All You Need to Know About UML Diagrams: Types and 5+ Examples

NOEL CETA

IN TALLYFY (/) ▸ TECHNOLOGY TRENDS (HTTPS://TALLYFY.COM/CATEGORY/TECHNOLOGY-TRENDS/)

A UML diagram is a diagram based on the UML (Unified Modeling Language) with the purpose of **visually representing a system** along with its main actors, roles, actions, artifacts or classes, in order to better understand, alter, maintain, or document information about the system.

What is UML?

UML is an acronym that stands for **Unified Modeling Language**. Simply put, UML is a modern approach to modeling and documenting software. In fact, it's one of the most popular business process modeling techniques (https://tallyfy.com/business-process-modeling-techniques).

It is based on **diagrammatic representations** of software components. As the old proverb says: "a picture is worth a thousand words". By using visual representations, we are able to better understand possible flaws or errors in software or business processes.

UML was created as a result of the chaos revolving around software development and documentation. In the 1990s, there were several different ways to represent and document software systems. The need

arose for a more unified way to visually represent those systems and as a result, in 1994-1996, the UML was developed by three software engineers working at Rational Software (https://en.wikipedia.org/wiki/Rational_Software). It was later adopted as the standard in 1997 and has remained the standard ever since, receiving only a few updates.

Before we continue, here's a shameless plug from Amit (CEO of Tallyfy)

> If you're building software – consider Tallyfy (https://tallyfy.com) as an API-driven platform that solves workflow problems, without needing to build basic workflow functionality from scratch.

What is the use of UML?

Mainly, UML has been used as a general-purpose modeling language in the field of software engineering. However, it has now found its way into the documentation of several business processes (https://tallyfy.com/business-process) or workflows (https://tallyfy.com/what-is-a-workflow/). For example, activity diagrams, a type of UML diagram, can be used as a replacement for flowcharts. They provide both a more standardized way of modeling workflows as well as a wider range of features to improve readability and efficacy.

UML itself finds different uses in software development and business process documentation:

Sketch

UML diagrams, in this case, are used to communicate different aspects and characteristics of a system. However, this is only a top-level view of the system and will most probably not include all the necessary details to execute the project until the very end.

- **Forward Design** – The design of the sketch is done before coding the application. This is done to get a better view of the system or workflow that you are trying to create. Many design issues or flaws can be revealed, thus improving the overall project health and well-being.

Backward Design – After writing the code, the UML diagrams are drawn as a form of documentation for the different activities, roles, and workflows.

Blueprint

In such a case, the UML diagram serves as a complete design that requires solely the actual implementation of the system or software.

Often, this is done by using CASE (https://en.wikipedia.org/wiki/Computer-aided_software_engineering) tools (Computer Aided Software Engineering Tools). The main drawback of using CASE tools is that they require a certain level of expertise, user training as well as management and staff commitment.

Pseudo Programming Language

UML is not a stand-alone programming language like Java, C++ or Python, however, with the right tools, it can turn into a pseudo programming language. In order to achieve this, the whole system needs to be documented in different UML diagrams and, by using the right software, the diagrams can be directly translated into code. This method can only be beneficial if the time it takes to draw the diagrams would take less time than writing the actual code.

Despite UML having been created for modeling software systems, it has found several adoptions in business fields or non-software systems.

PRACTICAL EXAMPLE

One practical adoption would be to visually represent the process flow for telesales through an activity diagram. From the point in which an order is taken as an input, to the point where the order is completed and a specific output is given.

Types of UML Diagrams

There are several types of UML diagrams and each one of them serves a different purpose regardless of whether it is being designed before implementation or after (as part of documentation).

The most broad categories that encompass all other types are **Behavioral** UML diagram and **Structural** UML diagram. As the name suggests, some UML diagrams try to analyze and depict the structure of a system or process, whereas other describe the behavior of the system, its actors, and its building components. The different types are broken down as follows:

Behavioral UML Diagram

- Activity Diagram
- Use Case Diagram
- Interaction Overview Diagram
- Timing Diagram
- State Machine Diagram
- Communication Diagram
- Sequence Diagram

Structural UML Diagram

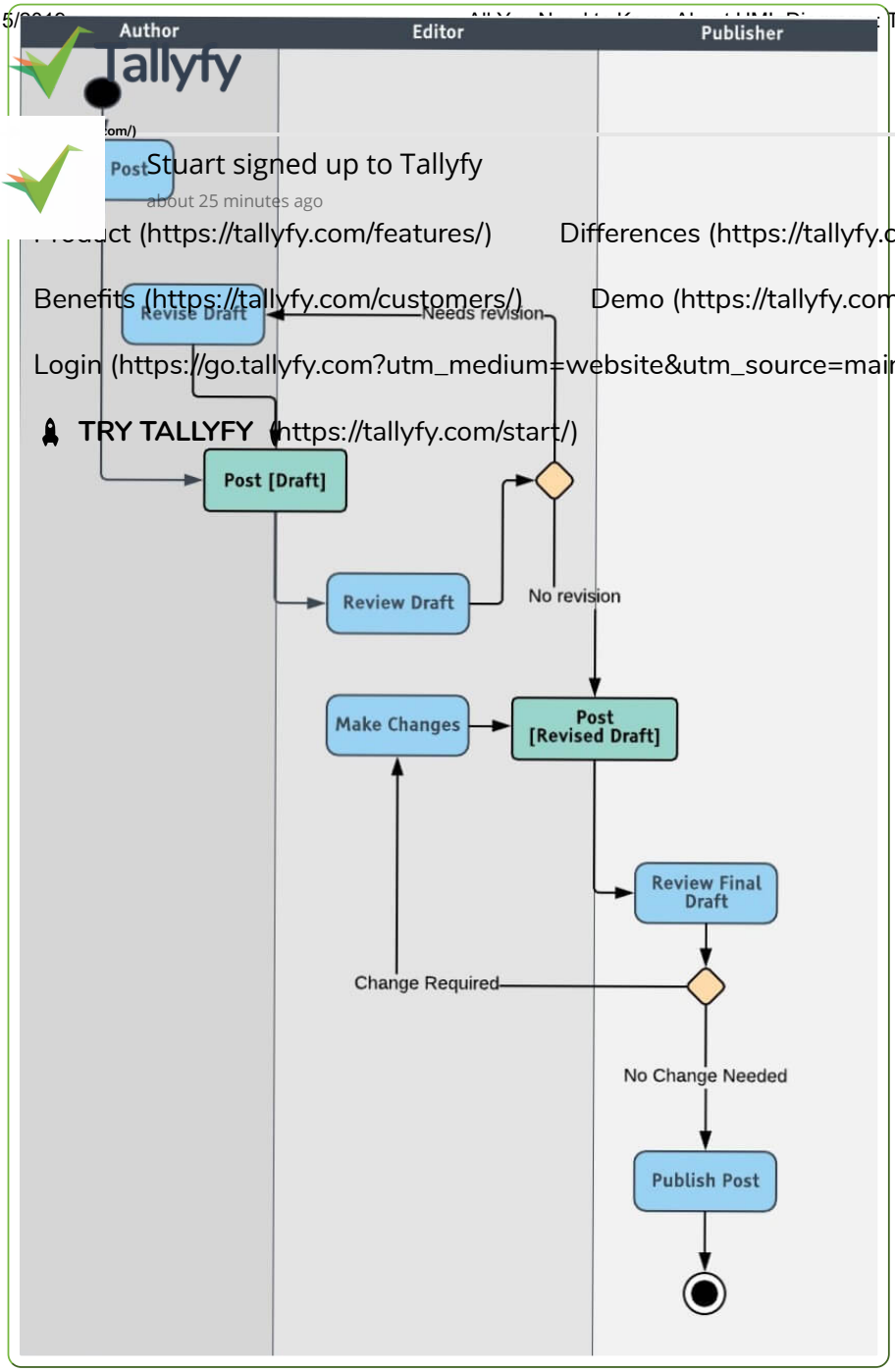
- Class Diagram
- Object Diagram
- Component Diagram
- Composite Structure Diagram
- Deployment Diagram
- Package Diagram
- Profile Diagram

Not all of the 14 different types of UML diagrams are used on a regular basis when documenting systems and/or architectures. The Pareto principle (https://betterexplained.com/articles/understanding-the-pareto-principle-the-8020-rule/) seems to apply in terms of UML diagram usage.

(https://saturnnetwork.wordpress.com/2010/10/22/five-reasons-developers-dont-use-uml-and-six-reasons-to-use-it/) as well – 20% diagrams are being used 80% of the time by developers. The frequently used ones in software development are: Use Case diagrams, Class diagrams, and Sequence diagrams.

Activity Diagram

Activity diagrams are probably the most important UML diagrams for doing business process modeling (https://tallyfy.com/business-process-modeling/). In software development, it is generally used to describe the flow of different activities and actions. These can be both sequential and in parallel. They describe the objects used, consumed or produced by an activity and the relationship between the different activities. All the above are essential in business process modeling.



A process is not focused on what is being produced but rather on the set of activities that lead to one the other and how they are interconnected, with a clear beginning and end. The example above depicts the set of activities that take place in a content publishing process. In a business environment, this is also referred to as business process mapping (https://tallyfy.com/business-process-mapping/) or business process modeling (https://tallyfy.com/business-process-modeling).

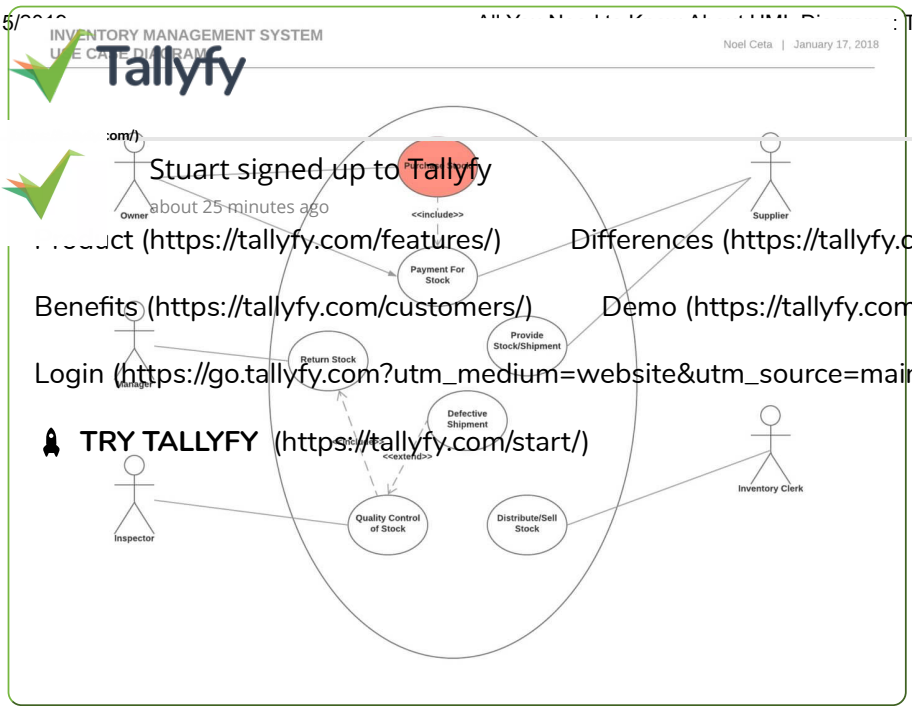
The main actors are the author, the editor and the publisher. In the diagram, you can see how the diamond shape is used to describe es that require branching or repetitive processes, i.e: loops. In mple, one of the loops happens when the reviewer is reviewing the draft and decides that some changes need to be done. The author then revises the draft and pushes it down the pipeline again, for the review to analyze.

Use Case Diagram

A cornerstone part of the system is the functional requirements (https://reqtest.com/requirements-blog/functional-vs-non-functional-requirements/) that the system fulfills. Use Case diagrams are used to analyze the system's high-level requirements (http://www.testablerequirements.com/testablerequirements/ident_hlrs.htm). These requirements are expressed through different use cases. We notice three main components of this UML diagram:

- **Functional requirements** – represented as use cases; a verb describing an action
- **Actors** – they interact with the system; an actor can be a human being, an organization or an internal or external application
- **Relationships** between actors and use cases – represented using straight arrows

The example below depicts the use case UML diagram for an inventory management system. In this case, we have the owner, the supplier, the manager, the inventory clerk and the inventory inspector.



Within the circular containers, we express the actions that the actors perform. Such actions are: purchasing and paying for the stock, checking stock quality, returning the stock or distributing it. As you might have noticed, use case UML diagrams are good for showing dynamic behaviors between actors within a system, by simplifying the view of the system and not reflecting the details of implementation.

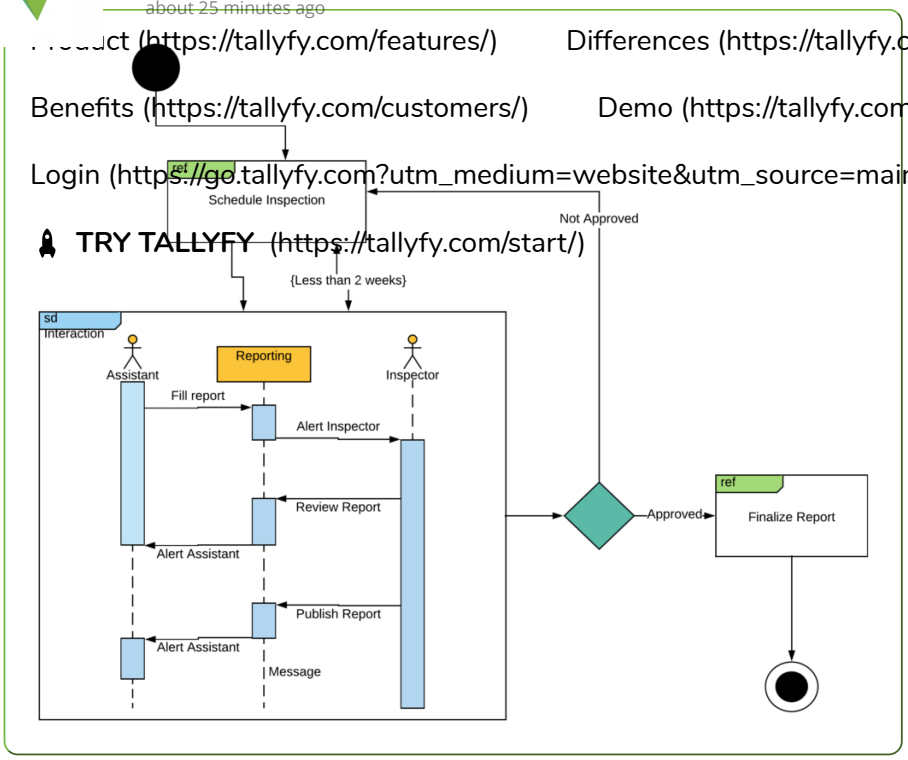
Interaction Overview Diagram

Interaction Overview UML diagrams are probably some of the most complex ones. So far we have explained what an activity diagram is. Additionally, within the set of behavioral diagrams, we have a subset made of four diagrams, called Interaction Diagrams:

- Interaction Overview Diagram
- Timing Diagram
- Sequence Diagram
- Communication Diagram

So, the interaction overview diagram is an activity diagram made of different interaction diagrams. Let's say that it is a mix of activity diagrams with interaction diagrams, however, most websites like to regard them as specialized activity diagrams. What this means is that

You can use most annotations that are used within an activity diagram, with the addition of elements such as interaction, interaction use, time hit, duration etc...



The example above shows how UML diagrams can be used to describe the dynamic behavior of a system, the structural organization, and interaction among objects. All of this, while considering the time and order in which events happen, thus keeping an eye on the sequence of events and message flows.

The diagram has a starting and ending point, just like any activity diagram. Then, on a top-level view it depicts interactions and interaction uses through the use of the rectangular frames. Within the interactions (rectangular frames), we have included a complete stand-alone sequence diagram, containing three main actors: the assistant, the middleware reporting system and the inspector. Once the sequence of actions is completed, the flow state branches out and either repeats the previous interaction or moves on to a new interaction and then ends the flow.

Timing diagram

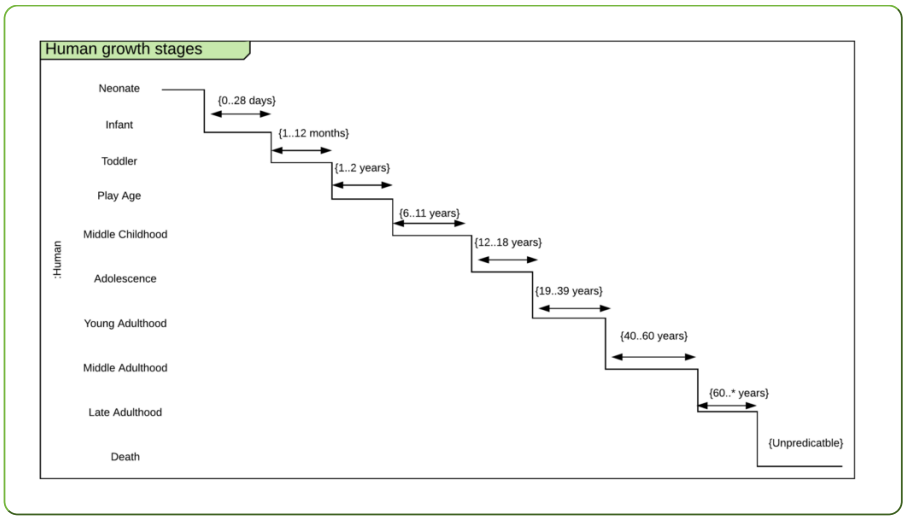
Timing UML diagrams are used to represent the relations of objects when the center of attention rests on time. We are not interested in how objects interact or change each other, but rather we want to know how objects and actors act along a linear time axis.

Each individual participant is represented through a lifeline, which is essentially a line forming steps since the individual participant transits from one stage to another. The main focus is on time duration of events and the changes that occur depending on the duration constraints.

The main components of a timing UML diagram are:

- **Lifeline** – individual participant
- **State timeline** – a single lifeline can go through different states within a pipeline
- **Duration constraint** – a time interval constraint that represents the duration of necessary for a constraint to be fulfilled
- **Time constraint** – a time interval constraint during which something needs to be fulfilled by the participant
- **Destruction occurrence** – a message occurrence that destroys the individual participant and depicts the end of that participant's lifeline

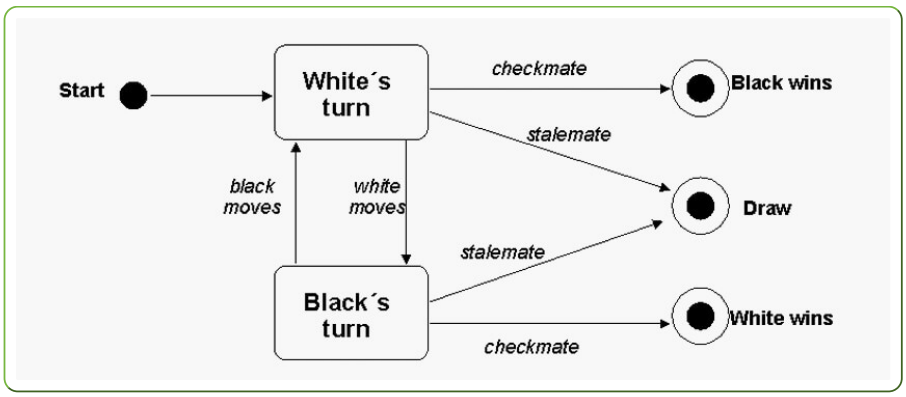
An example of a simplified timing UML diagram is given below. It represents the stages of human growth. As a result, it has only one lifeline.



State Machine UML diagram

State machine UML diagrams, also referred to as Statechart diagrams, are used to describe the different states of a component within a system. It takes the name state machine because the diagram is basically a machine that describes the several states of an object and how it changes based on internal and external events.

A very simple state machine diagram would be that of a chess game. A typical chess game consists of moves made by White and moves made by Black. White gets to have the first move and thus initiates the game. The conclusion of the game can occur regardless of whether it is the White's turn or the Black's. The game can end with a checkmate, resignation or in a draw (different states of the machine).



Statecharts find usage mainly in forward and reverse engineering of different systems.

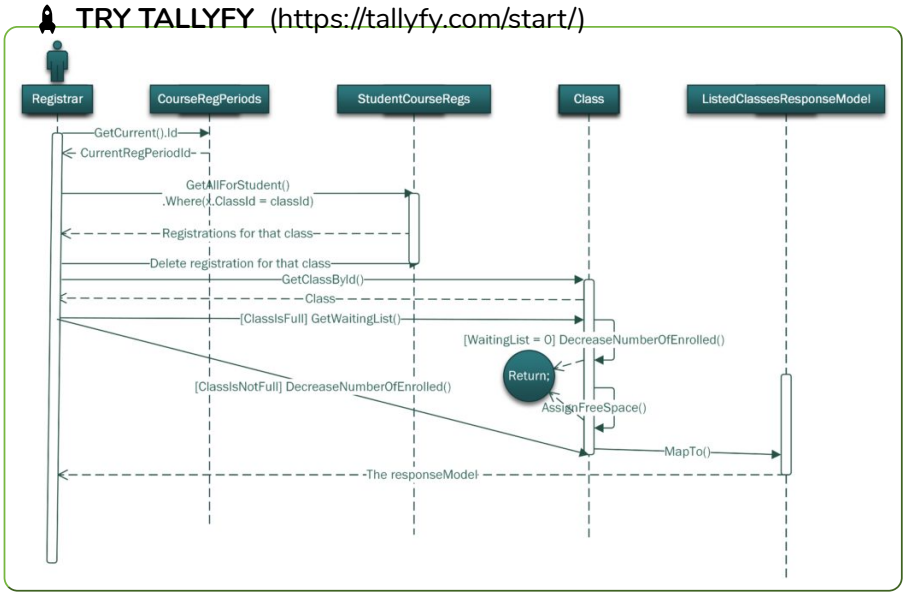
Sequence UML Diagram

Sequence diagrams are probably the most important UML diagrams among not only the computer science community but also as design-level models for business application development. Lately, they have become popular in depicting business processes, because of their visually self-explanatory nature.

As the name suggests, sequence diagrams describe the sequence of messages and interactions that happen between actors and objects. Actors or objects can be active only when needed or when another object wants to communicate with them. All communication is represented in a chronological manner. To get a better idea, check the example of a UML sequence diagram below.

As the name suggests, structural diagrams are used to depict the structure of a system. More specifically, it is used in software development to represent the architecture of the system and how the different components are interconnected (not how they behave or communicate, simply where they stand).

Below you can see an example of a sequence diagram, depicting a course registration system.



Communication UML diagram

In UML 1.x, communication diagrams used to be called collaborative diagrams. As the name suggests, the main focus of this type of UML diagram is on communication between objects.

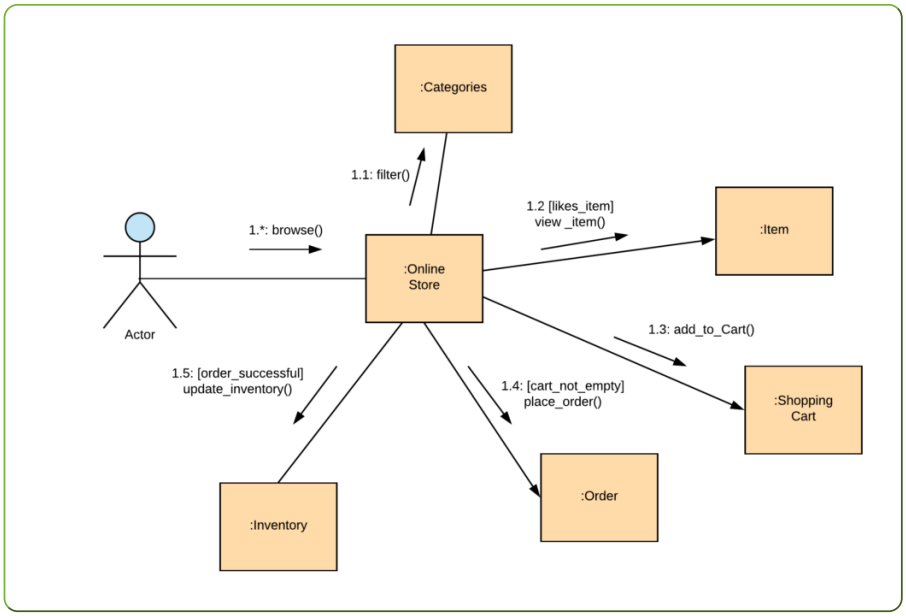
Since the core components are the messages that are exchanged between objects, we can build communication diagrams the same way we would make a sequence diagram. The only difference between the two is that objects in communication diagrams are shown with association connections.

Visually, the two differ in that sequence diagrams are well-structured vertically and the message flow follows a top-down chronological approach. Communication UML diagrams on the other hand use number schemes and pointing arrows in order to depict the message flow.

If you would have to choose between the two when writing documentation for a process or system, sequence diagrams would be a better choice. Many software engineers prefer sequence diagrams not only because they are better structured, but also because they have been given more attention in terms of the available annotations within the UML documentation.

On the other hand, communication diagrams are much easier to design because you can literally add an object anywhere on the drawing board. After all, in order for objects to be connected, they only need to be part of the numbered sequence, without having to be physically close to each other.

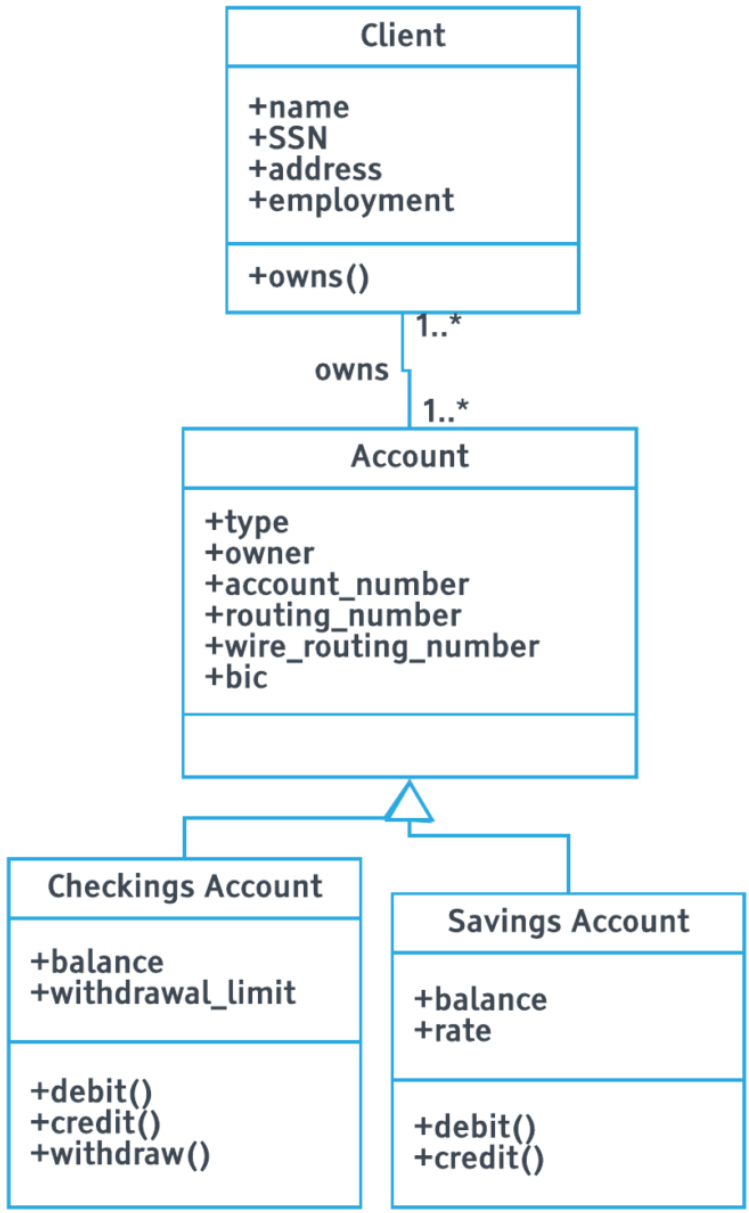
Below we are analyzing sequence diagrams. If you would like to read more about the differences between communication and sequence diagrams, you can read up on it here (http://www.sparxsystems.com/resources/uml2_tutorial/uml2_communicationdiagram.html).



Class Diagram

Class UML diagram is the most common diagram type for software documentation. Since most software being created nowadays is still based on the Object-Oriented Programming paradigm (https://en.wikipedia.org/wiki/Object-oriented_programming), using class diagrams to document the software turns out to be a common-sense solution. This happens because OOP is based on classes and the relations between them.

In a nutshell, class diagrams contain classes, alongside with their attributes (also referred to as data fields) and their behaviors (also referred to as member functions). More specifically, each class has 3 the class name at the top, the class attributes right below the name, the class operations/behaviors at the bottom. The relation between different classes (represented by a connecting line) makes up a class diagram.



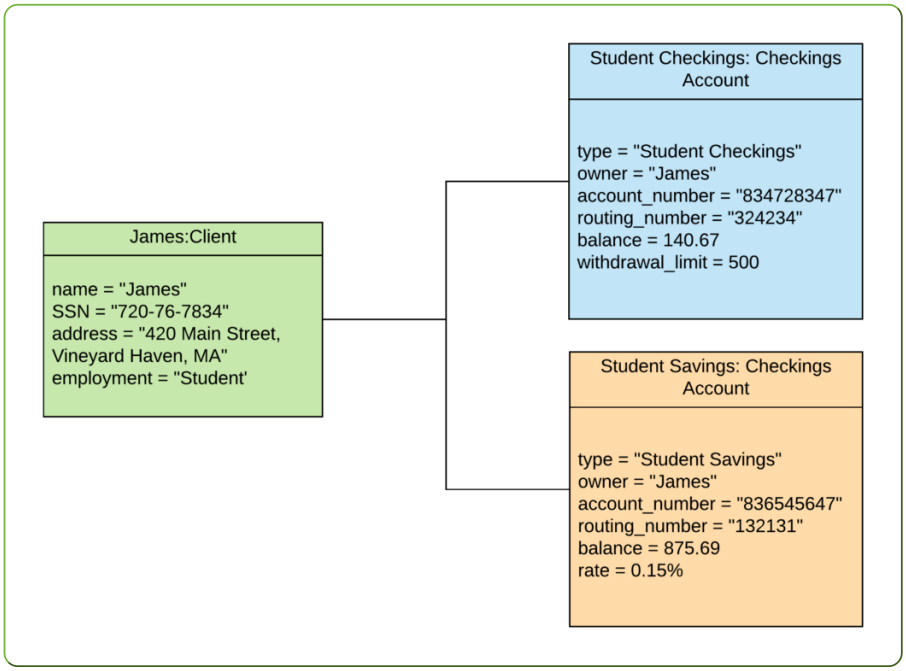
The example above shows a basic class diagram. The 'Checkings Account' class and the 'Savings Account' class both inherit from the more general class, 'Account'. The inheritance is shown using the

blank-headed arrow. The other class in the diagram is the ‘Client’ class. The diagram is quite self-explanatory and it clearly shows the different and how they are interrelated.

Object Diagram

When we discuss structural UML diagrams, we have no choice but to delve deeper into computer science-related concepts. In software development, Classes are considered abstract data types, whereas objects are instances of the abstract class. For example, if we have a class “Car” which is a generic abstract type, then an instance of the class “Car” would be an “Audi”.

Object UML diagrams help software developers check whether the generic abstract structure that they have created (class diagram), represents a viable structure when put into practice, i.e: when the objects of a class are instantiated. Some developers see it as a secondary level of accuracy checking.



The object UML diagram above is based on the class diagram we showed earlier. It depicts instances (objects) of the classes we created earlier. To be more precise, the general class ‘Client’, now has an actual client called “James”. James is an instance of the more generic class and it has the same attributes, however with given values. The same thing has been done with the Checkings and Savings account. They are both objects of their respective classes.

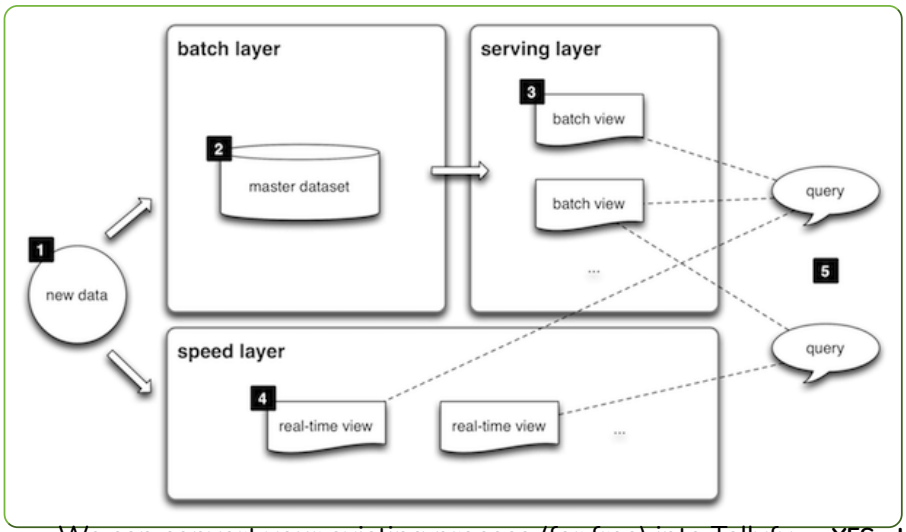
Do you notice any mistake? Take a look at the class diagram example. You can notice that the attributes ‘account_number’ and ‘routing_number’ are different for the Checkings and Savings account. As a result, it makes more sense to put those attributes in their respective classes, rather than in the more generic class ‘Account’.

Additionally, we notice that we do not use the attributes ‘wire_routing_number’ and ‘bic’. This is an indicator that something could be wrong in the design of our system. Perhaps we don’t require them in this specific example, thus allowing us to keep the old structure. However, there is a good chance that there is a design flaw which must be resolved immediately.

Component Diagram

When dealing with documentation of complex systems, component UML diagrams can help break down the system into smaller components. Sometimes it is hard to depict the architecture of a system because it might encompass several departments or it might employ different technologies.

For example, Lambda architecture (https://mapr.com/developercentral/lambda-architecture/) is the typical example of a complex architecture that can be represented using a component UML diagram. Lambda architecture is a data-processing architecture employed by several companies for storing and processing data in a distributed system. It is made up of three different layers: the speed layer, the batch layer and the serving one.



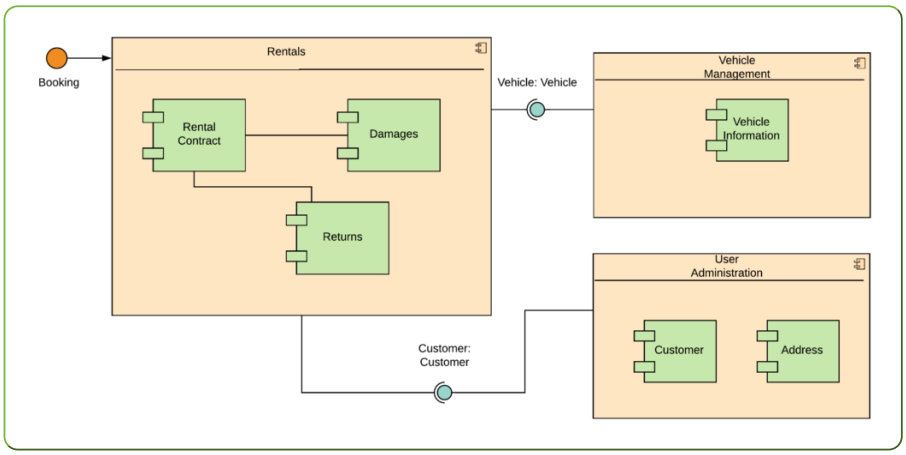
The image above shows how a component diagram can help us get a top-level view of a more complex system. The annotations are not tailored according to UML standards, however, they are very similar and provide a good visual example.

Composite Structure Diagram

This type of UML diagram is not commonly used because its function is very specific. It only represents the internal structure of a class and the relations between different class components.

Business professionals are not generally interested in composite structure diagrams because their main focus is on the top level view of components and how they communicate with one the other. It is almost irrelevant for a manager to know how a specific data member of a class is related to a data member of another class.

Below, you can find a simplified example for getting a general idea of how it looks.



Deployment Diagram

Deployment diagrams are used to visualize the relation between software and hardware. To be more specific, with deployment diagrams we can construct a physical model of how software components (artifacts) are deployed on hardware components, known as nodes.

A typical simplified deployment diagram for a web application would include:

- application server and database server)
- application client and database schema

The nodes host the artifacts. The database schema runs on the database server and the application client runs on the application server.

As the name suggests, the deployment diagram shows exactly where each software component is deployed.

Package Diagram

The package diagram is like a macro container for deployment UML diagrams that we explained above. Different packages contain nodes and artifacts. They organize the model diagrams and components into groups, the same way a namespace encapsulates different names that are somewhat interrelated.

Ultimately a package can also be constructed by several other packages in order to depict more complex systems and behaviors. The main purpose of a package diagram is to show the relations between the different large components that make up a complex system. Programmers find this abstraction opportunity a good advantage for using package diagrams, especially when some details can be left out of the big picture.

Profile Diagram

Profile diagram is not the typical UML diagram type. In fact, it can be regarded more as an extensibility mechanism rather than a diagram type like any other.

With the use of stereotypes, tagged values, and constraints, you can extend and customize already existing UML notations. Profile diagrams are like a language, if you speak English you can create new sentences, and if you speak profile diagrams, well, then you can create new properties and semantics for UML diagrams.

- **Stereotypes** – are used for extending the available UML elements. They allow you to create, edit or derive a new element or building block that then be directly used in a diagram.
- **Tagged values** – think of this as adding new attributes to already existing models. A new tagged value will result respectively in a new keyword.
- **Constraints** – the word is self-explanatory, however, think of constraints as new conditions that you can add to your diagrams. For example, a constraint could be: “the outstanding balance must be greater than $3”. This constraint can be used to control when a checkings account should be terminated by the bank’s system.

UML diagrams have become a very powerful tool lately. In the early stages, only software developers and professionals from the IT industry used UML to document models, systems and software architecture. Nowadays, however, UML diagrams are used across different industries and many business people have started adopting them in their daily work.

Tools for drawing UML Diagrams

Just like any other thing in life, in order to get something done properly, you need the right tools. For documenting software, processes or systems, you need the right tools that offer UML annotations and UML diagram templates. There are different software documentation tools (https://tallyfy.com/software-documentation-tools/) that can help you draw a UML diagram. They are generally divided into these main categories:

- **Paper and pen** – this one is a no-brainer. Pick up a paper and a pen, open up a UML syntax cheatsheet from the web and start drawing any diagram type you need
- **Online tools** – there are several online applications that can be used to draw a UML diagram. Most of them offer free trials or a limited number of diagrams on the free tier. If you are looking for a long-term solution

for drawing UML diagrams, it is generally more beneficial to buy a premium subscription for one of the applications.

Online Tools – these do pretty much the same thing that the paid ones. The main difference is that the paid ones also offer tutorials and ready-made templates for specific UML diagrams. A great free tool is draw.io (https://www.draw.io/).

Desktop application – a typical desktop application to use for UML diagrams and almost any other sort of diagram is Microsoft Visio (https://products.office.com/en/visio/flowchart-software). It offers advanced options and functionality. The only downside is that you have to pay for it.

Conclusion

As you might have noticed by now, using a UML diagram for documenting processes and systems can be very beneficial. The downside is that it can seem complex at first to draw one. You gotta learn the syntax, you need to choose which diagram out of the 14 different types is the most efficient for the job, etc.. However, once you start thinking in UML standards, you will get a better understanding of the process or system that you are mapping.

Ultimately, it can help you discover flaws or possible optimizations that you might not have thought of before. We hope this article helped you get started with UML diagrams and how they can be used in a business environment. If you would like to add something to this post or if you feel like we might have missed something, let us know in the comments section below.

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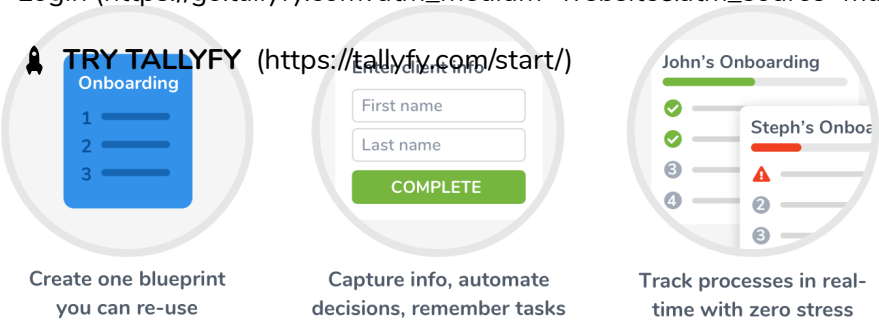

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5 thoughts on "All You Need to Know About UML Diagrams: Types and 5+ Examples"

hello. you said "Not all of the 14 different types of UML diagrams are used on a regular basis when documenting systems and/or architectures". Can you help me to give me some reference book that says it. Thank you. I hope you answer my question.

wilda

June 24, 2018 (https://tallyfy.com/uml-diagram/#comment-2651)

REPLY ↓

↳ Hello Wilda! Thank you for reading our post on UML diagrams and asking such a valuable question.
There has been several research conducted related to this. I have linked two among many of the conducted research/surveys below:

https://pdfs.semanticscholar.org/18fa/60329a3f466207faa3dc998dcaf1637befde.pdf (https://pdfs.semanticscholar.org/18fa/60329a3f466207faa3dc998dcaf1637befde.pdf)

and

https://www.researchgate.net/publication/220373821_Dimensions_of_UML_Diagram_Use_A_Survey_of_Practitioners (https://www.researchgate.net/publication/220373821_Dimensions_of_UML_Diagram_Use_A_Survey_of_Practitioners)

We hope this is the answer you were looking for and we will be glad to answer any further questions on the topic.

Noel Ceta

AUTHOR

June 24, 2018 (https://tallyfy.com/uml-diagram/#comment-2652)

Thank you for this broad and comprehensive overview of UML diagrams. One thing I'll say in response to your statement about Class Diagrams:

Igor Ganapolsky

September 25, 2018 (https://tallyfy.com/uml-

~"most software being created nowadays is still based on the Object-Oriented Programming paradigm"

diagram/#comment-2991)

REPLY ↓

ly, most software is taking the functional and reactive approach

ays (i.e. RxJava, Node.js, Kotlin). How would you alter your Class

Diagram to meet such a shift in thinking?

↳ Hi Amit,

Amit Kothari

October 13, 2018 (https://tallyfy.com/uml-diagram/#comment-3128)

I think the basic notion still applies to micro-services. Instead of designing monolithic software, you'd instead design smaller micro-services which trigger from events. Such an approach is highly scalable and would also let you compute requests in parallel. So the difference to your design portion is that class diagrams are smaller and more numerous.

I hope this helps?

Amit

Hello, Thank you for this great Article

med

November 18, 2018 (https://tallyfy.com/uml-diagram/#comment-3472)

REPLY ↓

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