Tarski: A Platform for Automated Analysis of Dynamically Configurable Traceability Semantics

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Ah1 @JQ/2Hq`Bi2`, avM+?`QMBx2/ .Q+m

?iiTb,ffBi2 jXQ`;fT`QD2+ifKQ/2Hr`Bi2`X?iK

Ah1 @ aalJ1, zQ`/ #H2 a 72 a2+m`2 JQ

?iiTb,ffBi2 jXQ`;fT`QD2+if bbmK2X?iKH

aQm`+2 +Q/2b- / i b2ib M/ b+`22M+ bib

?iiTb,ff;Bi?m#X+QKfJQ/2Hq`Bi2`fqSj

R AMi`Q/m+iBQM

JQiBp iBQM

AM/mbi`B H lb2 * b2b

k TT`Q +?

h` +2 #BHBiv .QK BM JQ/2H

6B`bi@Q`/2` _2H iBQM H JQ/2H M/ GQ;B

hvT2 MMQi iBQM M/ h` +2@_2H iBQMb

6Q`K H a2K MiB+b M/ miQK i2/ M HvbB

j .2KQMbi` iBQM

6Q`K H aT2+B}+ iBQM Q7 h` +2 #BHBiv a

h` +2 #BHBiv J M ;2K2Mi

6B`bi@Q`/2` JQ/2H J M ;2K2Mi

miQK i2/ M HvbBb Q7 h` +2 #BHBiv

9 *QM+HmbBQM M/ 6mim`2 qQ`F

R AMi`Q/m+iBQM
JQiBp iBQM
AM/mbi`B H lb2 * b2b
k TT`Q +?
h` +2 #BHBiv .QK BM JQ/2H
6B`bi@Q`/2` _2H iBQM H JQ/2H M/ GQ;B
hvT2 MMQi iBQM M/ h` +2@_2H iBQMb
6Q`K H a2K MiB+b M/ miQK i2/ M HvbB
j .2KQMbi` iBQM
6Q`K H aT2+B}+ iBQM Q7 h` +2 #BHBiv a
h` +2 #BHBiv J M ;2K2Mi
6B`bi@Q`/2` JQ/2H J M ;2K2Mi
miQK i2/ M HvbBb Q7 h` +2 #BHBiv
9 *QM+HmbBQM M/ 6mim`2 qQ`F

q? i Bb h` +2 #BHBiv\

h` +2 #BHBiv + M #2 /2}M2/ b i?2 /2;`22 iQ r
+ M #2 2bi #HBb?2/ KQM; rQ`F T`Q/m+ib U F
/2p2HQTK2Mi T`Q+2bbX

q? i Bb + b2@# b2/ Q` T`QD2+i@# b2/ i`

_B;Q`QmbHv bT2+B}+ iBQM i?2 b2K MiB+b Q

q?v Bb _2 bQMBM; #Qmi h` +2 #BHBiv Bk

_B+?2` M/ T`2+Bb2 miQK i2/ i` +2 #BHBiv
*QKTHB M+2 M/ *2`iB}+ iBQM BM miQKQiB

a2K MiB+ HHv K2 MBM;7mH i` +2 #BHBiv

i` +2 #BHBiv `2H iBQMb b?QmH/ ? p2 `B
BMbi2 / Q7 #2BM; bBKTH2 #B@/B`2+iBQM

*QM};m` iBQM Q7 i` +2 #BHBiv UTQbbB#

h` +2 #BHBiv a2K MiB+b Bb Q7i2M bi iB+

a2K MiB+ HHv K2 MBM;7mH i` +2 #BHBiv

i` +2 #BHBiv `2H iBQMb b?QmH/ ? p2 `B
BMbi2 / Q7 #2BM; bBKTH2 #B@/B`2+iBQM

*QM};m` iBQM Q7 i` +2 #BHBiv UTQbbB#

h` +2 #BHBiv a2K MiB+b Bb Q7i2M bi iB+

h?2 b2K MiB+b + MMQi #2 2 bBHv / Ti2/ T
/Bz2`2Mi T`QD2+ibX

a2K MiB+ HHv K2 MBM;7mH i` +2 #BHBiv

i` +2 #BHBiv `2H iBQMb b?QmH/ ? p2 `B
BMbi2 / Q7 #2BM; bBKTH2 #B@/B`2+iBQM

*QM};m` iBQM Q7 i` +2 #BHBiv UTQbbB#

h` +2 #BHBiv a2K MiB+b Bb Q7i2M bi iB+

h?2 b2K MiB+b + MMQi #2 2 bBHv / Ti2/ T
/Bz2`2Mi T`QD2+ibX

.Bz2`2Mi i` +2 #H2 2H2K2Mib M/ i?2 `2H
BM/mbi`B H b2iiBM;b-

a2K MiB+ HHv K2 MBM;7mH i` +2 #BHBiv

i` +2 #BHBiv `2H iBQMb b?QmH/ ? p2 `B
BMbi2 / Q7 #2BM; bBKTH2 #B@/B`2+iBQM

*QM};m` iBQM Q7 i` +2 #BHBiv UTQbbB#

h` +2 #BHBiv a2K MiB+b Bb Q7i2M bi iB+

h?2 b2K MiB+b + MMQi #2 2 bBHv / Ti2/ T
/Bz2`2Mi T`QD2+ibX

.Bz2`2Mi i` +2 #H2 2H2K2Mib M/ i?2 `2H
BM/mbi`B H b2iiBM;b-

GBF2rBb2- /Bz2`2Mi i` +2 #BHBiv M Hvb
a2p2` H BM/mbi`B2b /2K M/b 7Q`K H T`QQ

R AMi`Q/m+iBQM
JQiBp iBQM
AM/mbi`B H lb2 * b2b
k TT`Q +?
h` +2 #BHBiv .QK BM JQ/2H
6B`bi@Q`/2` _2H iBQM H JQ/2H M/ GQ;B
hvT2 MMQi iBQM M/ h` +2@_2H iBQMb
6Q`K H a2K MiB+b M/ miQK i2/ M HvbB
j .2KQMbi` iBQM
6Q`K H aT2+B}+ iBQM Q7 h` +2 #BHBiv a
h` +2 #BHBiv J M ;2K2Mi
6B`bi@Q`/2` JQ/2H J M ;2K2Mi
miQK i2/ M HvbBb Q7 h` +2 #BHBiv
9 *QM+HmbBQM M/ 6mim`2 qQ`F

.P@Rd3*

aQ7ir `2 *QMbB/2` iBQMb BM B`#Q`M2 avbi2
*2`iB}+ iBQM

h` +2 #BHBiv

.P@Rd3 `2[mB`2b /Q+mK2Mi2/ i`Q+M2 ri2BQM
i?2 +2`iB}+ iBQM `iB7 +i6X 6Q`2 2 K T2[mB`
UGGi_V+2b mT>iBQ ?G2p2H _2[mB`X2K2M i2U#>BGH_
M HvbBb i?2M mb2/ iQ 2Mb`m2[mB?2 2 mH}#vH 2/
i?2bQm`+2- i?Q/2 `+2?[mB`2bK2Mi- i? i2 +?HBM
bQm`+2?+Q/2Tm`TQb2 UBb +QMM2+i2/ iQ `2
7Q`i?X h` +2 #BHBiv 2Mbm`2b i?2 bvbi2K Bb

R AMi`Q/m+iBQM
JQiBp iBQM
AM/mbi`B H lb2 * b2b

k TT`Q +?
h` +2 #BHBiv .QK BM JQ/2H
6B`bi@Q`/2` _2H iBQM H JQ/2H M/ GQ;B
hvT2 MMQi iBQM M/ h` +2@_2H iBQMb
6Q`K H a2K MiB+b M/ miQK i2/ M HvbB

j .2KQMbi` iBQM
6Q`K H aT2+B}+ iBQM Q7 h` +2 #BHBiv a
h` +2 #BHBiv J M ;2K2Mi
6B`bi@Q`/2` JQ/2H J M ;2K2Mi
miQK i2/ M HvbBb Q7 h` +2 #BHBiv

9 *QM+HmbBQM M/ 6mim`2 qQ`F

AMi`Q/m+iBQM
JQiBp iBQM
AM/mbi`B H lb2 * b2b
TT`Q +?
h` +2 #BHBiv .QK BM JQ/2H
6B`bi@Q`/2` _2H iBQM H JQ/2H M/ GQ;B
hvT2 MMQi iBQM M/ h` +2@_2H iBQMb
6Q`K H a2K MiB+b M/ miQK i2/ M HvbB
.2KQMbi` iBQM
6Q`K H aT2+B}+ iBQM Q7 h` +2 #BHBiv a
h` +2 #BHBiv J M ;2K2Mi
6B`bi@Q`/2` JQ/2H J M ;2K2Mi
miQK i2/ M HvbBb Q7 h` +2 #BHBiv
*QM+HmbBQM M/ 6mim`2 qQ`F

h ? 2m M B pQ 7bi2 + 2 # B H B i v Q 7 i ? 2 + m ` ` 2 M i b

$$\cdot_h : f\ a_R;\ 1_R;\ 1_k;\ 1_j;\ 6_R;\ J_R;\ J_k;\ S_k g$$

h ? 2 1 v T 2 b B ; M i m ` 2

$$_h : f\ _1\ C v\ 1!\ *t\ J t\ 6;\ _C\ _1 v\ 6!\ a!\ 1 g$$

h ? 2 2 H i B Q M h M K /Q 2/ 2 i H ? 2 b B ; h M i m ` 2

$$J_i : f\ a = fh\ a_R i g;\ 1 = fh\ 1_R i; h\ 1_k i; h\ 1_j i g;\ C =$$
$$fh\ 6_R i; h J_R i; h J_k i; h S_k i g;\ _1\ C = fh\ 1_k;\ J_R i; h\ 1_k;\ J_k i; h\ 1_j;\ S_k i g;$$
$$_C\ _1 = fh\ 6_R;\ a_R;\ 1_R i g g$$

: _2H iBQM H ChQ`BMMb TMQ/b 2

h?2 2Qi DQMB/M MbTQT2` iQ`b 2Mbm`2 mMB7Q
M pB; iBQM i# 2+r22@ MQi?`iBQ;Mb 2@ BMFb
+QMbi` BMibX

^U_2~2tBp2V h` MbBiBp2 *HQbm`2

h` MbBiBp2 *HQbm`i2 2M+Q/BM; Q7 +QKKQI
+QMbi` BMib i? iQi?2`rBb2 +QmH/ MQi #2 2t
T`2p2MiBM; +v+HB+ /2T2 M/ 2M@+HBQXb #2 Q2bM

.QK BM M/ _ M;2 _2bi`B+iBQMb

h?2 `2bi`B+iBQM QT2` iQ`b `2 mb2/ iQ }Hi2`
/QK BM Q`` M;2X

: _2H iBQM H ChQ`BMMb TMQ/b 2

1: $_1 C = \{h\,1_{\dot{R}}; h\,1_{\dot{k}}; h\,1_j\} : \{h\,1_{\dot{k}}; J_{\dot{R}}; h\,1_{\dot{k}}; J_{\dot{k}}; h\,1_j; S_{\dot{k}}\}$
$= \{h\,J_{\dot{R}}; h\,J_{\dot{k}}; h\,S_{\dot{k}}\}$

C: $_1 C = \{h\,6_{\dot{R}}; h\,J_{\dot{R}}; h\,J_{\dot{k}}; h\,S_{\dot{k}}\} : \{h\,J_{\dot{R}}\,1_{\dot{k}}; h\,J_{\dot{k}}\,1_{\dot{k}}; h\,S_{\dot{k}}\,1_j\}$
$= \{h\,1_{\dot{k}}; h\,1_j\}$

^U_2~2tBp2V h` MbBiBp2 *HQbm`2

$\{h\,J_{\dot{R}}\,1_{\dot{R}}; h\,1_{\dot{R}}\,*_{\dot{R}}\} = \{h\,J_{\dot{R}}\,1_{\dot{R}}; h\,1_{\dot{R}}\,*_{\dot{R}}; h\,J_{\dot{R}}\,*_{\dot{R}}\}$

.QK BM M/ _ M;2 _2bi`B+iBQMb

S<: $_C\,1 = \{h\,S_{\dot{k}}\} < : \{h\,J_{\dot{R}}\,1_{\dot{k}}; h\,J_{\dot{k}}\,1_{\dot{k}}; h\,S_{\dot{k}}\,1_j\} = \{h\,S_{\dot{k}}\,1_j\}$

R AMi`Q/m+iBQM
JQiBp iBQM
AM/mbi`B H lb2 * b2b
k TT`Q +?
h` +2 #BHBiv .QK BM JQ/2H
6B`bi@Q`/2` _2H iBQM H JQ/2H M/ GQ;B
hvT2 MMQi iBQM M/ h` +2@_2H iBQMb
6Q`K H a2K MiB+b M/ miQK i2/ M HvbB
j .2KQMbi` iBQM
6Q`K H aT2+B}+ iBQM Q7 h` +2 #BHBiv a
h` +2 #BHBiv J M ;2K2Mi
6B`bi@Q`/2` JQ/2H J M ;2K2Mi
miQK i2/ M HvbBb Q7 h` +2 #BHBiv
9 *QM+HmbBQM M/ 6mim`2 qQ`F

R AMi`Q/m+iBQM
JQiBp iBQM
AM/mbi`B H lb2 * b2b

k TT`Q +?
h` +2 #BHBiv .QK BM JQ/2H
6B`bi@Q`/2` _2H iBQM H JQ/2H M/ GQ;B
hvT2 MMQi iBQM M/ h` +2@_2H iBQMb
6Q`K H a2K MiB+b M/ miQK i2/ M HvbB

j .2KQMbi` iBQM
6Q`K H aT2+B}+ iBQM Q7 h` +2 #BHBiv a
h` +2 #BHBiv J M ;2K2Mi
6B`bi@Q`/2` JQ/2H J M ;2K2Mi
miQK i2/ M HvbBb Q7 h` +2 #BHBiv

9 *QM+HmbBQM M/ 6mim`2 qQ`F

```
R   #bi` +ibB; `i27 +i & /2T2Mb/2bi `i27 +i'
k
j   @@ GQ+ i2!6BH2
9   QM2bB;aT2+B7B+ i2BtQ2M/b`i27 +i &
8       +QMi`:+bQK2*QMi` +i_2[mB`2K2Mi'
e
d   @@ GQ+ i2!h2ti
3   bB;*QMi` +i_2[mB`2Ki2M/b`i27 +i &
N       bvbi2Kb2iavbi2K_2[mB`2K2Mi-
Ry      +QMi BMb2i*QMi` +i_2[mB`2K2Mi'
RR
Rk  @@ GQ+ i2!_2[A6
Rj  bB;avbi2K_2[mB`2Ki2M/b`i27 +i &
R9      b iBb7B2/"bv2iAKTH2K2Mi iBQM-
R8      `2[mB`:2b2iavbi2K_2[mB`2K2Mi-
Re      `27BM2b2iavbi2K_2[mB`2K2Mi'
```

Rd #bi` +ibB;AKTH2K2Mi 2BiQM/b`i27 +i &
R3 7mH7B:HHQM*2QMi` +i_2[mB`2K2Mi'
RN
ky @@ GQ+ i2!C p
kR bB;*Q/2- *QKTQ2Mt2M/bAKTH2K2Mi iBQM &'
kk
kj @@ GQ+ i2!1J6
k9 bB;JQ/2H2ti2M/bAKTH2K2Mi iBQM &
k8 i` Mb7Q`Kb- +Q:M7Qi`JQb/2H-
ke ;2M2` i:2bb2iU*Q/[2 *QKTQM2MiV'
kd
k3 @@ a2K MiB+b!avbi2K_2[mB`2K2MiXb iBb7
kN 7 +i&8 B AKTH2K2Mi iBQMK3%X(b iBb7B2/"v'

*QMbBbi2M+v *?2+FBM;

h?2 bvbi2K +?2+Fb r?2i?2` i?2 mb2` KQ/2H b
bT2+B}+ iBQM Q` MQiX

_2 bQMBM; #Qmi h` +2@`2H iBQMb

A7 i?2 KQ/2H Bb T `iB H UBM+QKTH2i2V- i?
+QKTH2i2 i?2 KQ/2H rBi? `2bT2+i iQ i?2 b2K
bT2+B}+ iBQM BM72``BM; M2r i` +2@`2H iB

h` +2@2H2K2Mib .Bb+Qp2`v

A7 /2@bvM+?`QMBx iBQM Q++m`b`Q+2 @M2
T`Q# #Hv + mb2/ #v +? M;2 bm+? b /2H2iB
r2 i`v iQ `2T B` i?2 #`QF2M HBMF # b2/ QM i?

```
jy   @@  _2 bQM!*QMi` +i_2[mB`2K2MiXbvbi2K
jR  7 +i&8 b a vbi2K_2[mB`2K2MbiX- b`^27BM2b %
jk      b^X(bvbi=2Kb X(bvbi2K'
jj
j9   @@  _2 bQM!avbi2K_2[mB`2K2MiX`2[mB`2b
j8  7 +i&8 b- b:^ avbi2K_2[mB`2K2Mi %
je      b^BMb X`27BM=)2bb BMb^X`2[mB`2b '
jd
j3   @@  _2 bQM!AKTH2K2Mi iBQMX7mH7BHHb
jN  7 +i&8 B AKTH2K2Mi iBQMX-(bb iBb7B2/"v
9y      % BX7mH7=BbbX(bb vbi2K '
```

R AMi`Q/m+iBQM
JQiBp iBQM
AM/mbi`B H lb2 * b2b

k TT`Q +?
h` +2 #BHBiv .QK BM JQ/2H
6B`bi@Q`/2` _2H iBQM H JQ/2H M/ GQ;B
hvT2 MMQi iBQM M/ h` +2@_2H iBQMb
6Q`K H a2K MiB+b M/ miQK i2/ M HvbB

j .2KQMbi` iBQM
6Q`K H aT2+B}+ iBQM Q7 h` +2 #BHBiv a
h` +2 #BHBiv J M ;2K2Mi
6B`bi@Q`/2` JQ/2H J M ;2K2Mi
miQK i2/ M HvbBb Q7 h` +2 #BHBiv

9 *QM+HmbBQM M/ 6mim`2 qQ`F

R AMi`Q/m+iBQM
JQiBp iBQM
AM/mbi`B H lb2 * b2b

k TT`Q +?
h` +2 #BHBiv .QK BM JQ/2H
6B`bi@Q`/2` _2H iBQM H JQ/2H M/ GQ;B
hvT2 MMQi iBQM M/ h` +2@_2H iBQMb
6Q`K H a2K MiB+b M/ miQK i2/ M HvbB

j .2KQMbi` iBQM
6Q`K H aT2+B}+ iBQM Q7 h` +2 #BHBiv a
h` +2 #BHBiv J M ;2K2Mi
6B`bi@Q`/2` JQ/2H J M ;2K2Mi
miQK i2/ M HvbBb Q7 h` +2 #BHBiv

9 *QM+HmbBQM M/ 6mim`2 qQ`F

R AMi`Q/m+iBQM
JQiBp iBQM
AM/mbi`B H lb2 * b2b

k TT`Q +?
h` +2 #BHBiv .QK BM JQ/2H
6B`bi@Q`/2` _2H iBQM H JQ/2H M/ GQ;B
hvT2 MMQi iBQM M/ h` +2@_2H iBQMb
6Q`K H a2K MiB+b M/ miQK i2/ M HvbB

j .2KQMbi` iBQM
6Q`K H aT2+B}+ iBQM Q7 h` +2 #BHBiv a
h` +2 #BHBiv J M ;2K2Mi
6B`bi@Q`/2` JQ/2H J M ;2K2Mi
miQK i2/ M HvbBb Q7 h` +2 #BHBiv

9 *QM+HmbBQM M/ 6mim`2 qQ`F

R AMi`Q/m+iBQM
JQiBp iBQM
AM/mbi`B H lb2 * b2b
k TT`Q +?
h` +2 #BHBiv .QK BM JQ/2H
6B`bi@Q`/2` _2H iBQM H JQ/2H M/ GQ;B
hvT2 MMQi iBQM M/ h` +2@_2H iBQMb
6Q`K H a2K MiB+b M/ miQK i2/ M HvbB
j .2KQMbi` iBQM
6Q`K H aT2+B}+ iBQM Q7 h` +2 #BHBiv a
h` +2 #BHBiv J M ;2K2Mi
6B`bi@Q`/2` JQ/2H J M ;2K2Mi
miQK i2/ M HvbBb Q7 h` +2 #BHBiv
9 *QM+HmbBQM M/ 6mim`2 qQ`F