UML: Unified Modeling Language

http://d3s.mff.cuni.cz

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What is UML

- General-purpose graphical notation for modeling software systems
  - with formal semantics
- Many different aspects (viewpoints)
  - architecture of the system
  - processes (behavior)
  - states and transitions
  - interaction of components
- Levels of abstraction
  - conceptual
  - implementation

Basic perspective on usage

- Creating nice large and complex diagrams
  - Various aspects of software systems
- But there is formal semantics too
  - Allows for validation, reasoning about models, and generating code
- Relatively wide adoption
  - Who: business analysts, designers, architects
- Supported by many CASE tools and IDEs
  - CASE = computed-aided software engineering

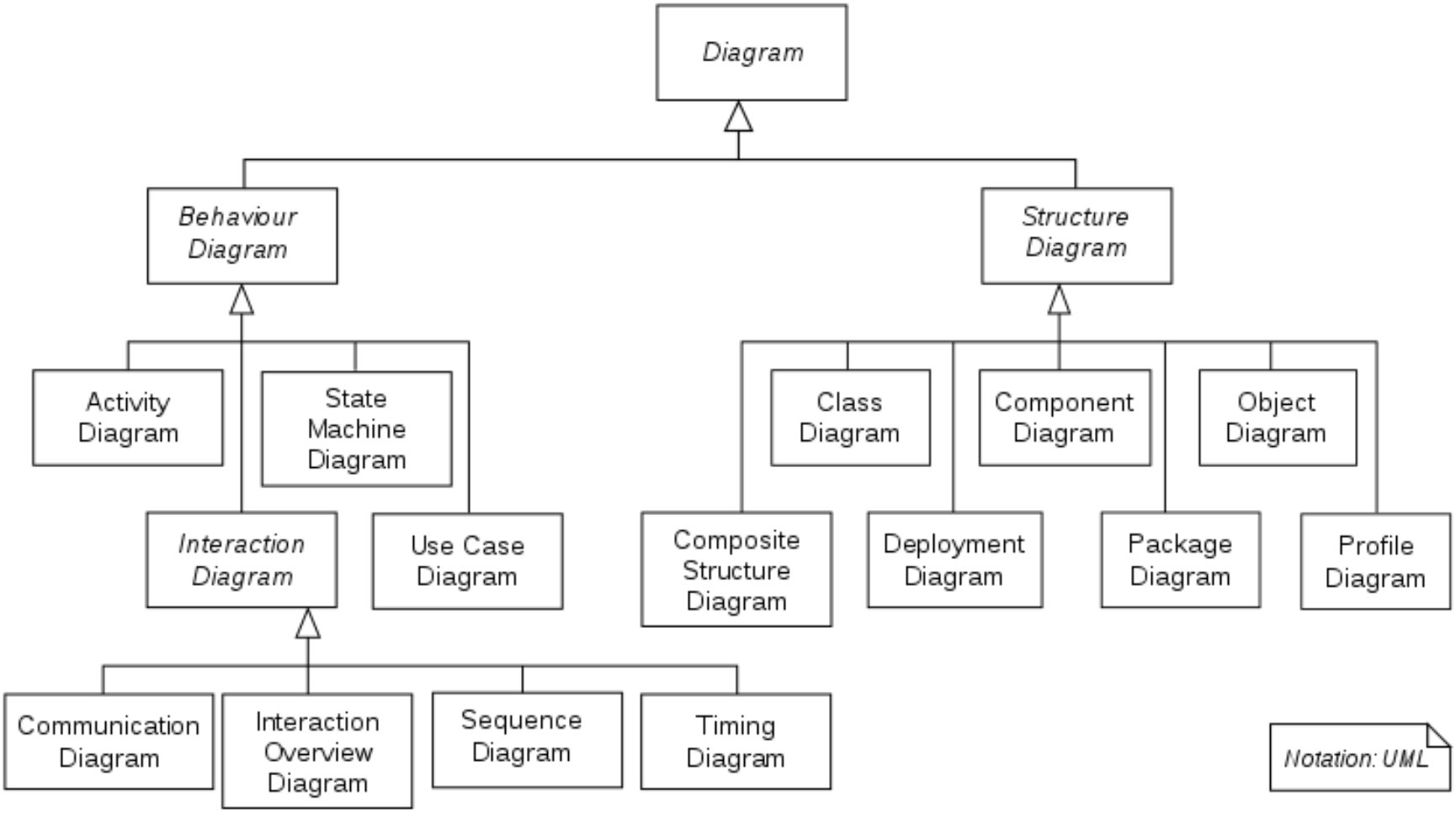
Official information

- Maintainers
  - Object Management Group (OMG)
- Industry standard
  - ISO/IEC 19501
- Resources
  - Official website (home page): http://uml.org/
  - Specification: https://www.omg.org/spec/UML
  - https://en.wikipedia.org/wiki/Unified_Modeling_Language

UML diagrams

- Structure
  - Class diagram
    - https://en.wikipedia.org/wiki/Class_diagram
  - Component diagram
  - …
- Behavior
  - Use case diagram
    - https://en.wikipedia.org/wiki/Use_case_diagram
  - Activity diagram
    - https://en.wikipedia.org/wiki/Activity_diagram
  - Sequence diagram
    - https://en.wikipedia.org/wiki/Sequence_diagram
  - State machine
  - …

UML diagrams – complete schema



Source: https://en.wikipedia.org/wiki/Unified_Modeling_Language

Tools

- Free tools for creating UML diagrams
  - https://app.diagrams.net/
- Microsoft Visio
  - https://www.microsoft.com/cs-cz/microsoft-365/visio/flowchart-software
- Plugins for IDEs
  - IntelliJ (UML Generator)
    - https://plugins.jetbrains.com/plugin/15124-uml-generator
  - Visual Studio (Class Designer)
    - https://learn.microsoft.com/en-us/visualstudio/ide/class-designer/designing-and-viewing-classes-and-types?view=vs-2022

Class diagrams

- Purpose: modeling structure of the system
  - Classes that represent sets of objects (real-world entities from a given domain) with the same characteristics (properties, features, constraints)
  - Various relationships between the objects
- Used at two levels
  - Conceptual (domain): where the domain entities and relations are captured
  - Implementation: which maps directly to source code in a programming language

Class diagrams – elements

- Classes
  - Basic information (name)
  - Attributes (fields)
    - name, type, multiplicity (number of values)
  - Operations (actions)
  - Endpoints for associations

- Relationships
  - Association
  - Composition
  - Aggregation

Class diagrams – associations

- Association ends labeled with
  - Relationship meaning (semantics)
  - Multiplicity (cardinality): `0/1..N`
- Binary
- N-ary
  - three or more endpoints
- Association classes

Class diagrams – part-of relationships

- Composition
  - Parts are not shared with other owners
  - Individual parts cannot exist without their owners
- Aggregation
  - Parts may be shared with other owners

Class diagrams – inheritance

- Specialization
- Generalization

- Expected semantics
  - As in common programming languages

Class diagrams – operations

- Operation = action that can be performed on class instances

- May be annotated with
  - pre-condition
  - post-condition
  - special body-condition over the result

Component diagram

- Purpose
  - How the components are connected together
- Entities
  - Components (with names)
  - Provided interfaces
  - Required interfaces
  - Bindings (connectors)
- Resources
  - https://en.wikipedia.org/wiki/Component_diagram

Activity diagram

- Purpose
  - Modeling various processes (computations)
- Entities
  - Actions (transitions)
  - Decisions (choices)
  - Concurrency (fork/join)
- Resources
  - https://en.wikipedia.org/wiki/Activity_diagram

Sequence diagram

- Purpose
  - Modeling interaction between objects and processes in terms of events over time
- Entities
  - Objects (processes)
  - General timeline
  - Procedure calls
  - Network messages
  - Scope of execution
- Resources
  - https://en.wikipedia.org/wiki/Sequence_diagram