Crafting Software Requirements & Picturing Architecture & Design

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University of Regina

FACULTY OF ENGINEERING & APPLIED SCIENCE
Software Systems Engineering

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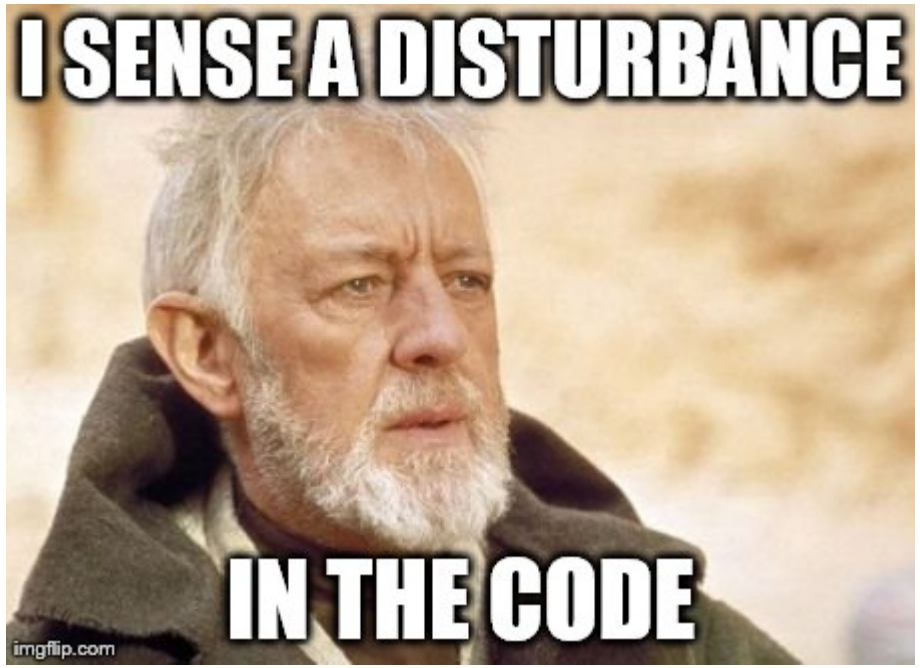
Outline

- Requirements and problem prerequisites
- Picturing architecture
- Unified Modelling Language (UML)
- Use case diagramming
- Activity diagramming
- Interaction diagramming
- Data diagramming
- Class/CRC diagramming
- Picturing design (we already know how to do this one!)

Requirements digging & prerequisites

- Recall: Software construction (programming, debugging) is really the only given in any software project



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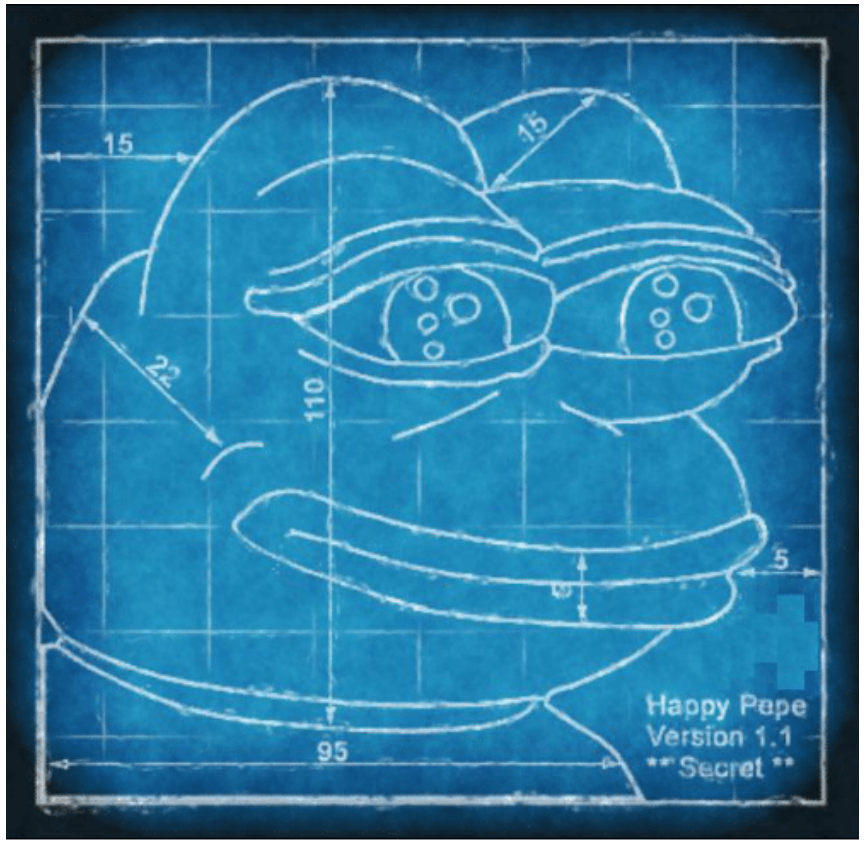
- Prep work for software construction



Rare Blueprint Pepe

Requirements digging & prerequisites

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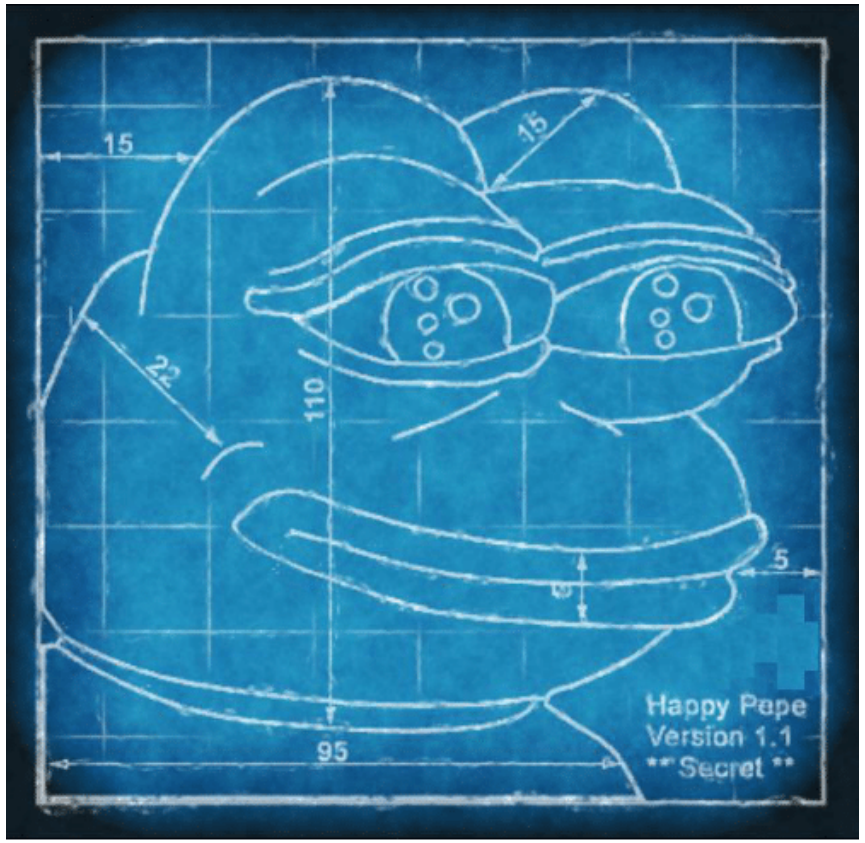
- Prep work for software construction
- Benefits



Rare Blueprint Pepe

Cost of defects

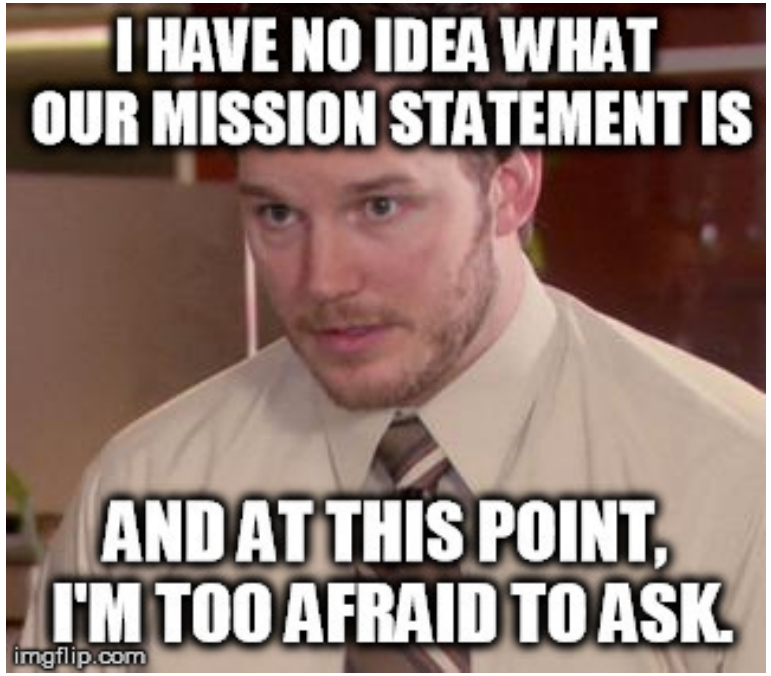
	Time Detected				
Time Introduced	Requirements	Architecture	Construction	System Test	Post-Release
Requirements	1	3	5–10	10	10–100
Architecture	—	1	10	15	25–100
Construction	—	—	1	10	10–25

Source: Adapted from "Design and Code Inspections to Reduce Errors in Program Development" (Fagan 1976), *Software Defect Removal* (Dunn 1984), "Software Process Improvement at Hughes Aircraft" (Humphrey, Snyder, and Willis 1991), "Calculating the Return on Investment from More Effective Requirements Management" (Leffingwell 1997), "Hughes Aircraft's Widespread Deployment of a Continuously Improving Software Process" (Willis et al. 1998), "An Economic Release Decision Model: Insights into Software Project Management" (Grady 1999), "What We Have Learned About Fighting Defects" (Shull et al. 2002), and *Balancing Agility and Discipline: A Guide for the Perplexed* (Boehm and Turner 2004).

- S. McConnell's. Code Complete, Second Edition. Microsoft Press. 2004

Problem-definition prerequisite

- Also called product vision, vision statement, mission statement, and product definition
  - As in the Business Case! – Hey, you know this!



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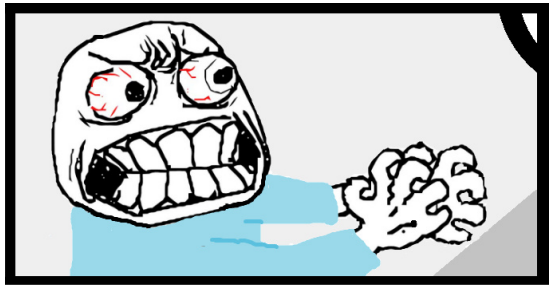

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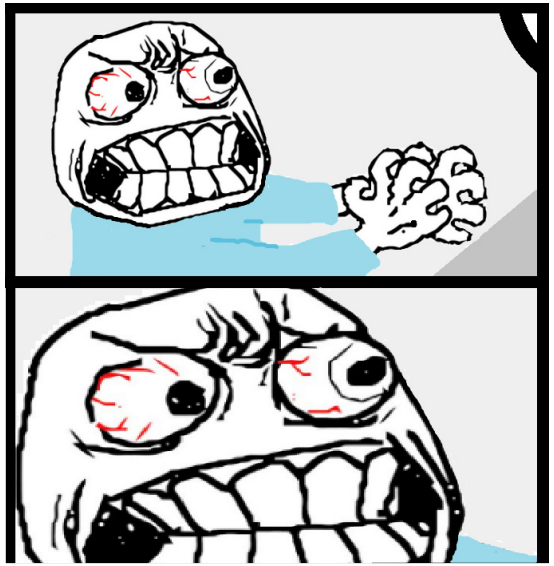

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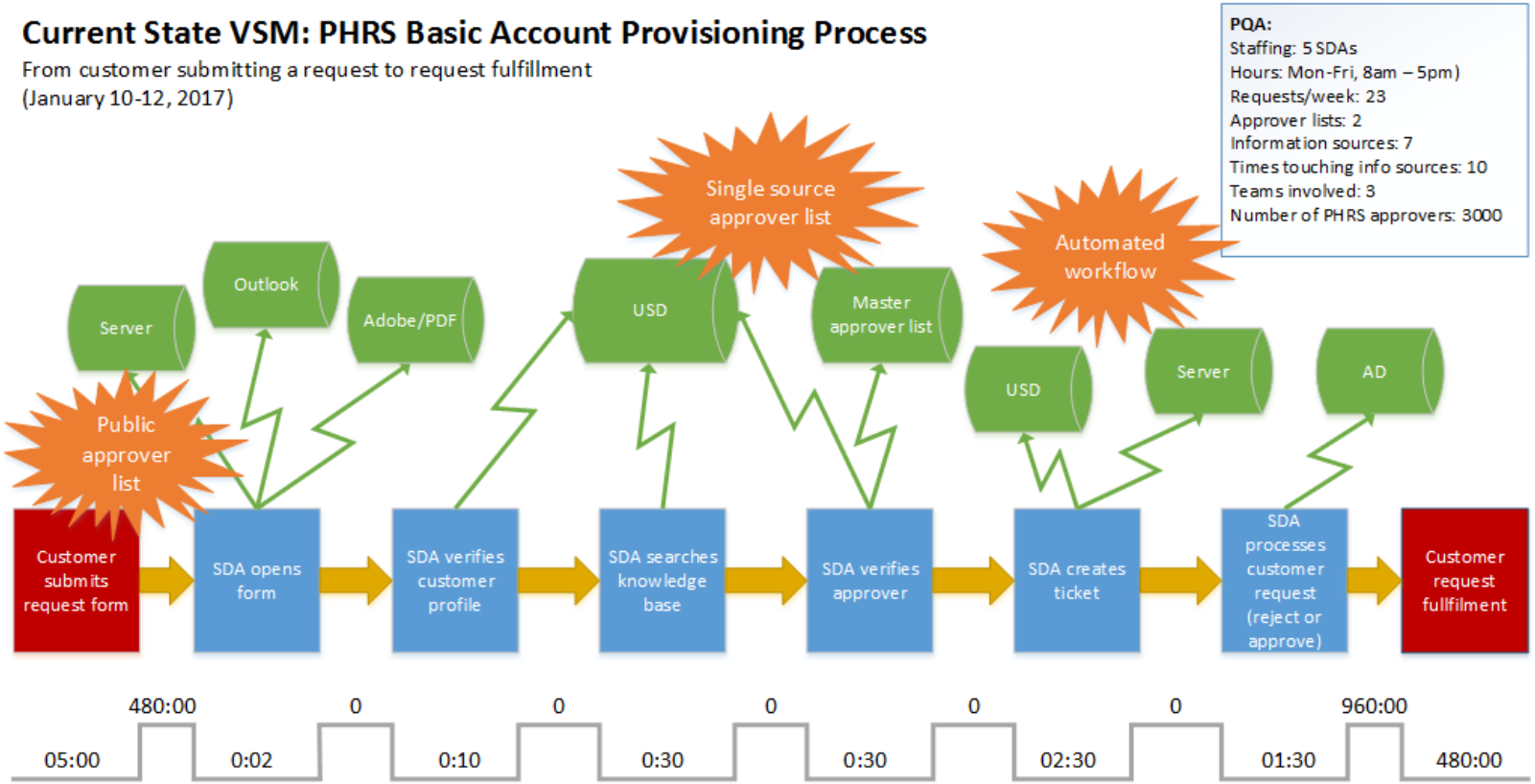
- Usually comes before detailed requirements digging

Requirements+problem prerequisite

- What is it and how does it help?



Picturing architecture = communication

- From Allen:
  - Can’t code effectively unless you can talk to other folks about what you’re doing
  - Again, all that we do is a social effort

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Picturing architecture = communication

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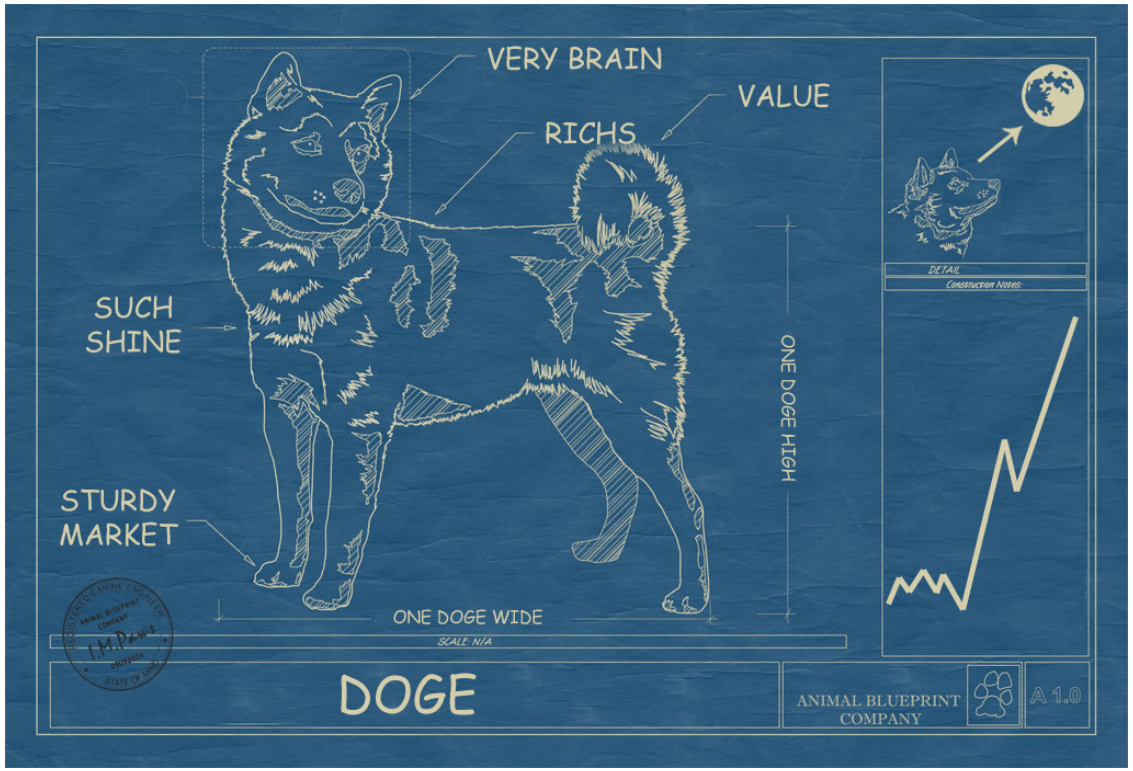
- Building a visual toolkit to visualize the structure and behavior of code
  - Using pictures, index cards, matrix charts, diagrams, UML, etc.



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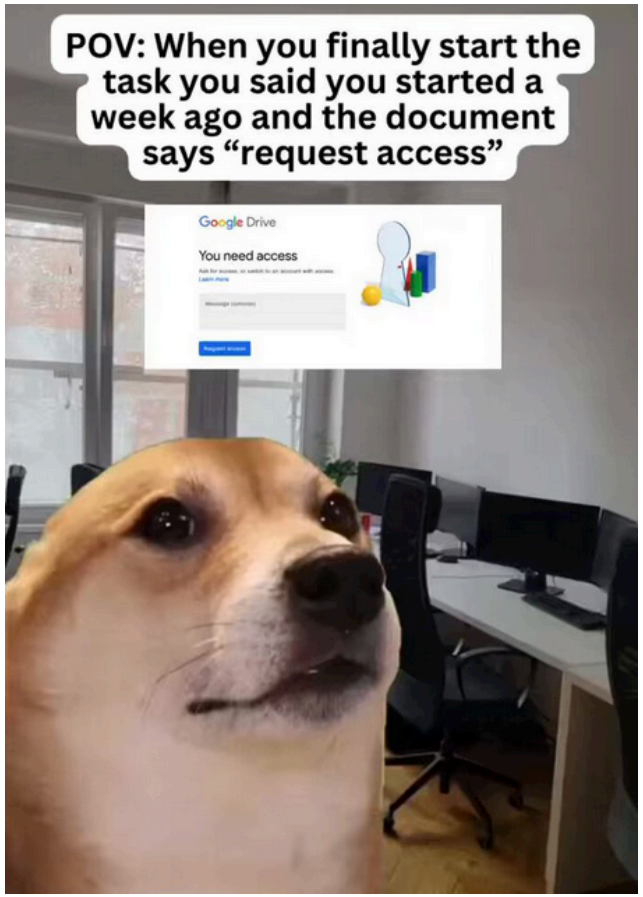
Architecture prerequisites

- Also called system architecture, high-level design, top-level design
- Program organization & all interconnected relationships
  - Context
  - User roles and permissions
  - Data flow
  - Classes
  - Business rules
  - Graphical user interface (GUI)
  - Resource management & performance (memory, GPU)
  - Security
  - Interoperability (does the program share resources?)
  - Scalability (can the system evolve to future demands?)
  - Feasibility (concerns/risks)
  - Buy vs. build decisions (pros and cons)
  - Change management strategy (operational and organizational)
  - Etc…

Defining access control

- Stemming from the problem and requirement prerequisites



- Escape (2024). Understanding Access Control Models. Online: https://escape.tech/blog/access-control-models/

Defining access control

- Stemming from the problem and requirement prerequisites
- Models
  - RBAC
  - ABAC
  - DAC

Allowable Action	Admin	Manager	User	Guest
Create Records	✓	✓	✗	✗
Read/View Records	✓	✓	✓	✓
Update/Edit Records	✓	✓	✓	✗
Delete Records	✓	✗	✗	✗
Manage Permissions	✓	✗	✗	✗

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Allowable Action	Admin Condition	Manager-in-Dept Condition	Record Owner Condition
Create Records	`isAdmin = true` → ✅	—	—
Read/View Records	`isAdmin = true` → ✅	`jobTitle = "Manager"` **AND** `user.department = resource.department` → ✅	`userId = resource.ownerId` → ✅
Update/Edit Records	`isAdmin = true` → ✅	`jobTitle = "Manager"` **AND** `user.department = resource.department` → ✅	—
Delete Records	`isAdmin = true` → ✅	—	—
Manage Permissions	`isAdmin = true` → ✅	—	—

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Allowable Action	Admin	Manager (same dept as record)	Record Owner (Employee)
Create Records	✓ *(by policy/ administrative privilege)*	✗	✗
Read/View Records	✓ *(ACL or global admin)*	✓ *(if owner added dept manager to ACL)*	✓ *(owner of the record)*
Update/Edit Records	✓	✓ *(if owner added dept manager to ACL)*	✗ *(owner retains read only in the given scenario)*
Delete Records	✓	✗	✗
Manage Permissions (ACL)	✓ *(admin override)*	✗ *(unless owner delegates)*	✓ *(as the resource owner)*

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Defining access control

- Stemming from the problem and requirement prerequisites
- Models
  - RBAC
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- Which to use?

Model	Basis	Strengths	Weaknesses
RBAC	Roles	Simple, scalable, widely implemented	Rigid when environments change
ABAC	Attributes	Highly flexible and granular	Complex to design and maintain
DAC	Ownership	Owners retain full control	Weaker security; prone to propagation errors

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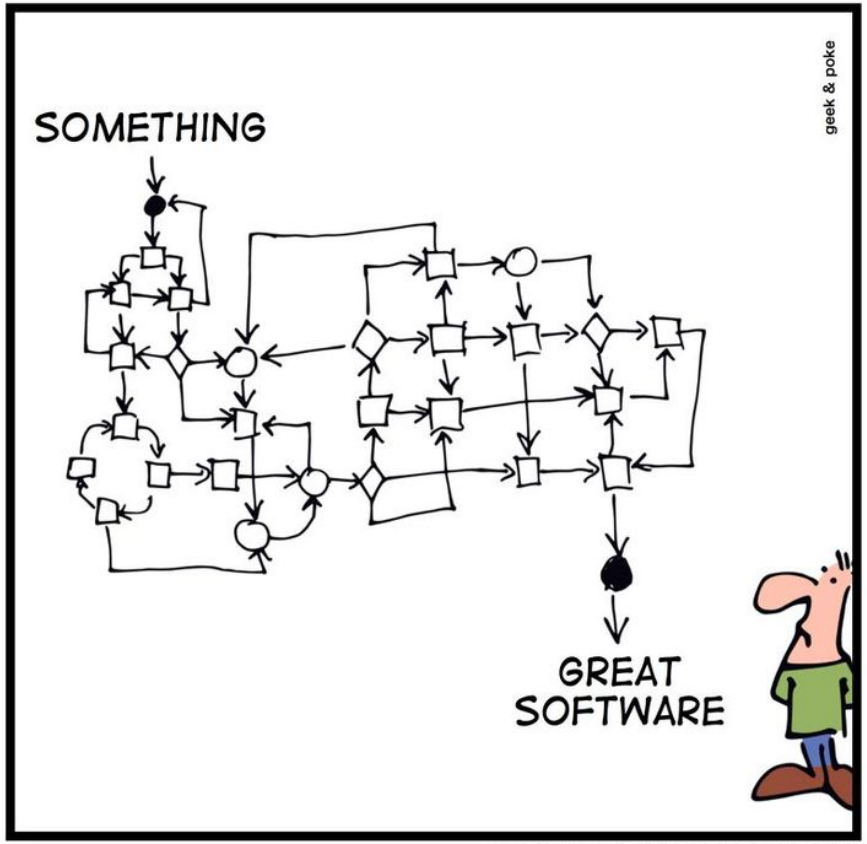
Unified Modelling Language (UML)

- Standard modelling/pictorial language



DEVELOPMENT PROCESS

- TutorialsPoint. (Online). https://www.tutorialspoint.com/uml/
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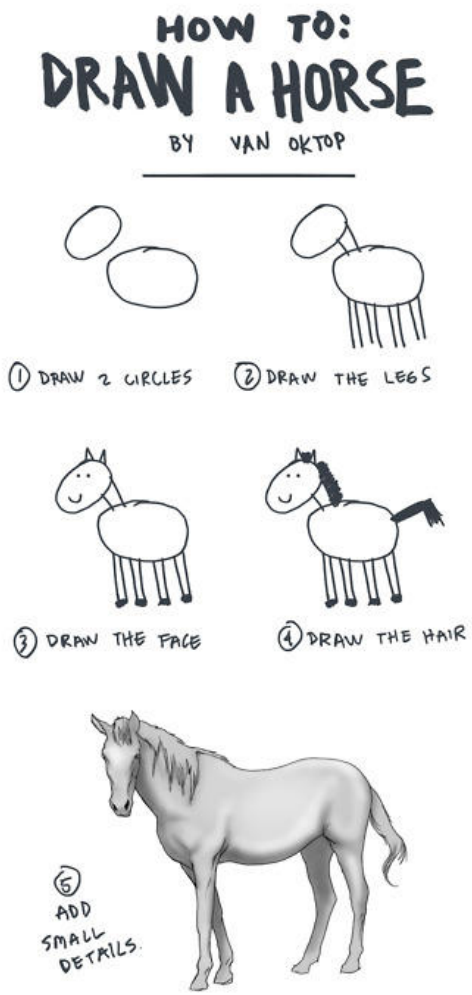

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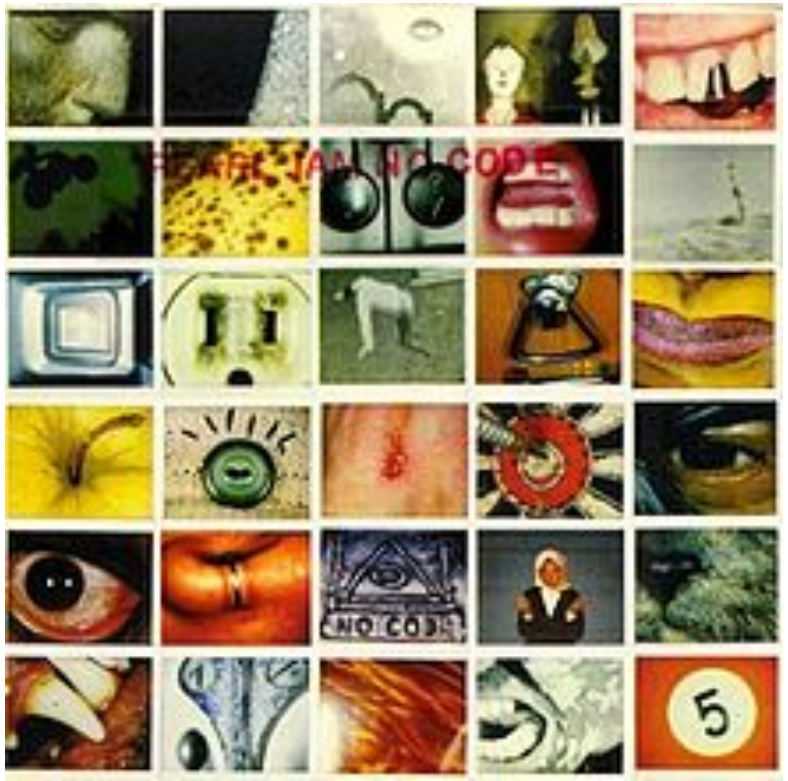

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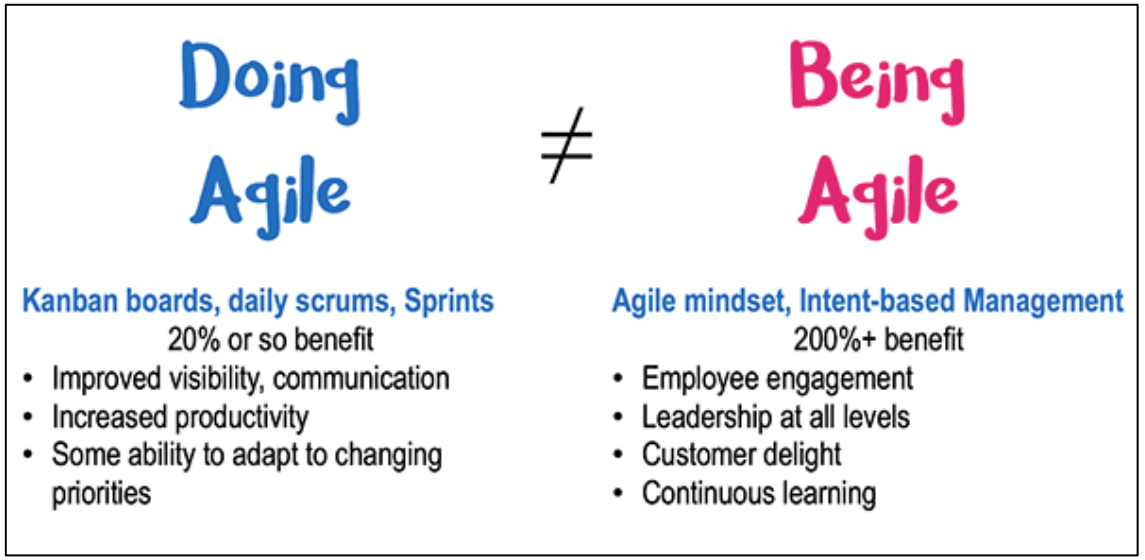

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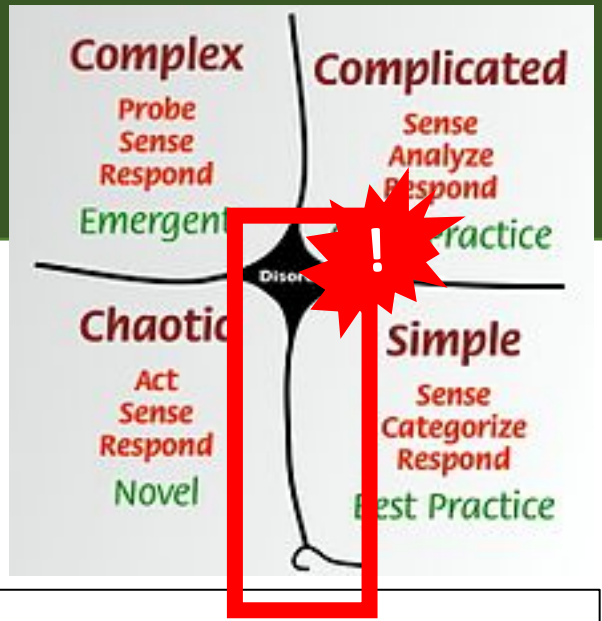

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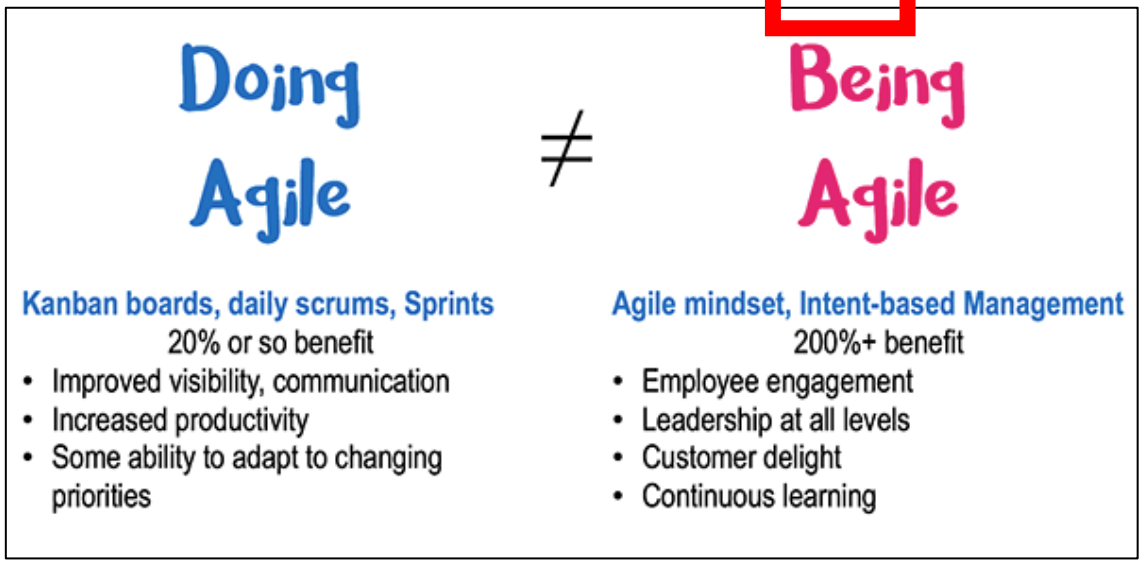

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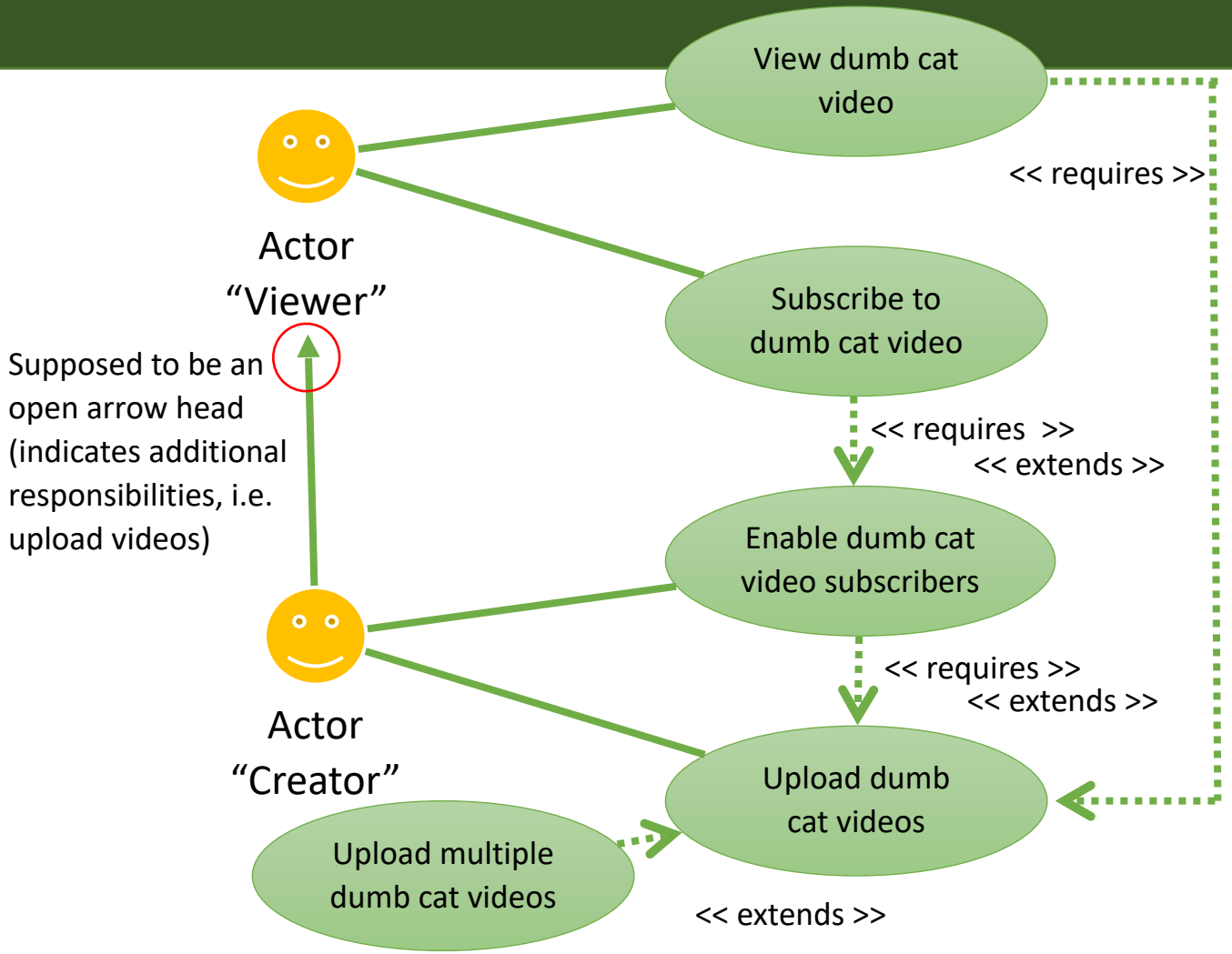
Use case (story) diagramming

- Represent user (type) activities and their dependencies and relationships
- Discussion
  - Would your parents understand this pic?
  - Can get complex



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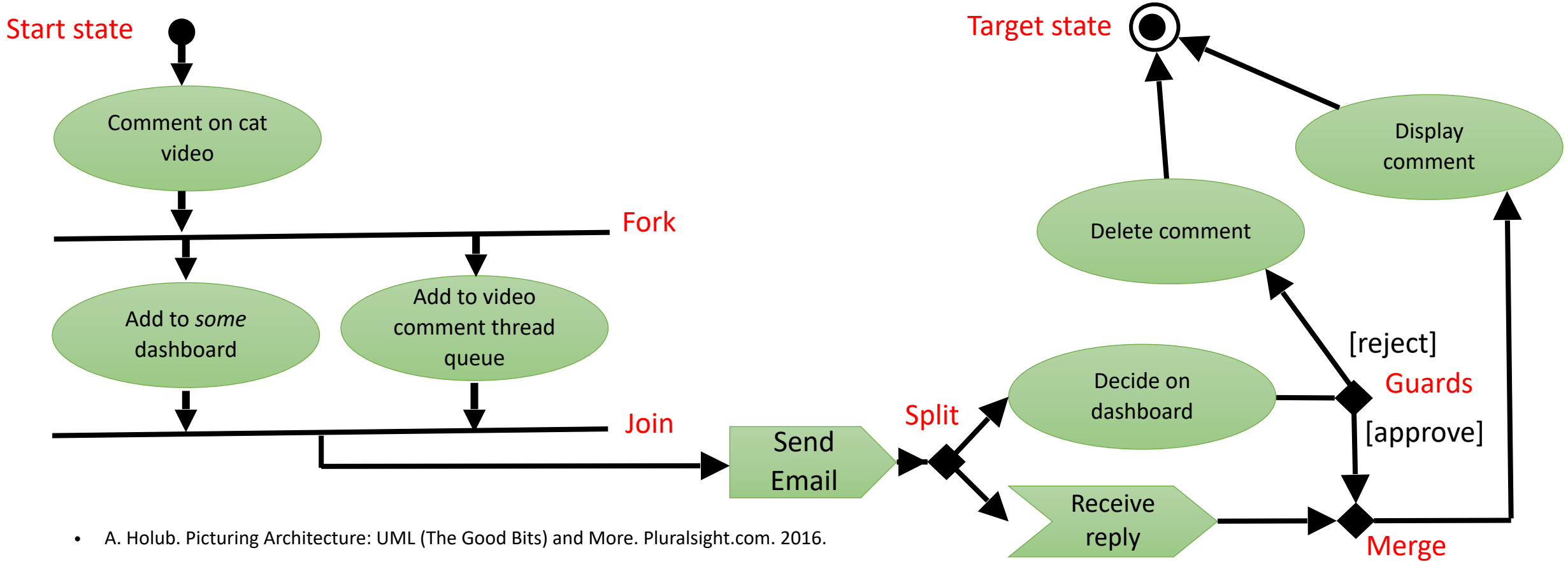
Activity (state) diagramming

- Represent specific activities and their dependencies and relationships (doesn't matter who's doing the activity)



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Interaction diagramming

- How objects interact at run time to do the *stuff and things* as per Stakeholder needs
- Focuses on the messages sent and received between objects
- Typically a single use case/interaction
- Two types of diagrams
  - Communication/collaboration
  - Sequence

- A. Wick. Requirements Elicitation and Analysis. Lynda.com. 2017.
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Communication/collaboration diagrams

- Visualization of how objects interact with each other
- Objects in boxes
- Numbers and arrows represent communication order and flow
- "*" means a message is sent more than once
- "order#[condition]: some msg" means a message is sent if the condition = true

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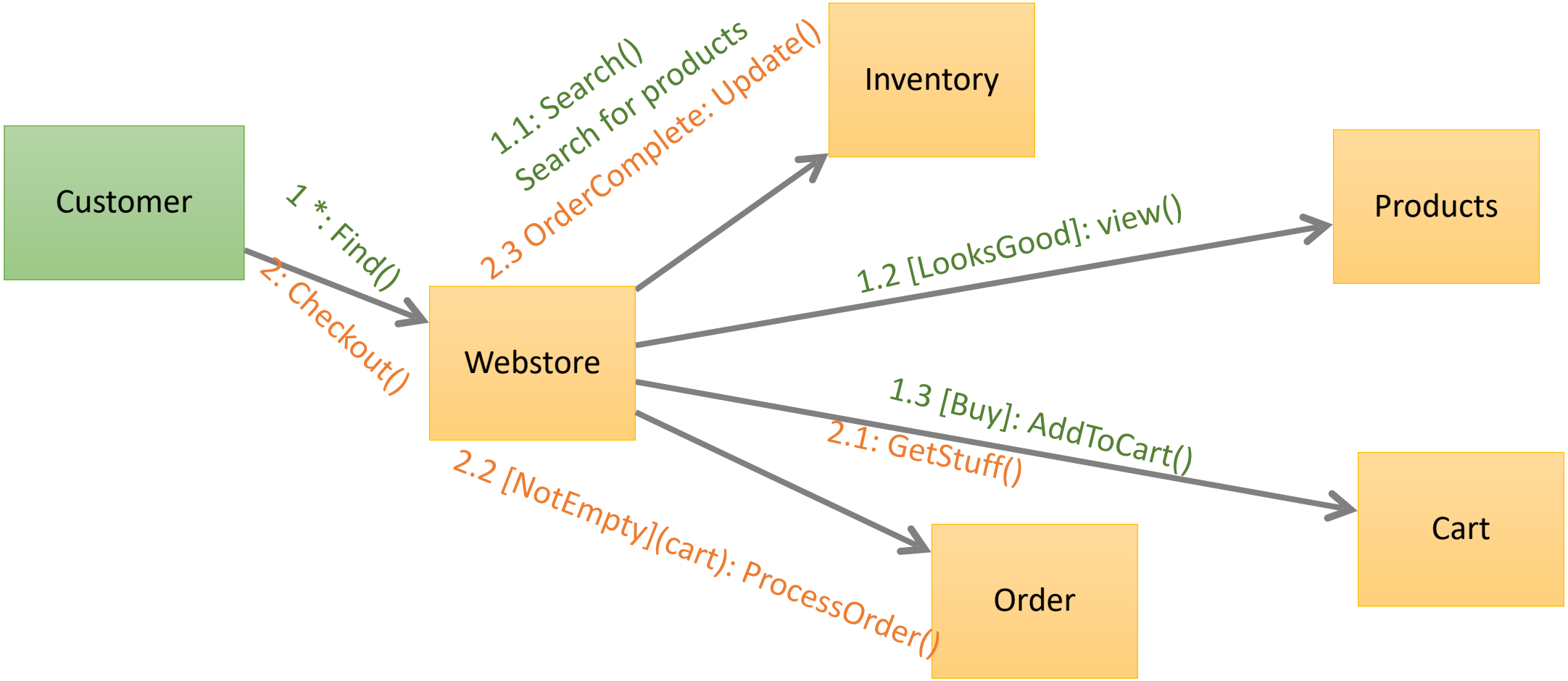
E.g. Communication/collaboration diagrams



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Sequence diagrams

- Sequence diagram, not a sequin diagram ☺
- Again, visualization of how objects interact with each other
- Messages are on the horizontal
- Objects/Time represented on the vertical
  - Represented as a dotted line stemming from object(s) – “lifeline”
- Boxes covering lifelines are called activations
  - Length of boxes represent time
- Whole bunch of other stuff…
  - Loops, timeouts, optionals, etc.
  - Holub: *Getting close to code, why not just code?!?*

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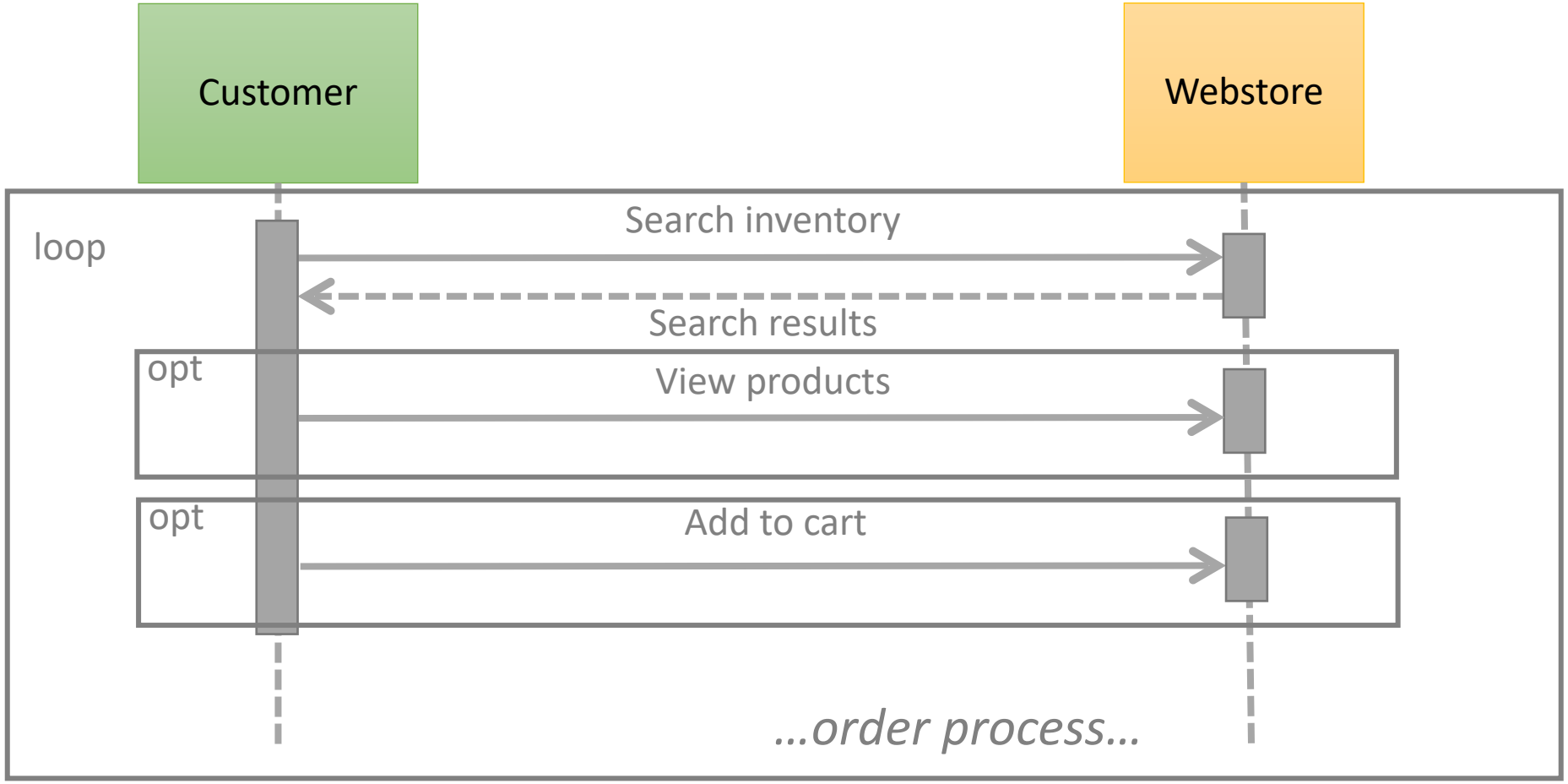
E.g. Sequence diagrams



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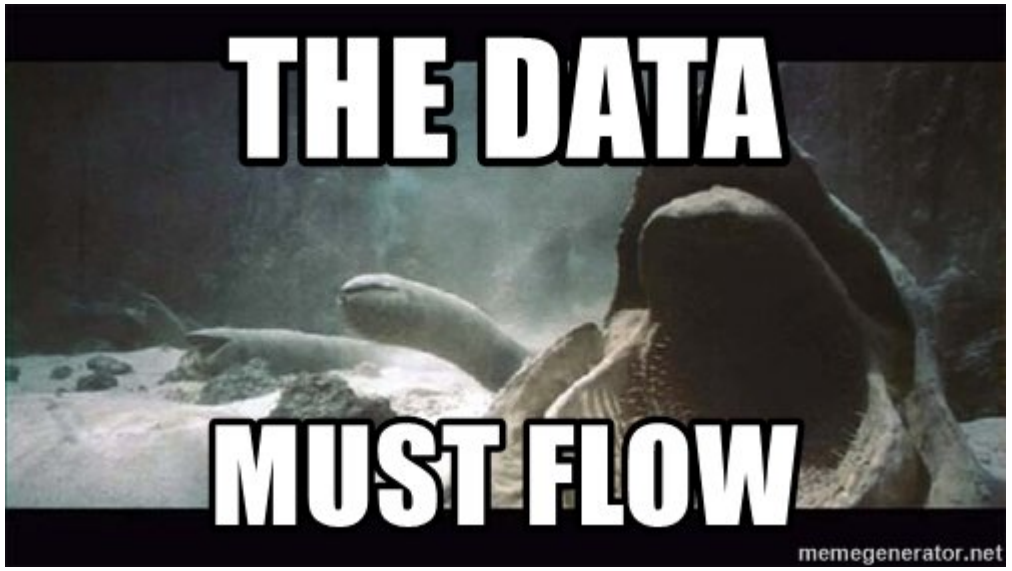
Data (flow) diagramming

- Mapping/visualizing the processes and associated data flow
  - Why?
  - Can get a better understanding of the system by examining the data flows
- Collaboration with Stakeholders (customers/clients, etc.) and development team
  - Eliciting requirements
  - Walking through all of the processes with a focus on data needs



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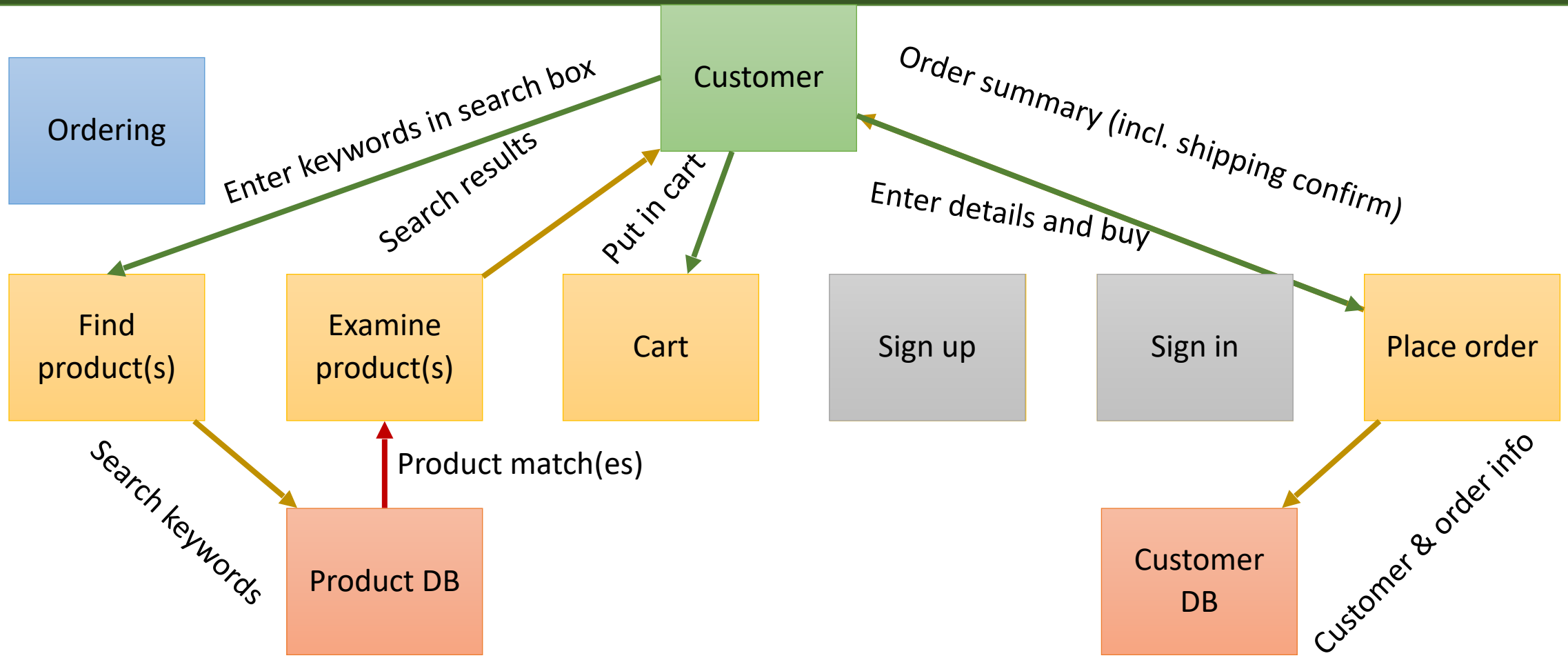

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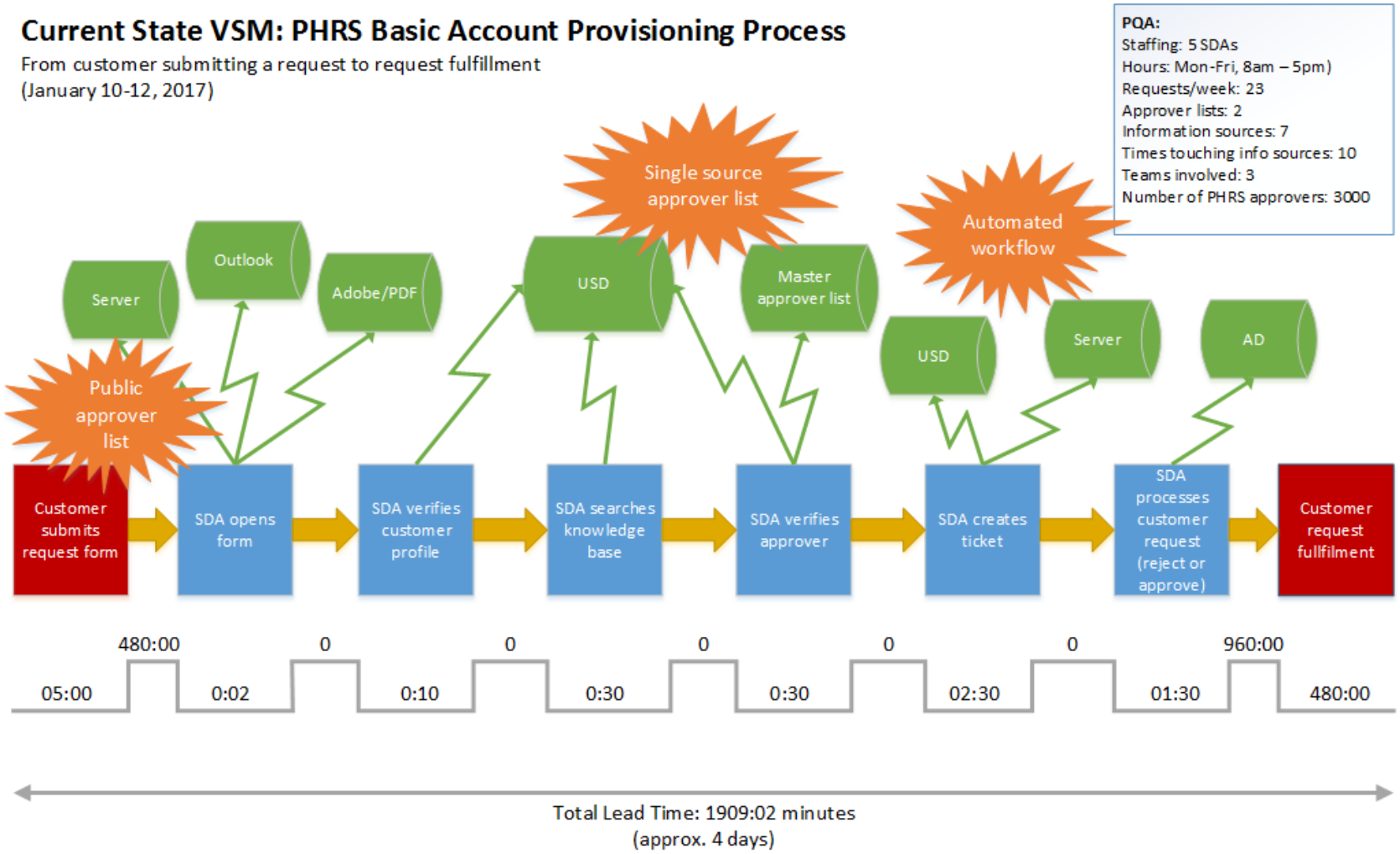
Lean (Current/Future) Value Stream Mapping



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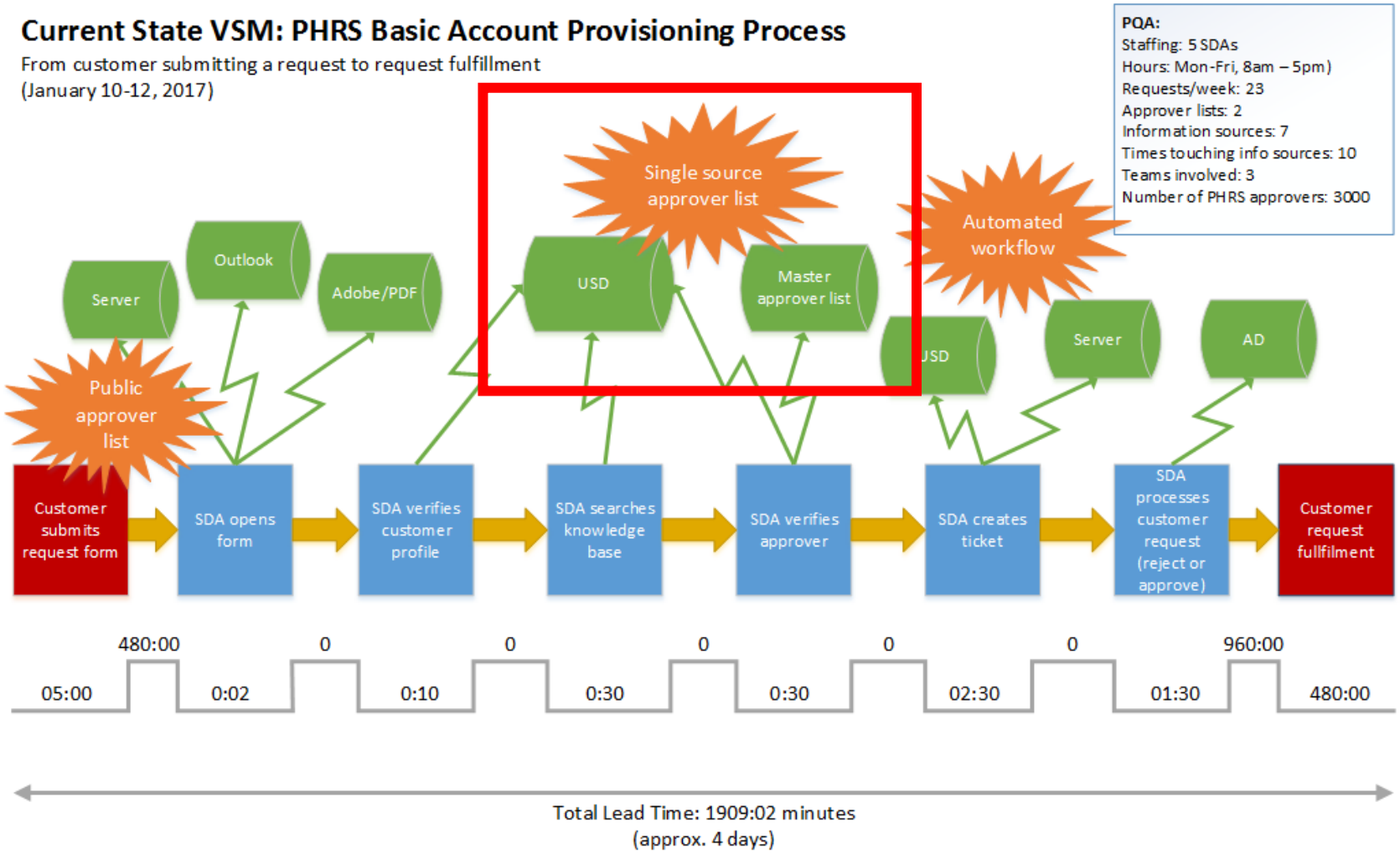

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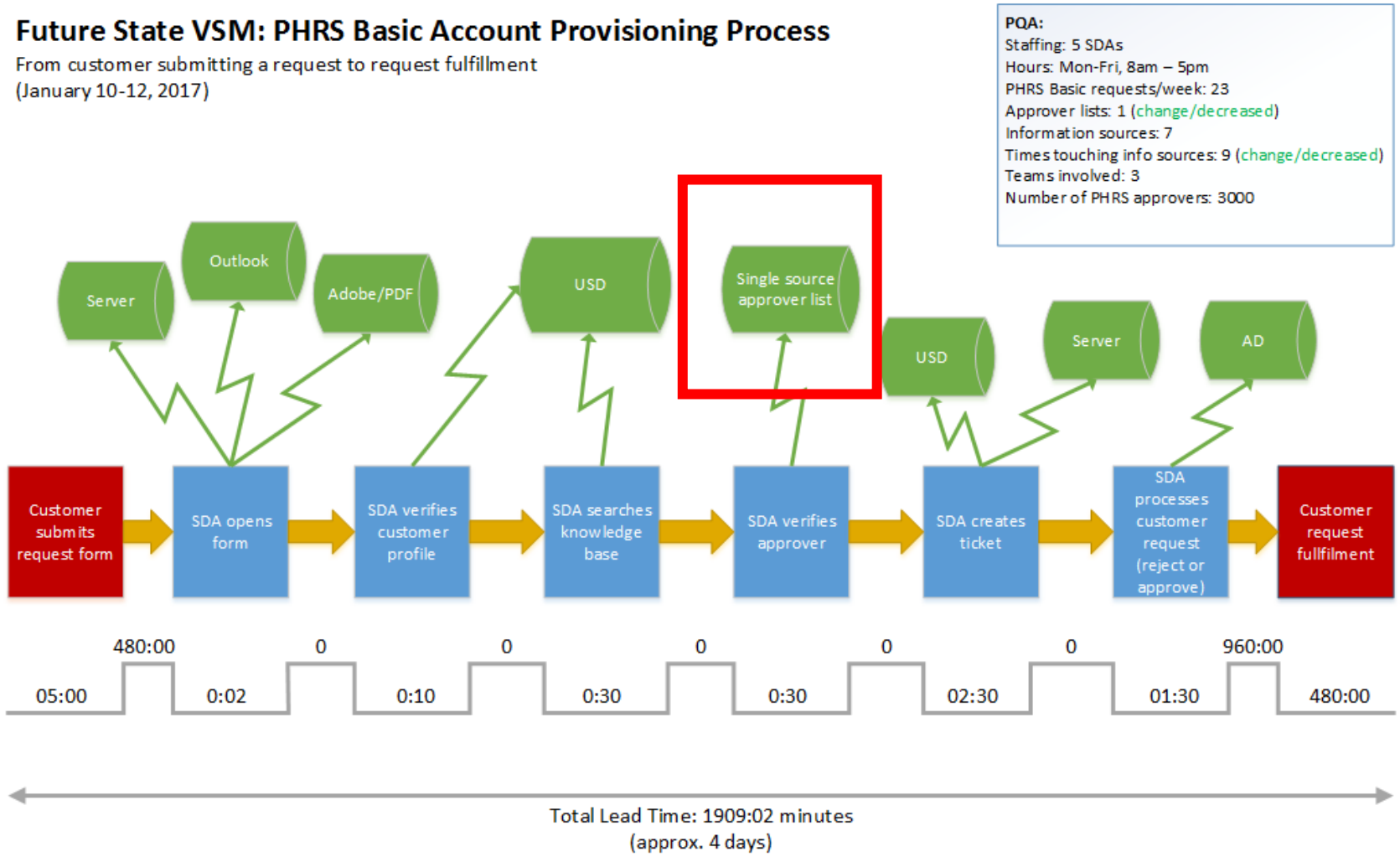
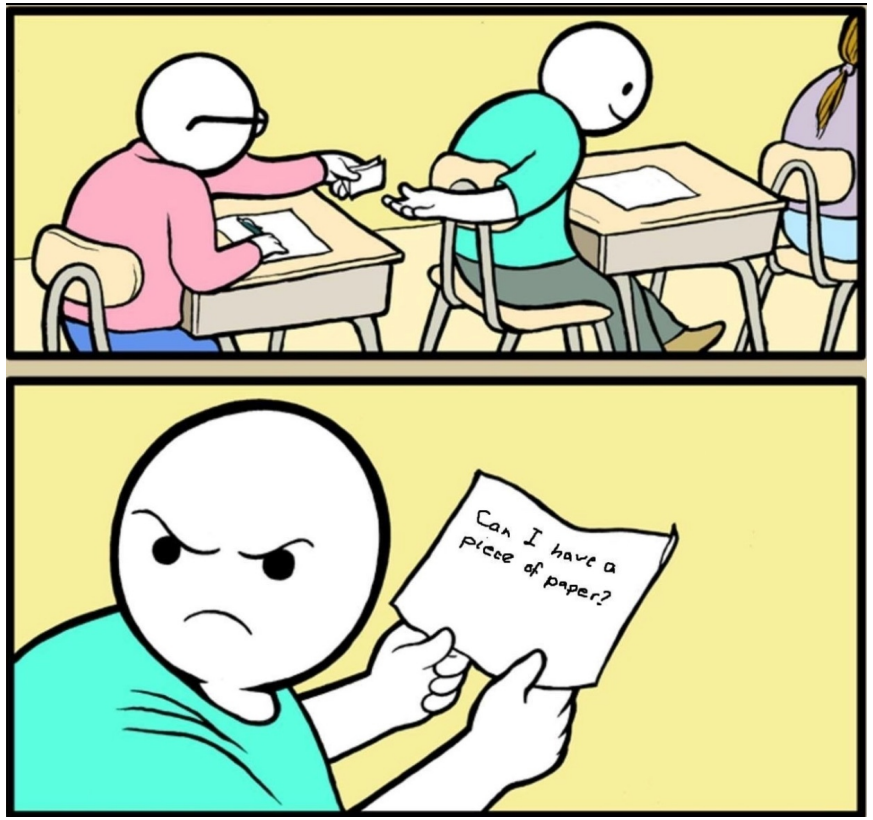


Class diagrams

- Important note



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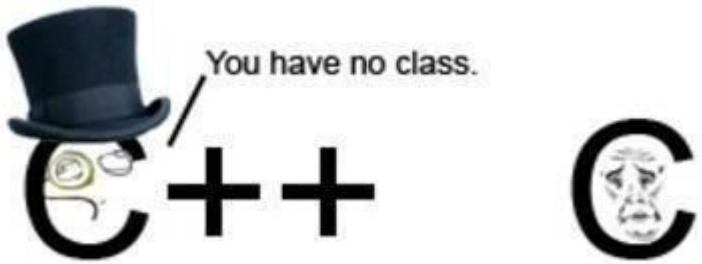
Class diagrams

- Important note
- Visualize the relationship between classes and objects



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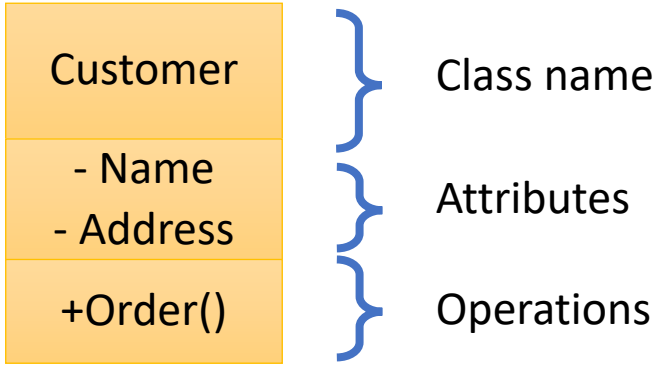

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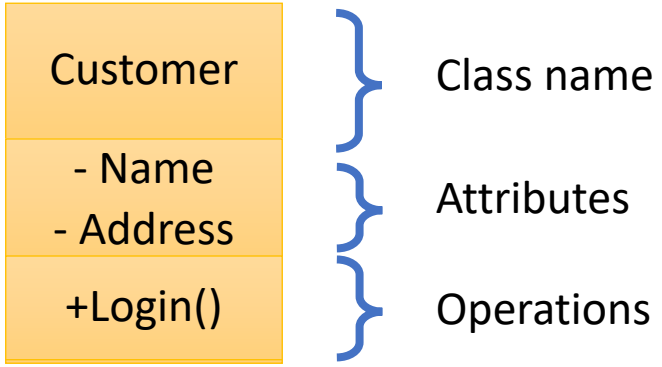

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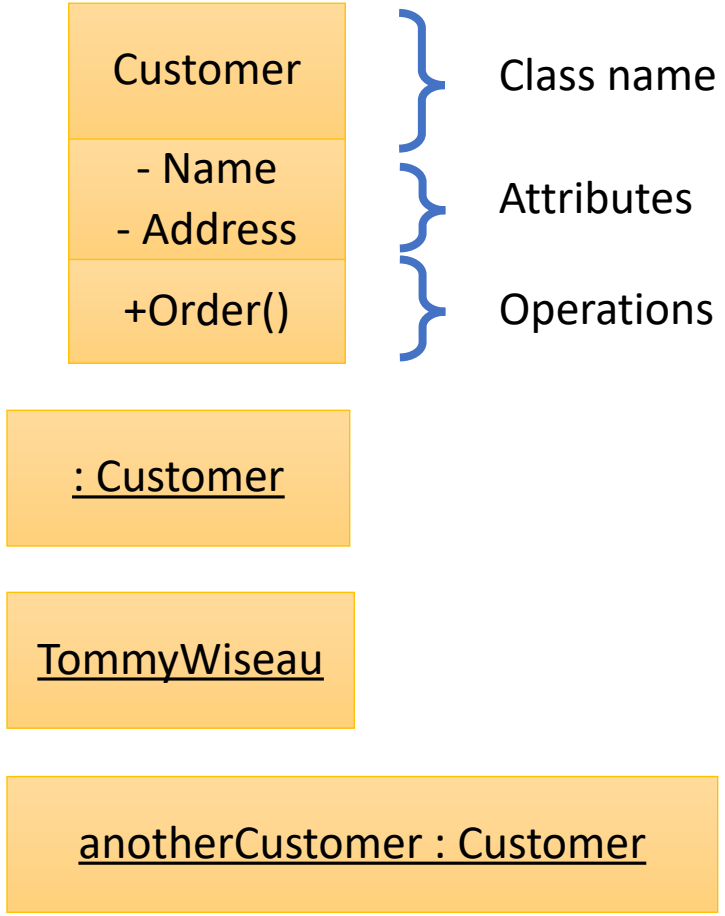

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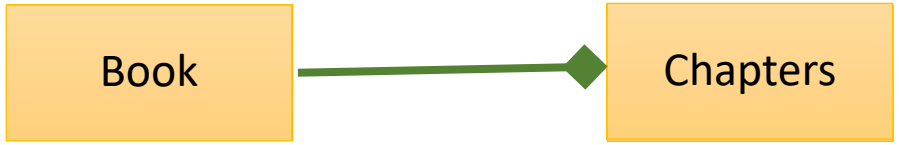
- A. Holub. Picturing Architecture: UML (The Good Bits) and More. Pluralsight.com. 2016.

Class diagrams

- Important note
- Visualize the relationship between classes and objects
- Representation
- A lot of weird arrows
  - Inheritance/Generalization
  - Aggregation hierarchy
  - Composition hierarchy



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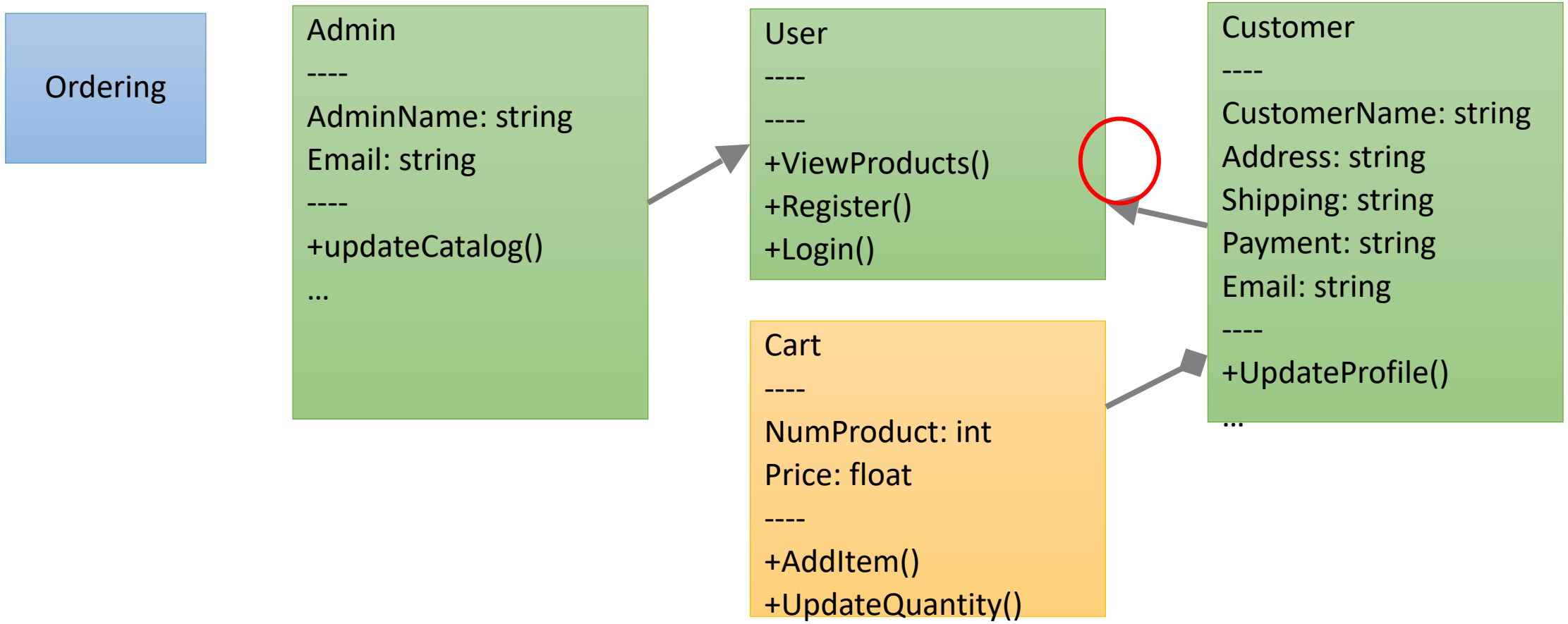
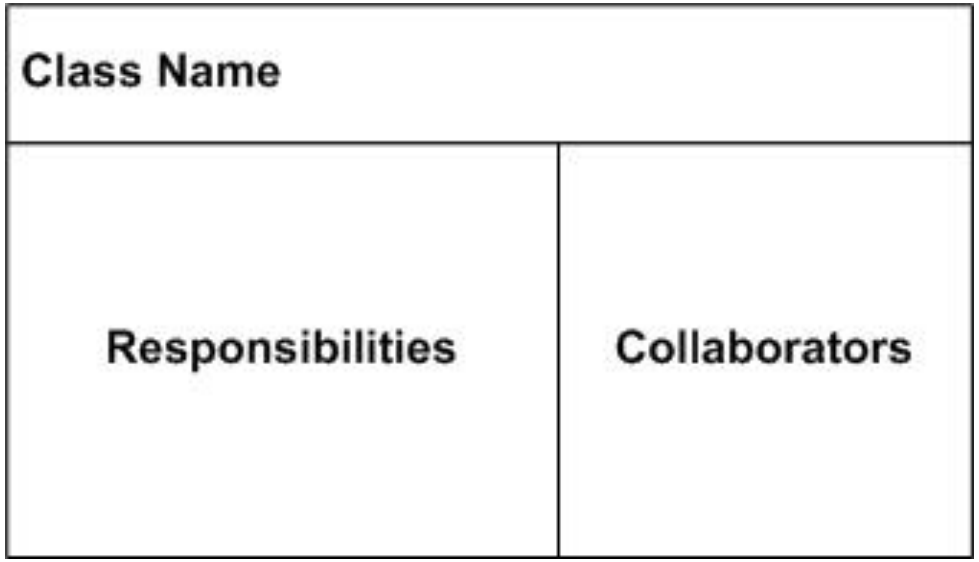
E.g. Class diagram for online shopping



- LucidChart. Class Diagram for Online Shopping System. Online: https://www.lucidchart.com/documents/edit/4c127ee0-7652-4bb9-b53c-738e2c3a4a35?demo=on#

CRC cards

- What are these?



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CRC cards

- What are these?
- Visual
  - Index cards representing classes
  - Relationships between objects
  - Responsibilities of the class

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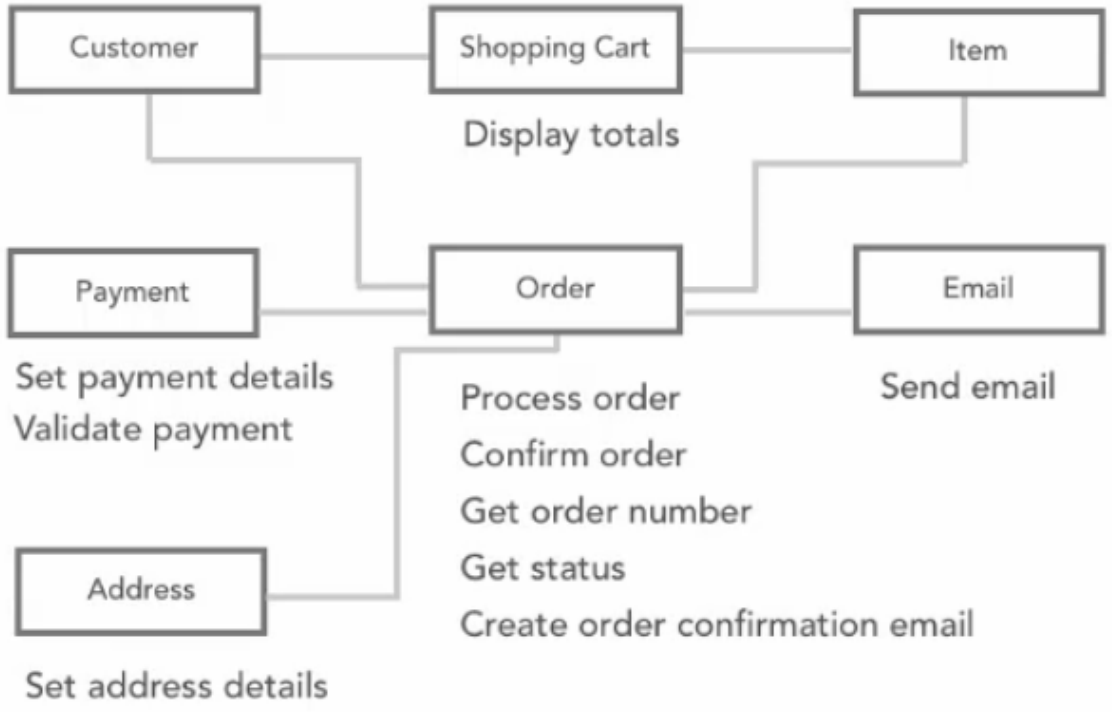

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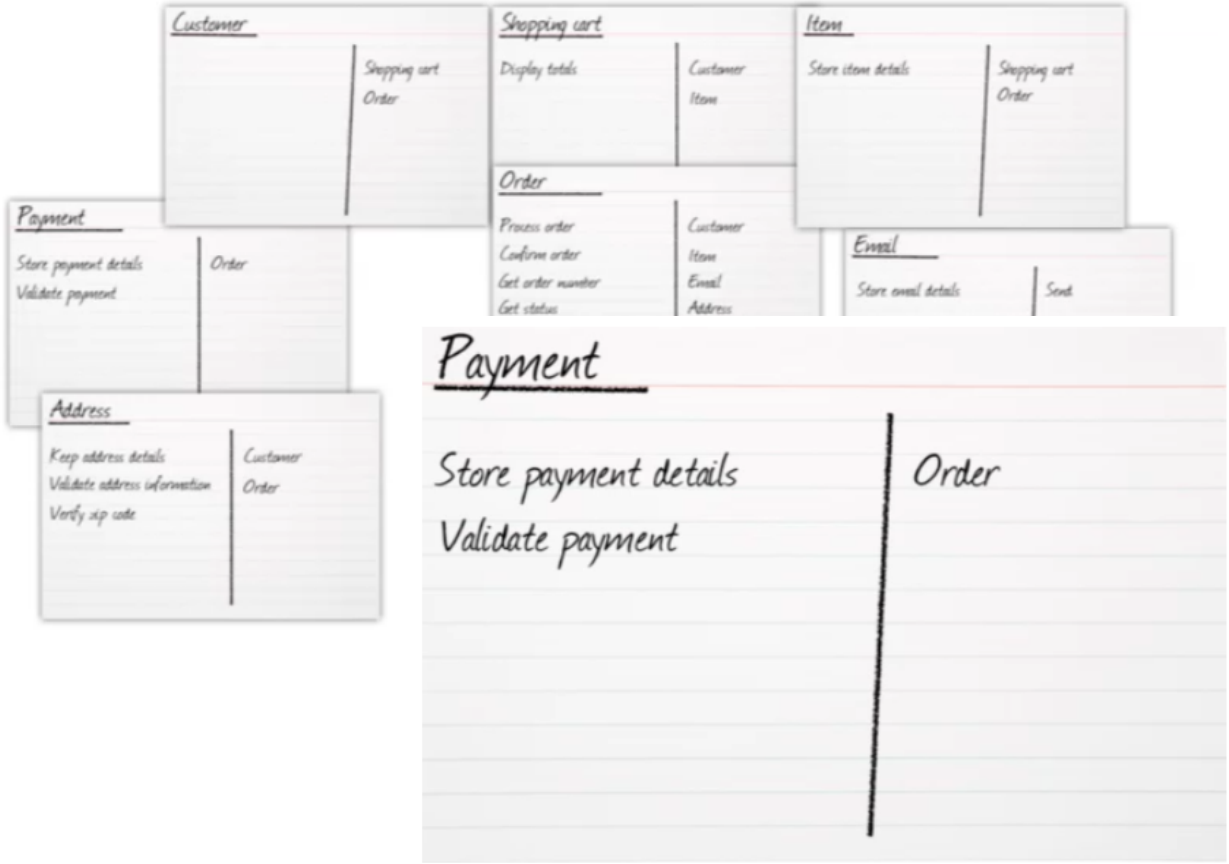

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A great resource

- A. Holub. Allen Holub's UML Quick Reference (2017). Online: https://holub.com/uml/

Picturing design: Lo-Fidelity (Lofi) prototyping

- You are not the user
  - ENSE 271 experience…
  - Recall: False-Consensus effect
- Lo-fi prototyping
- Quick way to
  - Realize system vision (design)
  - Test your design (the interface of your app is the user's doorway

- Nielsen Norman Group. The False-Consensus Effect (2018). Online: https://www.nngroup.com/videos/false-consensus-effect/
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Domain driven design & user stories

- About Domain Driven Design
  - E.g. Accounting system

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- T.A. Alspaugh. Narrative Requirements. 2015. Online: http://www.thomasalspaugh.org/pub/fnd/narrativeRequirements.html
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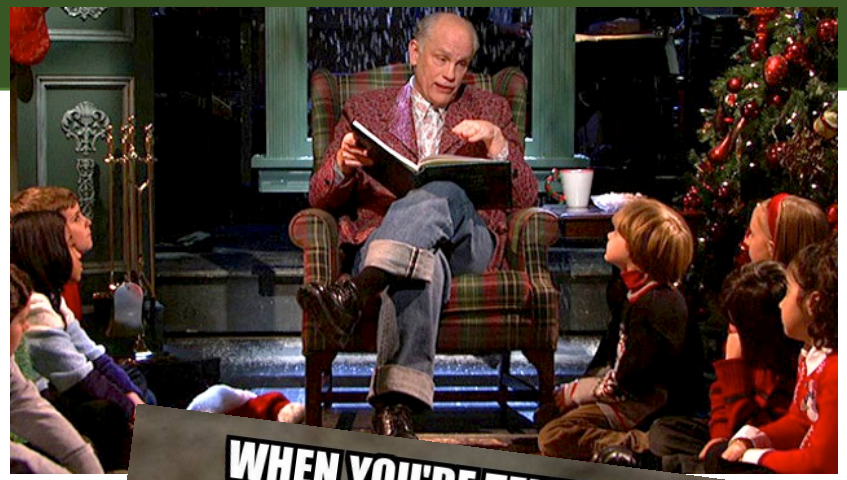

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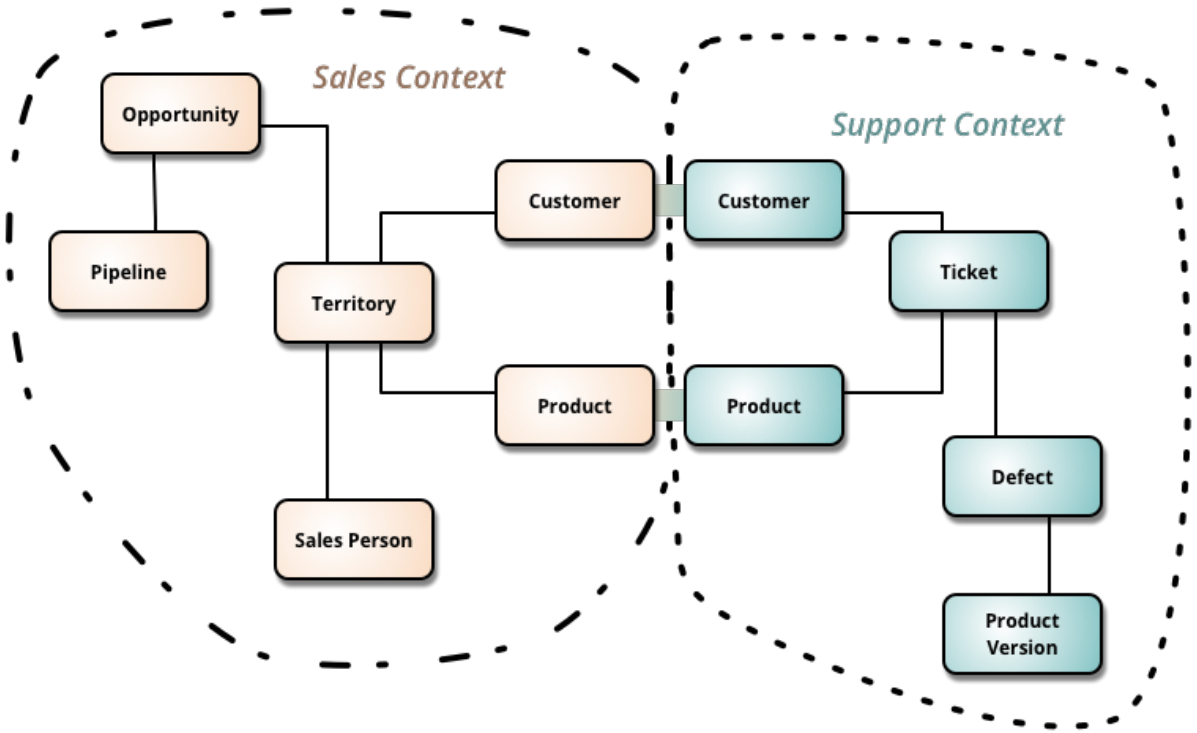

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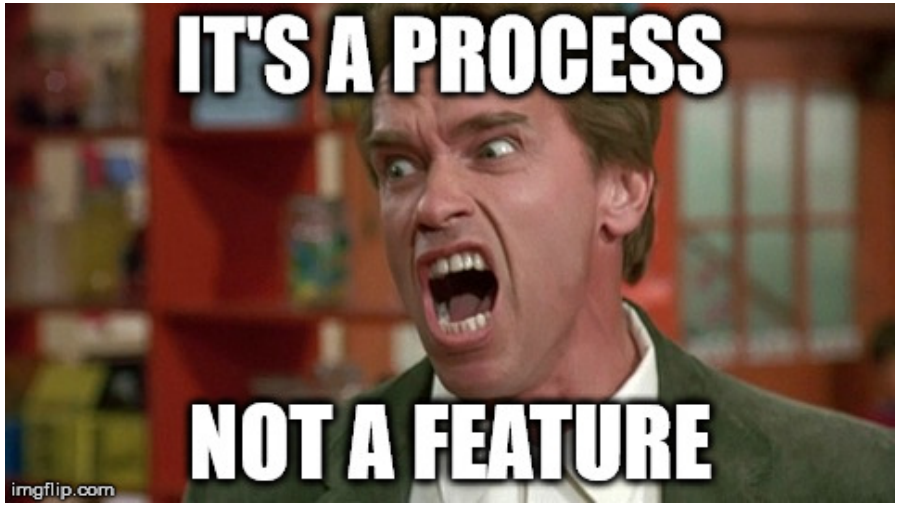
- M. Fowler. Bounded Context (2014). Online: https://martinfowler.com/bliki/BoundedContext.html

User story specifics

- About user stories
- Holub describes a story as “a narrative that takes a user through some process that results in a valuable outcome”



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Visualizing work

- Kanban board
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- Image from HBO's Silicon Valley - What's the emergency Erlich!!?? (haha)

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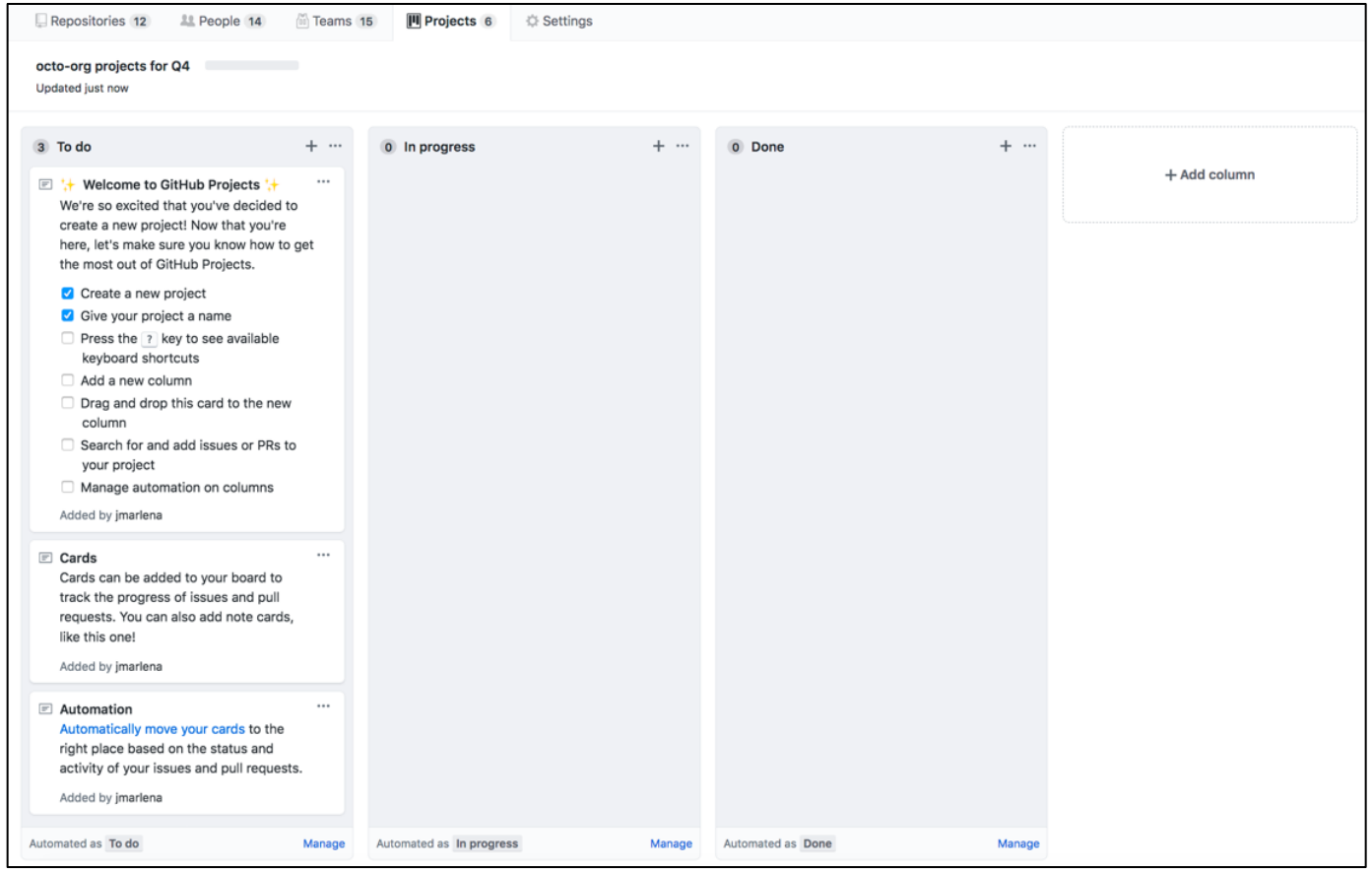

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Image refs

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