Contents & Goals

Last Lectures:
• Studied syntax and semantics of associations in the general case.

This Lecture:
• Educational Objectives:
  - Capabilities for following tasks/questions.
  - Cont'd: Please explain this class diagram with associations.
  - When is a class diagram a good class diagram?
  - What are purposes of modeling guidelines? (Example?)
  - Discuss the style of this class diagram.

Content:
• Effect of association semantics on OCL.
• Treat "the rest".
• Where do we put OCL constraints?
• Modeling guidelines, in particular for class diagrams (following [Ambler, 2005])
• Examples: modeling games (made-up and real-world examples)


definition of system states:

\[ \sigma = \left( \sigma_{B}, \lambda \right) \]

\[ \sigma_{B} : A \rightarrow \mathbb{N} \]

\[ \lambda : \left \{ \begin{array}{c}
\text{association} \\
\text{of the} \\
\text{form} \\
\langle \text{role}_{1}: \text{C}_{1}, \ldots, \text{role}_{n}: \text{C}_{n} \rangle \end{array} \right \} \rightarrow \mathbb{N} \times \mathbb{N} \]

\[
\text{such that for all } i, j \in \mathbb{N},\text{ we have: } \sigma_{B}(i) \geq \sigma_{B}(j) \text{ if } i < j
\]

\[ \sigma_{B}(i) = 0 \text{ for all } i \in \mathbb{N} \text{ not in the set } \{1, 3, 7\} \]

Class Diagram Example

- Class A with associations to Class C and Class D.
- Association A.C \rightarrow \{1\} C, A.D \rightarrow \{1, 3\} D.
- OCL constraints on the associations.

Association and OCL
OCL and Associations: Syntax

Example:

\[
\begin{align*}
\text{A} &= \{\text{B}, \text{C}, \text{D}\} \quad \text{C} = \{\text{E}, \text{F}\} \\
\text{OCL} &\quad \text{D} \in \text{C} \\
\text{Expression} &\quad \text{A} \cap \text{B} = \emptyset \\
\text{Set} &\quad \text{E} \neq \text{F}
\end{align*}
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OCL and Associations: Syntax

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The Rest

- Visibility

- Multiplicity

- Association name

- Properties

- Int

- Getting closer to pointers/references.

- Even more typing.

- We propose to view them as constraints.

- The standards says:

- x ∈...
If we have:

- Principal acceptable violated.

Use array of size \( \mu \).

```
\begin{align*}
\text{of object identifiers} &\cdot\text{multiplicities}\n\end{align*}
```

For \( \text{role} \) in \( \text{context} = \mu \) or \( \text{size} \rightarrow > \).

```
\begin{align*}
\text{inv}\ C \in \langle \text{role} \rangle \cup \{(\text{role}, \ldots, \text{role})\}
\end{align*}
```

```
\begin{align*}
\text{signature} &\cdot\text{attributes}
\end{align*}
```

```
\begin{align*}
\text{Int}: v \leq N
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```

Why Multiplicities as Constraints?

- From now on, we will move to class modeling page.
Properties

We don't want to cover association properties in detail, only some observations (assume binary associations):

<table>
<thead>
<tr>
<th>Property</th>
<th>Intuition</th>
<th>Semantical Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>unique</td>
<td>one object has at most one ( r )-link to a single other object</td>
<td></td>
</tr>
<tr>
<td>bag</td>
<td>one object may have multiple ( r )-links to a single other object</td>
<td></td>
</tr>
<tr>
<td>( \lambda(\tau) )</td>
<td>ordered, sequence an ( r )-link is a sequence of object identities (possibly including duplicates)</td>
<td></td>
</tr>
<tr>
<td>( \tau )</td>
<td>ordered, sequence</td>
<td></td>
</tr>
</tbody>
</table>

For subsets, redefines, union, etc. see [OMG, 2007a, 127].

Ownership

\( \star \) role \( \times \) Intuitively it says: Association \( r \) is not a "thing on its own" (i.e. provided by \( \lambda \)), but association end's role is owned by \( C \) (!). (That is, it's stored inside \( C \) object and provided by \( \sigma \)). So if multiplicity of role is 0, 1, or \( 1 \) or \( 1 \), then the picture above is very close to concepts of pointers/references. Actually, ownership is seldom seen in UML diagrams. Again: if target platform is clear, one may well live without (cf. [OMG, 2007b, 42] for more details). Not clear to me:

Recall: on some earlier slides we said, the extension of the signature is only to study associations in "full beauty". For the remainder of the course, we should look for something simpler...

Proposal:

\( \begin{align*} \forall i \in \{0, 1\} \quad & C \times i \\ \forall i \in \{0, \ldots, 1\} \quad & C \times i \\ \end{align*} \)

\( \forall i \in \{0, \ldots, 1\} \quad \text{role} \in \text{at} (\text{C}) \).

We drop \( \lambda \) and go back to our nice \( \sigma \) with \( \sigma(\text{u})\text{role} \subseteq \text{BW}(\tau) \).

OCL Constraints in (Class) Diagrams

Where shall we put OCL constraints?

Two options:

(i) Notes.

(ii) Particular dedicated places.

(i) Notes:

AUML note is a picture of the form "text text text" can principally be everything, in particular comments and constraints.

Sometimes, content is explicitly classified for clarity:

OCL: \( \text{expr} \)
Where Shall We Put OCL Constraints?

(ii) Particulardedicated places inclassdiagrams:

\[ \xi_v : \tau \{ p_1, \ldots, p_n \} \{ e \} \]

\[ \xi_f (v_1 : \tau, \ldots, v_n : \tau_n) : \tau \{ p_1, \ldots, p_n \} \{ \text{pre: } e_1 \text{ post: } e_2 \} \]

For simplicity, we view the above as an abbreviation for

\[ \xi_v : \tau \{ p_1, \ldots, p_n \} \{ \text{context } f \text{ pre: } e_1 \text{ post: } e_2 \} \]

InvariantsofaClassDiagram

- Let \( CD \) beaclassdiagram.
- Aswe(now) areabletorecogniseOCLconstraintswhentoseethem, we can define \( \text{Inv} (CD) \) astheset \( \{ \phi_1, \ldots, \phi_n \} \) ofOCLconstraintsoccurringin notesin \( CD \)—after unfolding all abbreviations (cf. next slides).
- Asusual: \( \text{Inv} (BV/BW) := \bigcup_{CD \in BV/BW} \text{Inv} (CD) \).
- Principallyclear: \( \text{Inv} (\cdot) \) foranykindofdiagram.

Invariant in Class Diagram Example

\[ C_v : \tau \{ v > 3 \} \]

If \( BV/BW \) consistsofonly \( CD \) withthesingle class \( C \), then

\[ \text{Inv} (BV/BW) = \text{Inv} (CD) = \{ \} \]

SemanticsofaClassDiagram

Definition. Let \( BV/BW \) beasetofclassdiagrams. Wesay, the semantics of \( BV/BW \) isthesignatureitinducesandthesetofOCLconstraintsoccurringin \( BV/BW \), denoted \( \langle CB (BV/BW), \text{Inv} (BV/BW) \rangle \).

Givenastructure \( BW \) of \( CB (BV/BW) \) and thus of \( BV/BW \), the classdiagrams describethesystemstates \( \Sigma_{BW/CB} \), of which somemay satisfy \( \text{Inv} (BV/BW) \).

In pictures:

\[ BV/BW = \{ CD_1, \ldots, CD_n \} \]

\[ \text{signature } CB (BV/BW) \]

\( \text{invariants } \text{Inv} (BV/BW) \)

basic (classes and attributes)

extended (visibility)
References

