PSTricks Macros for Databases*

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Abstract

The *pst-dbicons* package (originally called *dbicons only) provides some use-ful macros in the database area. It focusses on typesetting ER-Diagrams in a declarative style, i.e., by positioning some nodes and defining the position of all other nodes relative to them by using the standard database terminol-ogy. The PSTricks package is required for using pst-dbicons, but there is no deep knowledge of PSTricks commands required (although this is useful for exploiting the full functionality).*

1 Commands

1.1 ER-Diagrams

ER-Diagrams are a widely used graphical representation formalism for conceptual modeling; especially used in the database community. Their main notions are *entities* (e.g., persons, cities, or countries), *attributes* of entities (e.g., name, id-number, age), and relationships between entities (e.g., belongs_to, is_capital_of).

`\seticonparams` With

$\qquad$ `\seticonparams{`⟨*icon-type*⟩`}{`⟨*graphics parameters*⟩`}`

the graphical layout of icons (entities, relationships, and attributes) can be specified (by giving the optional argument for PSTricks' boxes). Default is `[fillstyle=none]` for all of them. in this documentation, we modify it to

```
\seticonparams{entity}{shadow=true,fillcolor=lightgray,fillstyle=solid}
\seticonparams{attribute}{fillcolor=lightgray,fillstyle=solid}
\seticonparams{relationship}{shadow=true,fillcolor=lightgray,fillstyle=solid}
```

From the user's point of view, every ER-icon (entities, relationships, attributes) has a name which should be typeset in the respective box. Additionally, there are

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internal identifiers of the boxes/nodes to allow for referencing by graphics commands in the standard PSTricks way. These *internal id*'s must start with a letter and must contain only letters and digits. In general, id's must be unique on every page.[1] Often, the *name* of the entity/relationship/attribute satisfies these conditions; in these cases, the name is also used as id. in other cases, name and id must be specified.

Thus, for all commands for typesetting ER-icons, the node id *must* be given, whereas the name to be typeset in the box is optional; if no name is specified, the id is typeset as the name.

1.2 Entities and Attributes
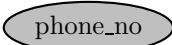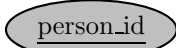
\entity   With

$$\entity[\langle property\rangle]\{\langle id\rangle\}[\langle text\rangle]$$

an entity type is set as a rectangular node. If the optional argument $\langle text\rangle$ is not given, $\langle id\rangle$ also provides the entity's text. $\langle property\rangle$ is used for *weak* entitiy types which are denoted by double lines:

Here is a simple entity \entity{Person}   Person   where Person serves also as

node text; \entity[weak]{cty}[City]   City   makes up a weak entity type where

the displayed name is different from the internal name.

\attribute   Attribute icons are set as an oval nodes by

$$\attribute[\langle property\rangle]\{\langle id\rangle\}[\langle text\rangle]$$

Here, the optional argument $\langle property\rangle$ can take the values mv (multivalued; resulting in a double-lined oval) or key (key attribute; resulting in underlining the attribute name). Here are three attributes:

- an ordinary one, \attribute{phone}[phone_no]   phone_no   ,

- a multivalued attribute, \attribute[mv]{nickname}   nickname   ,

- a key attribute, \attribute[key]{pid}[person_id]   person_id   .

Note that with *phone_no*, the optional argument is used for the node text (in case that the node text contains stuff that is not allowed in internal postscript ids – as a rough rule, only characters (and since dbicons v1.14, underscores) are allowed in ids).

\attributeof   In Section 1.3, relationship nodes are defined analogously. At first, it is described
\attrdist   how to attach attributes with entities:

$$\attributeof\{\langle id\rangle\}[\langle dist\rangle]\{\langle angle\rangle\}[\langle property\rangle]\{\langle id_2\rangle\}[\langle text\rangle]$$

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[1] people who are familiar with PSTricks know under which conditions non-unique node identifiers can be used.

typesets an attribute node at angle ⟨*angle*⟩ in distance ⟨*dist*⟩ from the node which is identified by ⟨*id*⟩ (which can be either an entity node or a relationship node). The attribute is made a node named ⟨*id*₂⟩. ⟨*id*₂⟩ and ⟨*text*⟩ work as for `\entity`. The argument ⟨*dist*⟩ is optional, it has not to be given with *every* attribute. By `\attrdist{`⟨*dist*⟩`}`, this value can be set to a default (as startup default, 2em is set).
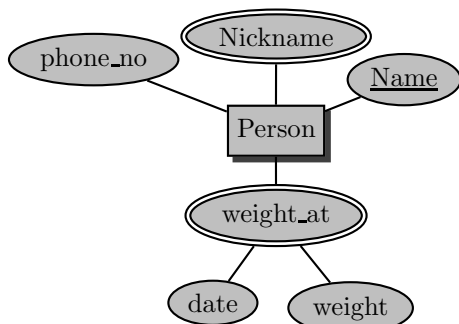

```
\entity{Person}
\attributeof{Person}{30}[key]{Name}
\attributeof{Person}{90}[mv]{Nickname}
\attributeof{Person}{4em}{150}
            {phone}[phone\_no]
\attributeof{Person}{270}[mv]{wt}[weight\_at]
\attributeof{wt}{220}{date}
\attributeof{wt}{300}{weight}
```

Note that *phone_no* is set with a bigger distance to *person*. Additionally, the example shows how complex attributes can be set with these commands.

1.3 Relationships

`\relationship`   With `\relationship[`⟨*property*⟩`]{`⟨*id*⟩`}[`⟨*text*⟩`]`, a relationship type is set as a diamond-shaped node. Here, the optional argument ⟨*property*⟩ is used to represent *identifying* relationships, used for *weak* entities – thus ⟨*property*⟩ can be equivalently `weak` or `ident` which results in a double-lined relationship type.

`\relationshipbetween`   For declaratively specifying nodes representing relationships between entities,

$$\texttt{\textbackslash relationshipbetween[}⟨property⟩\texttt{]\{}⟨entity\text{-}is_1⟩\texttt{\}\{}⟨entity\text{-}id_2⟩\texttt{\}}$$
$$\texttt{\{}⟨relationship\text{-}id⟩\texttt{\}[}⟨relationship\text{-}name⟩\texttt{]}$$

is used (which can be augmented with several optional arguments). In the simplest version, as given above, a relationship node is set in-between two entity nodes:

```
\entity{Person} \hspace*{6cm} \entity{Company}
\relationshipbetween{Person}{Company}{worksat}[works\_at]
```


Additionally, the *roles* of the entities in the relationship, and the cardinalities can be given (both as independent optional arguments):

```
\relationshipbetween[⟨property⟩]
    {⟨entity-id₁⟩}(⟨role₁⟩)[⟨card₁⟩]
    {⟨entity-id₂⟩}(⟨role₂⟩)[⟨card₂⟩]
    {⟨relationship-id⟩}[⟨relationship-name⟩]

\entity{Country} \hspace*{6cm} \entity{City}
\relationshipbetween{Country}(of)[1:1]{City}(is)[0:1]{capital}
```

Moreover, the placement of the relationship node wrt. the entities can be specified: above, the relationship node was put in the middle of an imaginary line in-between the entity nodes.

As a first, small, extension, the placement ratio of the diamond between the entities can be changed (default: 0.5):

`\relationshipbetween[`$\langle property \rangle$`]{`$\langle entity\text{-}id_1 \rangle$`}...{`$\langle entity\text{-}id_2 \rangle$`}...`
`    {`$\langle relationship\text{-}id \rangle$`}[`$\langle relationship\text{-}name \rangle$`](`$\langle placement\text{-}ratio \rangle$`)`

```
\entity{Country} \hspace*{6cm} \entity[weak]{City}
\relationshipbetween[ident]{Country}[0:n]{City}[1:1]{in}(0.8)
```
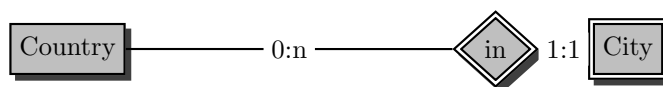

If this is still not enough, instead of an imaginary straight line, any other PSTricks node connection command can be used, most likely `\ncarc[...]` with suitable optional arguments:

`\relationshipbetween[`$\langle property \rangle$`]`
`    {`$\langle entity\text{-}id_1 \rangle$`}...{`$\langle entity\text{-}id_2 \rangle$`}...`
`    {`$\langle relationship\text{-}id \rangle$`}[`$\langle relationship\text{-}name \rangle$`]`
`    /`$\langle connection \rangle$`/(`$\langle placement\text{-}ratio \rangle$`)`

```
\entity{Country} \hspace*{6cm} \entity{City}
\relationshipbetween{Country}[0:n]{City}[1:1]
    {in}/\ncarc[arcangle=20]/(0.4)
```
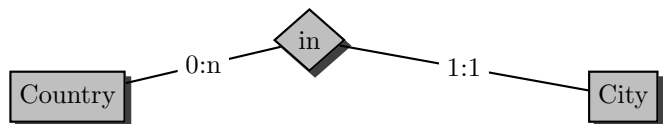

For TeX-insiders: Note that the use of `/.../` as argument delimiter avoids collisions with the delimiters used by PSTricks which thus can be used inside `/.../`.

In the above example, although the relationship is placed on an imaginary arc, the *connections* are straight lines. For these lines, PSTricks commands can be given, too. With this, the *full* syntax is

`\relationshipbetween[`$\langle property \rangle$`]`
`    {`$\langle entity\text{-}id_1 \rangle$`}(`$\langle role_1 \rangle$`)[`$\langle card_1 \rangle$`]/`$\langle connection_1 \rangle$`/`
`    {`$\langle entity\text{-}id_2 \rangle$`}(`$\langle role_2 \rangle$`)[[`$\langle card_2 \rangle$`]/`$\langle connection_2 \rangle$`/`
`    {`$\langle relationship\text{-}id \rangle$`}[`$\langle relationship\text{-}name \rangle$`]/ `$\langle connection \rangle$`/(`$\langle placement\text{-}ratio \rangle$`)`

where all arguments embraced with `(...)`, `[...]`, or `/.../` are optional.

With this, an example can be given where two different relationships can hold between a pair of entity types:

```
\entity{Country} \hspace*{6cm} \entity{City}
\relationshipbetween{Country}[0:n]{City}[1:1]{in}
/\ncarc[arcangle=20]/(0.4)
\relationshipbetween{Country}[1:1]/\ncarc[arcangle=-18]/
    {City}[0:1]/\ncarc[arcangle=-12]/
```

```
{Capital}/\ncarc[arcangle=-30]/(0.6)
```
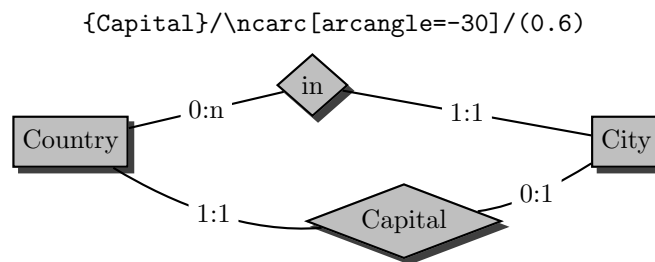

Note that for *capital*, `\ncarc` is used for the lines, where the `arcangle` of the whole arc is divided suitably to the placement ratio of the diamond node, and that the `arcangle` of the second entity is negative (since the connection always points from the entity to the relationship).

There is one more interesting special case of binary relationships: recursive relationships. There, the entity node cannot be set "between" the nodes – it has to be placed relative to the entity type which is involved in the relationship.

In this case, the argument ⟨*connection*⟩ has no effect, and last argument (⟨*placement ratio*⟩) has the syntax (⟨*distance*⟩,⟨*angle*⟩): the relationship node is set at angle ⟨*angle*⟩ in distance ⟨*dist*⟩ from the entity node. The default for ⟨*connection*₁⟩ and ⟨*connection*₂⟩ is set to `\ncarc[arcangleA=10,arcangleB=45]}` and `\ncarc[arcangleA=-10,arcangleB=-45]`, respectively.

```
\hspace*{6cm}\entity{Country}
\relationshipbetween{Country}(A)[0:n]{Country}(B)[0:n]
        {Neighbor}(8em,180)
```
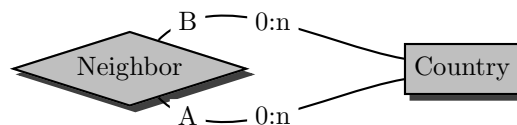

With the above commands, only binary relationships can be represented. Thus, there is one more macro, relating entity nodes with already existing relationship nodes:

> `\inrelationship[`⟨*property*⟩`]{`⟨*entity-id*⟩`}(`⟨*role*⟩`)[`⟨*card*⟩`]`
>   `/`⟨*connection*⟩`/{`⟨*relationship-id*⟩`}`

With this, n-ary relations can be represented:

```
\begin{tabular}{c}
\entity{Person} \hspace*{6cm} \entity{Project} \\[2cm]
\entity{Machine}
\end{tabular}
\relationshipbetween{Person}{Project}{worksatwith}[works\_at\_with]
        /\ncarc[arcangle=-20]/
\inrelationship{Machine}{worksatwith}
```
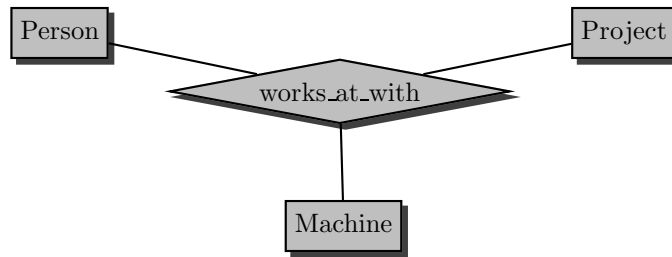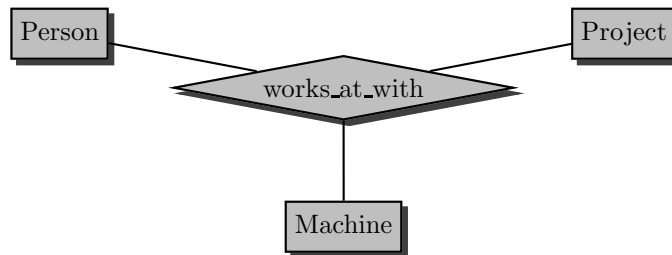
Additionally, there is a straightforward extension of \inrelationship to relationship nodes which do not already exist but are set by the command:

> \inrelationship{⟨*entity-id*⟩}(⟨*role*⟩)[⟨*card*⟩]/⟨*connection*⟩/
> {⟨*relationship-id*⟩}[⟨*relationship-name*⟩](⟨*distance*⟩,⟨*angle*⟩)

```
\begin{tabular}{c}
\entity{Person} \hspace*{6cm} \entity{Project} \\[2cm]
\entity{Machine}
\end{tabular}
\inrelationship{Machine}{worksatwith}[works\_at\_with](4em,90)
\inrelationship{Person}{worksatwith}
\inrelationship{Project}{worksatwith}
```


\rolepos The position where roles and cardinalities are placed on the node connection is
\cardpos determined by \rolepos and \cardpos which can be set by \rolepos{⟨*number*⟩}
and \cardpos{⟨*number*⟩}, where number underlies the same constraints as for npos
in PSTricks (i.e., for \ncline and \ncarc, it has to be between 0 and 1, other
values are allowed e.g. for \ncbar). The default setting is \cardpos{0.5} and
\rolepos{0.85}.

1.4 Annotations to Objects

\annote With

> \annote{⟨*id*⟩}{⟨*text*⟩}(⟨*distance*⟩,⟨*angle*⟩)

a node ⟨*id*⟩ can be annoted with a comment ⟨*text*⟩.

1.5 Usage

The package is intended to be used for two purposes:

- Typesetting small fragments of ER-diagrams, e.g., for lecture notes and slides: as shown in the above documentation, fragments of ER-diagrams can easily be integrated with the running text.

- Typesetting ER-Diagrams for project documentation: here the standard procedure is to design the ER-diagram based on a `tabular` environment in which the entity nodes are positioned; Then, attributes and relationships are positioned in the above declarative way. Using basic PSTricks commands, additional entity nodes can also be placed declaratively.

There are the following advantages compared to using graphics tools, e.g., xfig:

- the source code of the diagrams is written into the running source code of the document, thus there is no need for a bunch of separate `.fig` and `.eps` files.

- more flexibility wrt. renaming and layout changes.

- given the positions of some basic objects, the other objects are set with declarative commands, i.e. they automatically adjust when the positions change.

1.6 Example

TO BE FILLED

1.7 Miscellaneous

\nodeconnections   With `\nodeconnections{`⟨*PSTricks-node-connections*⟩`}`, the PSTricks-node connections and label commands do not require any extra horizontal or vertical space.

\database   The command

$$\text{\textbackslash database}[\langle pos\rangle]\{\langle width\rangle\}\{\langle height\rangle\}[\langle graph\_params\rangle]\{\langle text\rangle\}[\langle id\rangle]$$

defines a database barrel as a tabular which is vertically centered as given in the optional argument ⟨*pos*⟩ (Default: `[c]`). ⟨*text*⟩ is the text to be written on the front of the barrel, ⟨*width*⟩ and ⟨*height*⟩ give the width and height of the barrel; both must be a dimension, e.g., 2cm. With the optional graphics parameter ⟨*graph_params*⟩, the pstricks parameters fillstyle and fillcolor for the database can be set (see example below). The optional argument ⟨*id*⟩ is used as an internal name, it must start with a letter and must contain only letters and digits. ⟨*id*⟩ is used for `\rnode` definitions: ⟨*id*⟩ is the whole barrel `lu`⟨*id*⟩, `ru`⟨*id*⟩, `mu`⟨*id*⟩, and `muf`⟨*id*⟩ denote the points at the upper left corner, upper right corner, upper middle behind and aupper middle in front of the barrel. Analogously, `ll`⟨*id*⟩, `rl`⟨*id*⟩, and `ml`⟨*id*⟩, denote the lower left and lower right corner and lower middle in front of the barrel.

```
\psset{nodesep=2pt}
\begin{tabular}{lc}
  &\rnode{lu}{lu}\quad\rnode{mu}{mu}\quad
   \rnode{muf}{muf}\quad\rnode{ru}{ru}\\[1em]
  \rnode{db}{database}
   &\database[t]{2cm}{1cm}
        [fillstyle=solid,fillcolor=red]
        {database}[example] \\[5em]
   &\rnode{ll}{ll}\qquad\rnode{ml}{ml}
     \qquad\rnode{rl}{rl}
\end{tabular}
\nodeconnections{%
\ncline{->}{lu}{luexample}
\ncline{->}{mu}{muexample}
\ncline{->}{muf}{mufexample}
\ncline{->}{ru}{ruexample}
\ncline{->}{ll}{llexample}
\ncline{->}{ml}{mlexample}
\ncline{->}{db}{example}
\ncline{->}{rl}{rlexample}}
```
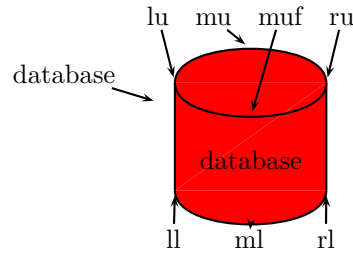

2 Code Documentation

```
1 \typeout{Style '\basename', Version \fileversion\space <\filedate>}
2 \ProvidesPackage{pst-dbicons}[\filedate \space\fileversion]
```

\seticonparams   \seticonparams{#1}{#2}

```
3 \def\seticonparams#1#2{\expandafter\def\csname #1@parm\endcsname{[#2]}}
4 \seticonparams{entity}{fillstyle=none}
5 \seticonparams{relationship}{fillstyle=none}
6 \seticonparams{attribute}{fillstyle=none}
```

\purifylabel   Macro \@purifylabel expands the string given in #2 and stores the result in com-
mand given in #1. Supported TeX commands in string #2: _, \textunderscore
Example: \@purifylabel{\templabel}{has_hq_in}, then use \templabel as
nodelabel for pstricks.

```
7 \def\dbi@purifylabel#1#2{%
8   \begingroup
9     \edef\_{\string_}%
10    \edef\textunderscore{\string_}%
11    \edef\x{\endgroup
12      \def\noexpand#1{#2}%
13    }%
14  \x
15 }
```

\entity   \entity[#1a]{#1b}[#2]

```
16 \def\entity{%
17 \@ifnextchar[{\entity@i}{\entity@i[normal]}}
18 \def\entity@i[#1]#2{%
19 \@ifnextchar[{\entity@ii{#1}{#2}}{\entity@ii{#1}{#2}[#2]}}
20 \def\entity@ii#1#2[#3]{\csname entity@#1\endcsname{#2}{#3}}
```

```
21 \def\entity@normal#1#2{%
22   \dbi@purifylabel{\dbi@prfd@nodename}{#1}%
23   \rnode{\dbi@prfd@nodename}{\expandafter\psframebox\entity@parm{\strut#2}}}
24 \def\entity@weak#1#2{%
25   {\psset{doubleline=true}%
26    \dbi@purifylabel{\dbi@prfd@nodename}{#1}%
27    \rnode{\dbi@prfd@nodename}{\expandafter\psframebox\entity@parm{\strut#2}}}}
```

\attribute   \attribute[#1]{#2}[#3]

```
28 \def\attribute{%
29   \@ifnextchar[{\attribute@i}{\attribute@i[sv]}}
30 \def\attribute@i[#1]#2{%
31   \@ifnextchar[{\attribute@ii{#1}{#2}}{\attribute@ii{#1}{#2}[#2]}}
32 \def\attribute@ii#1#2[#3]{\csname attribute@#1\endcsname{#2}{#3}}
33 \def\attribute@mv#1#2{{\psset{doubleline=true}%
34    \dbi@purifylabel{\dbi@prfd@nodename}{#1}%
35    \expandafter\ovalnode\attribute@parm{\dbi@prfd@nodename}{#2}}}
36 \def\attribute@sv#1#2{%
37    \dbi@purifylabel{\dbi@prfd@nodename}{#1}%
38    \expandafter\ovalnode\attribute@parm{\dbi@prfd@nodename}{#2}}
39 \def\attribute@key#1#2{
40    \dbi@purifylabel{\dbi@prfd@nodename}{#1}%
41    \expandafter\ovalnode\attribute@parm{\dbi@prfd@nodename}{\underline{#2}}}
```

\attributeof   \attributeof{#1}[#2]{#3}[#4]{#5}[#6]

```
42 \newdimen\@attrdist
43 \@attrdist2em  % Default value for distance of attribute from entity
44 \def\attrdist#1{\@attrdist#1} % set default distance

45 \def\attributeof#1{%
46  \@ifnextchar[{\attributeof@i{#1}}{\attributeof@i{#1}[\@attrdist]}}
47 \def\attributeof@i#1[#2]#3{%
48  \@ifnextchar[{\attributeof@ii{#1}[#2]{#3}}{\attributeof@ii{#1}[#2]{#3}[sv]}}
49 \def\attributeof@ii#1[#2]#3[#4]#5{%
50  \@ifnextchar[{\attributeof@iii{#1}[#2]{#3}[#4]{#5}}%
51                {\attributeof@iii{#1}[#2]{#3}[#4]{#5}[#5]}}
52 \def\attributeof@iii#1[#2]#3[#4]#5[#6]{%
53   \SpecialCoor
54   \dbi@purifylabel{\dbi@prfd@nodename}{#1}%
55   \uput{#2}[#3]{0}(\dbi@prfd@nodename){\attribute[#4]{#5}[#6]}%
56   \NormalCoor
57   \ncline{-}{#1}{#5}}
```

\relationship   \relationship[#1a]{#1b}[#2]

```
58 \def\relationship{%
59  \@ifnextchar[{\relationship@i}{\relationship@i[normal]}}
60 \def\relationship@i[#1]#2{%
61  \@ifnextchar[{\relationship@ii{#1}{#2}}{\relationship@ii{#1}{#2}[#2]}}
62 \def\relationship@ii#1#2[#3]{\csname relationship@#1\endcsname{#2}{#3}}
63 \def\relationship@normal#1#2{%
64    \dbi@purifylabel{\dbi@prfd@nodename}{#1}%
65    \expandafter\dianode\relationship@parm{\dbi@prfd@nodename}{#2}}
66 \def\relationship@weak#1#2{%
67   {\psset{doubleline=true}%
```

```
68    \dbi@purifylabel{\dbi@prfd@nodename}{#1}%
69    \expandafter\dianode\relationship@parm{\dbi@prfd@nodename}{#2}}}
70 \let\relationship@ident\relationship@weak
```

\relationshipbetween   \relationshipbetween[#1a]{#1b}(#2)[#3]/#4/{#5}(#6)[#7]/#8/{#9}[#10]/#11/(#12)

```
71 \newtoks\rolepos
72 \rolepos{0.85}%
73 \newtoks\cardpos
74 \cardpos{0.5}%
75 \newif\ifdbi@recursive
76 \def\relationshipbetween{%
77 \@ifnextchar[{\relationshipbetween@type}{\relationshipbetween@type[normal]}}
78 \def\relationshipbetween@type[#1]#2{\dbi@recursivefalse%
79 \def\relationtype{#1}%
80 \@ifnextchar({\relationshipbetween@i@role{#2}}%
81              {\relationshipbetween@i@role{#2}(\relax)}}
82 \def\relationshipbetween@i@role#1(#2){%
83 \@ifnextchar[{\relationshipbetween@i@card{#1}{#2}}%
84              {\relationshipbetween@i@card{#1}{#2}[\relax]}}
85 \def\relationshipbetween@i@card#1#2[#3]{%
86 \@ifnextchar/{\relationshipbetween@i@linetype{#1}{#2}{#3}}%
87              {\relationshipbetween@i@linetype{#1}{#2}{#3}/\relax/}}
88 \def\relationshipbetween@i@linetype#1#2/#3/#4/#5{%
89 \def\dbi@linecmd@i{#4}%
90 \def\dbi@tempa{#1}\def\dbi@tempb{#5}%
91 \ifx\dbi@tempa\dbi@tempb\dbi@recursivetrue\fi
92 \ifx#4\relax
93    \ifdbi@recursive
94       \def\dbi@linecmd@i{\ncarc[arcangleA=10,arcangleB=45]}%
95    \else\def\dbi@linecmd@i{\ncline}\fi\fi
96 \@ifnextchar({\relationshipbetween@ii@role{#1}{#2}{#3}{#5}}%
97              {\relationshipbetween@ii@role{#1}{#2}{#3}{#5}(\relax)}}%
98 \def\relationshipbetween@ii@role#1#2#3#4(#5){%
99 \@ifnextchar[{\relationshipbetween@ii@card{#1}{#2}{#3}{#4}{#5}}%
100             {\relationshipbetween@ii@card{#1}{#2}{#3}{#4}{#5}[\relax]}}
101 \def\relationshipbetween@ii@card#1#2#3#4#5[#6]{%
102 \@ifnextchar/{\relationshipbetween@ii@linetype{#1}{#2}{#3}{#4}{#5}{#6}}%
103              {\relationshipbetween@ii@linetype{#1}{#2}{#3}{#4}{#5}{#6}%
104               /\relax/}}%
105 \def\relationshipbetween@ii@linetype#1#2#3#4#5#6/#7/#8{%
106 \def\dbi@linecmd@ii{#7}%
107 \ifx#7\relax
108    \ifdbi@recursive
109       \def\dbi@linecmd@ii{\ncarc[arcangleA=-10,arcangleB=-45]}%
110    \else\def\dbi@linecmd@ii{\ncline}\fi\fi
111 \@ifnextchar[{\relationshipbetween@optname{#1}{#2}{#3}{#4}{#5}{#6}{#8}}%
112              {\relationshipbetween@optname{#1}{#2}{#3}{#4}{#5}{#6}{#8}[#8]}}%
113 \def\relationshipbetween@optname#1#2#3#4#5#6#7[#8]{%
114 \@ifnextchar/{\relationshipbetween@linetype{#1}{#2}{#3}{#4}{#5}{#6}{#7}{#8}}%
115              {\relationshipbetween@linetype{#1}{#2}{#3}{#4}{#5}{#6}{#7}{#8}%
116               /\ncline/}}%
117 \def\relationshipbetween@linetype#1#2#3#4#5#6#7#8/#9/{%
118 \def\dbi@linecmd{#9}%
```

```
119  \@ifnextchar({\relationshipbetween@pos{#1}{#2}{#3}{#4}{#5}{#6}{#7}{#8}}%
120                {\relationshipbetween@pos{#1}{#2}{#3}{#4}{#5}{#6}{#7}{#8}(0.5)}}%
121  \def\relationshipbetween@pos#1#2#3#4#5#6#7#8(#9){%
122    \ifdbi@recursive
123      \relationshipbetween@rec{#1}{#2}{#3}{#5}{#6}{#7}{#8}(#9)\else
124      \relationshipbetween@nonrec{#1}{#2}{#3}{#4}{#5}{#6}{#7}{#8}(#9)\fi}

125  \def\relationshipbetween@nonrec#1#2#3#4#5#6#7#8(#9){%
126  \dbi@purifylabel{\dbi@prfd@nodename@i}{#1}%
127  \dbi@purifylabel{\dbi@prfd@nodename@ii}{#4}%
128  \dbi@purifylabel{\dbi@prfd@nodename@iii}{#7}%
129  {\psset{linestyle=none}%
130    \dbi@linecmd{-}{\dbi@prfd@nodename@i}{\dbi@prfd@nodename@ii}}%
131  \ncput[npos=#9]{\relationship[\relationtype]{#7}[#8]}%
132  \dbi@linecmd@i{-}{\dbi@prfd@nodename@i}{\dbi@prfd@nodename@iii}%
133  \ifx#3\relax\else\ncput*[npos=\the\cardpos]{#3}\fi
134  \ifx#2\relax\else\ncput*[npos=\the\rolepos]{#2}\fi
135  \dbi@linecmd@ii{-}{\dbi@prfd@nodename@ii}{\dbi@prfd@nodename@iii}%
136  \ifx#6\relax\else\ncput*[npos=\the\cardpos]{#6}\fi
137  \ifx#5\relax\else\ncput*[npos=\the\rolepos]{#5}\fi}

138  \def\relationshipbetween@rec#1#2#3#4#5#6#7(#8,#9){%
139  \dbi@purifylabel{\dbi@prfd@nodename@i}{#1}%
140  \dbi@purifylabel{\dbi@prfd@nodename@ii}{#6}%
141  \SpecialCoor
142  \uput{#8}[#9]{0}(\dbi@prfd@nodename@i)%
143          {\relationship[\relationtype]{#6}[#7]}%
144  \NormalCoor
145  \dbi@linecmd@i{-}{\dbi@prfd@nodename@i}{\dbi@prfd@nodename@ii}%
146   \ifx#3\relax\else\ncput*[npos=\the\cardpos]{#3}\fi
147   \ifx#2\relax\else\ncput*[npos=\the\rolepos]{#2}\fi
148  \dbi@linecmd@ii{-}{\dbi@prfd@nodename@i}{\dbi@prfd@nodename@ii}%
149   \ifx#5\relax\else\ncput*[npos=\the\cardpos]{#5}\fi
150   \ifx#4\relax\else\ncput*[npos=\the\rolepos]{#4}\fi}
```

\inrelationship   \inrelationship[#1a]{#1b}(#2)[#3]/#4/{#5}[#6](#7,#8)

```
151  \def\inrelationship{%
152  \@ifnextchar[{\inrelationship@type}{\inrelationship@type[normal]}}
153  \def\inrelationship@type[#1]#2{%
154  \def\relationtype{#1}%
155  \@ifnextchar({\inrelationship@role{#2}}%
156                {\inrelationship@role{#2}(\relax)}}
157  \def\inrelationship@role#1(#2){%
158  \@ifnextchar[{\inrelationship@card{#1}{#2}}%
159                {\inrelationship@card{#1}{#2}[\relax]}}
160  \def\inrelationship@card#1#2[#3]{%
161  \@ifnextchar/{\inrelationship@linetype{#1}{#2}{#3}}%
162                {\inrelationship@linetype{#1}{#2}{#3}/\ncline/}}%
163  \def\inrelationship@linetype#1#2#3/#4/#5{%
164  \dbi@purifylabel{\dbi@prfd@nodename@i}{#1}%
165  \dbi@purifylabel{\dbi@prfd@nodename@ii}{#5}%
166  \def\dbi@linecmd{#4}%
167  \@ifnextchar[{\inrelationship@newrel{#1}{#2}{#3}{#5}}%
168                {\@ifnextchar({%
169                    \inrelationship@newrel{#1}{#2}{#3}{#5}[#5]}%
```

```
170                  {\dbi@linecmd{-}{\dbi@prfd@nodename@i}{\dbi@prfd@nodename@ii}
171                      \ifx#3\relax\else\ncput*[npos=\the\cardpos]{#3}\fi
172                      \ifx#2\relax\else\ncput*[npos=\the\rolepos]{#2}\fi}}%
173  \def\inrelationship@newrel#1#2#3#4[#5]{%
174  \@ifnextchar({\inrelationship@newrel@pos{#1}{#2}{#3}{#4}{#5}}%
175                  {\PackageError{\basename}{Position of relationship #4
176                      undefined.}\@eha}}
177  \def\inrelationship@newrel@pos#1#2#3#4#5(#6,#7){%
178      \SpecialCoor
179      \dbi@purifylabel{\dbi@prfd@nodename@i}{#1}%
180      \dbi@purifylabel{\dbi@prfd@nodename@ii}{#4}%
181      \uput{#6}[#7]{0}(\dbi@prfd@nodename@i){\relationship[\relationtype]{#4}[#5]}%
182      \NormalCoor
183      \dbi@linecmd{-}{\dbi@prfd@nodename@i}{\dbi@prfd@nodename@ii}
184      \ifx#3\relax\else\ncput*[npos=\the\cardpos]{#3}\fi
185      \ifx#2\relax\else\ncput*[npos=\the\rolepos]{#2}\fi}
```

\annote

```
1  \def\annote#1#2(#3,#4){%
2      \dbi@purifylabel{\dbi@prfd@nodename}{#1}%
3      \SpecialCoor
4      \uput{#3}[#4]{0}(\dbi@prfd@nodename){#2}%
5      \NormalCoor}
```

\nodeconnections

```
1  \def\nodeconnections#1{\hbox to 0cm{\vbox to 0cm {#1}}}
```

\database   \database[#1]{#2}{#3}[#4]{#5}[#6]

```
2  \def\database{\@ifnextchar[{\database@i}{\database@i[c]}}
3  \def\database@i[#1]#2#3{%
4      \@ifnextchar[{\database@ii{#1}{#2}{#3}}%
5                  {\database@ii{#1}{#2}{#3}[fillstyle=none]}}
6  \def\database@ii#1#2#3[#4]#5{%
7      \@ifnextchar[{\database@iii{#1}{#2}{#3}{#4}{#5}}%
8                  {\database@iii{#1}{#2}{#3}{#4}{#5}[#5]}}
9  \def\database@iii#1#2#3#4#5[#6]{%
10     \psset{nodesep=0pt}%
11     \dbi@purifylabel{\dbi@prfd@nodename}{#6}%
12     \rnode{\dbi@prfd@nodename}{%
13     \begin{tabular}[#1]{c}%
14     \rnode{lu\dbi@prfd@nodename}{}\hspace{#2}\rnode{ru\dbi@prfd@nodename}{}\\[#3]
15     \rnode{ll\dbi@prfd@nodename}{}\hspace{#2}\rnode{rl\dbi@prfd@nodename}{}%
16     \end{tabular}}%
17     \nodeconnections{%
18     \ncbar[linestyle=none,#4,
19          angleA=180,angleB=180,armB=0]{ru\dbi@prfd@nodename}{ll\dbi@prfd@nodename}
20     \ncbar[linestyle=none,#4,
21          angleA=0,angleB=0,armA=0]{ru\dbi@prfd@nodename}{ll\dbi@prfd@nodename}
22     \nccurve[#4,angleA=90,angleB=90,ncurv=.6]{lu\dbi@prfd@nodename}{ru\dbi@prfd@nodename}%
23          \ncput{\rnode{mu\dbi@prfd@nodename}{}}%
24     \nccurve[angleA=-90,angleB=-90,ncurv=.6]{lu\dbi@prfd@nodename}{ru\dbi@prfd@nodename}%
25          \ncput{\rnode{muf\dbi@prfd@nodename}{}}%
26     \nccurve[#4,angleA=-90,angleB=-90,ncurv=.6]{ll\dbi@prfd@nodename}{rl\dbi@prfd@nodename}%
```

```
27        \ncput{\rnode{ml\dbi@prfd@nodename}{}}%
28 \ncline{lu\dbi@prfd@nodename}{ll\dbi@prfd@nodename}%
29 \ncline{ru\dbi@prfd@nodename}{rl\dbi@prfd@nodename}%
30 \ncline[linestyle=none]{muf\dbi@prfd@nodename}{ml\dbi@prfd@nodename}\ncput[npos=0.4]{#5}}}
```

2.1 Acknowledgements

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