The Unified Modelling Language

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What is the UML

Premise

Software systems are complex. We need simpler views of them in order to master that complexity.

UML is a language for visual modelling.

- Visual modelling is one way of creating accessible abstractions of complex systems.
- UML is a visual language — follows the tradition of Booch notation and OMT.
- UML supports OO analysis and design.

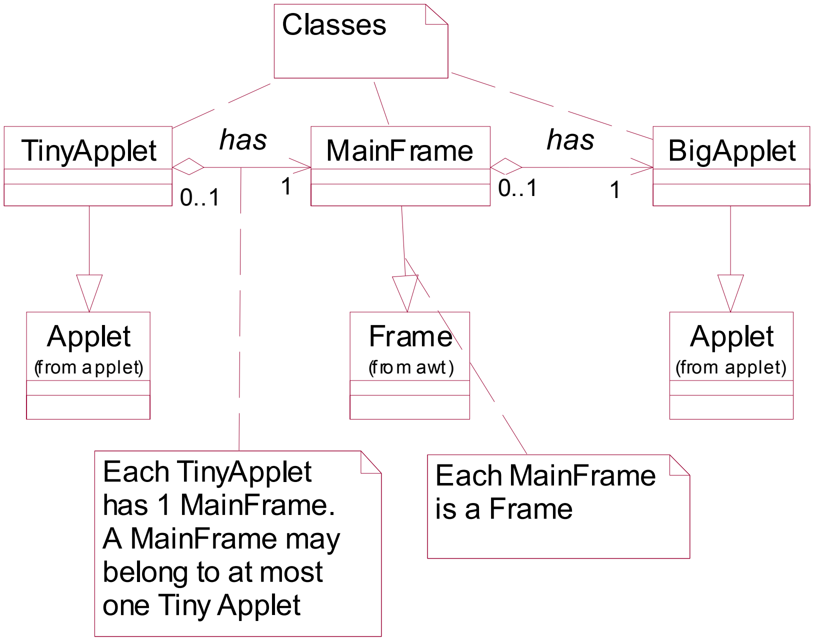
Use of UML

- In analysis and specification phases to model
  - real-world objects and classes, situations, and processes (e.g., business processes).
  - existing software components.
  - interactions between planned software and the above.
- In design phase to model internal components and processes.
- To document legacy systems.

Diagrams of UML

- Class diagrams – classes and packages, their properties, relationships.
- Object diagrams – snapshots of objects and their relationships.
- Use-case diagrams – use cases, actors, relationships.
- Sequence diagrams and Collaboration diagrams – typical sequences of events (e.g., calls).
- Statechart diagrams – finite state machines.
- Activity diagrams – algorithms / data-flow.
- Component diagrams – implementation components (e.g. source & object files)
- Deployment diagrams – deployment of components on computers.

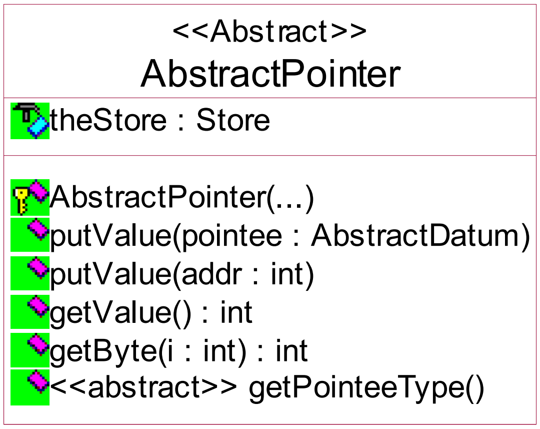
A Class Diagram


Classes
TinyApplet
has
MainFrame
has
BigApplet
0..1
1
0..1
1
Applet
(from applet)
Frame
(from awt)
Applet
(from applet)
Each TinyApplet has 1 MainFrame. A MainFrame may belong to at most one Tiny Applet
Each MainFrame is a Frame

Diagrams shows

- 6 classes
- 3 inheritance relationships
- 2 has-a relationships.

Supplying information about a class



<<Abstract>>
AbstractPointer

theStore : Store

AbstractPointer(...)
putValue(pointee : AbstractDatum)
putValue(addr : int)
getValue() : int
getByte(i : int) : int
<<abstract>> getPointeeType()

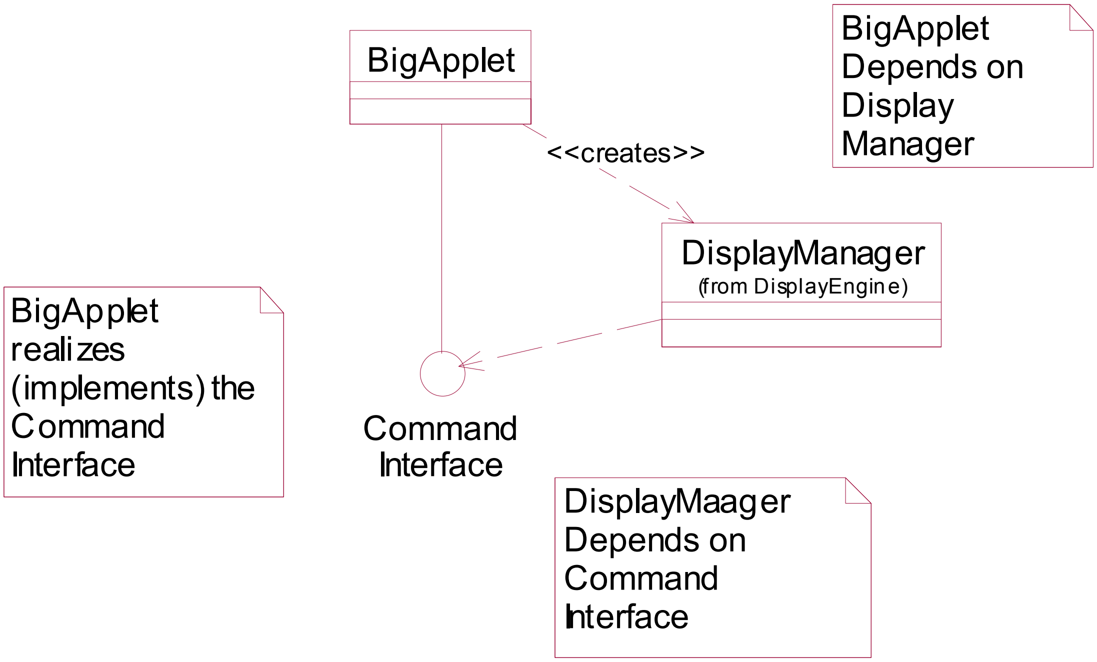
Each class is displayed as a box with 3 or more parts:

- *<<stereotype>> Name*. Stereotypes are used to identify classes that are used in stereotypical ways, e.g. interfaces, abstract classes, actors (agents outside system), exceptions, etc. The Name is the name.
- Attributes. (A.k.a. Fields / data members). This class has one.
- Operations. (A.k.a. Method signatures, function members).
- Other parts as you please. E.g., responsibilities

Operations and attributes are marked according to visibility.

We can model dependance

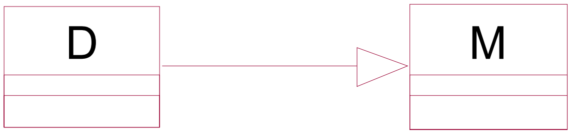
How to do cyclic calling without cyclic dependance.


BigApplet
<<creates>>
BigApplet Depends on Display Manager
DisplayManager
(from DisplayEngine)
BigApplet realizes (implements) the Command Interface
Command Interface
DisplayMaager Depends on Command Interface

Class relationships

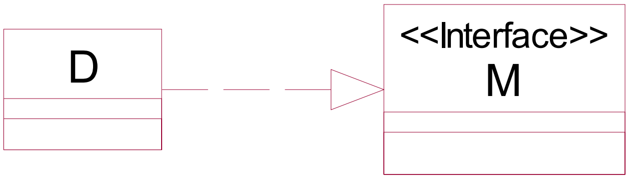
- Is-a (specialization): Every D is an M. Class D specializes class M. Class D inherits from class M.

  In C++ we say D derives from M. In Java D extends M.

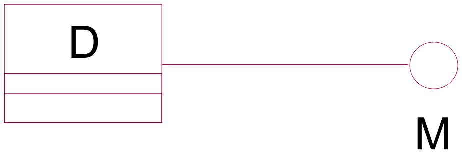


  Note that class D depends on M.

- Realizes. D implements interface M. Special case of above for interfaces.

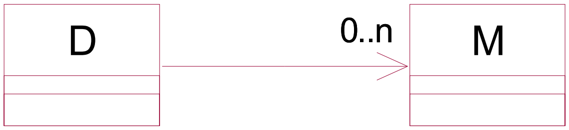


  or lollypop notation:



- Knows-a (association): Every D can (potentially) easily find an M.

  In C++ (or Java) D might have a data member (field) that is a pointer to an M.

  In the above diagram the D object knows 0 of more M objects. In C++ you might have a data member that is a vector of pointers to M objects.

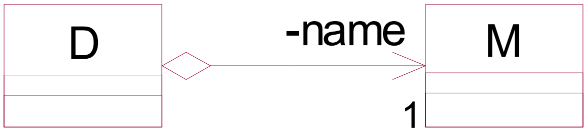
  Use a two way arrow if the M object can find the D object that can find it.

  Use no arrow if there is an association, but you don’t want to imply that either can find the other.

  Usually (with the arrow) D depends on M.

- Has-a (aggregation): Every D has an M’s.

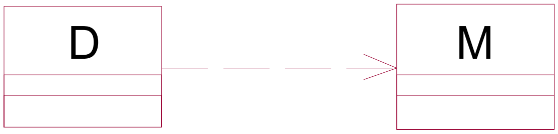
  This is a special case of “knows-a”. Use it when the lifetimes are coincident; i.e. creating a D object creates the M object and destroying the D object destroys the M object.



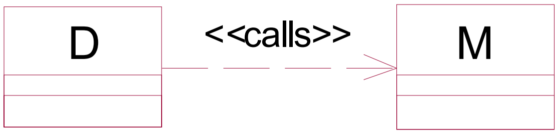
In C++, D might have a private data member of type M called name, or D might have a pointer to an M object that is set with new when a D is constructed and sent to delete when a D is destructed..

- Depends on: Use when there is dependance, but none of the above are appropriate.

  E.g. Some method D.foo() takes an M as a parameter, returns an M as a result, creates an M, but doesn't maintain a long term association, or calls a static method of M.

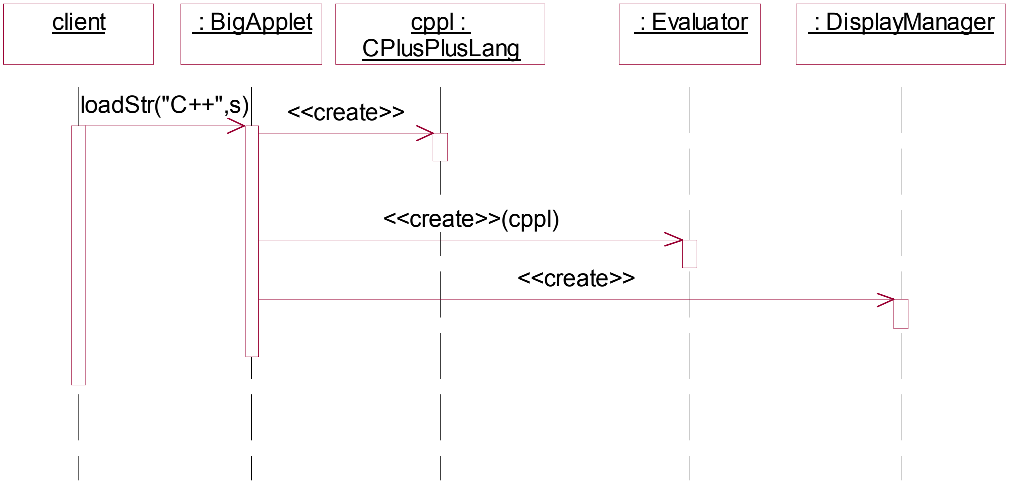


It is good to use a stereotype to describe the type of dependance. E.g.:

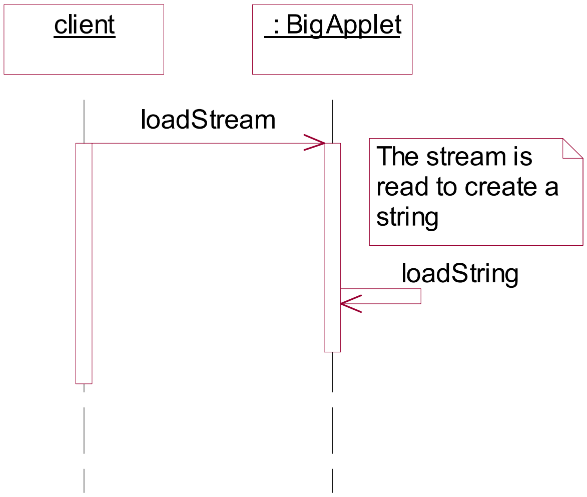


Sequence diagrams

Show typical scenarios – not algorithms.

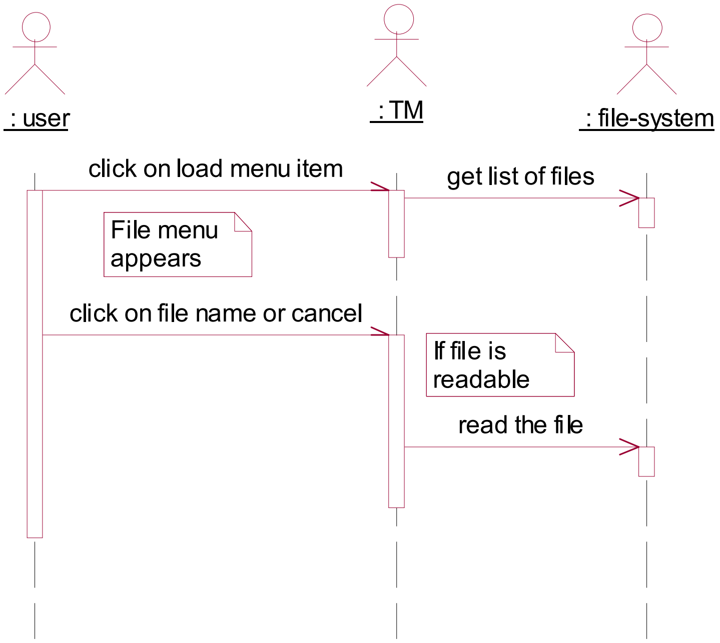


Messages may be sent to self



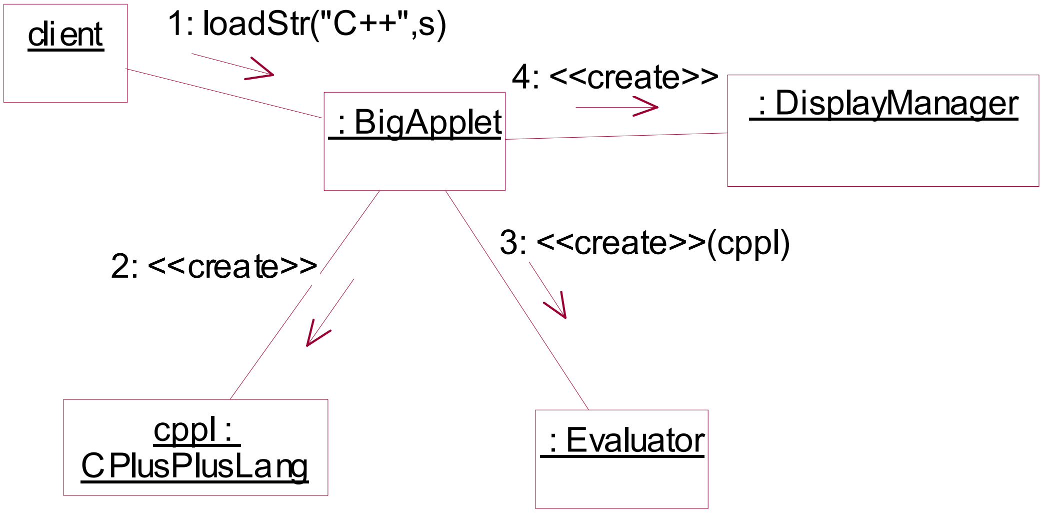
Sequence diagrams

... can show the interaction of a system with objects outside (specification)



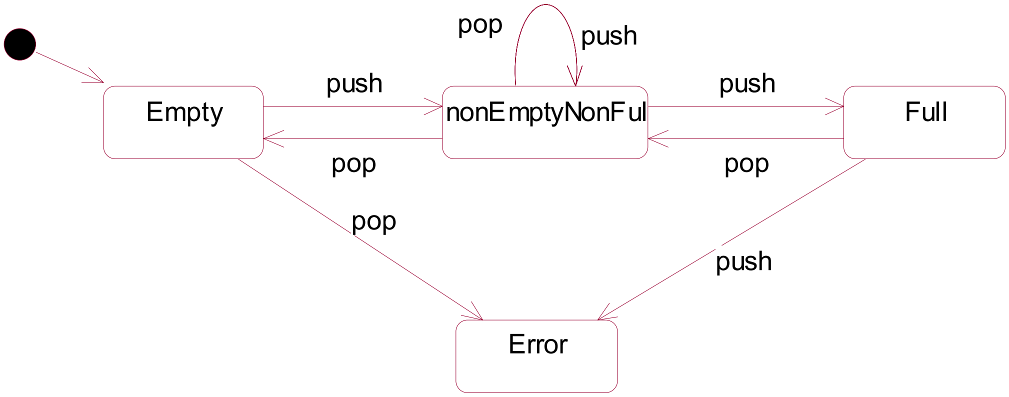
Collaboration Diagrams

Same info as sequence diagram, but in different form

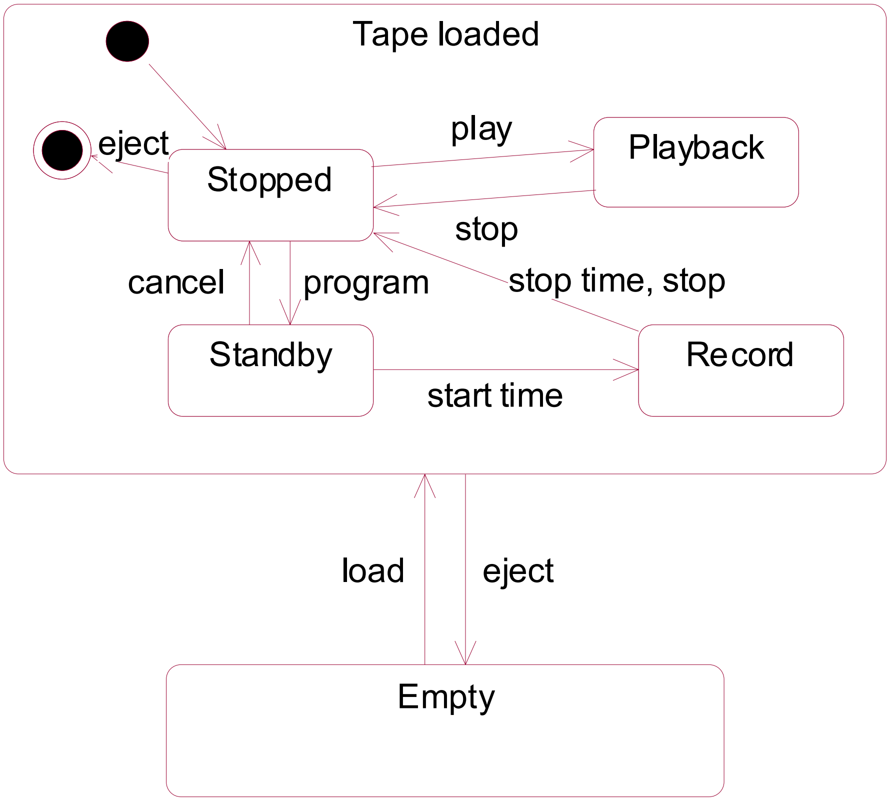


State Diagrams

Allows description of finite number of states



A VCR showing substates



Conclusions and Assessment

UML has considerable momentum.

- Lots of books.
- Good industry uptake.

UML is big and expandable.

- It offers something to everyone.
- But it is weak on data flow.
- Assertion language (OCL) is defined, but not widely known and may define semantics of classes better than state or activity diagrams.

Tools

There are several tools that hold models

- Keep diagrams consistent with database.
- Automatic analysis of source code.
- Automatic generation of source code.
- Round-trip engineering.