;k3PE*%f!<%6%$%s%?%U%'!<%9$rMQ$$$?0[<o>pJs8;E}9gMxMQ;Y1g

?9Eh 8|9† KL@n GnG††

† C^GHBg3XBg3X1!9)3X8&5f2O ††C^GHBg3X EE;R!&>pJs9)3X7O

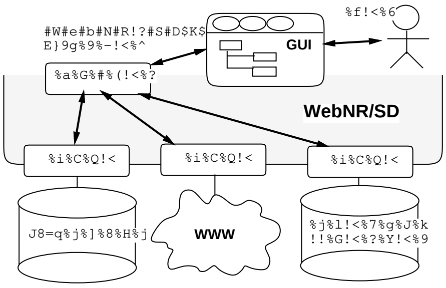
MW;]

6aG/!$%3%s%T%e!<%?%M%C%H%o!<%/$rDL8?3F<o>pJs8;XN%"%/%;%9$,MF0W$HJk$K=>$$!$0[<o>pJs8;$NE}9gMxMQ$,=EMW$J2]BjHJCF$$$k!%2f!9$O!$9=B$2=J8=q%j%]%8%H%j!$Web!$%j%l!<%7%g%J%k%G!<%?%Y!<%9$rBP>]$H7?0[<o>pJs8;E}9gMxMQ4D6-$N8&5f3+H/$r9TJC$F$$$k!%$^$?!$$3li$NE}9gMxMQ$N$?$a$N%G!<%?%b%G%k$H7F!$WebNR/SD$rDs0F7F$$$k!%K\9FGO!$K\4D6-$K$*$1$k;k3PE*%f!<%6%$%s%?%U%'!<%9$N@_7W$K$D$$$F=RYk!%K\;k3PE*%f!<%6%$%s%?%U%'!<%9$NFCD'$O<!$NDLjG$"$k!%(1)%a%?%G!<%?/%G!<%?KBP9$k%V%i%&%8%s%0$HLd9g$;$rM;9g7?BPOCE*>pJsC5::!%(2)0[<o>!&J#;($J%G!<%?9=B$$r;}$D%G!<%?$rBP>]H7$?;k3PE*Ld9g$;8@8l!%5i$KK\9F$G$O!$;k3PE*Ld9g$;8@8l$G5-=R5l$?Ld9g$;$+$i WebNR/SD Be?t<0XNJQ49KD$$$F$b@bL@$9$k!%

1 O8aK

6aG/!$%3%s%T%e!<%?%M%C%H%o!<%/$rDL8?3F<o>pJs8;XN%"%/%;%9$,MF0W$HJk$K=>$$!$0[<o>pJs8;$NE}9gMxMQ$,=EMW$J2]BjHJCF$$$k!%FC$K!$9=B$2=J8=q$O World Wide Web(Web)!$EE;R>&<h0z!$EE;R?^=q4[$H$$$C$?%3%s%T%e!<%?$N?7$7$$1~MQ$GCf?4E*$JF/$-$r7F$*$j!$9=B$2=J8=q$H%G!<%?%Y!<%9$NE}9gMxMQ$,6/$/5aailF$$$k!%

2f!9$O!$9=B$2=J8=q%j%]%8%H%j!$Web!$%j%l!<%7%g%J%k%G!<%?%Y!<%9 (RDB) $rBP>]$H7?0[<o>pJs8;E}9gMxMQ4D6-$N8&5f3+H/$r9TJC$F$$$k [7][8]!%$^$?!$$3li$NE}9gMxMQ$N$?$a$N%G!<%?%b%G%k$H7F!$WebNR/SD $rDs0F$7$F$$$k [8]!%3F>pJs8;Cf$N9=B$2=J8=qH7FO!$SGML$H XML $rA[Dj$7$F$$$k!%K\E}9gMxMQ4D6-$N9=@.$r?^1$K<($9!%$^$:!$%i%C%Q!<$,3F>pJs8;$N%G!<%?$r WebNR/SD $KJQ49$9$k!%%a%G%#%(!<%?$OE}9g%9%-!<%^$HA`:n7O$rDs6!9k!%%f!<%6$O;k3PE*%f!<%6%$%s%?%U%'!<%9 (GUI) rDL8$FK\E}9gMxMQ4D6-$rMxMQ9k!%K\9FGO!$K\4D6-$K$*$1$k GUI $N@_7W$K$D$$$F=RYk!%



?^ 1. E}9gMxMQ4D6-

=>Mh$N%G!<%?%Y!<%9$K$*$1$k%G!<%?A`:n$O!$Ld9g$;$rEjF~8e!$$=$N7k2L$r%V%i%&%8%s%0$9$k$H$$$C$?C1=c$J<j=g$

A Graphical User Interface for Integration of Heterogeneous Information Sources

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4pK\G"$k!%$7$+$7!$0[<o>pJs8;$rBP>]H7$?8=<B$N4D6
K*$$$F$O!$$3Nh$&$JC1=c$J<j=g$G$NE}9gMxMQ$OAjEv:
FqG"kH9M$($ilk!%3l$O<!$NM}M3Kh$k!% (1) BP>]
H9$k>pJs8;$N%G!<%?9=B$$N>pJs$,Bg5,LO!$B?MM!$J#;($
$"$k!%FC$K!$9=B$2=J8=q$d Web $H$$$C$?H>9=B$2= / Hs9=B$
2=%G!<%?K*$$$F$O!$%G!<%?4H$K0[$J$k9=B$$r;}$D!%$
$N7k2L!$Ld9g$;:n@.$KI,MW$JCN<1 (%9%-!<%^>pJs$r;OaH$
$?%a%?>pJs) $N3MF@$,:FqG$"$j!$2?$rI&Ld$$9go;F
$$$N$+$o$+$i$J$$!% (2) %a%?>pJs$r3MF@$7$?$H7F$b!$0[
<o> / J#;($J%G!<%?$,BP>]G"k?$a!$Ld9g$;<0<+BN$,J#;
HJ$j!$:n@.$,:$FqG"$k!%

K\GUI $NL\E*$O!$0J>e$Nh&$J@-<A$r;}$D0[<o>pJs8;$N
E}9gMxMQ$r!$;k3PE*!&BPOCE*5;K!$rMQ$$$F8z2LE*$K;Y1g$
k3HG$"$k!%6qBNE*$JFCD'$O<!NDLjG"$k!% (A) Ld9
$;$rEjF~!$7k2L$r%V%i%&%8%s%0$H$$$C$?C1=c$JMxMQGO$
$/!$%a%?%G!<%?$d%G!<%?$KBP9k%V%i%&%8%s%0$HLd9g$;$
M-5!E*KAH_9go;$?BPOCE*>pJsC5::$N<jCJ$rDs6!$9$k!
(B)GUI $N5!G=$N0lDH7F!$0[<o> / J#;($J%G!<%?$rBP>]
H7$?;k3PE*Ld9g$;8@8l$rMQ0U$7!$Ld9g$;:n@.$NO+NO$ND
8:$r?^$k!%

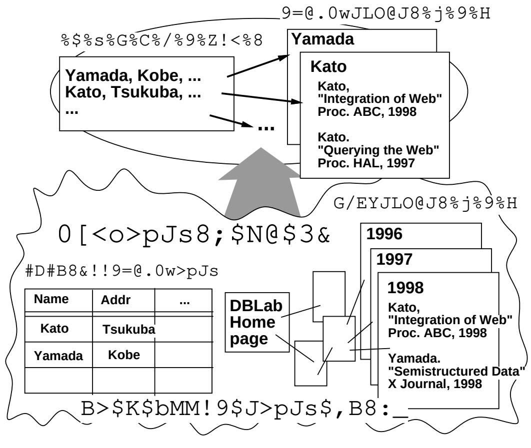
K\9F$O<!$Nh&$K9=@.$5lF$$$k!% 2 >O$G0[<o>pJs8;
$NE}9gA`:nNc$r<($9!% 3 >O$G WebNR/SD KD$$$F@bL@$9
$k!% 4 >O$GK\ GUI $N9M$(J}$H!$K\ GUI $rMQ$$$?E}9gA`:n
$N2aDx$r@bL@9k!% 5 >OGO!$;k3PE*Ld9g$;8@8l$G5-=R$
l?Ld9g$;$r WebNR/SD Be?t<0$XJQ49$9$k<j=g$K$D$$$F
@bL@9k!% 6 >O$G4XO"8&5f$K$D$$$F=RYk!% 7 >OG^Ha
$H:#8e$N2]Bj$r=R$Y$k!%

2 E}9gMxMQNc

0[<o>pJs8;$NE}9gA`:nNc$r<($9!%<!$N2>Dj$r9T$J$&!%$
$kBg3X$N%G!<%?%Y!<%9 (DB) 8&5f<<$K!$?7$7$$3X@8$,G[B0
5l$?!%H`$O!$8&5f<<$N@hGZ$+$i<!NFsD$r65$(il$?!
(a) RDB $K!$8&5f<<$N9=@.0w>pJs (L>A0!$=;=jJI) $,3J
G<5l$F$$$k!% (b) Web >e$K!$DB 8&5f<<K*1kG/EYJL
$N8xI=O@J8%j%9%H$,B8:_$7!$8&5f<<$N%[!<%`%Z!<%8$+$i%
%/%;%92DG=G"$k!% (c) 3liN>pJs8;$O!$E}9gMxMQ4D6-
rDL8$FMxMQ2DG=$G$"$k!%B3$$$F!$3X@8$O<!Nh$&$J;X<
$r<u$1$?!%!VG/EYJL$GJ/!$9=@.0w$4HNO@J8%j%9%H$r3
Web %Z!<%8H7$F:n@.$;$h!%9=@.0w$O!$3X@RHV9f 95000 Bf
0J9_$N<T$rBP>]H;$h!%$^$?!$$=lir^Ha$k%%s%G%
%/%9%Z!<%8$rMQ0U$7!$$=3G$O!$RDB Cf$N9=@.0w>pJs$b
8x3+$;$h!%!W3X@8$O!$E}9gMxMQKD$$$FGyA3H?^ 2 Nh$
J%$a!<%8$r;}C?!%7+$7$3$N;~E@$G$O!$$3$l0J>e$N6
BNE*$JCN<1$r0l@Z;}$?$J$$$H2>Dj9k!%

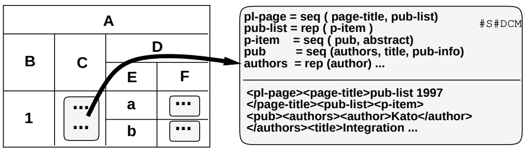
3 WebNR/SD

WebNR/SD $N%G!<%?9=B$$O!$F~$l;R7?%j%l!<%7%g%J%k
%b%G%k$K!$9=B$2=J8=q$r07$&$?aNCj>]%G!<%?7? (SD 7?)
$rF3F~$7$?$bNG$"$k (?^ 3)!%3F9=B$2=J8=q$O!$SD 7?$N
%"%H%_%C%/$JCM (SD CM) H7$F07$olk!%SD CM$O!$J8=q
9=B$$rI=$9 DTD(Document Type Definition) $H!$$=$N
DTD $K=>$C$?%?%0IU$-%F%-%9%H$+$i9=@.5l$k!%%F%-%9%H
Cf$GF1$8L>A0$N%?%0$G6h@Zil$?ItJ,$rMWAG$H8F$V!%

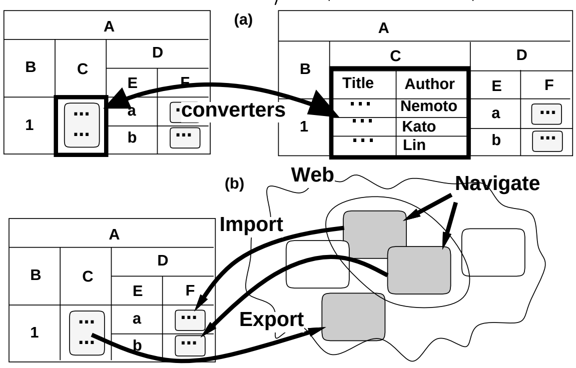


?^ 2. E}9gMxMQNc$N%$%a!<%8

WebNR/SD Be?tGO!$DL>o$NF~$l;R7?%j%l!<%7%g%J%k Be?t1i;;;R$rMxMQ2DG=$J$[$+!$8GM-$N1i;;;RH7$F!$ 9= B$2=J8=q$HF~$l;R7?%j%l!<%7%g%s9=B$$rAj8_JQ49$9$k%3%s %P!<%? (converters, ?^ 4(a)) $H!$ Web %G!<%?A`:n$N$?$a $N1i;;;R Navigate!$ Import!$ Export $r;}$D (?^ 4(b))!% Navigate $O!$ ;XDj$5$l$?>r7o$rK~$?$9 Web %Z!<%8$r8+ $D$1=P$9!% Import $O!$ Web %Z!<%8$r SD CM$H$7$F%j%l!< %7%g%s9=B$$K<h$j9~$`!% Export $O!$ %j%l!<%7%g%s9=B$Cf $N SD CM$r!$?7$?$J Web %Z!<%8H7$F Web $N@$3&$K @8@.$9$k!% WebNR/SD O3li$rMQ$$$F!$9=B$2=J8=q!$ Web!$%j%l!<%7%g%s$NE}9gA`:n$r<B8=$9$k!%



?^ 3. WebNR/SD $N%G!<%?9=B$



?^ 4. WebNR/SD 8GM-$N1i;;;R

0J>eNh$&$K!$ WebNR/SD $O%O%$%V%j%C%I%G!<%?%b%G %k%G$"$k!%9JoA!$0[<o>pJs8;$N%G!<%?$r%0%i%U$J%I$N C10l$NCj>]I=8=$K%^%C%T%s%0$;$:!$9=B$2=J8=q!$ Web!$%j %l!<%7%g%s$r$=$N$^$^$N7A<0$G07$&!%$7$?$,CF!$ 4 >O$G @bL@$9$k GUI Gb!$%f!<%6$O3F>pJs8;$N%G!<%?r=l>$l $=$N$^$^$N7A<0$G8+k3HKJk!%

$3$3GO!$ WebNR/SD Be?t$r9=@.$9$k1i;;;R$N$&$A!$ K\9F$NM}2r$KI,MW$J1i;;;R$N$_$r4JC1$K@bL@$9$k!%$h$j>\ :Y$J@bL@$dB>$N1i;;;R$N@bL@$O [8] $G9T$JCF$$$k!%

%3%s%P!<%?

%W%j%_%F%#%V$J%3%s%P!<%?$H7F!$ Unpack (**U**) $H Pack (**P**) $,$"$k!% Unpack $O!$ SD CMCf$NMWAG72$r4^$`I{%j%l!<%7%g%s9=B$$r:n@.9k!% Pack $O!$I{%j%l!<%7%g%s$r SD CM$KJQ49$9$k!%?^ 5 $O (1) <0$H (2) <0$NE,MQ7k2L$G$"$k!%

$$r_2 := \mathbf{U}_{B \to C(O, D[c \subset d] \ as \ x)}(r_1) \qquad (1)$$

$$r_1 := \mathbf{P}_{C(O, D \ as \ x) \to B}(r_2) \qquad (2)$$

(1) <0Kh$j!$ r_2 $NB0@- C $N3FI{%j%l!<%7%g%s$K$O!$$Q %i%a!<%?$G;XDj$5lkMWAG72$KBP1~$9$k SD CM$,3JG<5l $k!%MWAG72$N;XDjKO%j!<%8%g%sBe?t<0 [3] $rMxMQ$9$k!%$ NNcG$O!$%j!<%8%g%sBe?t<0 $c \subset d$ KhCF!$MWAG7? c $r ;}$DMWAGN&$A!$MWAG d $K4^$^lkbN$r;XDj$7$F$$$k!% r_2 $K (2) <0$rE,MQ9k$H!$3FI{%j%l!<%7%g%s$NB0@- B $N SD CM$r%F%s%W%l!<%HH7$F?7$?$J SD CM$KJQ49$7!$ r_1 $rF@$k!%

r_1:

A	B
1	⟨ b:**seq**(c, d:**rep**(c)), “<c>T1</c><d><c>T2</c><c>T3</c></d>” ⟩

r_2:

A	B	C	
		O	D
	⟨ b:**seq**(c, d:**rep**(c)), “</c>T1</c><d>&x.1;&x.2</d>” ⟩	1	⟨ c, “<c>T2</c>” ⟩
		2	⟨ c, “<c>T3</c>” ⟩

?^ 5. %W%j%_%F%#%V$J%3%s%P!<%?$N<B9TNc

3liN%W%j%_%F%#%V$J%3%s%P!<%?$K2C$(!$J#9g%3%s %P!<%?$rMQ0U$7$F$$$k!%3liO!$%W%j%_%F%#%V$J%3%s %P!<%?$HB>$N1i;;;RrAH_9go;$FDj5A$5lF$*$j!$%W% %_%F%#%V$J%3%s%P!<%?HO0[Jk%Q%i%a!<%?$N;XDjJ}K!$;}$D!% (3) <0$N<B9T7k2L$r?^ 6 $K<($9!%

$$r_4 := \mathbf{U}_{B \to (D[(c \cap 1) \subset_d b] \ as \ x)}(r_3) \qquad (3)$$

r_3:

A	B
1	⟨ b:**seq**(c, c, d:**seq**(c)), “<c>T1</c><c>T2</c><d><c>T3</c></d>” ⟩

r_4:

A	B	D
1	⟨ b:**seq**(c, c, d:**seq**(c)), “&x.1<c>T2 </c><d><c>T3</c></d>” ⟩	⟨ c, “<c>T1</c>” ⟩

r_5:

A	B	C
1	⟨ c, “<c>T1</c>” ⟩	⟨ e, “<e>T2</e>” ⟩

r_6:

A	D
1	⟨ f:**seq**(c, e), “<f><c>T1</c><e>T2</e></f>” ⟩

?^ 6. J#9g%3%s%P!<%?$N<B9TNc

3NJ#9g%3%s%P!<%?$O!$%j!<%8%g%sBe?t<0KhCF;XD 5l$kMWAG$N8D?t$,0l$DG"$k>l9g$KMxMQ5l$k!% (3) <0 GO!$ $(c \cap 1) \subset_d b$ KhCF!$MWAG7? c $r;}$DMWAGN& $A!$MWAG7? b $NMWAG$ND>@\$NI{MWAGG"CF!$$+$DBh 1 H\ L\$K8=lkI{MWAGG"kh$&$JMWAG$r;XDj$7$F$$$k!%3

$G!$ “1” OG0U$NMWAG$NBh 1 I{MWAG$KBP1~$9$k%j!<%8%g%s $N=89g$G$"$k!%3NJ#9g%3%s%P!<%?GO!$I{%j%l!<%7%g%s 9=B$$GOJ$/!$ SD 7?$NB0@- ($3$N<0$G$OB0@- D) $K!$$3$N MWAG$r3JG<9k!%$3$3$,%W%j%_%F%#%V$J Unpack $H0[$J$k E@$G$"$k!%

?^ 6 $O (4) <0$N7k2L$b<($7$F$$$k!%3N%3%s%P!<%?$O!$ J#?t$N SD CM$+iJ$kNs9=B$$r;}Dh$&$J!$?7$?$J SD CM $r:n@.$9$k!%

$$r_6 := \mathbf{P}_{(B,C)\to D:SC,'f'}(r_5) \qquad (4)$$

Export

Export (**E**) $O%j%l!<%7%g%sCf$N SD CM$NFbMF$r;}$D%Z!<%8$r Web >e$K:n@.$7!$$=$N%Z!<%8$r;2>H9k%O%$%Q!<%E%-%9%H%j%s%/$r;}$D SD CM$rF@$k!%?^ 7 $O (5) <0$N<B9TNcG"$k!%

$$r_8 := \mathbf{E}_{B,U,L,G}(r_7) \qquad (5)$$

r_7:

A	B	U	L	G
1	⟨ e:**seq**(f:**rep**(g),h), “<e><f><g>T4</g></f> <h>T5</h></e>” ⟩	http://T.ac.jp/p1.xml	T Univ	a

r_8:

A	B
1	⟨ a:**hlink**, “ T Univ ” ⟩

?^ 7. Export $N<B9TNc

URL

URL generator $\mathbf{URL}_U(r)$ $O!$ r $KB0@-$ U $rDI2C$9$k!% U KO!$B>$H=EJi$J$$?7$?$J URL 72$,3JG<$5lk!%3liN URL $O!$ Export $rMQ$$$F?7$?$J Web %Z!<%8$r:n@.$9$k:]$KMxMQ5l$k!%?^ 8 $K (6) <0$NE,MQ7k2L$r<($9!%

$$r_{10} := \mathbf{URL}_U(r_9) \qquad (6)$$

r_9:

A	B
1	b1
2	b2

r_{10}:

A	B	U
1	b1	http://.../new/1
2	b2	http://.../new/2

?^ 8. URL $N<B9TNc

$=$NB>

%I%a%$%sJQ49;R $\mathbf{A}_{Attr,type}(r)$ $O!$B0@- *Attr* $N%I%a%$%s $r *type* $KJQ99$9$k. $?$@$7!$ *type* $, SD 7?$N>l9g$O!$%E%-%9%H$N%?%0$KMxMQ5l$k6&DL<1JL;R g $rL@<(E*$K;XDj9kI,MW$,$"$k!%

2~L>1i;;;R $\delta_{A\to B}(r)$ $O!$%j%l!<%7%g%s r $NB0@-L> A $r B $KJQ99$9$k!%

4 GUI $rMQ$$$?E}9gMxMQ;Y1g

4.1 4pK\E*$J9M$(J}: 2?$,LdBj$G2?$,FCD’$+

K\@aGO!$K\ GUI $rMQ$$$?%G!<%?A‘:n$N4pK\E*$J9M$($J}KD$$$F=R$Y!$%G!<%?A‘:nK*1kLdBjE@$H!$$=lr=h9k$?$a$NK\ GUI $NFCD’$rhj6qBNE*$K@bL@$9$k!%K\ GUI $rMQ$$$? 2 >O$NE}9gA‘:n$O!$<!$N<j=g$G9T$olk!%

1. %sB?MM!&J#;(!&Bg5,LO$J%G!<%?9=B$$r;}$D%G!<%?72$+$i!$9=@.0w>pJs%G!<%?$+$iJk=89g$H!$G/EYJLO@J8%j%9%H%G!<%?$+$iJk=89g$rF@$k!%J*!$<B:]$K$O!$$=l>lKBP1~9k WebNR/SD $N%j%l!<%7%g%s9=B$$,:n@.5l$k!%
2. 9=@.0wL>$HO@J8$NCx<TL>$rMQ$$$F>e5-$N 2 <oN‘$N%G!<%?$N7k9g$7!$$5iK:F9=@.$r9T$C$F!$MW5a5l$k%G!<%?9=B$$r9=C[9k!%

K\ GUI GO!$<j=g 1 Nh$&$J!VB?MM!&J#;(!&Bg5,LO$J%G!<%?9=B$$r;}$D%G!<%?72$+$i!$A‘:nBP>]HJ$k%G!<%?=89g$r<1JL!&;XDj9k!WA‘:n$r!$ *Target Discovery* $H8F$V!%$^$?!$<j=g 2 Nh$&$J!V%G!<%?=89gKBP7$F%G!<%?$NA*Br$d:F9=@.$JINA‘:n$r9TJ&!W$3Hr!$ *Data Operation* $H8F$V!%01HLE*KO!$K\ GUI Kh$k%G!<%?A‘:n$O3N 2 DrAH$_9go;$k3HKhCF9Tol$k!%

K\Nc$+$ibo$+$kh&$K!$$3$N<j=g$G0[<o>pJs8;$NE}9gMxMQ$r9TJ&:]KO<!$NLdBj$,$"$k!%

(LdBj **1**) Target Discovery $,:$FqG"$k!%$3$NM}M3$O!$BP>]%G!<%?$N%G!<%?9=B$$,B?MM!&J#;(!&Bg5,LOG"$j!$%-!<%^>pJs$r;O$aH7$?%a%?>pJs$N3MF@$,Fq$7$$>e!301Nh&$JF1<o$N%G!<%?r^Ha$k35G0$,B8:_9kHO8B$J$$$?aG$"$k!%Nc$($P!$ Web $+$iG/EYJLO@J8%j%9%H%Z!<%8$rFCDj$9k3HO4JC1GO$J$$!%

(LdBj **2**) %a%?>pJs$r3MF@$7!$A‘:nBP>]$HJk%G!<%?=89g$r;XDj$G$-$?H7Fb!$A‘:nBP>]$H9k%G!<%?9=B$$dMW5a5l$k%G!<%?9=B$$,K\<AE*$KJ#;($J$?$a!$ Data Operation $,J#;($JbNHJ$k!%Nc$($P!$ 2 >ONNcG$O!V9=@.0wJL$NO@J8%j%9%H$r;}$D Web %Z!<%8$H!$$=lr^Ha$k%$%s%G%C%/%9 Web %Z!<%8$r:n@.$7!$$$%s%G%C%/%9%Z!<%8KO%G!<%?$KBP1~$9$k3JG<$5lF$$$k9=@.0w>pJs$rF~$l$h!W$H;XDj9kI,MW$,$"$k!%

K\ GUI $GLdBj 1 $KBP=h$9k?aN%"%W%m!<%A$,!$%a%?%G!<%?$H%G!<%?$KBP9k%V%i%&%8%s%0$HLd9g$;rAH_9go;$?!$BPOCE*>pJsC5::Kh$k Target Discovery $N;Y1g$G$"$k!%BgNL$N%G!<%?$+$i Data Operation $NBP>]$HJk%G!<%?=89g$r9=C[$9k?aK$O!$%a%?%G!<%?KBP9$k%V%i%&%8%s%0$@1GOJ$/!$Ld9g$;$bI,MWG"$k!%$5iK!$BP>]%G!<%?$,H>9=B$2=%G!<%?$dHs9=B$2=%G!<%?$r4^$`$N$G!$%a%?%G!<%?$@$1GJ$/!$%G!<%?KBP9$k%V%i%&%8%s%0$dLd9g$;$bI,MWHJ$k!%K\ GUI GO!$%a%?%G!<%?$H%G!<%?$r0lBN2=7?%V%i%&%8%s%05!9=$H!$%a%?%G!<%?$H%G!<%?KBP9$kLd9g$;$NOHAH$rMQ0U9k!%$^$?!$%V%i%&%8%s%0%W%m%;%9$HLd9g$;%W%m%;%9$N4V$N%b!<%I$d2hLL$N@ZBX$(JI$rGS=|$7!$$3li$NM;9g$r?^$k!%LdBj 2 KBP7FO!$0[<o!?J#;(%G!<%?$rBP>]H7$?;k3PE*Ld9g$;8@8l HQBE (Query By Example for Heterogeneous information sources) $rMQ0U$7!$Ld9g$;:n@.O+NO$NDc8:$r?^$k!%

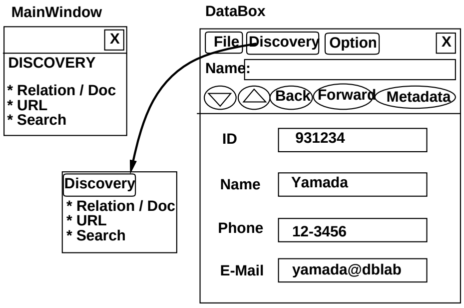
4.2 GUI $N9=@.MWAG

K\ GUI $N<gMW$J9=@.MWAG$O!$ 0[<o%G!<%?72KBP7$F Target Discovery $r9T$J$&:]$N5rE@HJ$k MainWindow $H!$ <1JL!&;XDj5l$?3F%G!<%?=89g$rI=<(9k DataBox G"$k (?^ 9)!%0J2<$G$O!$ FC$K:.Mp$N$J$$8B$j%G!<%?=89g$H DataBox $rF10l;k$9$k!% MainWindow GO!$ <!$N Target Discovery $N<jCJ$rMxMQ2DG=G"$k!%

- >pJs8;L>$H!$%j%l!<%7%g%sL>$dJ8=q%j%]%8%H%jCf$NJ8=q%3%l%/%7%g%sL>$rD>@\;XDj$7!$%?%W%k$dJ8=q$N=89g$rI=<(9k DataBox $r:n@. (Relation / Doc)

- URL $r;XDj$7!$$=$N%Z!<%8$@1r;}$D DataBox $r:n@. (URL)

- %a%?%G!<%?$d%G!<%?$K4X9k8!:w>r7oJI$r;XDj$7!$$=1K01CW9k%G!<%?=89g$r;}$D DataBox $r:n@. (Search)



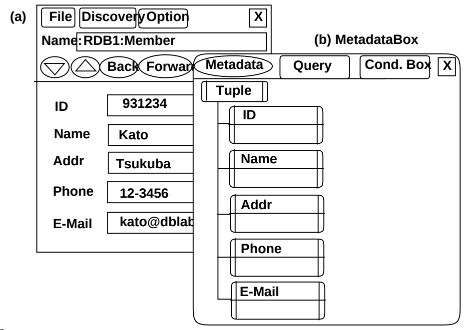
?^ 9. GUI $NCf?4$HJkFsDN%&%$%s%I%&

DataBox GO!$!V"&!W!V"$!W%\%?%s$rMQ$$$F!$ %G!<%?=89g$N%V%i%&%8%s%0$r9T$&!%$^$?!$ Discovery %a%K%e!<$+$i$O!$ MainWindow $HF1$85!G=$r8F$S=P$9$3H,2DG=G"$k!% MainWindow $N >l9g$H0[JkE@$O!$?7$?$J DataBox $r@8@.$;$:!$ $=$N DataBox <+?H$NFbMF$,JQ99$5$1kH$$$&3HG"$k!%!VBack!W!VForward!W%\%?%s$G!$$=$N DataBox $GI=<($5$1$F$$$?%G!<%?=89g$NMzNr$r$?$Ik3H,G-$k!%$^$?!$ DataBox $+$i$N Search $O<!$Nh&$K5!G=$,3HD%$5$1$F$$$k!%9JoA!$8=:_ DataBox $KI=<($5$1$F$$$k>pJs$rMxMQ$7$? Target Discovery $r9T$J$&$3H,G-$k!%$3$1$K$D$$$F$O<!@a$G@bL@9k!%

4.3 BPOCE*>pJsC5::

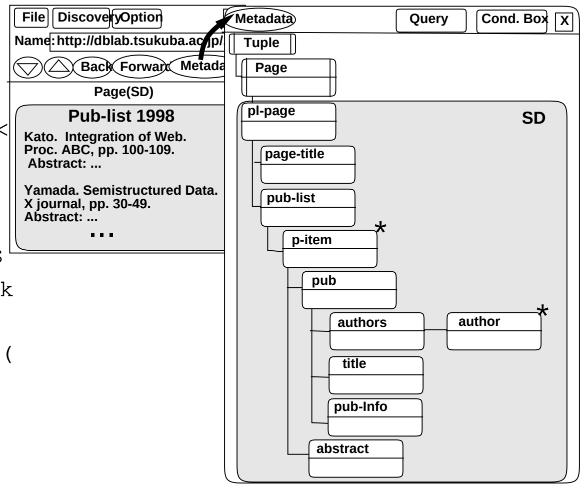
K\ GUI GO!$ Target Discovery $r!$%a%?%G!<%? / %G!<%?KBP9$k%V%i%&%8%s%0$HLd9g$;$rAH$_9g$o$;$?BPOCE*>pJsC5::KhCF9T$&!% 2 >O$NNcGO!$9=@.0w>pJs%G!<%?=89g$KBP1~9k DataBox $H!$G/EYJLO@J8%j%9%H%Z!<%8=89g$KBP1~$9$k DataBox $r!$$=1>$1:n@.$9kI,MW,$"$k!%

9=@.0w>pJs%G!<%?=89g$KBP1~$9$k **DataBox** $r:n@. MainWindow $+$i Relation/Doc %a%K%e!<$rA*$V$H!$>pJs8;H=1>$1K3JG<$5$1$F$$$k>pJs (%j%l!<%7%g%s$d DB 8&5f<<$N9=@.0w>pJs%j%l!<%7%g%s$H;W$o1kbN$rA*Br$9kH!$$=$N%j%l!<%7%g%s$KBP1~9k DataBox $,@8@.$5$1$k (?^ 10(a))!% Metadata %\%?%s$r2!$9$H!$ MetadataBox(?^ 10(b)) $,=P8=$7!$%j%l!<%7%g%s$N%a%?%G!<%?$rI=<($9$k!%$3Nh$&$K!$%G!<%?$H%a%?%G!<%?$r01BN2=$7$?%V%i%&%8%s%0$,Ds6!$5$1$k!%$b$7%j%l!<%7%g%s$r%V%i%&%8%s%0$7$?7k2L!$ DB 8&5f<<$N9=@.0w>pJs%j%l!<%7%g%s$G$J$$$3H,H=1P!$ Discovery %a%K%e!<$+$i Relation/Doc $r:F$SA*Br$7!$%V%i%&%8%s%0$r B39T$9$k!%0J2<$G$O!$$3$3$G:n@.7? DataBox $r D1 $H8F$V!%



?^ 10. %a%?%G!<%?$d%G!<%?$r%V%i%&%8%s%0$9$k3HKh$j DB 8&5f<<$N9=@.0w>pJs$r;}$D DataBox (D1) $r:n@.

G/EYJLO@J8%j%9%H%Z!<%8=89g$KBP1~$9$k **DataBox** $r:n@. MainWindow $G URL %a%K%e!<$rA*$S!$ DB 8&5f<<$N%[!<%`%Z!<%8$N URL $rF~NO$9$k$H!$$=$N%Z!<%8$@$1$r4^$` DataBox $,@8@.$5$1$k!%0J2<GO!$$3$N DataBox $r D2 $H8F$V!%DL>o$N Web %V%i%&%6$HF1MM$K!$%[!<%`%Z!<%8Cf$N%O%$%Q!<%F%-%9%H%j%s%/r?Ik3H$,$G$-$kNG!$ Web $N%V%i%&%8%s%0$r9T$$!$G/EYJL8xI=O@J8%j%9%H$rC5$9!%?^ 11 O?IjCe$$$?H3mG$"$k!%%a%?%G!<%?$r8+$k3HKh$j!$$3$N%Z!<%8$NJ8=q9=B$$,H=L@9k!%



?^ 11. G/EYJLO@J8%j%9%H$r%V%i%&%8%s%0$KhjC5:w (D2)

5i$K%V%i%&%8%s%0$KhC$F!$ Web $KB8:_$9$kB>$NG/EYJLO@J8%j%9%H%Z!<%8$rD4$Yk&AK!$<!$N;v<B$,H=L@$7$?!%(1) A4$F$NO@J8%j%9%H%Z!<%8$,F10l$NFbIt9=B$$r;}Do1GOJ$$!$$"$k%Z!<%8$O!$O@J8$4HKMW;]$,$D$$$F$$$k!%JL$N%Z!<%8$O!$O@J8$r%W%m%8%'%/%H4H$KJ,N`$7$F$$$k!%(2) $7$+$70J2<$N 2 E@$OA4$F$N%Z!<%8$G6&DL$7$F$$$k!%$^$:!$A4$F$N%Z!<%8$K page-title %?%0$,$"$j!$$=$3$K$OJ8;zNs “Pub-list” $,I,$:4^$^$1$F$$$k!%$^$?!$:Y$+$JJ8=q9=B$$O0[$J$k$b$N$N!$3F%Z!<%8$,A4BN$H$7$F=q;o>pJs$r4^$`$H$$$&9=B$$r;}D3HKOJQoj,$J$$!%A4FN=q;o>pJs$O pub %?%0$G0O$^$1$F$$$k!%

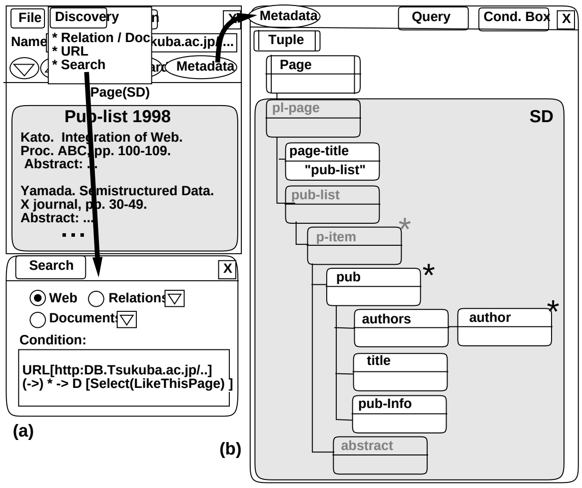
$=$3$G!$$3Nh$&$J9=B$$r;}$DG/EYJLO@J8%j%9%H%Z!<%8$r;}$D DataBox $r:n@.$9$k!%$^$:$O D2 $N Discovery %a%K%e!<$+$i Search $rA*Br$9kH!$>r7oF~NO2hLL$,8=1k (?^ 12(a))!%$3$3$KC5:wHO0O$H!$M_$7$$O@J8%j%9%H%Z!<%8$N>r7o$rF~NO9k!%K\Nc$G$OC5:wHO0OH7$F Web $r;XDj$7!$>r7o$H7F!VDB 8&$N%[!<%`%Z!<%8$+$iE~C#2DG=$G$"$j!$$+$DF10l Web %5!<%P!<$KB8:_9k%Z!<%8N&$A!$8=:_ MetadataBox $KI=<($5$1$F$$$k>r7o$rK~$?$9

9bNrA*Br$;$h!W$H;XDj$7$F$$$k!%<!$K!"D2 Meta-dataBox(G/EYJLO@J8%j%9%H$N9=B$$rI=<(7F$$$k) $r4p$k!%

$K!$>r7o$r:n@.$9$k (?^ 12(b))!%$3$3$G$O!$!Vpage-title $K "pub-list" $r4^$_!$ pub $N7+JV$79=B$$r;}Db$N!W$H;XDj5l$k!% 7F$$$k!%?^ 12(b) $+$ibo$+$kh&$K!$%a?%G!<%?$H%G!<%? 9kLd9g$;>r7o$O!I,MWJ9=B$$0J30$r>C5n$9k3HKhC$F9T$& (>C5n5l$? pub $N?FMWAG p-item $,7+JV$79=B$$r;}CF$$$?NG!$<+F0E*$K pub $K7+JV$79=B$%^!<%/ "*" $,IUM?$5lF$$$k)!%3Nh&$K!$%G!<%?9=B$$,ItJ,E*KDLG"kh$&$J%G!<%? (3N>l9g$OG/EYJLO@J8%j%9%H%8) $N=89g$N9=C[$b;XDj2DG=$G$"$k!%$^$?!$ MetadataBox KO!$%$%s%9%?%s%9$,K~$?9Y$->r7o ($3NNcG$O!Vpage-title $K "pub-list" $r4^$`!W) $bD>@\5-=R$G$-$k!%:G8e$K!$(a) $N Search %\%?%s$r2!9H!$$3$N>r7o$rK~$?$9$Z!<%8$,D2 $K3JG<$5lk!%3Nh&$K!$%a?%G!<%?$H%G!<%?$KhkLd9g$;$r<B8=7F$$$k!%

$,8=$1kN$G!$$=3+$iLd9g$;7k2L$r%V%i%&%8%s%02DG=$G$"$k!%

HQBE $NLd9g$;$O WebNR/SD $NBe?t<0$KJQ49$5$l$F<B$5lk!% HQBE KhCF!$ DataBox Cf$N%G!<%?=89g$K$kC1=c$JA*Br1i;;$d<M1F1i;;$r5-=RG-k3HOJsN3$H!$<!Nh$&$J WebNR/SD $NFCD'$r@k8@E*Jr=R$GMxMQ2DG=$G$"$k!% (1) 9=B$2=J8=q$JINJ#;($J9=B$;}$D%G!<%?$NA`:n$r9T$&!%6qBNE*$K$O!$A*Br$d7k9g1i;$K$C$($F!$?7$?$JF~$l;R9=B$$d%O%$%Q!<%F%-%9%H%j%s%/$r:n@.$G$-$k$,2DG=$J$N$G!$$3$NNc$N$h$&$J#;($J%G!<%?:F9=@.$r<B8=$G$-$k!% (2) $3$NNc$K$*$1$kG/EYJLO@J8%j%9%H$N$h$&$K!$6&DL9=B$$OB8:_$9$k$,B?>/9=B$$,0[$J$k$h$&$J%G!<%?$N=89g$KBP$7$F!$E}0lE*$J%G!<%?A`:n$r9T$&!% (3) Ld9g$;7k2L$N%G!<%?I=8=H7$F!$%j%l!<%7%g%s!$9=B$2=J8=q!$Web%Z!<%8$N%O%$%Q!<%F%-%9%H9=B$$H$$$C$?0[<o%G!<%?I=8=$r;H$$$J,1k!%

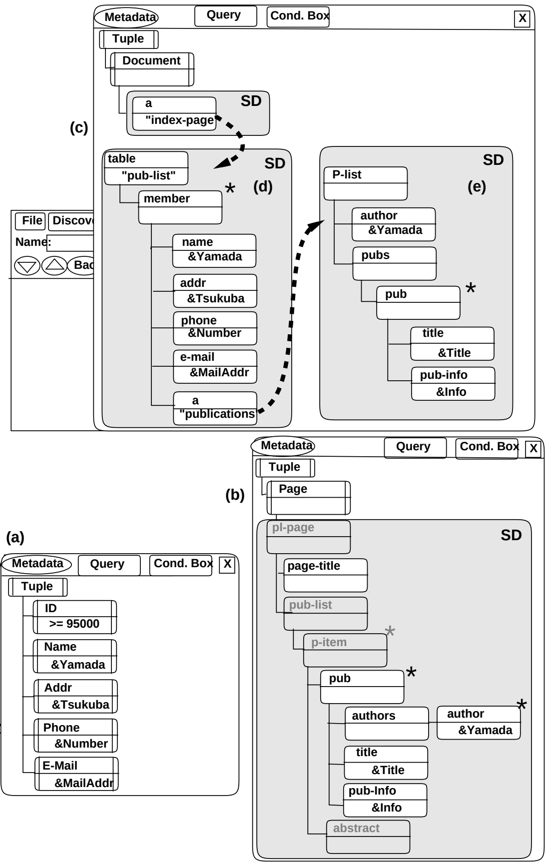


?^ 12. %a%?%G!<%?$H%G!<%?$KBP9kLd9g$;$rMxMQ7F!$ D2 $rG/EYJLO@J8%j%9%H$N=89g$KBP1~$5$;$k

0J>eNh$&$K!$%a%?%G!<%?$d%G!<%?KBP9$kLd9g$;$d%V%i%&%8%s%0$r%7!<%`%l%9$K0\F0$9k3HKhj!$$3li$rM-5!E*$KAH$_9g$o$;$?BPOCE*>pJsC5::$r;Y1g$7$F$$$k!%

4.4 ;k3PE*Ld9g$;8@8l

0[<o!&J#;($JA`:nBP>]%G!<%?$KBP$9$kLd9g$;$N:n@.$r;Y1g$9$k$?$a!$K\ GUI $G$O;k3PE*Ld9g$;8@8l HQBE $rMQ0U$7$F$$$k!%?^ 13 $O!$ 2 >O$NE}9gA`:nNc$GMW5a5l$F$$$k%G!<%?A`:n$r HQBE $G5-=R$7$?$bNG$"$k!% 4.3 @a$G:n@.$7$? DataBox D1 $H D2 $,4{$KB8:_9k$H2>Dj$9$k!%<!$N<j=g$GLd9g$;$r:n@.$9$k!%$^$:!$ D1 $H D2 $N Meta-dataBox($=l>lN%G!<%?9=B$$,I=<(5l$k) $K!$ QBE[10] $HF1MM$NNc<(MWAG ($3$3GO'&' $G;O$^$kJ8;zNs) $d>r7o$r5-=R9k (?^ 13(a)(b))!%B3$$$F!$ Bh;0$N DataBox $ D3 $r?7$?$K@8@.$9$k!%$3lOFCDj$N%G!<%?=89g$KBP1~7J$$6u$N DataBox G"$k (K\ GUI $N%a%K%e!<$K!$6u$N DataBox $r:n@.$9$k5!G=$,B8:_9k)!%7?$,$C$F!$ D3 $N Meta-dataBox $N=i4|>uBV$O%V%i%s%/G"$k!%$3$3$K!$MW5a$5lk%G!<%?$N%G!<%?9=B$$rIA2h$7!$Nc<(MWAG$r5-F~$9$k (?^ 13(c))!%?^ 13 $N (d) $H (e) $,$=l>l%$s%G%C%/%9%Z!<%8$H9=@.0wJLO@J8%j%9%H$rI=$9!%$^$?!$E@@~Lp0u$O%O%$%Q!<%F%-%9%H%j%s%/$rI=8=7F$$$k!%:G8eKN Query %\%?%s$r2!$9!%Ld9g$;$N7k2L$O D3 $=$l$k!%$3NNcG$O!$%$%s%G%C%/%9%Z!<%8$KBP9k%O%$%Q!<%F%-%9%H



?^ 13. ;k3PE*Ld9g$;8@8l$Khj!$9=@.0wJLO@J8%j%9%H%Z!<%8$H%$%s%G%C%/%9%Z!<%8$N:n@.$r;XDj$9$k

7k2L$O DataBox $K3JG<$5lkNG!$$3lr4p$K!$$5iJ$kBPOCE*>pJsC5::$d HQBE Kh$kA`:n$,2DG=G"$k!%

5 HQBE $NLd9g$;$+$i WebNR/SD Be?t<0XNJQ49

K\>OGO!$ HQBE $G5-=R$5l?Ld9g$;$+$i WebNR/SD Be?t<0$X$NJQ49$K$D$$$F@bL@9k!%NcH7$F 4.4 @a$NLd9g$;$rMQ$$$k!%Ld9g$;$r9=@.9k MetadataBox N&$A!$Ld9g$;BP>]$HJk%G!<%?=89g$KBP1~$9$k MetadataBox $r!$ Target MetadataBox $H8F$V (4.4 @aNNcG$O D1 $H D2 $N

MetadataBox)!%$^$?!$Ld9g$;7k2L$N%G!<%?9=B$$rI=8=$9
$k MetadataBox $r!$ Output MetadataBox $H8F$V (D3$N
MetadataBox)!%

0J9_$N5DO@$O!$?^ 13 Nh$&$J?^I=8=$=$NbNGOJ/!$Ld9g$;$r%F%-%9%HI=5-7?$bNKBP7F9TJ&!% Target MetadataBox K*1kLd9g$;5-=R$N%F%-%9%HI=5-$r Target Expression $H8F$S!$ Output MetadataBox Cf$N5-=R$N%F%-%9%HI=5-$r Output Expression $H8F$V!%

5.1 Ld9g$;$N%F%-%9%HI=5-$H0UL#

?^ 13 $NLd9g$;$rI=8=$9$k Target Expression $r<!$K<($9!%

D1 KBP9$k **Target Expression**

```
NULL:R(
    ID:Integer[>= 95000],
    Addr:String[&Tsukuba],
    Name:String[&Yamada],
    Phone:String[&Number],
    E-Mail:String[&MailAddr]
)
```

D2 KBP9$k **Target Expression**

```
NULL:R(
  Page:SD(
    {
      ⊃ pub*
        {
          ⊃d authors.1{⊃d author*[&Yamada]},
          ⊃d title.2[&Title],
          ⊃d pub-info.3[&Info]
        }
    }
  )
)
```

Target Expression $O<!$N 2 DN>pJs$r;}$D!% (1) BP>]%G!<%?$N%G!<%?9=B$!% (2) Nc<(MWAG$H>r7o!% Target Expression K*1k=EMW$J%]%$%s%H$O!$ SD CM$NFbIt9=B$$r!$DL>o$N DTD Kh$k5-=R$hjb4Kd+$K5-=R$7$F$$$k3HG"$k!%$3Nh$&$J SD CM$N9=B$$N5-=R$r Loose Structure Specification $H8F$V!%Ld9g$;$NBP>]%G!<%?$O!$ Loose Structure Specification 5(K~$?$7F*1P!$ DTD $,0[$JCF$$$F$b9=$o$J$$!% Target Expression (Loose Structure Specification $r4^$`) $N9=J8$H0UL#$r<!$K<($9!%

```
TE::= 'NULL:R(' Attr ':' SubSt { ',' Attr ':' SubSt } ')'
                                        // :G$b30B&$N%j%l!<%7%g%s9=B$
SubSt::= 'R' '(' Attr ':' SubSt { ',' Attr ':' SubSt } ')'
                            // I{%j%l!<%7%g%s9=B$
       | 'SD''('  LooseSt ')'
                            //SD CM$N9=B$$O LooseStructure $G5-=R
       | OtherType [ '[' Example | Condition ']' ]
                            // B>$N7?$N8e$m$K$ONc<(MWAG$+
                               >r7o$r$D$1$k$3$H$,$G$-$k

LooseSt::= '{' ContainmentSpec { ',' ContainmentSpec } '}'
           // 3F ContainmentSpec $GI=8=$5$1$kMWAG72$rA4$F4^$`

ContainmentSpec::= SpecElem LooseSt
                    // SpecElem $GI=8=$5$1$kMWAG$r4^$`
                    // $=$NMWAG$NFbIt9=B$$O LooseSt $G$"$k
                | SpecElem '[' Example | Condition ']'
                    // SpecElem $GI=8=$5$1$kMWAG$r4^$`
                    // $3$NMWAG$KNc<(MWAG$+>r7o$rBP1~$5$;$k

SpecElem::= '⊃' gi //gi 7?$N%F%-%9%HMWAG$rFbIt$K01$D4^$`
          | '⊃d' gi '.'  Int // Bh Int I{MWAG$H$7$F
                                  //gi 7?$N%F%-%9%HMWAG$r01$D4^$`
          | '⊃' gi '*' //gi 7?$N%F%-%9%HMWAG$rFbIt$KJ#?t4^$`
          | '⊃d' gi '*' // I{MWAG$H$7$F
                              //gi 7?$N%F%-%9%HMWAG$rJ#?t4^$`
```

7?$,$C$F!$ D2 KBP9$k Target Expression $G;XDj$5$1$F$$$k Loose Structure Specification $O!$<!Nh$&$K2r<a$5$1$k!%

!V3N SD CM$O pub $rJ#?t4^$`!% pub $OBh 1!$Bh 2!$Bh 3 I{MWAG$H$7$F$=$1$>$1 authors!$ title!$ pub-info $r4^$`!% authors $OI{MWAG$H7F author $rJ#?t4^$`!% author, title, pub-info O=1>$1Nc<(MWAG &Yamada!$ &Title!$ &Info $KBP1~$9$k!W

?^ 13 $NLd9g$;$N Output Expression $O<!$Nh&KJ$k!%

Output Expression

```
R_1(Document:SD(
   a:hlink[``indexpage''](
     table:rep_1(
         member:seq(
            name[&Yamada],
            addr[&Tsukuba],
            phone[&Number],
            e-mail[&MailAddr],
            a:hlink[``publications''](
               p-list:seq(
                  author[&Yamada],
                  pubs:rep_1(
                     pub:seq(
                        title:[&Title],
                        pub-info:[&Info]
                     )
                  )
               )
            )
         )
      )
   )
))
```

Output Expression $O!$Ld9g$;7k2L$N%G!<%?9=B$$rI=$9!% Target Expression HO<!$NE@$,0[Jk!% (1)SD CM$NFbIt9=B$$,6qBNE*$J DTD $G;XDj$5$1$F$$$k!% Loose Structure Specification GO$J$$!%3NM}M3$O!$7k2L$N%G!<%?9=B$$r:n@.9k$?$aKO6qBNE*$J9=B$$N;XDj$,IT2D7g$@$+$G$"$k!% (2) I{%j%l!<%7%g%s9=B$ (R) $H!$ SD CMCf$N repetition 9=B$ (rep) $KHV9f$,IU$/!%$3$NHV9f$O!$F10l$NF~$1;R9=B$Cf$KB8:_$9$k R $d rep KBP7$F!$ 1, 2, . . . $H?6$k!%3NHV9f$O Grouping 1i;;$NE,MQ=g=x$r;XDj$7$F$$$k!%9JoA!$ Output Expression $K=>$C$FLd9g$;7k2L$N%G!<%?9=B$$r:n@.9k:]$K!$F10l$NF~$1;R%l%Y%kK*1kJ#?t$N Grouping 1i;;$,!$$3$NHV9f$N=g=x$G9T$Jo1$k!%$3$N;XDj$,I,MW$JM}M3$O!$F10l%l%Y%k$NF~$1;R$GJ#?t$N Grouping 1i;;$r9TJC$?7k2L$O!$$=$N1i;;=g=x$KhC$FF0[$JkaG"$k!%

5.2 JQ49$GF@$ilk **WebNR/SD** Be?t<0

$3$3GO!$ HQBE $G5-=R$5l?Ld9g$;$rJQ49$7$?7k2LF@ il$k WebNR/SD Be?t<0$K$D$$$F@bL@9k!%A`:nBP>]$H Jk3F Databox Cf$N%G!<%?=89g$r!$$=l>$l WebNR/SD $N%j%l!<%7%g%s$H7F07$&!%Ld9g$;O3li$r%*%Z%i%s%F H9$kBe?t<0$H7FI=5l!Bg-$/J,1F<!$N 3 DNItJ, $+$i9=@.5l$k!%

1. Cj=PIt: A`:nBP>]$N%j%l!<%7%g%s72$rJQ7A$7!$$=$l $>$l%U%i%C%H$J%j%l!<%7%g%s$r:n@.9k!%3liN%j %l!<%7%g%s$NB0@-CM$O!$3F Target Expression K*$$ $FNc<(MWAG$d>r7o$,;XDj$5lF$$$kB0@-NCMd%F%-%9 %HMWAG$rCj=P$7$?$bNG$"$k!%

2. A*Br!&7k9gIt: 3F%j%l!<%7%g%s4H$N>r7o$K=>CF$= l>$lA*Br1i;;$r9TJC$?8e!$A4FN7k2L$r7k9g7F 0lDN%j%l!<%7%g%s$r:n@.9k!%

3. :F9=@.It: Output Expression $K=>$C$F%j%l!<%7%g%s $r:F9=@.$9k3HKhj!$MW5a$5lk%G!<%?9=B$$r:n @.9k!%

Ld9g$;$KhCFO3liNItJ,$NA4$F$,B7$&o1GO$J $$!%Nc$($P!$>r7o$K9gCW9k%?%W%k$rA*Br$9k@1NLd9g $;$O!$C1=c$JA*Br1i;;$KJQ49$5lk!%3l$O!$A*Br!&7k9g It$@$1$r;}$A!$$5iK$=$NCfGbA*Br1i;;$@$1$,9T$Jol $F$$$k3HKJ$k!%

5.1 @a$NLd9g$;$+$i:n@.5l$k WebNR/SD Be?t<0$N3F ItH=l>lN<B9T7k2L$r<!$K<($9!%

Cj=PIt:

$$r_1 := \delta_{ID \to CondAttr_1}(\delta_{Addr \to \&Tsukuba_1}(\delta_{Name \to \&Yamada_1}(\delta_{Phone \to \&Number_1}(\delta_{E\text{-}Mail \to \&MailAddr_1}(D1)))))$$

r_1:

CondAttr$_1$	&Tsukuba$_1$	&Yamada$_1$	&Number$_1$	&MailAddr$_1$

$$r_2 := \pi_{\&Yamada_2,\&Title_1,\&Info_1}(\mu_D(\mathbf{U}_{C \to D(O_2,\&Yamada_2[author \subset_d \mathbf{I}])}(\mathbf{U}_{A \to (C[(authors \cap 1) \subset_d \mathbf{I}])}(\mathbf{U}_{A \to (\&Title_1[(title \cap 2) \subset_d \mathbf{I}])}(\mathbf{U}_{A \to (\&Info_1[(pub\text{-}info \cap 3) \subset_d \mathbf{I}])}(\mu_B(\mathbf{U}_{Page \to B(O_1,A[pub \subset \mathbf{I}])}(D2))))))))$$

r_2:

&Yamada$_2$	&Title$_1$	&Info$_1$

A*Br!&7k9gIt:

$$r_3 := \gamma_{\&Yamada_2 \to String}(r_2) \bowtie_{\&Yamada_1 = \&Yamada_2} \sigma_{CondAttr_1 > 95000}(r_1))$$

r_3:

&CondAttr$_1$	&Tsukuba$_1$	&Yamada$_1$	&Number$_1$	&MailAddr$_1$	&Yamada$_2$	&Title$_1$	&Info$_1$

:F9=@.It:

(1) I,MW$JB0@-$N$_$r;D$9

$$r_4 := \pi_{\&Tsukuba_1,\&Yamada_1,\&Number_1,\&MailAddr_1,\&Yamada_2,\&Title_1,\&Info_1}(r_3)$$

(2) 9=@.0wJLO@J8%j%9%H%Z!<%8$r:n@.

$$r_5 := \mathbf{P}_{B(A) \to C:RC,'pubs'}(\nu_{B=(A)}(\mathbf{P}_{(\&Title_1,\&Info_1) \to A:SC,'pub'}(r_4)))$$

$$r_6 := \mathbf{P}_{(\&Yamada_2,C) \to D:SC,'p\text{-}list'}(\gamma_{\&Yamada_2 \to SD(author)}(r_5))$$

(3) 9=@.0wJLO@J8%j%9%H%Z!<%8$r Web >e$K Export

$$r_7 := \mathbf{E}_{D,U_1,'publications','a'}(\mathbf{URL}_{U_1}(r_6))$$

(3) %$%s%G%/%9%Z!<%8$r:n@.$7!$ Web >e$K Export

$$r_8 := \mathbf{P}_{F(E) \to H:RC,'table'}(\nu_{F=(E)}(\mathbf{P}_{(\&Yamada_1,\&Tsukuba_1,\&Number_1,\&MailAddr_1,D) \to E:SC,'member'}(\gamma_{\&MailAddr_1 \to SD(e\text{-}mail)}(\gamma_{\&Number_1 \to SD(phone)}(\gamma_{\&Tsukuba_1 \to SD(addr)}(\gamma_{\&Yamada_1 \to SD(name)}(r_7)))))))$$

$$r_9 := \delta_{H \to Document}(\mathbf{E}_{H,U_2,'index\text{-}page','a'}(\mathbf{URL}_{U_2}(r_8)))$$

r_9:

Document

5.3 JQ49<j=g

$3$3GO!$ HQBE $NLd9g$;$r WebNR/SD Be?t<0$KJQ 49$9$k<j=g$N35MW$r@bL@9k!%

Cj=PIt$N@8@.

A`:nBP>]HJ$k3F%j%l!<%7%g%s R KD$$$F0J2<$r9T$J $&!%

1. R_i $KBP1~$9$k Target Expression TE_i $K=>$$!$ R_i $N F~$l;R7?%j%l!<%7%g%s9=B$$r Unnest 7F%U%i%C%H$J %j%l!<%7%g%s$r:n@.9k e_i^1 $O:n@.$9$k!%$3$N:]!$B0 @-L>$r0J2<$Nh&$KJQ99$9k?aN2~L>1i;;;R (δ) $r DI2C$9$k
   - Hs SD 7?B0@-N&$A!$Nc<(MWAG *&example* $r4^ $`B0@-$NB0@-L>$r *&example$_i$* ($i$ $OF1$8Nc<(MWAG $r;}$DB0@-$r6hJL$9k?aNHV9f) $KJQ99
   - >r7o$r4^$`Hs SD B0@-L>$r CondAttr$_i$ $KJQ99!% $3$3$G!$ i $O<B:]$N>r7o$r<1JL$9k?aN ID $G $"$k!%Nc$($P!$ 5.2 @aGO>r7o [> 95000] $K ID '1' $r7k$SIU1k$?$a!$ CondAttr$_1$ $K4X$9$k>r7o $, > 95000 G"kH$$$&>pJs$,J]B8$5lk!%

2. TE_i Cf$NA4$F$N Loose Structure Specification LS_j $K4p$E$-!$ Unnest $H Unpack NJBS$r e_i^1 $KDI2C$7!$ e_i^2 H9$k!%$3$N:]!$ Unpack $KMQ$$$ilk%j!<%8%g%s Be?t<0$N@8@.$r LS_j $K4p$E$$$F9TJ&!%Nc$($P!$ LS_j LS Cf$N9=B$ $\supset_d$ *title*.2 $+$i!$%j!<%8%g%sBe?t<0 $(title \cap 2) \subset_d$ $\mathbf{I}$ $,@8@.$5lk!%$3$3$G!$ $\mathbf{I}$ $O SD CM$r9=@.9k :G>e0L$NMWAG$N$_$r4^$`%j!<%8%g%s=89g$G$"$k!%

A*Br!&7k9gIt$N@8@.

1. Cj=PIt$G@8@.$5l?3F R_i KBP9$k<0 e_i^2 KBP7$F!$ B0 @- CondAttr$_j$ $K4X$9$kA*Br1i;;$rDI2C$7!$ e_i^3 H9 $k!%

2. A4FN?<0$r7k9g$9$k1i;;;R$rDI2C$7H$9$k!%$3 3G$O!$B0@- &example $N &example ItJ,$,01CW$9 $kB0@-$K4X7FEy7k9g$r9T$J$&!%$3$N:]!$Hf3SBP>]$H JkB0@-$N7?$,IT01CWG"$k>l9g$O!$ String 7?$KJQ49 7?>e$GHf3S$r9TJ&!%

:F9=@.It$N@8@.

1. Output Expression OE NCfKB8:_9kNc<(MWAG$rD4 $Y!$I,MW$JB0@-$N$_$r;D$9<M1F1i;;$rDI2C$7!$ e_B H9$k!%

2. OE $G;XDj$5lF$$$k%G!<%?9=B$:n@.$9k?aN!$ Nest!$ Pack!$ Export!$$JIN1i;;;R$rDI2C$7!$:G=* <0$rF@$k!%$3$N:]!$F10l%l%Y%kGN Nest 1i;;$O!$ OE $NF10l%l%Y%k$G$N'R' $d'rep' $KIUM?$5lF$$$kHV9f$K =g$K<B9T5lkh$&!$<0$r:n@.$9$k!%

6 4XO"8&5f

K\8&5f$NFCD'$O!$0[<o>pJs8;$NE}9gMxMQ%W%m%;%9$r!$ Target Discovery $H Data Operation $NAH9g$;G"kH%b %G%k2=$7!$;k3PE*!$BPOCE*$J;Y1g5!9=r=l>lKBP7F MQ0U7?3HK"$k!%K\ GUI GO!$$3li$N4V$r%7!<% %l%9$K0\F02DG=$J$?$a!$MxMQ<T$,0U<1$9$kI,MWOJ$$$b$N $N!$>e5-NFsD$N%W%m%;%9$KBP9k;Y1g5!9=$N>GE@$KO= 3N$J0c$$$,$"$k!%0J2<GO$=$l$>$lKBP7$F4XO"$N?<$$$$ $/$D$+$N8&5fKD$$$F=RYk!%

Target Discovery GO!$%G!<%?$H%a%?%G!<%?$=$l$>$l$K BP$9$kLd9g$;$H%V%i%&%8%s%0$rM-5!E*KAH_9go;$?BP OC7?A`:n$,MW5a$5$l$k!% PESTO[2] $O%$%s%9%?%s%9$KBP$9 $kLd9g$;$H%V%i%&%8%s%0$N6hJL$r0U<1$7$J$$$h$&@_7W$5 $l$F$$$k!% VQL[6] $O%$%s%9%?%s%9$KBP$7$F$@$1$G$J$/!$ %a%?%G!<%?$KBP$7$F$bLd9g$;$,2DG=$J;k3PE*8@8l$G$"$k!% OPOSSUM[5] $O%a%?%G!<%?$r;k3P2=$7!$%V%i%&%8%s%0$r ;Y1g$9$k%7%9%F%`$G$"$k!% [4] $N>GE@$OH>9=B$2=%G!<%?$K BP9k%a%?%G!<%?$N:n@.$G$"$k$,!$%a%?%G!<%?$N%V%i%&%8 %s%0$K$D$$$F$b?($l$F$$$k!%0J>e$N8&5f$O!$%a%?%G!<%?/ %G!<%?$KBP9kLd9g$;$H%V%i%&%8%s%0$NM;9g$H$$$&4QE@$+ $i8+$?>l9g!$FCDj$NAH9g$;$N$_$rDs6!7?bN$H$$$($k!%

Data Operation GO!$0[<o>!&J#;($J9=B$$r;}$D%G!<%?$r BP>]H7$?!$%G!<%?9=B$:F9=@.G=NO$,MW5a5l$k!%K\ GUI $N HQBE $O!$ QBE[10] $r%Y!<%9$K!$$3li$N5!G=$r<B8= 7?bNG"$k!% STBE[9] $H VISUAL[1] $O!$Ld9g$;7k2L H7$F!$?7$?$JF~$l;R9=B$$r;}$D%G!<%?$r9=C[2DG=$J;kBP E*Ld9g$;8@8lG"$k!%$3li$N8@8l$G$O!$Ld9g$;$NBP>]$H Jk%G!<%?=89g$,!$F10l$N%G!<%?9=B$$K=>CF$$$kI,MW$, $"$k!%3lKBP7!$ HQBE GO!$BP>]%G!<%?A`:n$K4X7F 6&DL$N@-<A$rM-7F$$$l$P!$ 0[Jk9=B$$r;}$D%G!<%?$N8! 9g$r!$Ld9g$;$NBP>]H9k3H,2DG=G"$k!%$5iK!$Ld 9g$;7k2L$NI=8=$H7F!$%j%l!<%7%g%s!$9=B$2=J8=q!$ Web $N%O%$%Q!<%F%-%9%H9=B$$H$$$C$?0[<o>$N%G!<%?I=8=$r;H$$ J,1ilk3H$bFH<+$NFCD'$N0l$DG"$k!%

7 $*$ojK

K\9FGO!$9=B$2=J8=q!$ Web!$%j%l!<%7%g%J%k%G!<%? %Y!<%9$rBP>]$H7?0[<o>pJs8;E}9gMxMQ4D6-K*1k GUI KD$$$F@bL@7?!%K\ GUI $O!$<!$NFCD'$Khj!$0[<o>pJs 8;E}9gMxMQA`:n$r;Y1g9k!% (1) %a%?%G!<%? / %G!<%?$KBP 9k%V%i%&%8%s%0$HLd9g$;$rM;9g7?BPOCE*>pJsC5::!% (2 0[<o>!&J#;($J%G!<%?9=B$$r;}$D%G!<%?$rBP>]H7$?;k3PE Ld9g$;8@8l!%

$#8e$N2]BjH7FO<!Nh$&$JbN$,$"$k!% (1) hjB? ?t$N>pJs8;$,@\B3$5lF$$$k>u67XNBP1~!%6qBNE*KO! %a%?%G!<%?$d%G!<%?$NMWLs$N:n@.$d!$$3li$rMQ$$$?>pJ 8;$NC5:w$N;Y1g!% (2)DTD NJ$$ XML J8=qJI$N!$%a%? %G!<%?$,L@<(E*$KB8:_7J$$%G!<%?$+$i!$%a%?%G!<%?$rC =P9k5!9=$N3+H/!% (3) K\ GUI!$FC$K HQBE $N5-=RNO$N J,@O!%

8=:_!$K\ GUI $N%W%m%H%?%$%W%7%9%F%`$r9=C[Cf$G$"$k!%

<U<-

K\8&5f$N0lIt$O!$J8It>J2J3X8&5fHqJd=u6b=EE@NN0h8&5 !V9bEY%G!<%?%Y!<%9!W (08244101)!$4pHW8&5f (C)(09680321)! JiSKC^GHBg3X!VEl@>8@8l J82=$NN`7?O@!WFCJL%W%m%8% %/%H$N=u@.$Khk!%

:29MJ88%

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