))) P: (i == 3 i == 10) T: (i == 2) L: (i == 1 i == 7) R: (i == 4) Interval: Built ... Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #40: - L T P R -- L T - P - Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: [] (L & !R -> (!P W (T v R))) P: (i == 3 i == 10) T: (i == 2 i == 8) L: (i == 1 i == 7) R: (i == 4) Interval: Built ... Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #41: - L T P R -- L T - P R Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: [] (L & !R -> (!P W (T v R))) P: (i == 3 i == 10) T: (i == 2 i == 8) L: (i == 1 i == 7) R: (i == 4 i == 11) Interval: Built ... Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #42: - L T P R -- L -- P R Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: [] (L & !R -> (!P W (T v R))) P: (i == 3 i == 10) T: (i == 2) L: (i == 1 i == 7) R: (i == 4 i == 11) Interval: Built ... Built Expected Result: Not valid Actual Result: Not valid</p>
<p>Test #41: - L -- T - L - P R Pattern : Precedence : (T) Precedes (P) Scope : After L Until R Formula: [] (L & !R -> (!P W (T v R))) P: (i == 8) T: (i == 4) L: (i == 1 i == 6) R: (i == limit) Interval: Built ... Built Expected Result: Not Valid</p>	

Actual Result: Not Valid	
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Table10. Test suite for the *response* pattern in SPS.

<p>Test #1 : ----- Pattern : Response: (T) Responds to (P) Scope : Global Formula: $(P \rightarrow \diamond T)$ P: $(i > \text{limit} + 1)$ T: $(i < 0)$ Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #2 : --- T ----- Pattern : Response: (T) Responds to (P) Scope : Global Formula: $(P \rightarrow \diamond T)$ P: $(i > \text{limit} + 1)$ T: $(i == 3)$ Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #3 : ----- P Pattern : Response: (T) Responds to (P) Scope : Global Formula: $(P \rightarrow \diamond T)$ P: $(i == \text{limit})$ T: $(i > \text{limit} + 1)$ Interval: Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #4 : --- T ----- P Pattern : Response: (T) Responds to (P) Scope : Global Formula: $(P \rightarrow \diamond T)$ P: $(i == 3)$ T: $(i == 3)$ Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #5 : --- P ----- Pattern : Response: (T) Responds to (P) Scope : Global Formula: $(P \rightarrow \diamond T)$ P: $(i == 3)$ T: $(i > \text{limit} + 1)$ Interval: Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #6 : - P - T ----- Pattern : Response: (T) Responds to (P) Scope : Global Formula: $(P \rightarrow \diamond T)$ P: $(i == 1)$ T: $(i == 3)$ Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #7 : ----- Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow ((\neg R) \cup (T \wedge \neg R)))) \cup R)$ P: $(i > \text{limit} + 1)$ T: $(i < 0)$ R: $(i < 0)$ Interval: Not built Expected Result: Valid Actual Result: Valid</p>	<p>Test #8 : ----- P ----- Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow ((\neg R) \cup (T \wedge \neg R)))) \cup R)$ P: $(i == 5)$ T: $(i < 0)$ R: $(i > \text{limit} + 1)$ Interval: Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #8 : --- -R --- P - -R Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow ((\neg R) \cup (T \wedge \neg R)))) \cup R)$ P: $(i == 10)$ T: $(i < 0)$ R: $(i == 4 \parallel i == \text{limit})$ Interval: Not built</p>	<p>Test #8 : --- P - -R --- -R Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow ((\neg R) \cup (T \wedge \neg R)))) \cup R)$ P: $(i == 2)$ T: $(i < 0)$ R: $(i == 4 \parallel i == \text{limit})$ Interval: Not built</p>

<p>Expected Result: Not Valid Actual Result: Not Valid</p>	<p>Expected Result: Not Valid Actual Result: Not Valid</p>
<p>Test #9 : - - - - - R - - - Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) \cup (T \wedge \neg R))) \cup R$ P: (i > limit + 1) T: (i < 0) R: (i == 6) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #10 : - - - - - R - P - Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) \cup (T \wedge \neg R))) \cup R$ P: (i == 8) T: (i < 0) R: (i == 6) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #11 : - - - P - - R - - Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) \cup (T \wedge \neg R))) \cup R$ P: (i == 3) T: (i < 0) R: (i == 6) Interval: Built Expected Result: Not Valid Actual Result: Not valid</p>	<p>Test #12 : R - - - - - Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) \cup (T \wedge \neg R))) \cup R$ P: (i > limit + 1) T: (i < 0) R: (i == 0) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #13 : - P - - T - - R - - Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) \cup (T \wedge \neg R))) \cup R$ P: (i == 1) T: (i == 4) R: (i == 7) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #14 : - - - P - - R - - T Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) \cup (T \wedge \neg R))) \cup R$ P: (i == 3) T: (i == 3) R: (i == 7) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #15 : - - - P - - - - - R Pattern : Response: (T) Responds to (P) Scope : Before R Formula: $\diamond R \rightarrow ((P \rightarrow (\neg R) \cup (T \wedge \neg R))) \cup R$ P: (i == 3) T: (i > i) R: (i == 3) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #16 : - - - - - Pattern : Response: (T) Responds to (P) Scope : After L Formula: $[] (L \rightarrow [] (P \rightarrow \langle \rangle T))$ P: (i < 0) T: (i > limit + 1) L: (i > i) Interval: Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #17 : - - - L - - - - - Pattern : Response: (T) Responds to (P) Scope : After L Formula: $[] (L \rightarrow [] (P \rightarrow \langle \rangle T))$ P: (i < 0) T: (i > limit + 1) L: (i == 3)</p>	<p>Test #18 : - T - L - - - - - Pattern : Response: (T) Responds to (P) Scope : After L Formula: $[] (L \rightarrow [] (P \rightarrow \langle \rangle T))$ P: (i < 0) T: (i == 1) L: (i == 3)</p>

<p>Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #19 : ---L----- P T Pattern : Response: (T) Responds to (P) Scope : After L Formula: [] (L -> [] (P -> <>T)) P: (i == 3) T: (i == 3) L: (i == 3) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #20 : --L--T-P--- Pattern : Response: (T) Responds to (P) Scope : After L Formula: [] (L -> [] (P -> <>T)) P: (i == 7) T: (i == 5) L: (i == 2) Interval: Built Expected Result: Not Valid Actual Result: Not valid</p>
<p>Test #21 : -L--P--T-- Pattern : Response: (T) Responds to (P) Scope : After L Formula: [] (L -> [] (P -> <>T)) P: (i == 4) T: (i == 7) L: (i == 1) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #22 : --L--P----- T Pattern : Response: (T) Responds to (P) Scope : After L Formula: [] (L -> [] (P -> <>T)) P: (i == 5) T: (i == 5) L: (i == 2) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #23 : ----- Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: ((L ∧ ¬R ∧ ◇R) → (P → (¬R U (T ∧ ¬R)))) U R P: (i > limit + 1) T: (i < 0) L: (i < i) R: (i > i) Interval: Not built Expected Result: Valid Actual Result: Valid</p>	<p>Test #24 : ---P----- Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: ((L ∧ ¬R ∧ ◇R) → (P → (¬R U (T ∧ ¬R)))) U R P: (i == 3) T: (i < 0) L: (i < i) R: (i > i) Interval: Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #25 : ---R---P--L- Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: ((L ∧ ¬R ∧ ◇R) → (P → (¬R U (T ∧ ¬R)))) U R P: (i == 7) T: (i < 0) L: (i == 10) R: (i == 3) Interval: Not Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #26 : -L--P--T--R- Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: ((L ∧ ¬R ∧ ◇R) → (P → (¬R U (T ∧ ¬R)))) U R P: (i == 4) T: (i == 6) L: (i == 1) R: (i == 9) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #27 : ---R-L-P-- Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: ((L ∧ ¬R ∧ ◇R) → (P → (¬R U (T ∧ ¬R)))) U R P: (i == 7)</p>	<p>Test #28 : --R-P--L--- T Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: ((L ∧ ¬R ∧ ◇R) → (P → (¬R U (T ∧ ¬R)))) U R P: (i == 4)</p>

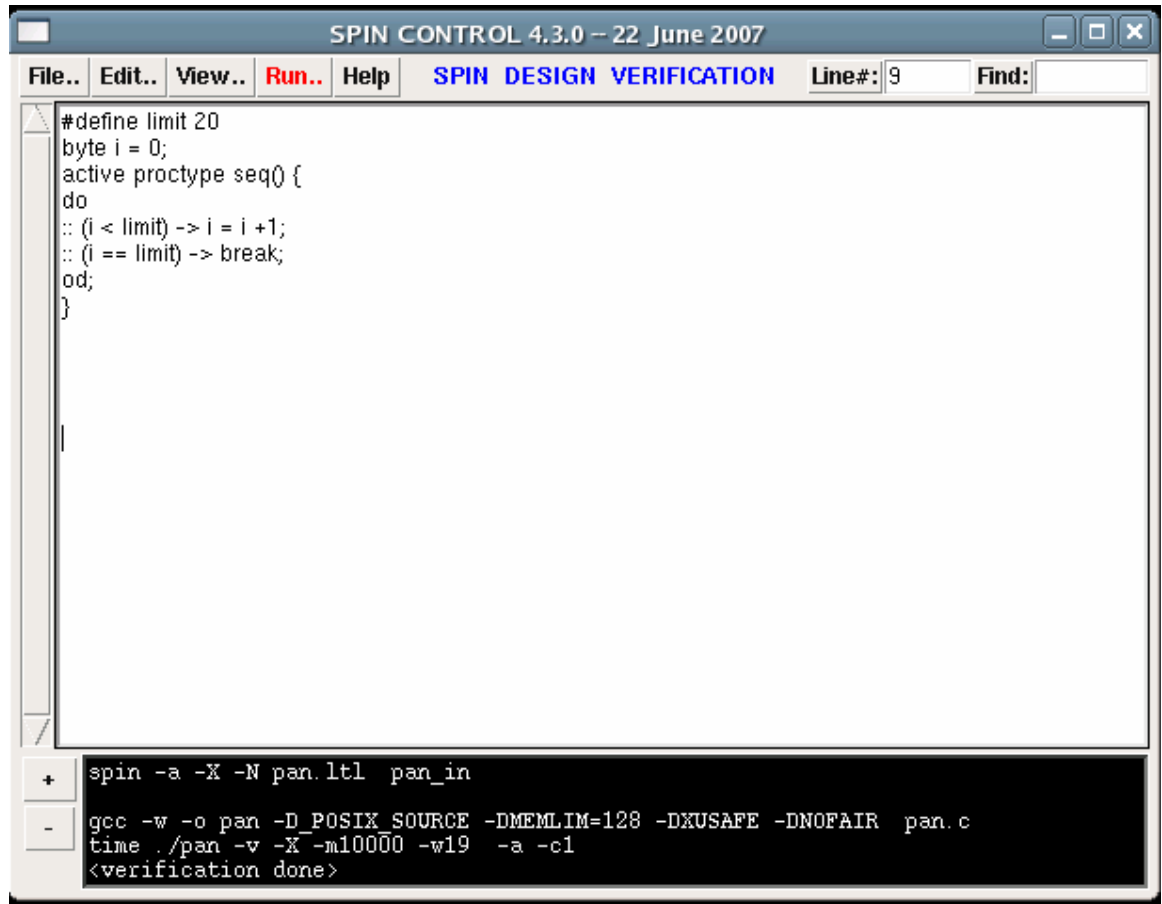
<p>T: (i < 0) L: (i == 5) R: (i == 3) Interval: Not built Expected Result: Valid Actual Result: Valid</p>	<p>T: (i == 4) L: (i == 7) R: (i == 2) Interval: Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #29 : -- L - P -- R -- T Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$ P: (i == 4); T: (i == 4) L: (i == 2); R: (i == 7) Interval: Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #30 : - L P - T R - L - P Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$ P: (i == 2 i == 9) T: (i == 4) L: (i == 1 i == 7) R: (i == 5) Interval: Built ... Not built Expected Result: Valid Actual Result: Valid</p>
<p>Test #31 : - L P - T R - L - P - R Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$ P: (i == 2 i == 9) T: (i == 4) L: (i == 1 i == 7) R: (i == 5 i == 11) Interval: Built ... Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #32 : - L P - T R - L P T - R Pattern : Response: (T) Responds to (P) Scope : Between L and R Formula: $((L \wedge \neg R \wedge \diamond R) \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R$ P: (i == 2 i == 8) T: (i == 4 i == 9) L: (i == 1 i == 7) R: (i == 5 i == 11) Interval: Built ... Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #33 : ----- Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) W R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$ P: (i < 0) T: (i < i) L: (i > i) R: (i > limit + 1) Interval: Not built Expected Result: Valid Actual Result: Valid</p>	<p>Test #34 : ---P --- L ----- Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) W R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$ P: (i == 3) T: (i < i) L: (i == 6) R: (i > limit + 1) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #35 : --L - T P -- R ----- Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) W R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$ P: (i == 5) T: (i == 4) L: (i == 2) R: (i == 8) Interval: Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #36 : --L - P - T - R ----- Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) W R)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$ P: (i == 4) T: (i == 6) L: (i == 2) R: (i == 8) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #37 : --L - T - R -----</p>	<p>Test #38 : --L - R --- P -----</p>

<p style="text-align: center;">P</p> <p>Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) WR)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$ P: (i == 6) T: (i == 6) L: (i == 2) R: (i == 8) Interval: Built Expected Result: Valid Actual Result:</p>	<p>Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) WR)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$ P: (i == 7) T: (i > i) L: (i == 2) R: (i == 4) Interval: Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #39 : - L P T R - - L - - P - Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) WR)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$ P: (i == 2 i == 10) T: (i == 3) L: (i == 1 i == 7) R: (i == 4) Interval: Built ... Built Expected Result: Not valid Actual Result: Not valid</p>	<p>Test #40 : - L P T R - - L P - T - Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) WR)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$ P: (i == 2 i == 8) T: (i == 3 i == 10) L: (i == 1 i == 7) R: (i == 4) Interval: Built ... Built Expected Result: Valid Actual Result: Valid</p>
<p>Test #41 : - L P T R - - L P - T R Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) WR)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$ P: (i == 2 i == 8) T: (i == 3 i == 10) L: (i == 1 i == 7) R: (i == 4 i == 11) Interval: Built ... Built Expected Result: Valid Actual Result: Valid</p>	<p>Test #42 : - L P T R - - L - - P R Pattern : Response: (T) Responds to (P) Scope : After L Until R Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) WR)$ Formula: $((L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) \parallel (L \wedge \neg R \rightarrow (P \rightarrow (\neg R U (T \wedge \neg R)))) U R)$ P: (i == 2 i == 10) T: (i == 3) L: (i == 1 i == 7) R: (i == 4 i == 11) Interval: Built ... Built Expected Result: Not valid Actual Result: Not valid</p>

3. Using Xspin to Test LTL Formulas

This section provides screenshot descriptions of the use of Spin (through Xspin)

to test the correctness of LTL formulas. This is the approach used in [3].



The screenshot shows the SPIN CONTROL 4.3.0 interface. The title bar reads "SPIN CONTROL 4.3.0 - 22 June 2007". The menu bar includes "File..", "Edit..", "View..", "Run..", and "Help". The main window displays the following Promela code:

```
#define limit 20
byte i = 0;
active proctype seq0 {
do
:: (i < limit) -> i = i + 1;
:: (i == limit) -> break;
od;
}
```

At the bottom, a terminal window shows the execution of the spin command:

```
spin -a -X -N pan.ltl pan_in
gcc -w -o pan -D POSIX_SOURCE -DMEMLIM=128 -DXUSAFE -DNOFAIR pan.c
time ./pan -v -X -m10000 -w19 -a -c1
<verification done>
```

Figure 2: Defining the Promela Model in Xspin

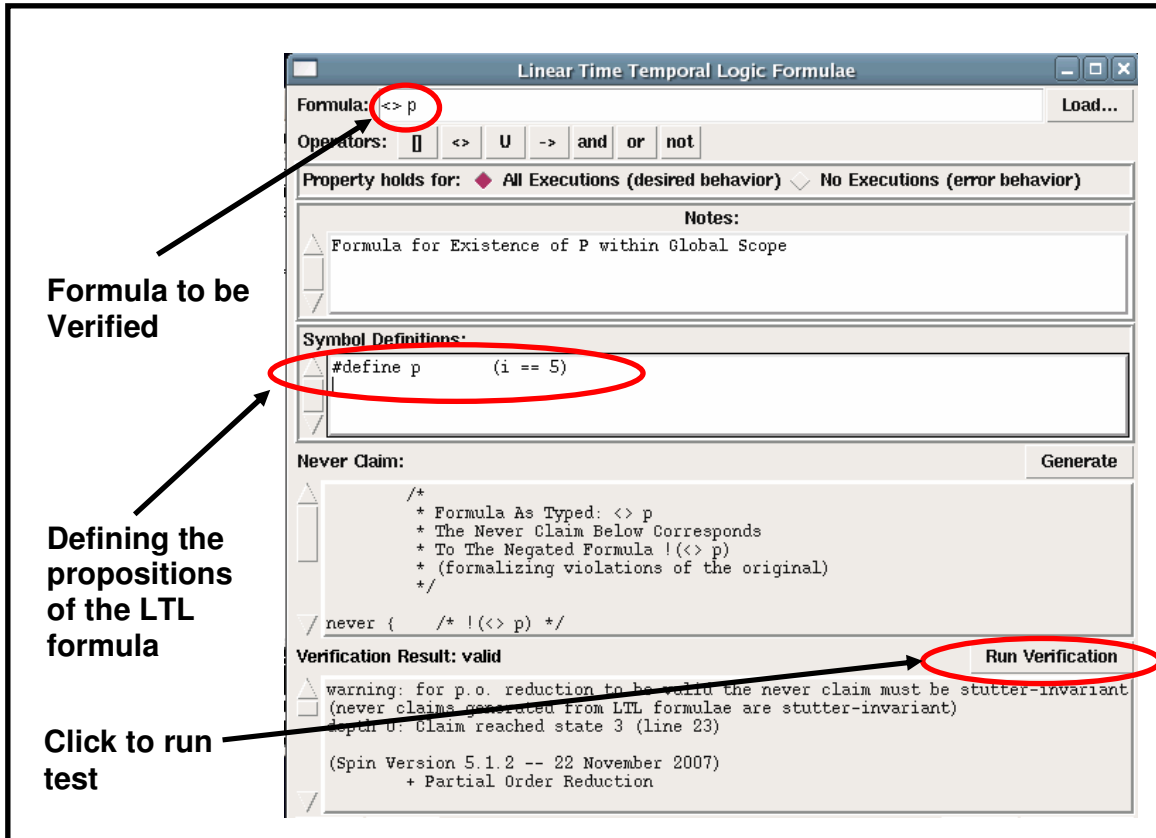


Figure 3: LTL Property Manager Used to Define the LTL Formula to be Verified and its Propositions

The screenshot displays the Spin model checker interface with the following components:

- Formula being tested:** $[] ((q \ \&\& \ (!r) \ \&\& \ <r) \ \rightarrow \ (!r) \ U \ (p \ \&\& \ !r))$
- Test trace:** `-- q - - - - - p - - - - r - - - -`
- Definitions of propositions:**

```
#define p (i == 10)
#define q (i == 2)
#define r (i == 15)
```
- Spin's returned result:** **Verification Result: valid**

Additional details from the interface include the property holds for "All Executions (desired behavior)", a note about the formula's scope, and a never claim section with a warning about stutter-invariant reduction.

Figure 4: Valid Test Case

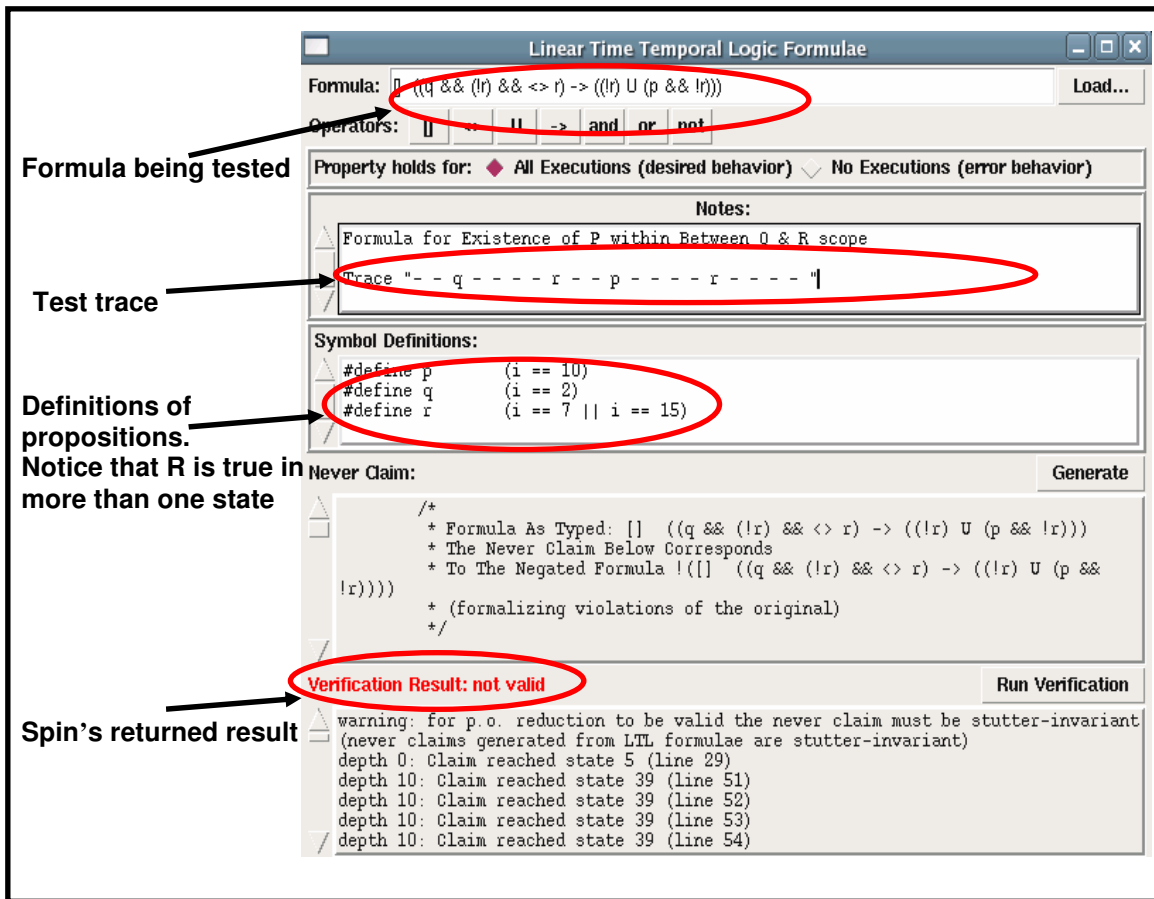


Figure 5: Invalid Test Case

4. References

- [1] Mondragon, O., and Gates, A.Q., "Supporting Elicitation and Specification of Software Properties through Patterns and Composite Propositions," *Int'l J. Software Engineering and Knowledge Engineering*, 14(1), February, 2004.
- [2] Dwyer, M.B., Avrunin, G.S., and Corbett, J.C., "Patterns in property specifications for finite-state verification," *Int. Conf. on Software Engineering, ICSE*, Los Angeles, CA, May, 1999, pp. 411–420.
- [3] Salamah, S., Gates, A., Roach, S., and Mondragon, O., "Verifying Pattern-Generated LTL Formulas: A Case Study." 12th International SPIN Workshop, Aug. 2005.