UML – SEQUENCE DIAGRAMS

CSE416-S01 - Software Engineering

And also Activity Diagrams (for the Python part of your system)

Reading / Reference

- Reading

www.lucidchart.com/pages/uml-sequence-diagram

www.ibm.com/developerworks/rational/library/3101.html

https://en.wikipedia.org/wiki/Activity_diagram

Interaction Diagrams

- Sequence diagrams and collaboration diagrams
- Describe the dynamic behavior of an OO system
- Often used to model a use case
- Purpose:
  - Model interactions between objects
  - Verify/revise the class diagram
  - Assign responsibilities/operations to classes

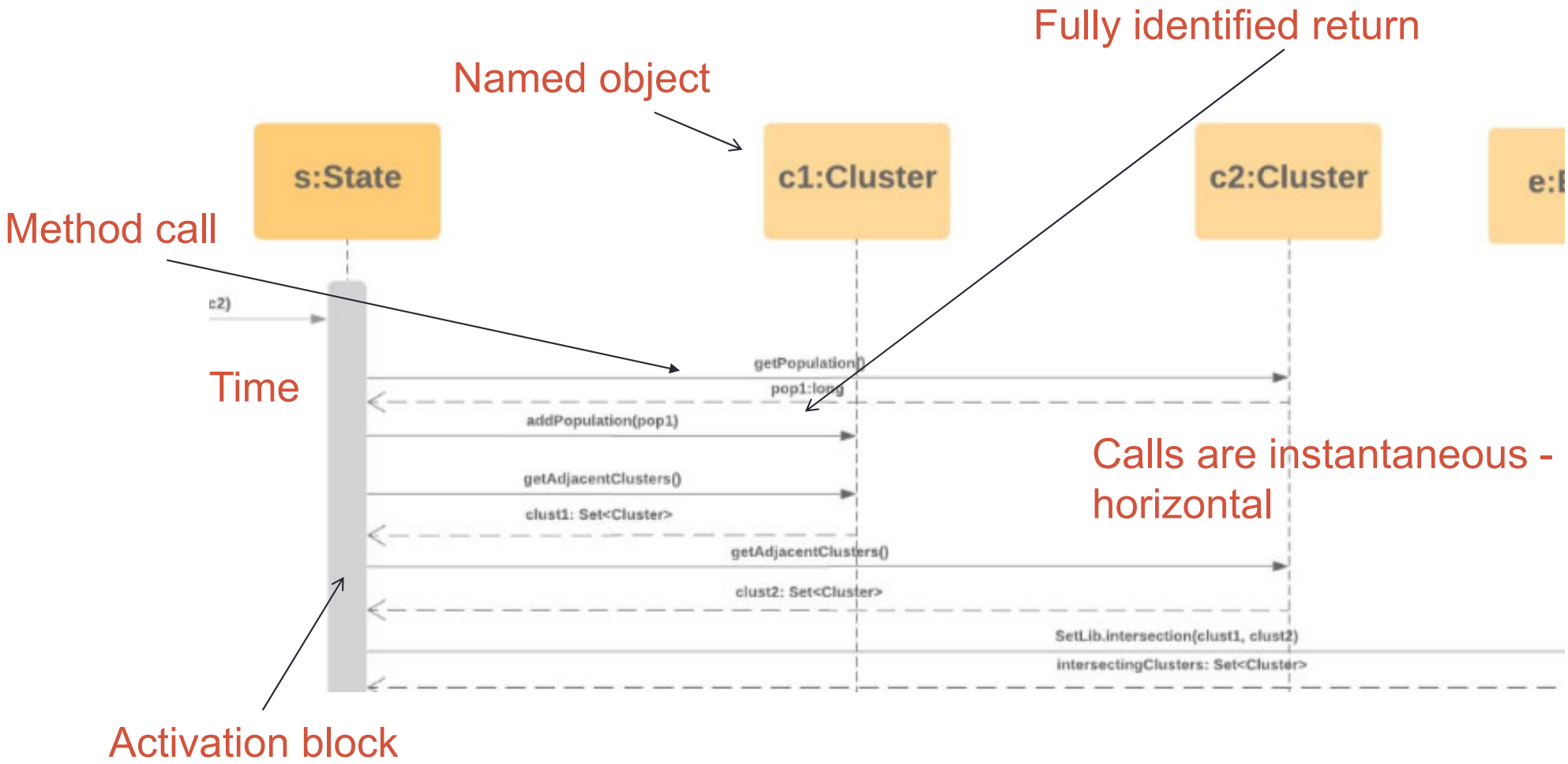
We focus on sequence diagrams

UML Sequence Diagram

- **Sequence diagram** - an interaction diagram that models a single scenario (use case) executing in the system
  - perhaps 2nd most used UML diagram (behind class diagram)
- Illustrates how objects interact with each other
- Emphasizes time ordering of messages
- Can model simple sequential flow, branching, iteration, recursion and concurrency

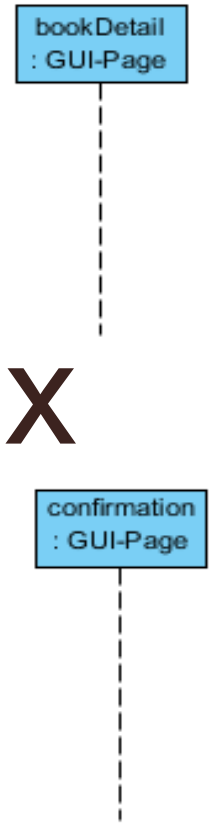
Helps you design proper encapsulation of your data

Sequence Diagram Syntax



Lifeline

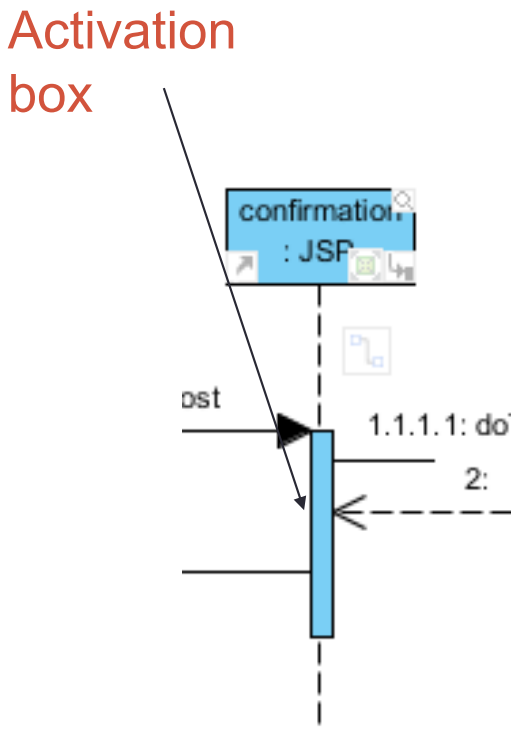
- Think of a lifeline as a “live” object
- Lifelines usually represent object instances
- An “X” is shown when the object is destroyed
- Placement
  - Usually across the top of the diagram
  - Depending on tool, you might lower the placement of the lifeline if object activation occurs during the use case



Might not be shown if it doesn’t clarify the design

Indicating Method Calls

- Activation box: thick box over object's lifeline; drawn when object is on the stack
  - Either that object is running its code, or it is on the stack waiting for another object's method to finish
  - Nest to indicate recursion



Key Components

- **Participant**: an object or entity that acts in the sequence diagram
  - sequence diagram starts with an unattached arrow or an arrow attached to an actor
- **Message**: communication between objects/actors
- Axes in a sequence diagram:
  - horizontal: which object/participant is acting
  - vertical: time (down -> forward in time)

For complex logic, the diagram can start with another use case

In a GUI system the initial participant is usually an actor

Messages

- An interaction between two objects is performed as a message sent from one object to another
  (e.g., method call)
- If an object sends a message to another object, object 1 must have visibility to object 2 (i.e., have a handle)
- A message is labeled at a minimum with the method name, and if space permits, the parameters

Arrow Labels

- Method call
  - Label the call arrow with the method name
  - Include parameters if they are not obvious
- Return
  - Model a return value when you need to refer to it elsewhere, e.g., as a parameter passed in another message

In general, don't model obvious interactions if the modeling tool is not able to automatically generate code

Simplification

- In your design review, you can simplify some cases, once you have shown an understanding
- Examples
  - Do not show any client logic other than the user trigger on a DOM object and client communications object (Axios/XMLHttpRequest/Window)
  - Do not show client server detail – show a message from client (e.g., Window object) to server Controller object
  - Do not show any DB access – stop at message to EntityManager object

Show HTTP method

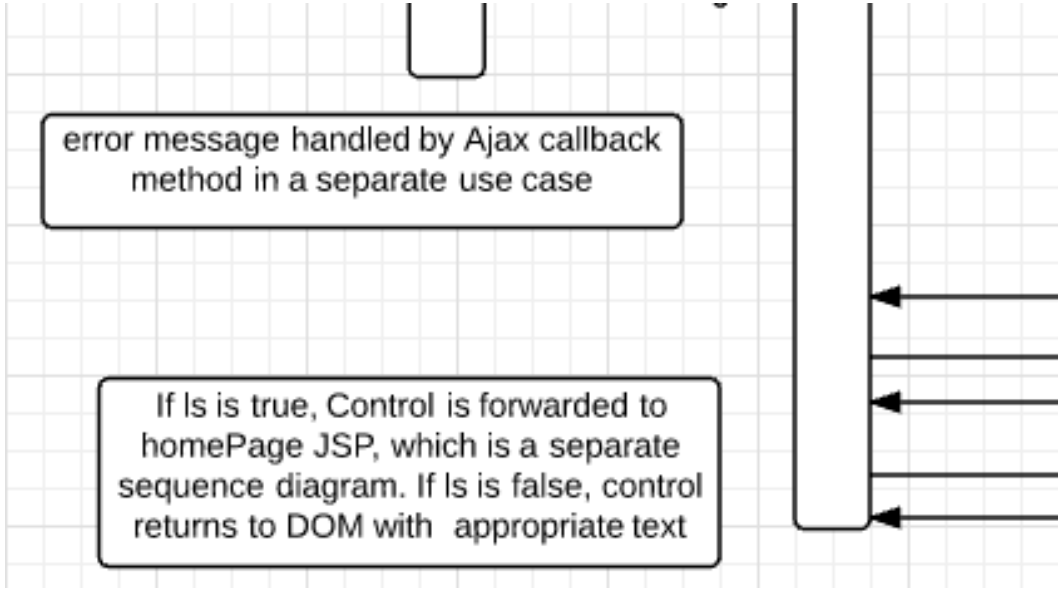
Simplification – Fundamental Objects

- DOM – object representation of the GUI
- Client request
  - Axios
  - XMLHttpRequest– Standard browser object - interacts with the server
  - Window object uses a fetch method to interact with server
- Persistence layer – Standard server object to receive object requests for the DB
  - Best represented as the em:EntityManager object
  - Receives calls as in JPA

The only client-side elements needed are the actor, the DOM, and the interface object (e.g., Axios)

Simplification Comments

- Some simplification should be indicated with comments



Realistic Design Approach

- Use your sequence diagrams to identify classes and class attributes needed in your class diagram
- Work both simultaneously (e.g., add methods to your class diagram once you see that you need it)
- Don’t be reluctant to modify your design during this stage

Project Team Approach

- The first few sequence diagrams will be very difficult to do
- Do the first few as a team (with lots of team interaction)
- Once your team begins to understand your design philosophy and framework philosophy, you will be able to assign parts to team members
- Look for common design approaches (e.g., DB access, server access, session management), you might be able to use sub-diagrams

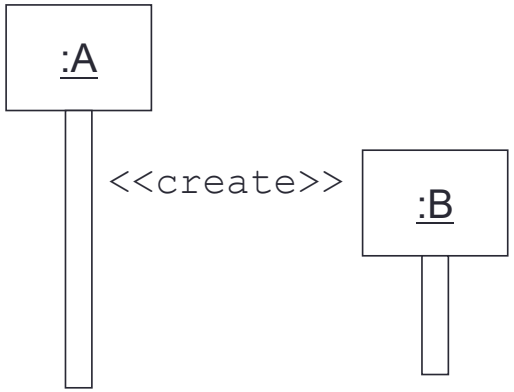
Design Review

- Design review will be organized along the lines of use cases (and corresponding sequence diagrams and activity diagrams)
- Your team gets to pick the first use case to show
- Clarity of thinking and consistency are more important than getting the best possible design approach
- Think encapsulation in your OO design

Object Instantiation

- An object may create another object via a `<<create>>` message.

Preferred



Using new is OK, but you might use the factory design pattern

Indicating Selection and Loops

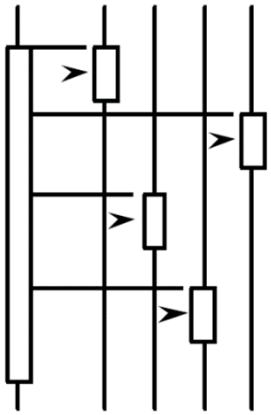
- frame: box around part of a sequence diagram to indicate selection or loop
  - if -> (opt) [condition]
  - if/else -> (alt) [condition], separated by horiz. dashed line
  - loop -> (loop) [condition or items to loop over]

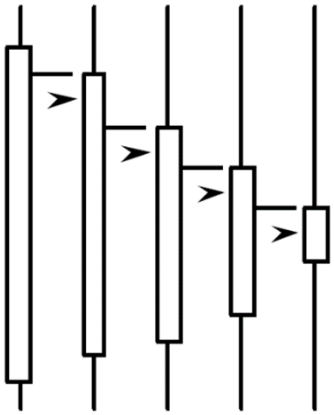
Loops are not very helpful in sequence diagrams. If you need to show a loop, you might just indicate it with a comment

Maybe think about a method call to abstract a loop

(De)centralized System Control

- What can you say about the control flow of each of the following systems?
  - centralized?
  - distributed?





This will help you think about whether your design properly uses encapsulation

Why Not Just Code It?

- A sequence diagram allows you to think through design issues
- A sequence diagram is well above the level of code
- Tool might generate code
- Sequence diagrams are somewhat language-agnostic (can be implemented in many different OO languages)
- Easier to do as a team
- Can see many objects/classes at the same time

Expected in design reviews

Activity Diagrams

- For the Python parts of the project, assume a procedural programming model
- To show your procedural design, use a UML activity diagram
- Show major activities (e.g., calculate box & whisker data)) and data flows (e.g., district plan)
- Use ellipses (actions), diamonds (decisions), arrows, circles (start and end)

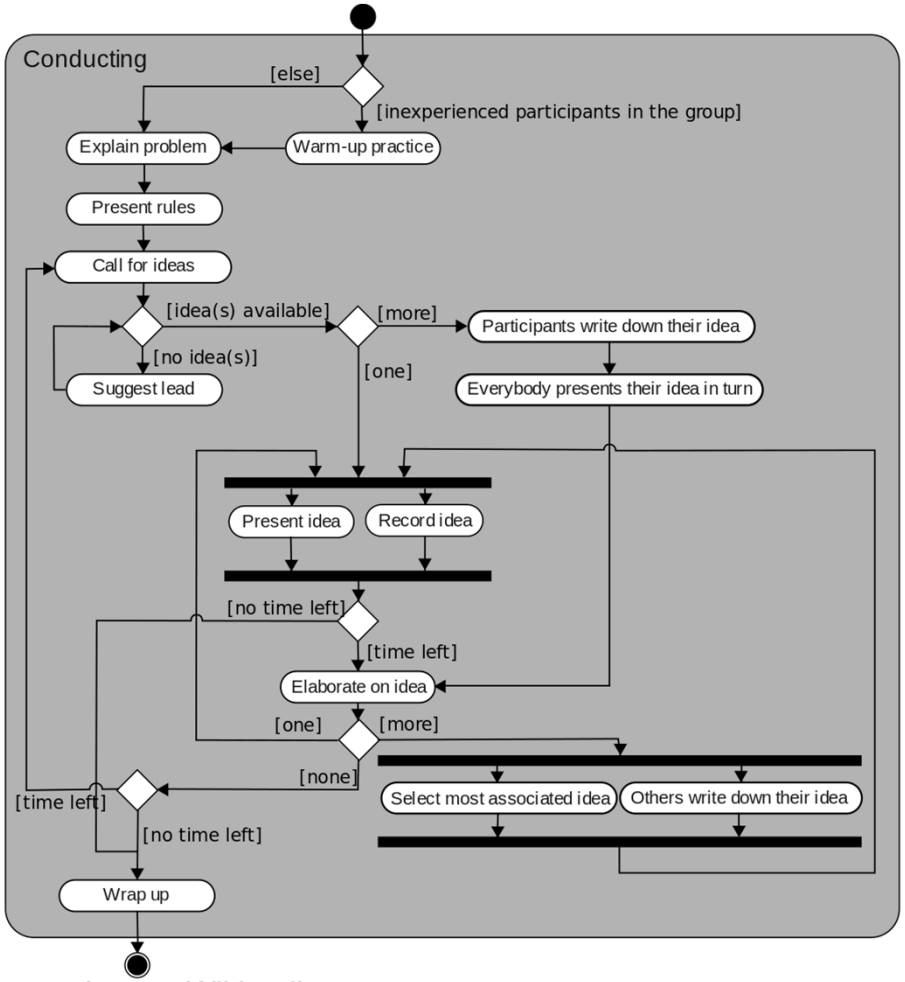
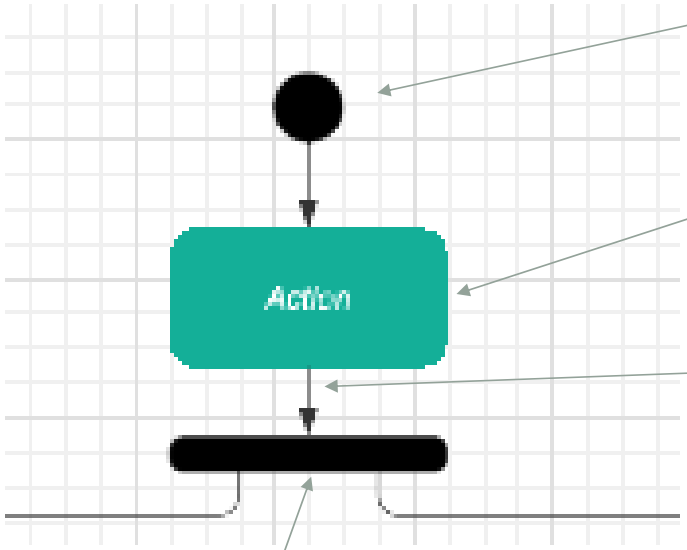


Image: Wikipedia

Activity Diagrams

- Demonstrate the logic of an algorithm
- More detail as compared with a sequence diagram
- Appropriate for non-OO parts of a system (e.g., SeaWulf code)

Activity Diagram Symbols …



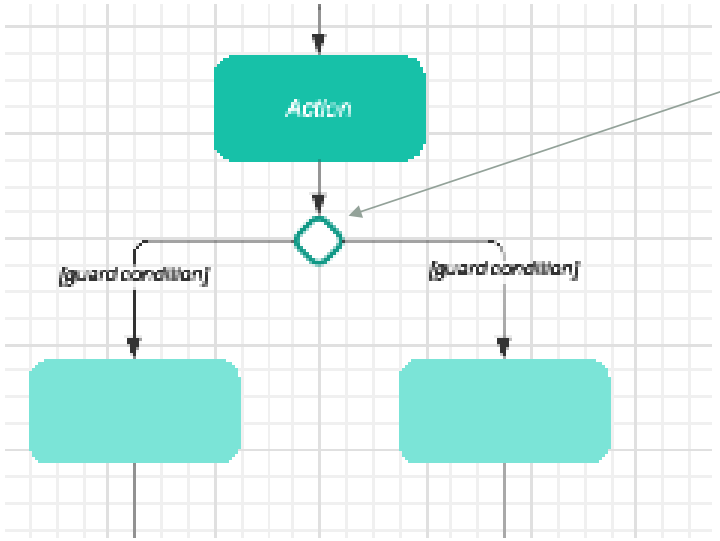
Start symbol – represents the beginning of a process

Activity – indicates an activity that is part of a process

Connector – shows the control flow of the activity

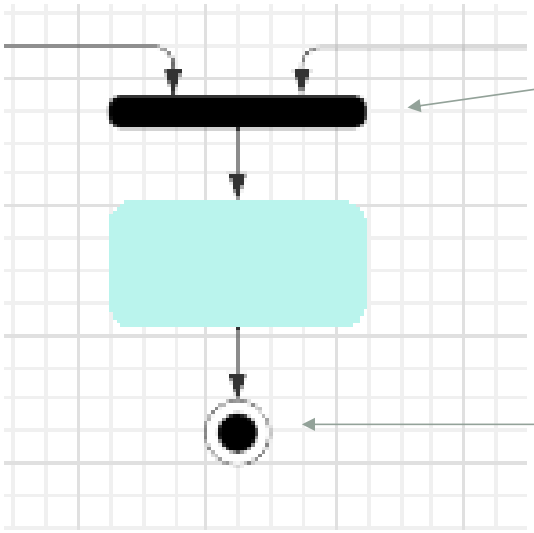
Fork symbol – splits a single activity into two concurrent activities

… Activity Diagram Symbols …



Decision symbol – represents a decision and has at least 2 paths branching out with condition text

… Activity Diagram Symbols



Joint symbol bar – combines 2 concurrent activities

End symbol – marks the end state of an activity

Activity Diagram Suggestions

- Activity boxes should identify substantial parts of system (e.g., module to compute spanning tree)
- Label connectors to show data flow