Figure 7.19 - Graphic notation indicating exactly one association end owned by the association

Figure 7.20 - Combining line path graphics

Lecture 09: Class Diagrams III

Capabilities for following tasks/questions.

• This Lecture: Software Design, Modelling and Analysis in UML
  completed class diagrams... except for associations
  Btw.: where do we put OCL constraints?
  • Study effect on OCL.
  • Temporarily
  • Study concrete syntax for "associations".
  • Content:
  • What's the difference between "aggregation" and "composition"?
    What is "reading direction", "navigability", "ownership", . . . ?
  • What is "multiplicity"? How did we treat them semantically?
  • What's a role name? What's it good for?
  • Which annotations of an association arrow are semantically relevant?
  Please explain this class diagram with associations.

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Dr. Bernd Westphal
Assoziation

Attributierte Assoziation

\[ \mu \in \{ \times, \leq, \geq \} , \] 

\[ \forall i : \mu \in \{ \times, \leq, \geq \} \] 

properties \[ N \ldots M \] .

\[
\begin{aligned}
&\begin{cases}
\mu \\
\end{cases} \\
&\text{with}
\end{aligned}
\]

\[ v_1 \mid v_2 \}

\[ \{ \}

\[ \mu, \mu^* \]

\[ \mu \text{ for multiplicities:} \]

\[ \text{role} \]

\[ \text{association} \]

\[ \mu \text{role} \]

\[ \text{r, o, P} \]

\[ \langle r, o, P \rangle \]

\[ \text{from association lines to extend signatures} \]

\[
\begin{aligned}
&\begin{cases}
\mu \\
\end{cases} \\
&\text{with}
\end{aligned}
\]

\[ \text{We only consider} \]

\[ \mu \text{role} \]

\[ \text{r, o, P} \]

\[ \langle r, o, P \rangle \]

\[ \text{from association lines to extend signatures} \]
What If Things Are Missing?

Association Example

Algorithms Semantics

Association Semantics

Ownership (in general) and Properties:

Consider:

- for now assume Properties

primary goal is the precision/unambiguity

In UML-As-Blueprint mode, precision "doesn't matter", so convenience (for writer) can even be a primary goal.

And misunderstandings are in most cases annoying.

But: (e.g. leading to misunderstanding), (even in UML-As-Blueprint mode)

In practice, it is often convenient to suppress some of the arrows and crosses and just " Various options may be chosen for showing navigation arrows on a diagram.

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Recall: We consider associations of the following form:

\[
\langle r: \langle \text{role}_1: C_1, \mu_1, P_1, \xi_1, \nu_1, o_1 \rangle, \ldots, \langle \text{role}_n: C_n, \mu_n, P_n, \xi_n, \nu_n, o_n \rangle \rangle
\]

Only these parts are relevant for extended system states:

\[
\langle r: \langle \text{role}_1: C_1, \mu_1, P_1, \xi_1, \nu_1, o_1 \rangle, \ldots, \langle \text{role}_n: C_n, \mu_n, P_n, \xi_n, \nu_n, o_n \rangle \rangle
\]

(recall: we assume \( P_1 = P_n = \{ \text{unique} \} \)).

The UML standard thinks of associations as \( n \)-ary relations which "live on their own" in a system state. That is, links (\( = \) association instances)

- do not belong (in general) to certain objects (in contrast to pointers, e.g.)
- are "first-class citizens" next to objects,
- are (in general) not directed (in contrast to pointers).

---

**Association Example**

Signature: \( S = (\{ \text{Int} \}, \{ C, D \}, \{ x: \text{Int}, \langle \text{A}C \text{D}: \langle c: C, 0..*+, \{ \text{unique} \}, \times, 1 \rangle, \langle n: D, 0..*+, \{ \text{unique} \}, >, 0 \rangle \rangle \}, \{ C \mapsto \emptyset, D \mapsto \{ x \mapsto 1 \} \}) \)

A system state of \( S \) is \( (\sigma, \lambda) \) with:

\[
\sigma = \begin{cases} 
1 & C \mapsto \emptyset \\
3 & D \mapsto \{ x \mapsto 1 \} \\
7 & D \mapsto \{ x \mapsto 2 \} 
\end{cases}
\]

\[
\lambda = \begin{cases} 
\text{A} \text{C} \text{D} \mapsto \{ (1 \text{C}, 3 \text{D}), (1 \text{C}, 7 \text{D}) \} 
\end{cases}
\]
