Interaction Modelling: Activity Diagrams

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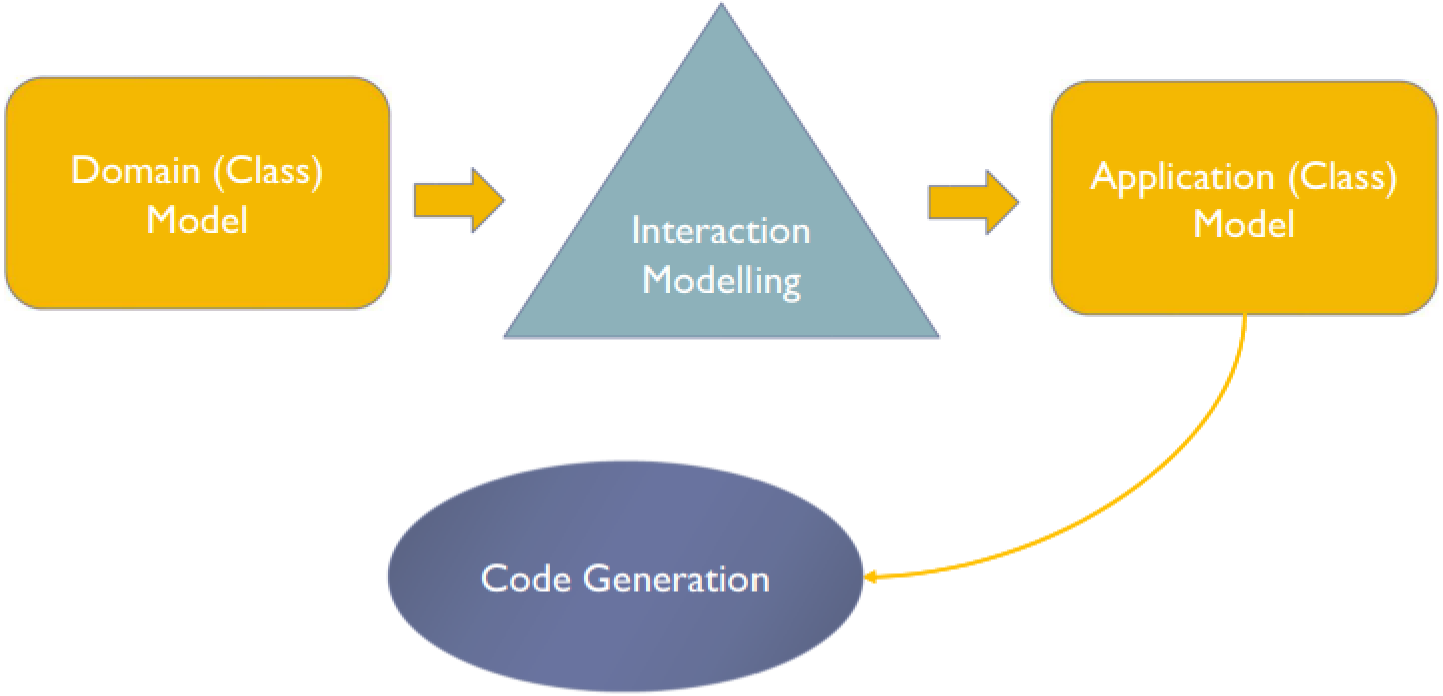
Some practical info

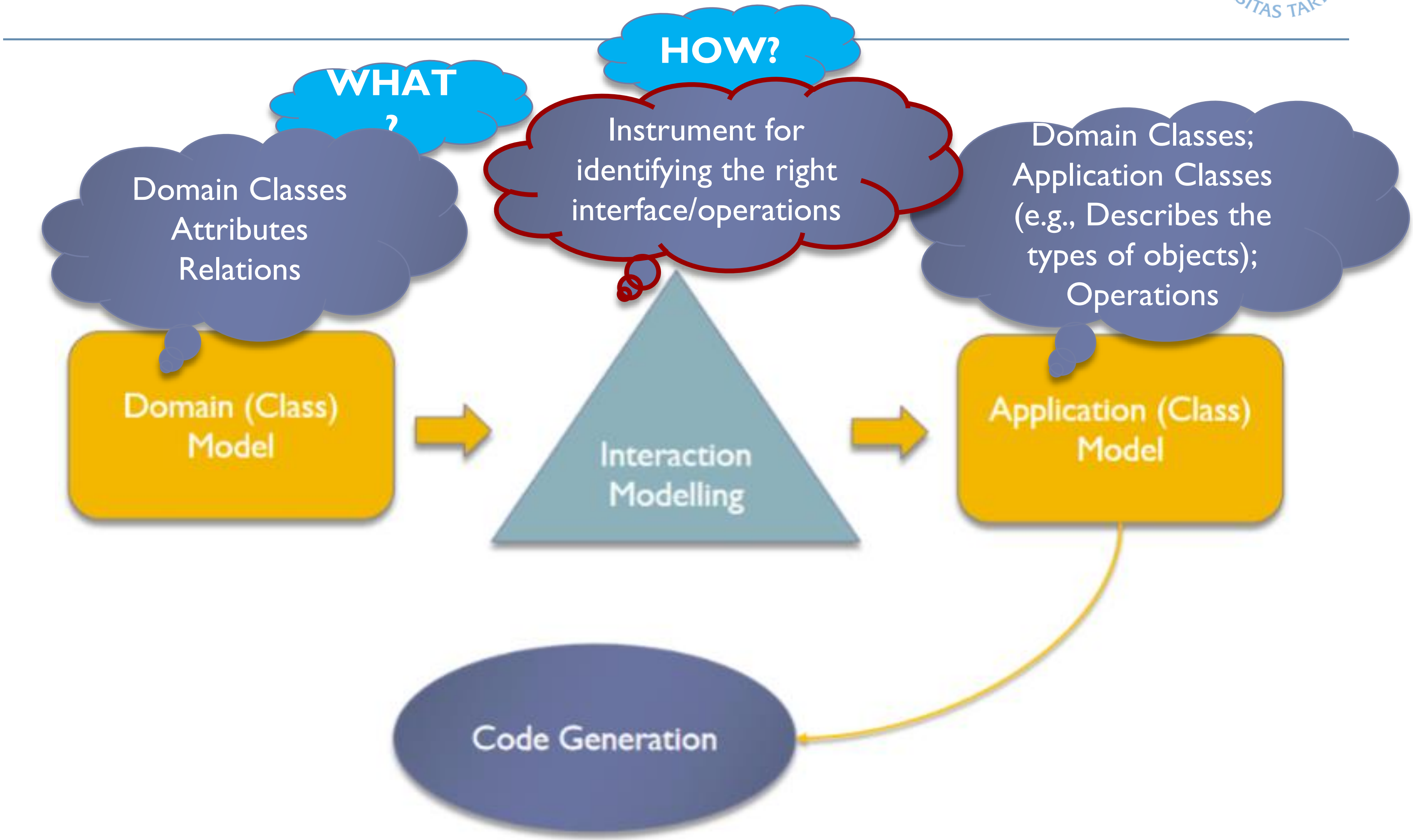
- **Assignment#2 is announced,** **deadline – 12.11.2023**
- **Homework is announced,** **deadline – 19.11.2023**
- **31.10 – Guest Lecture – Business Process Modelling, Marlon Dumas**
- **7.11 – no lecture, no practical session (no new tasks) – consultation instead of lecture**

Some practical info

- ➢ **BONUS points for filling in the survey on ChatGPT adoption**

Software Development Methodology





WHAT
?

Domain Classes
Attributes
Relations

HOW?

Instrument for
identifying the right
interface/operations

Domain Classes;
Application Classes
(e.g., Describes the
types of objects);
Operations

Domain (Class)
Model

Interaction
Modelling

Application (Class)
Model

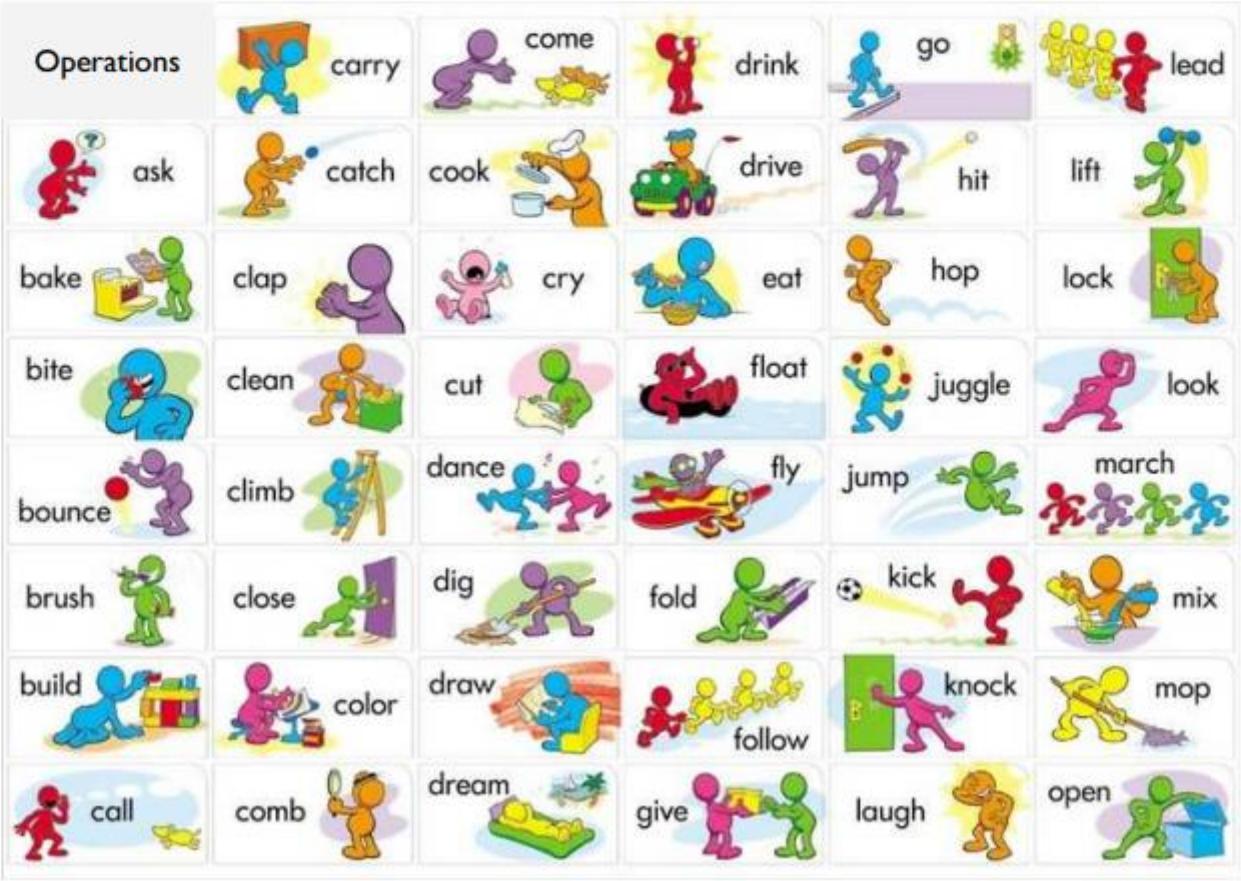
Code Generation

Interaction modelling: overview

Behaviour

Interactions

Interaction modelling: output



HOW?

Activity Diagrams

- Activity diagram is another important diagram in UML to describe the dynamic aspects of the system

- Activity diagram is basically a flowchart* to represent the flow from one activity to another activity** referring to the steps involved in the execution of a use case

  **Activity can be described as a particular operation of the system

- The control flow is drawn from one operation to another, and it can be (1) sequential, (2) branched, or (3) concurrent

  *compared to flowchart, activity diagrams have some additional capabilities ⇒ activity diagram is an advanced version of a flowchart

Source: https://www.ibm.com/docs/en/rsas/7.5.0?topic=model-modeling-user-workflow-by-using-activity-diagrams, https://www.oreilly.com/library/view/learning-uml-20/0596009828/ch03.html,
Source: https://www.tutorialspoint.com/uml/uml_activity_diagram.htm

Use-cases vs. Activity Diagrams

Use cases show *what* the system should do (functionality)

Activity diagrams allow specifying *how* the system will accomplish its goals

Activity diagrams show high-level actions chained together to represent a process occurring in the system, i.e., the workflow depicting *conditions*, *constraints*, *sequential and concurrent activities*

e.g., to model the steps involved with creating a blog account

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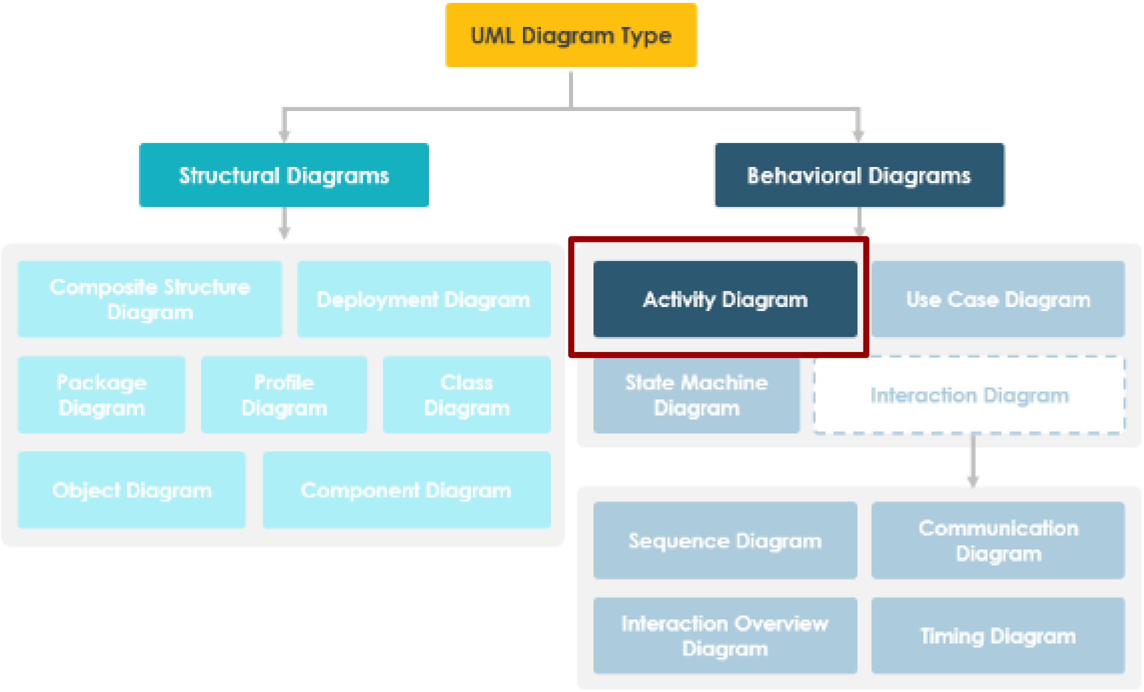
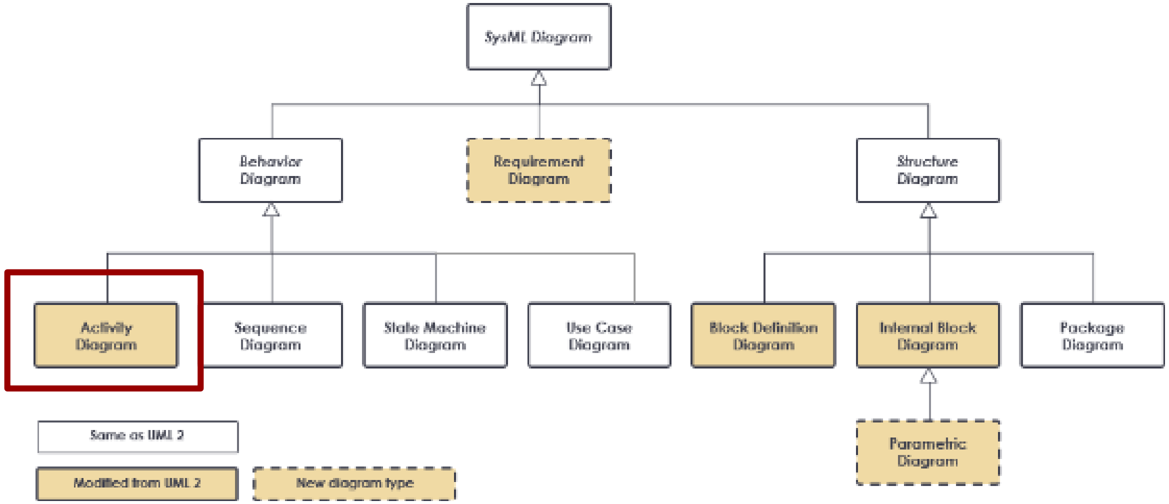
Activity diagram

Similarly to other behaviour(al) diagrams/models/charts,

it captures the dynamic behavior of the system



https://www.visual-paradigm.com/guide/uml-unified-modeling-language/what-is-activity-diagram/



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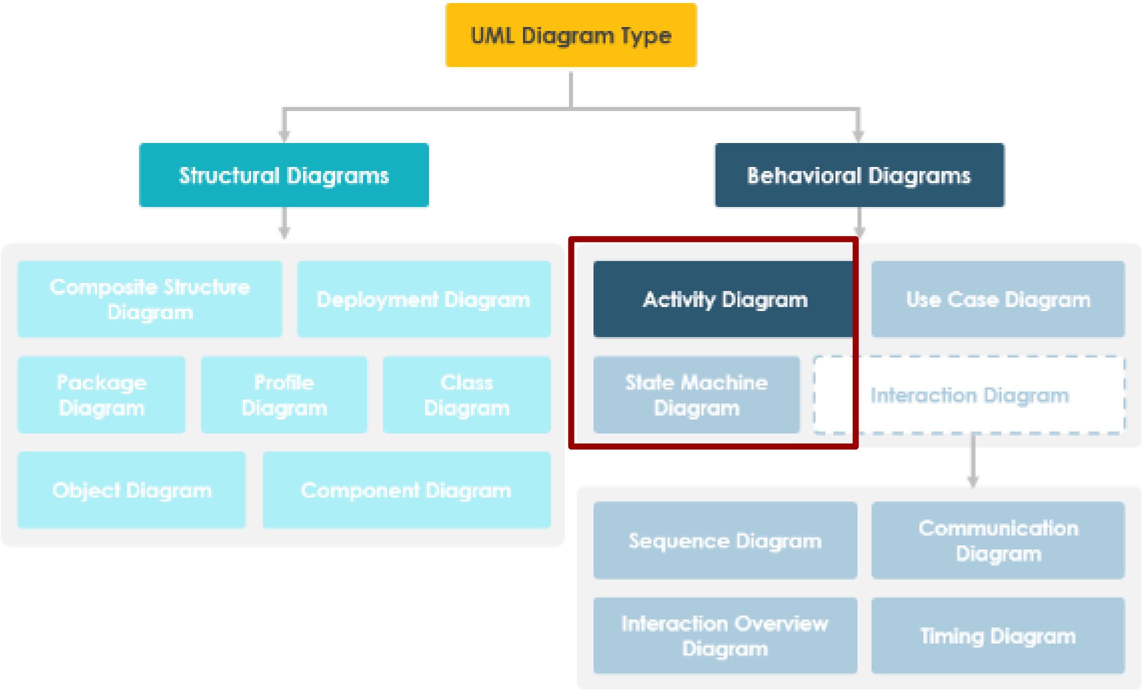

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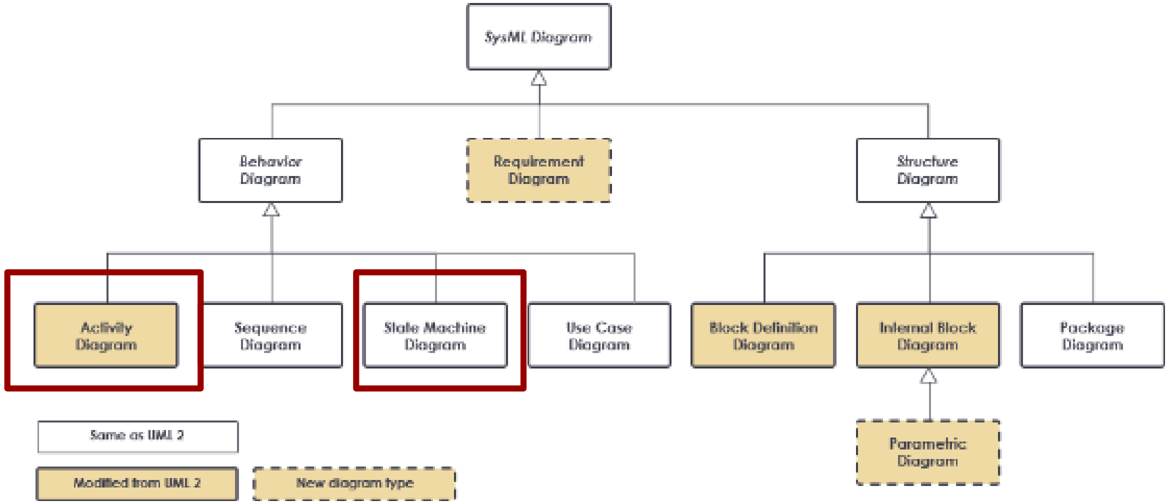

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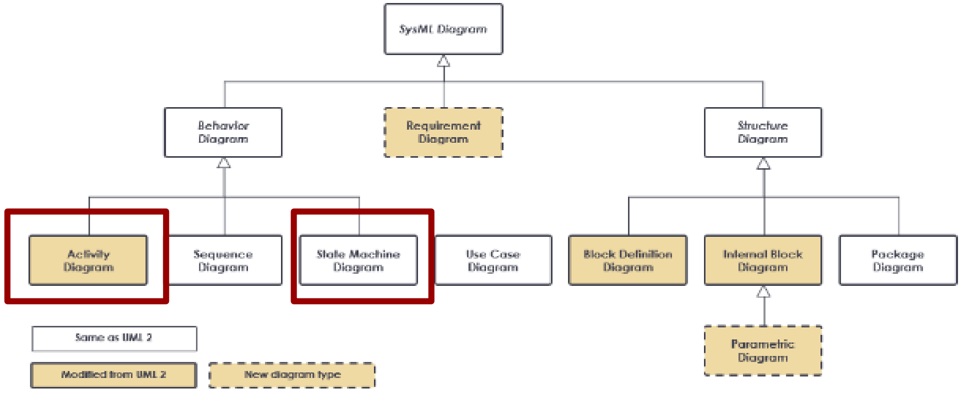
Activity Diagrams

Before UML 2.0, activity diagrams were part of state machines and were referred to as activity graphs

Since UML 2.0 the activity diagram is a distinct diagram, separate from a state machine, that focuses on the tasks that are performed



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Activity diagram

Similarly to other behaviour(al) diagrams/models/charts, it captures the dynamic behavior of the system

The purpose can be described as:

- **to understand and show the flow of activities of a system;**
- **to show the sequence from one activity to another;**
- **to figure out constraints and conditions that cause particular events & show the constraints, conditions and logic behind algorithms;**
- **to understand and show the parallel, branched and concurrent flow of the system.**

The client: *«our functional requirements are very clear and unlikely to change»*

The requirements:

Source: https://www.linkedin.com/posts/ralph-aboujaoude-diaz-40838313_technology-project-requirements-activity-7121027413043474433-o5d1?utm_source=share&utm_medium=member_desktop

Activity diagram

An activity diagram cannot be exactly matched with the code, i.e., the activity diagram is made to understand the flow of activities

*****But they can be used to construct the executable system**

***Question*: How?**

***Answer*: by using forward and reverse engineering techniques (the only missing thing in the activity diagram is the message part, i.e., it does not show any message flow from one activity to another)**

Activity Diagrams

!!! Activity diagrams are particularly good at modeling *business processes.**

***A business process is a set of coordinated tasks that achieve a business goal**

Example: *shipping customers' orders*

Some business process management (BPM) tools allow defining business processes using activity diagrams [or a similar graphical notation], and then execute them ⇒

⇒ this allows to define and execute process, e.g., *a payment approval process where one of the steps invokes a credit card approval web service*—using an easy graphical notation

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Activity Diagrams

In UML modeling, activity diagrams are used to model

- **the sequence of actions that must occur in a system or application,**
- **or to describe what happens in a business process workflow.**

HOW TO DIFFERENTIATE BETWEEN THEM?

Source: https://www.ibm.com/docs/en/rsas/7.5.0?topic=model-modeling-user-workflow-by-using-activity-diagrams, https://www.oreilly.com/library/view/learning-uml-20/0596009828/ch03.html

Activity Diagrams

HOW TO DIFFERENTIATE BETWEEN THEM?

- In the **business process modeling** domain, activity diagrams describe **the workflow of a business use case.**
- In the **system modeling domain**, they show **the structure of the flow of events in a system use case.**

Activity nodes and edges are used to represent the flow of control and data between the objects in the use case

One or several activity diagrams to illustrate how the activity nodes, activity edges, and other activity diagram model elements relate to each other.

Source: https://www.ibm.com/docs/en/rsas/7.5.0?topic=model-modeling-user-workflow-by-using-activity-diagrams, https://www.oreilly.com/library/view/learning-uml-20/0596009828/ch03.html

When to use Activity Diagrams (1/2)

Activity Diagrams describe *how activities are coordinated to provide a service which can be at different levels of abstraction*.

Typically, an event needs to be achieved by some operations, particularly where the operation is intended to achieve a number of different "things" that require coordination, or how the events in a single use case relate to one another, in particular, use cases where activities may overlap and require coordination.

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When to use Activity Diagrams (2/2)

Activity Diagrams is also suitable for modeling how a collection of use cases coordinate to represent business workflows

1. **identify candidate use cases, through the examination of business workflows**
2. **identify pre- and post-conditions (the context) for use cases**
3. **model workflows between/within use cases**
4. **model complex workflows in operations on objects**
5. **model in detail complex activities in a high level activity diagram**

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How to draw Activity Diagram?

The main element of an activity diagram is the activity itself

After identifying the activities, we need to understand how they are associated with constraints and conditions

STEP I: Before drawing an activity diagram, identify the following elements:

- **initial and the final states**
- **activities to reach the final state**
- **conditions & constraints that change control flow**

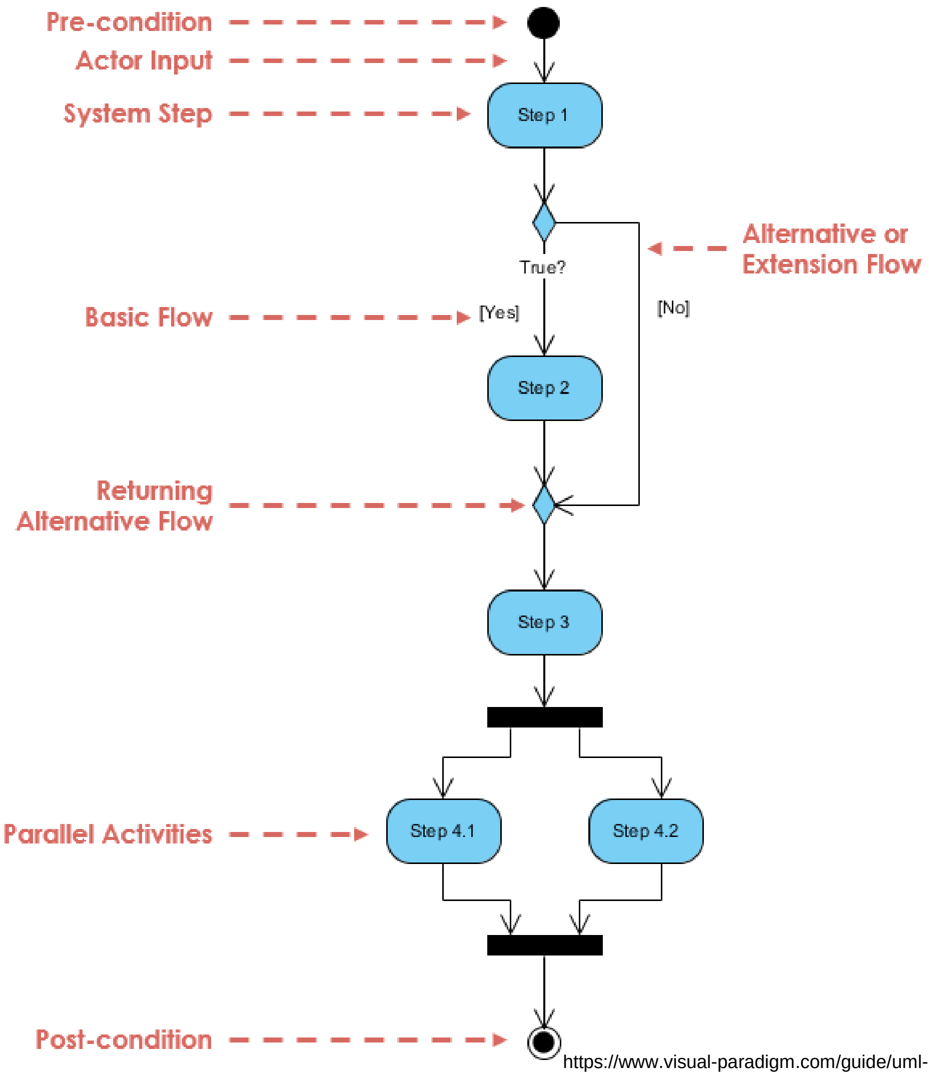
model-agnostic PDCA-based hint that can (should) be applicable to all types of diagrams

STEP II: Once the above is identified, make a mental layout of the entire flow

STEP III: Transform it then into an activity diagram.

Source: https://www.tutorialspoint.com/uml/uml_activity_diagram.htm

Activity Diagrams and its elements



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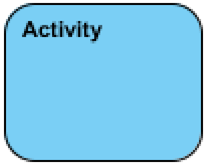
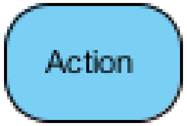
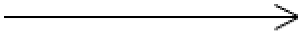
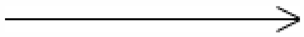
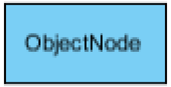
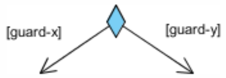
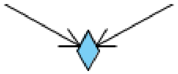
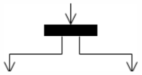
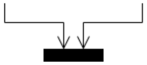
Activity Diagrams and its elements

Activity	Is used to represent a set of actions	
Action	A task to be performed	
Control Flow	Shows the sequence of execution	
Object Flow	Show the flow of an object from one activity (or action) to another activity (or action) An activity state can have multiple incoming and outgoing action flows. If there is a constraint to be adhered to while making the transition it is mentioned on the arrow	

https://www.visual-paradigm.com/guide/uml-unified-modeling-language/what-is-activity-diagram/, https://www.geeksforgeeks.org/unified-modeling-language-uml-activity-diagrams/

Activity Diagrams and its elements

Initial Node	Portrays the beginning of a set of actions or activities A process can have **only one** initial state unless we are depicting nested activities. For objects, this is the state when they are instantiated. The Initial State from the UML Activity Diagram marks **the entry point and the initial Activity State.**	●
Activity Final Node	Stop all control flows and object flows in an activity (or action)	◉
Object Node	Represent an object that is connected to a set of Object Flows	
Decision Node / Branching	Represent a test condition to ensure that the control flow or object flow only goes down one path The outgoing arrows from the decision node can be labelled with conditions or guard expressions.It always includes two or more output arrows.	
Merge Node	Bring back together different decision paths that were created using a decision-node.	
Fork Node	Split behavior into a set of parallel or concurrent flows of activities (or actions)	
Join Node	Bring back together a set of parallel or concurrent flows of activities (or actions)	

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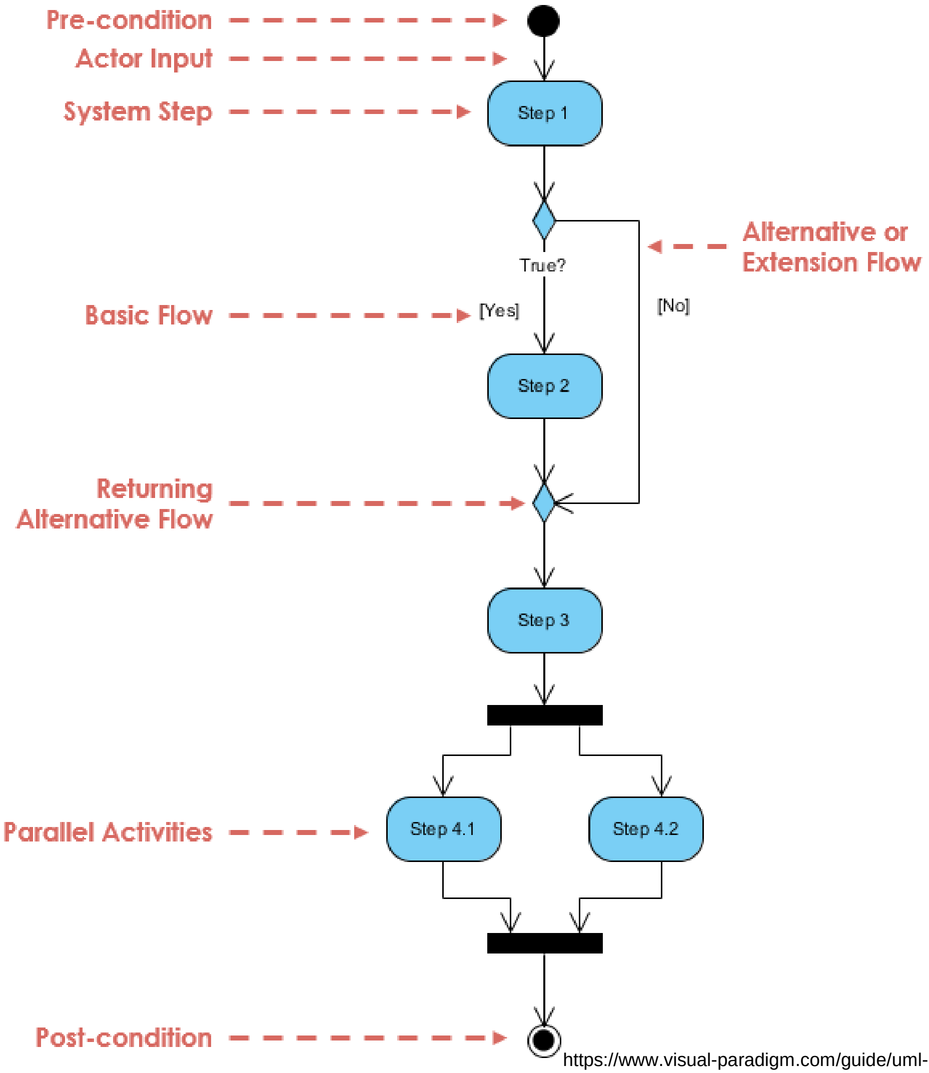
Activity Diagrams and its elements



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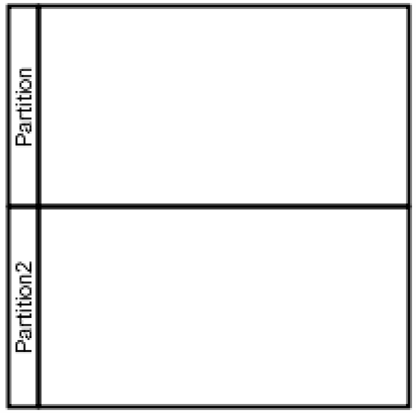
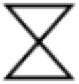
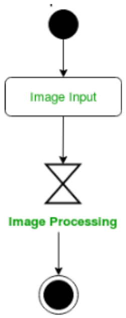
Activity Diagrams and its elements

Swimlane and Partition	A way to group activities performed by the same actor on an activity diagram or to group activities in a single thread	
Time event	a way to depict that an event takes some time to complete. For example – Let us assume that the processing of an image takes a lot of time.	



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Example I

Let us think of the workflow for a process to create a document

what would be the actions?

what would be the sequence, in which they are expected to take place?

what would be different "paths"/options? (if/else)

is there anything else we should consider?

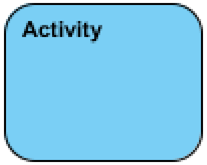
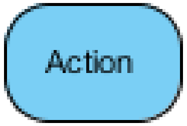
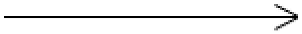
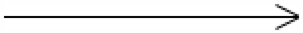
STEP I: Before drawing an activity diagram, identify the following elements:

- ➢ **Initial and the final states**
- ➢ **Activities to reach the final state**
- ➢ **Conditions & Constraints that cause the system to change control flow**

STEP II: Once the above is identified, make a mental layout of the entire flow

STEP III: Transform it then into an activity diagram.

Reminder: elements of activity diagram I

Activity	Is used to represent a set of actions	
Action	A task to be performed	
Control Flow	Shows the sequence of execution	
Object Flow	Show the flow of an object from one activity (or action) to another activity (or action)	

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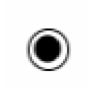
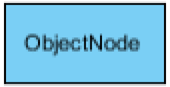
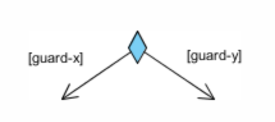
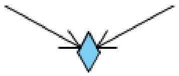
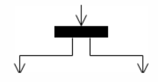
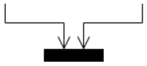
Reminder: elements of activity diagram II

Initial Node	Portrays the beginning of a set of actions or activities	
Activity Final Node	Stop all control flows and object flows in an activity (or action)	
Object Node	Represent an object that is connected to a set of Object Flows	
Decision Node	Represent a test condition to ensure that the control flow or object flow only goes down one path	
Merge Node	Bring back together different decision paths that were created using a decision-node.	
Fork Node	Split behavior into a set of parallel or concurrent flows of activities (or actions)	
Join Node	Bring back together a set of parallel or concurrent flows of activities (or actions)	

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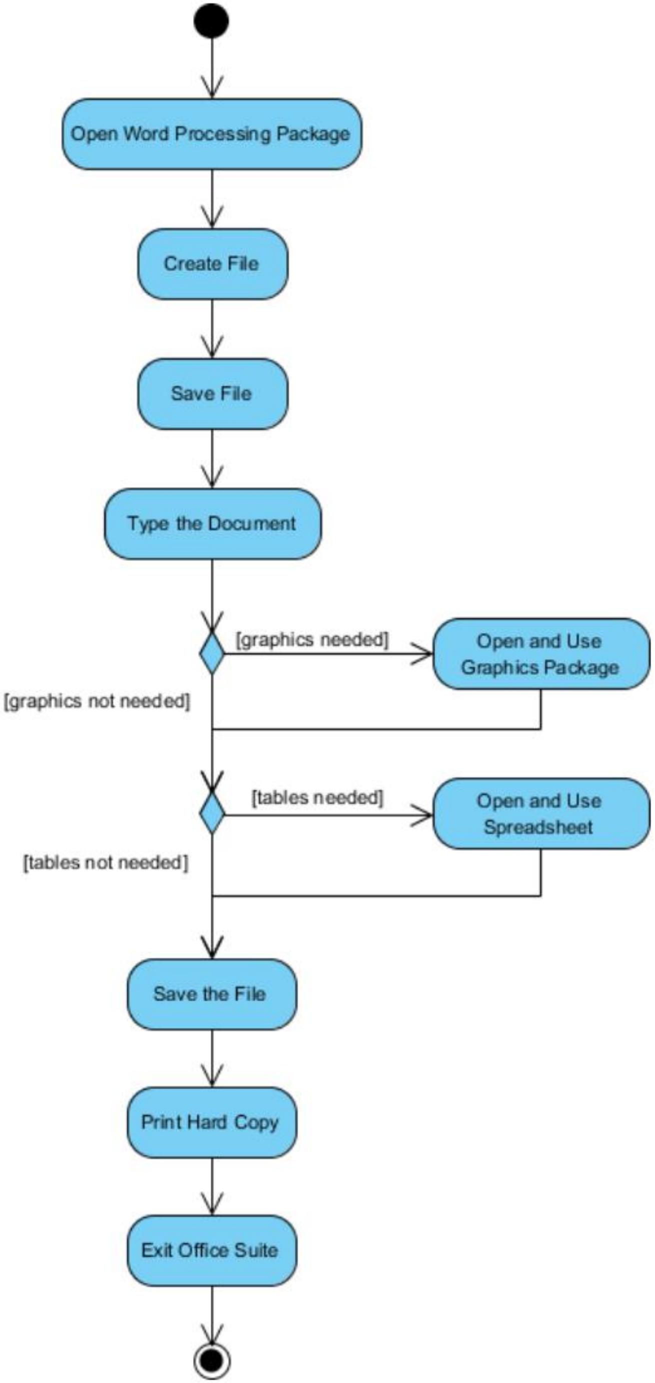
Example I

Let us describes the workflow for a word process to create a document through the following steps:

- Open the word processing package
- Create a file
- Save the file under a unique name within its directory
- Type the document
- If graphics are necessary, open the graphics package, create the graphics, and paste the graphics into the document
- If a spreadsheet is necessary, open the spreadsheet package, create the spreadsheet, and paste the spreadsheet into the document
- Save the file
- Print a hard copy of the document
- Exit the word processing package



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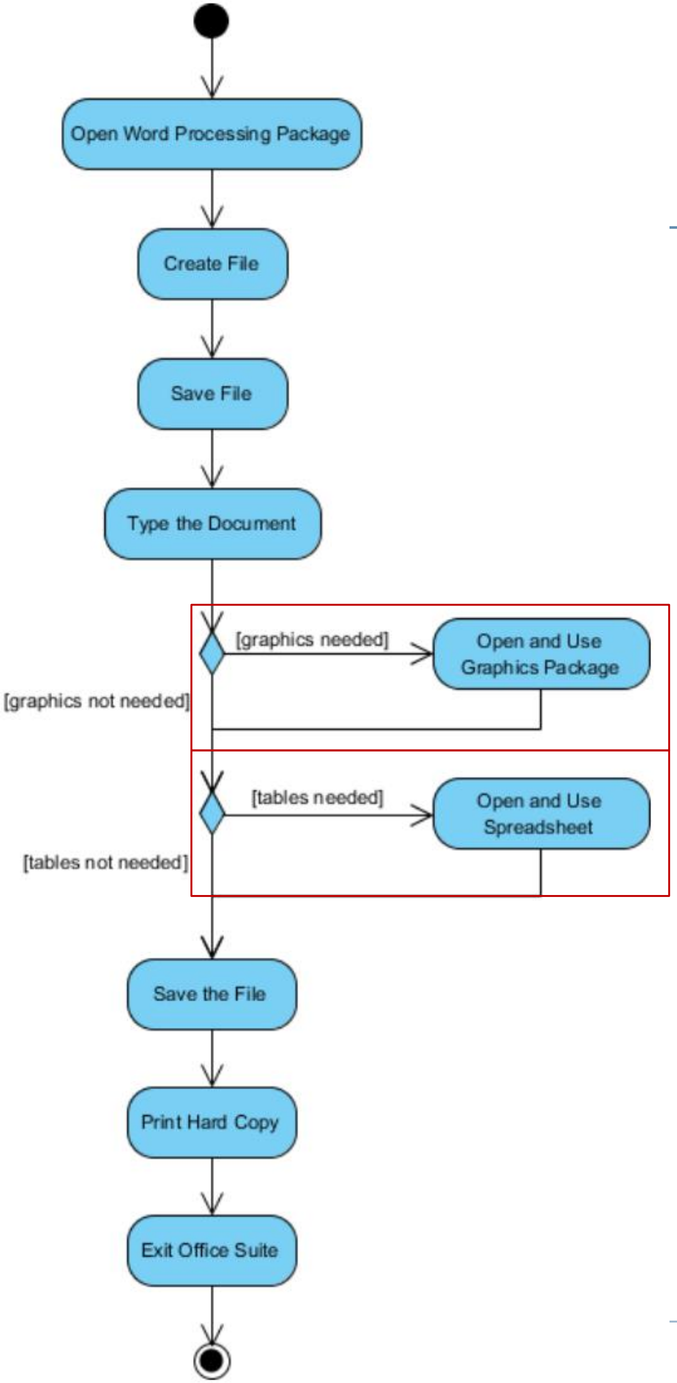
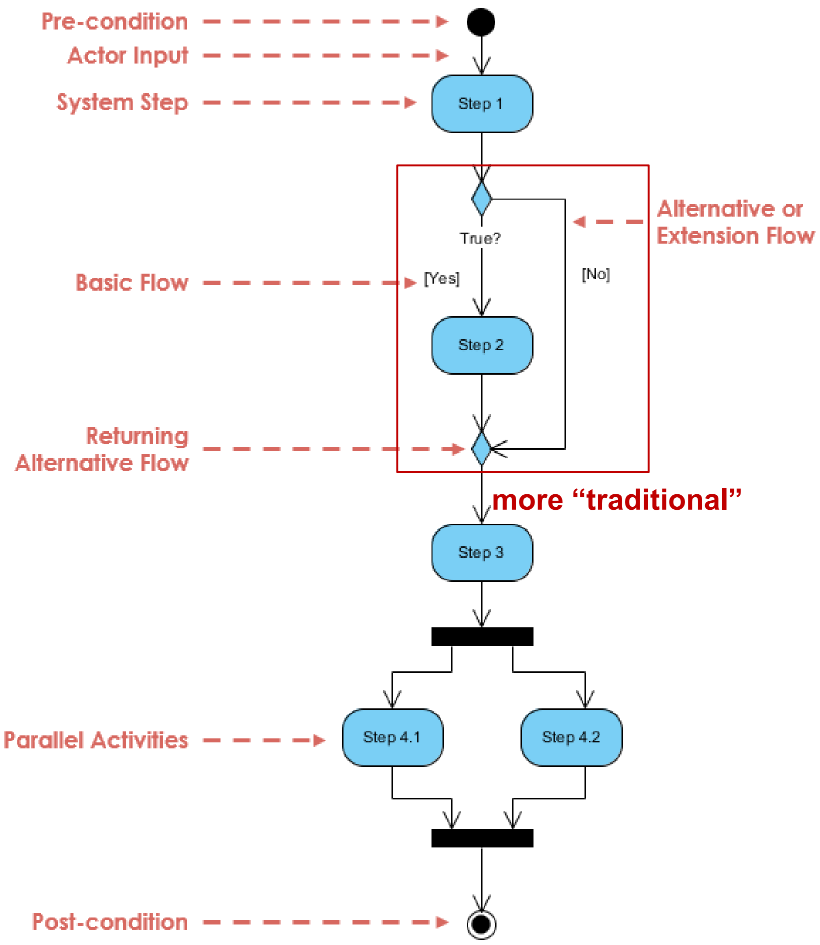
Example I


Open Word Processing Package
Create File
Save File
Type the Document
[graphics needed]
Open and Use Graphics Package
[graphics not needed]
[tables needed]
Open and Use Spreadsheet
[tables not needed]
Save the File
Print Hard Copy
Exit Office Suite

Example I



Pre-condition

Actor Input

System Step

Alternative or Extension Flow

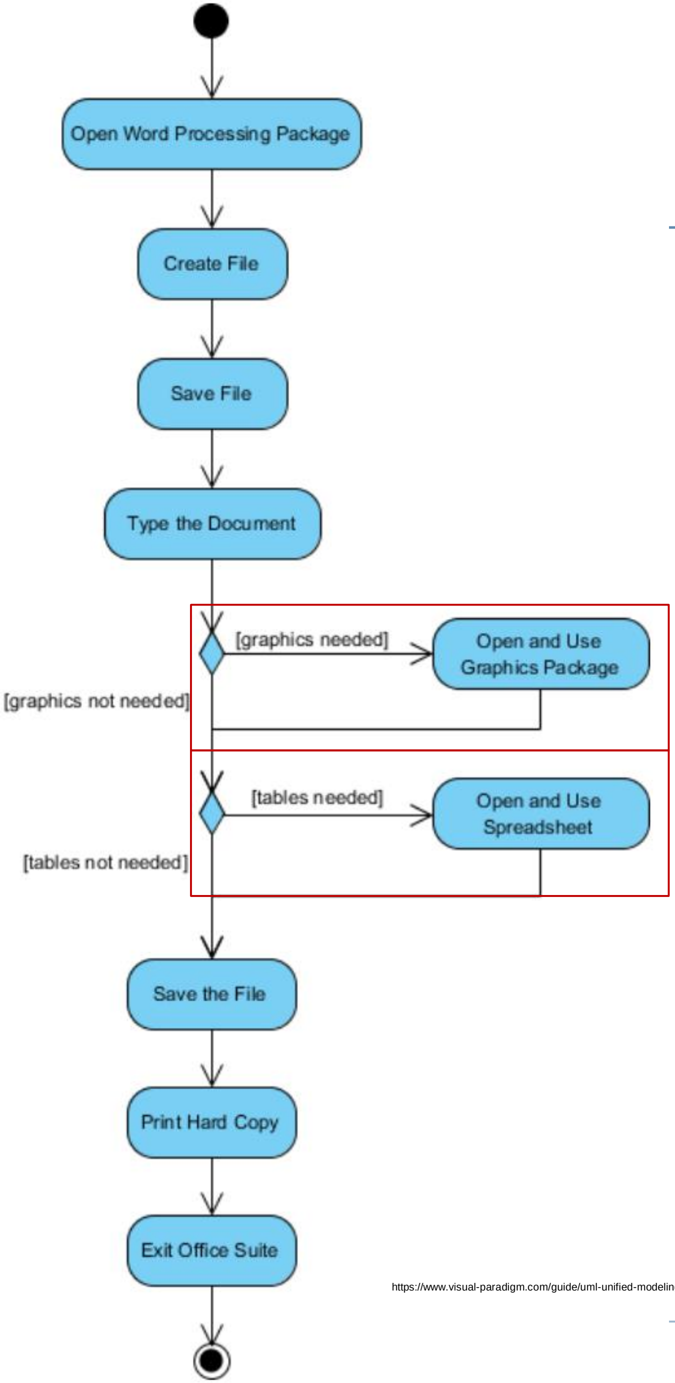
Basic Flow

Returning Alternative Flow

more "traditional"

Parallel Activities

Post-condition



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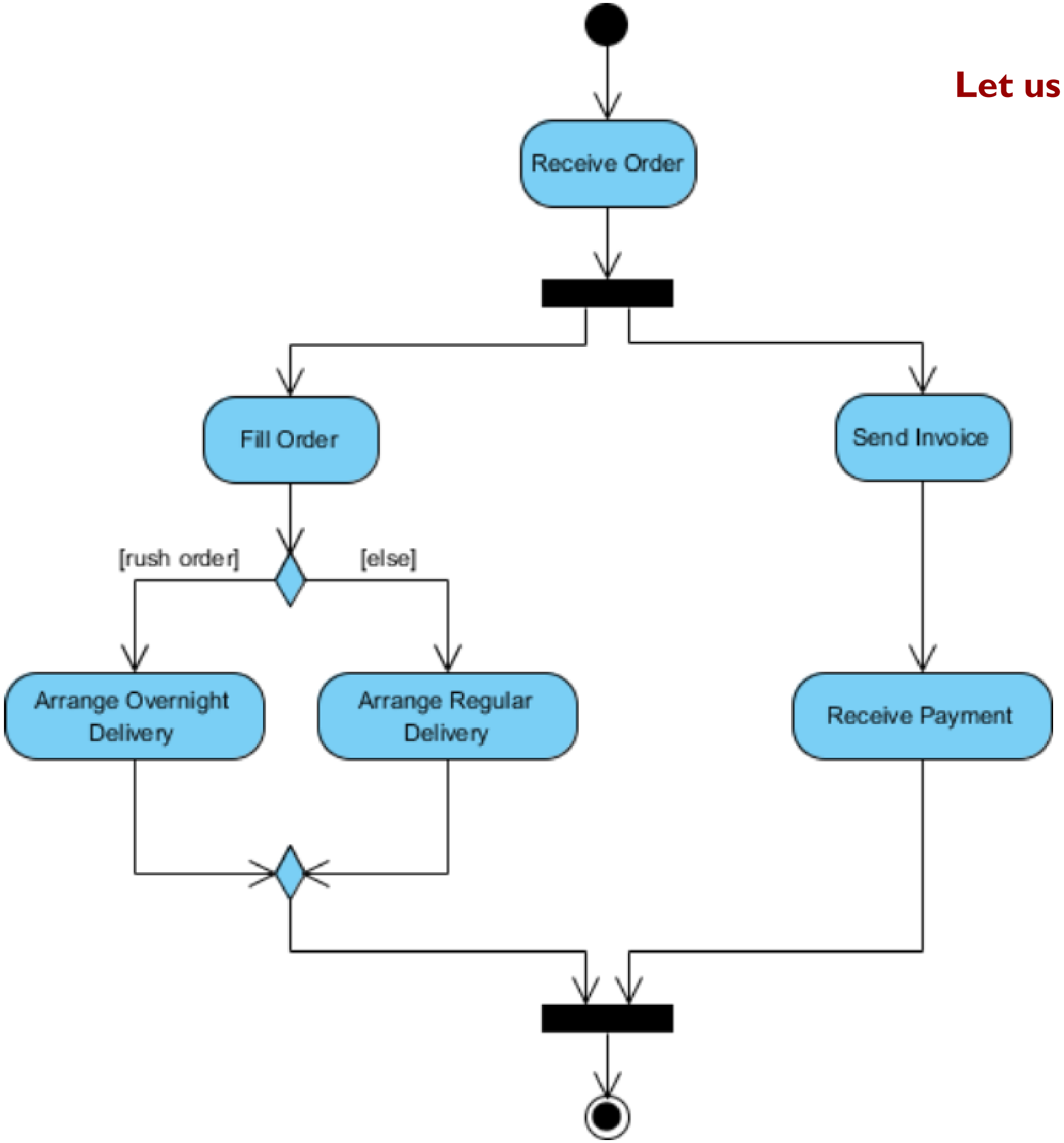
Example II

Let us think of Processing the Order

- ➢ **Once the order is received, the activities split into two parallel sets of activities. One side fills and sends the order while the other handles the billing.**
- ➢ **On the Fill Order side, the method of delivery is decided conditionally. Depending on the condition either the Overnight Delivery activity or the Regular Delivery activity is performed.**
- ➢ **Finally, the parallel activities combine to close the order.**

Example II



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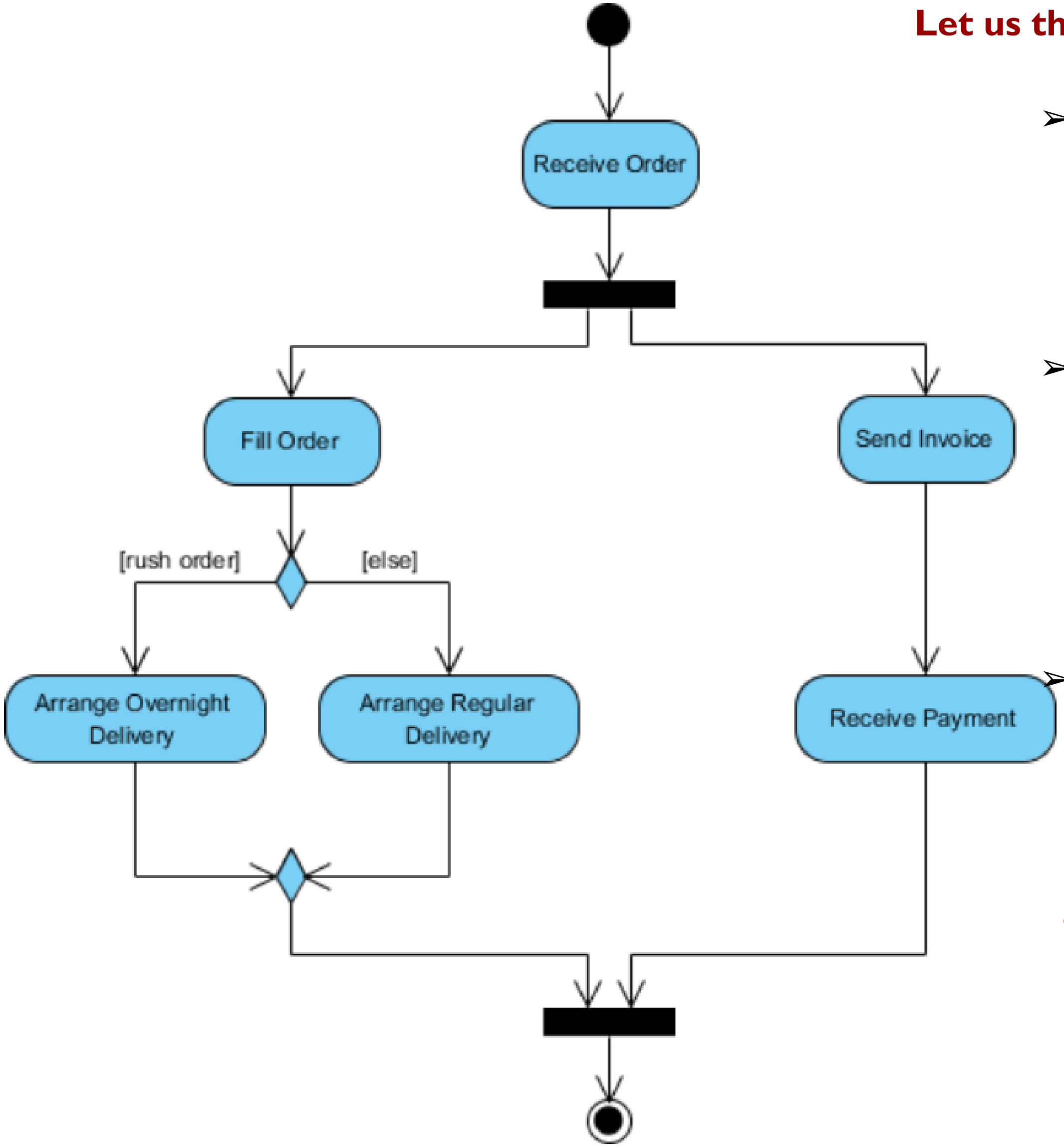


Let us think of Processing the Order

- ➢ **Once the order is received, the activities split into two parallel sets of activities. One side fills and sends the order while the other handles the billing.**
- ➢ **On the Fill Order side, the method of delivery is decided conditionally. Depending on the condition either the Overnight Delivery activity or the Regular Delivery activity is performed.**
- ➢ **Finally, the parallel activities combine to close the order.**

Can we somehow show that more than one actor is involved?

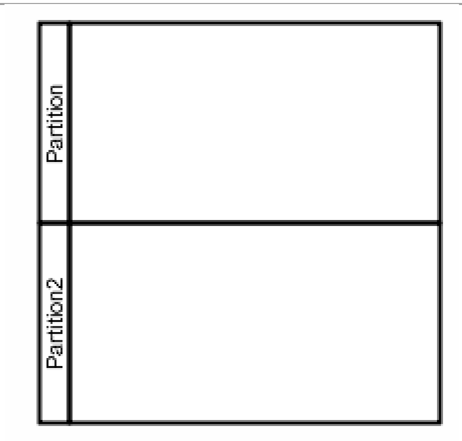
YES - swimlanes! To be continued…

https://www.visual-paradigm.com/guide/uml-unified-modeling-language/what-is-activity-diagram/

Swimlane IV

Let us think of Staff Expenses Submission

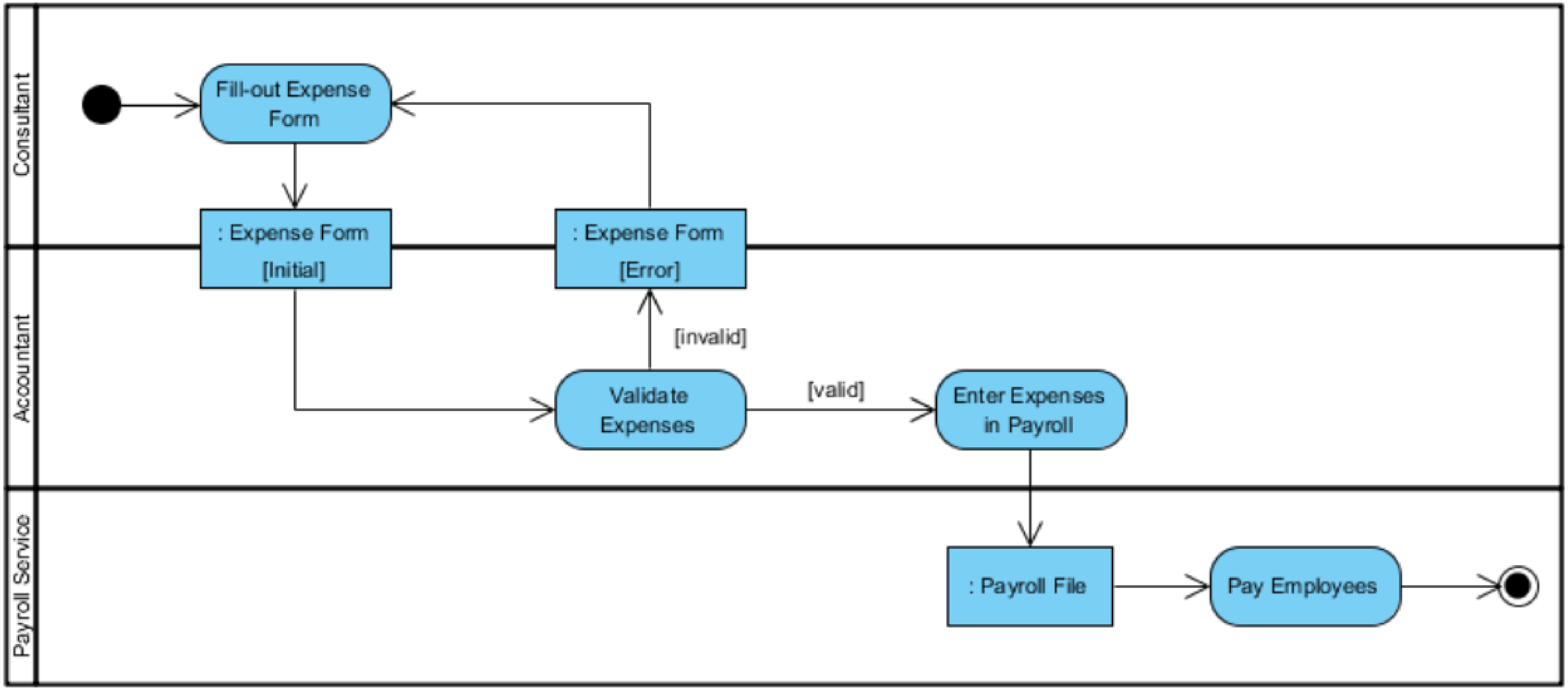
Let us also consider using swimlane!

Swimlane and Partition	A way to group activities performed by the same actor on an activity diagram or to group activities in a single thread	

https://www.visual-paradigm.com/guide/uml-unified-modeling-language/what-is-activity-diagram/

Example IV

Let us think of Staff Expenses Submission



https://www.visual-paradigm.com/guide/uml-unified-modeling-language/what-is-activity-diagram/

LET’S SUM UP…

WHY TO USE?

Activity diagrams can express complex control logic better than sequence diagrams and state machine diagrams*.

An activity diagram is **particularly good at expressing the flow of objects**—matter, energy, or data—**through a behavior**, with a focus on **how the objects can be accessed and modified in the execution of that behavior during system operation**.

to specify behavior, with a focus on the flow of control and the transformation of inputs into outputs through a sequence of actions

https://www.visual-paradigm.com/guide/sysml/how-to-use-activity-diagram/

WHY TO USE?

Common uses:

- as an analysis tool **to understand and express the desired behavior of a system,** including modelling sequential and concurrent activities;
- **to create graphical use case specifications,** which tend to be more concise and less ambiguous than the traditional text form of a use case specification;

- to dissect a single-use case specification either a text specification or an activity diagram, and subsequently for creating a set of sequence diagrams, one per path (scenario).

https://www.visual-paradigm.com/guide/sysml/how-to-use-activity-diagram/

The final remark…

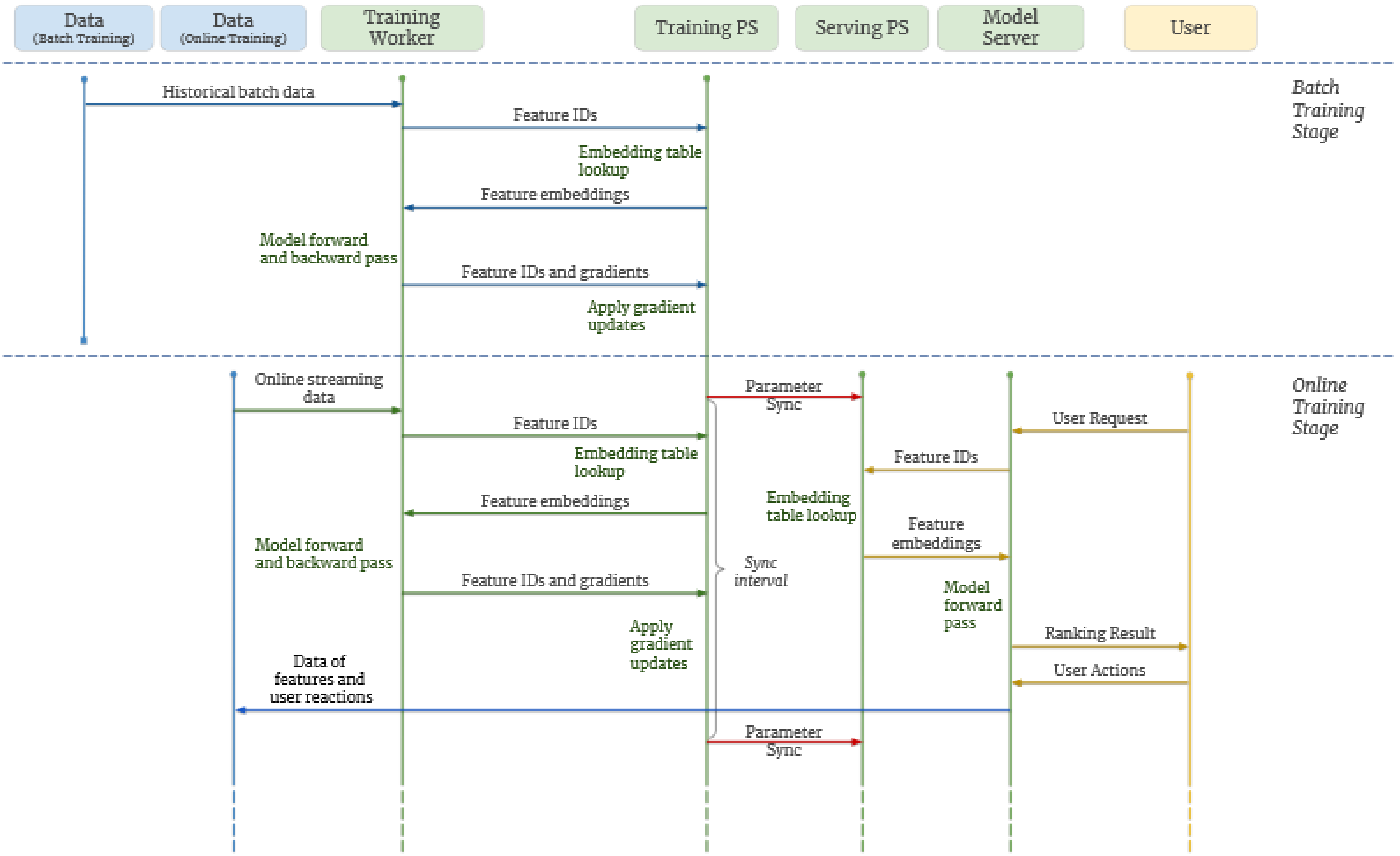


Figure 1: Monolith Online Training Architecture.

Zhuoran Liu, Leqi Zou, Xuan Zou, Caihua Wang, Biao Zhang, Da Tang, BolinZhu, Yijie Zhu, Peng Wu, Ke Wang, and Youlong Cheng. 2022. Monolith:Real Time Recommendation System With Collisionless Embedding Table.InProceedings of 5th Workshop on Online Recommender Systems and UserModeling, in conjunction with the 16th ACM Conference on RecommenderSystems (ORSUM@ACM RecSys 2022).ACM, New York, NY, USA, 10 pages., https://arxiv.org/pdf/2209.07663.pdf

Some practical info

- **Assignment#2 is announced, deadline – 12.11.2023**

- **Homework is announced, deadline – 19.11.2023**

- **31.10 – Guest Lecture – Business Process Modelling, Marlon Dumas**

- **7.11 – no lecture, no practical session (no new tasks) – consultation instead of lecture**

Some practical info

- ➢ **BONUS points for filling in the survey on ChatGPT adoption**

SCAN ME