

Software and systems engineering

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To do before class

- Watch videos
- Read chapter 7 in the textbook
- Send questions and opinions through slack
 - what haven't you understood? what don't you agree?
what haven't you liked? what are you missing to perform the project task?

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Requirements I , elicitation

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What is requirements
engineering?

We have to develop a new feature

- Contatos nacionais e internacionais relevantes criados ou ampliados em virtude do projeto
- Contribuição direta do(s) projeto(s) para a formação de recursos humanos e a produção científica do Núcleo (isso inclui a totalização de projetos de iniciação científica; dissertações de mestrado; teses de doutorado; alunos de pós-doutorado; artigos completos publicados em periódicos A1, A2, B1, B2, B3, B4, B5, C, SEM QUALIS; trabalhos completos em Anais; livros; capítulos de livros; trabalhos apresentados em conferências/oficinas; palestras proferidas em eventos científicos; patentes geradas)

We have to develop a new system

- We have to develop a system for helping professors manage their classes
- The system should keep track of students and their grades, compute averages and final grade

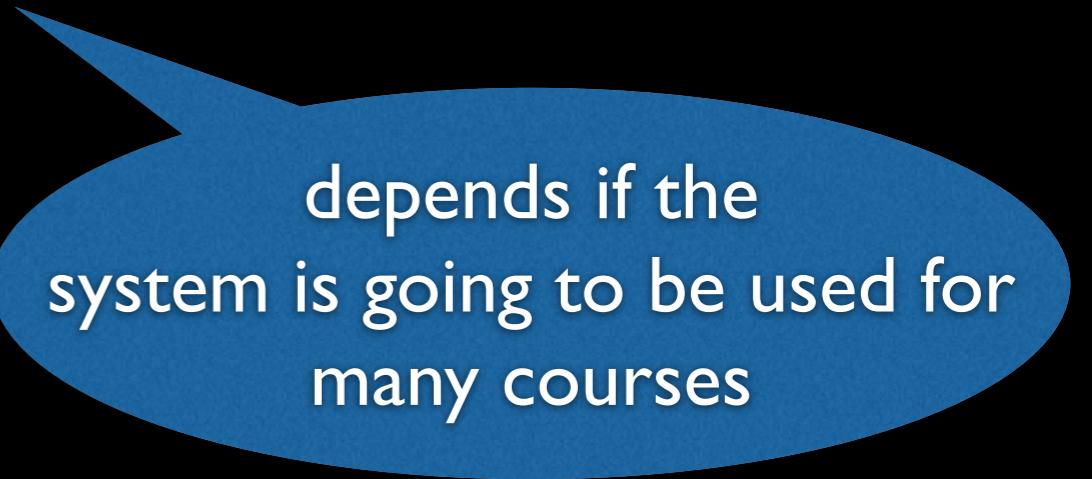
Who are the
stakeholders?

Professors

Students

Assistants

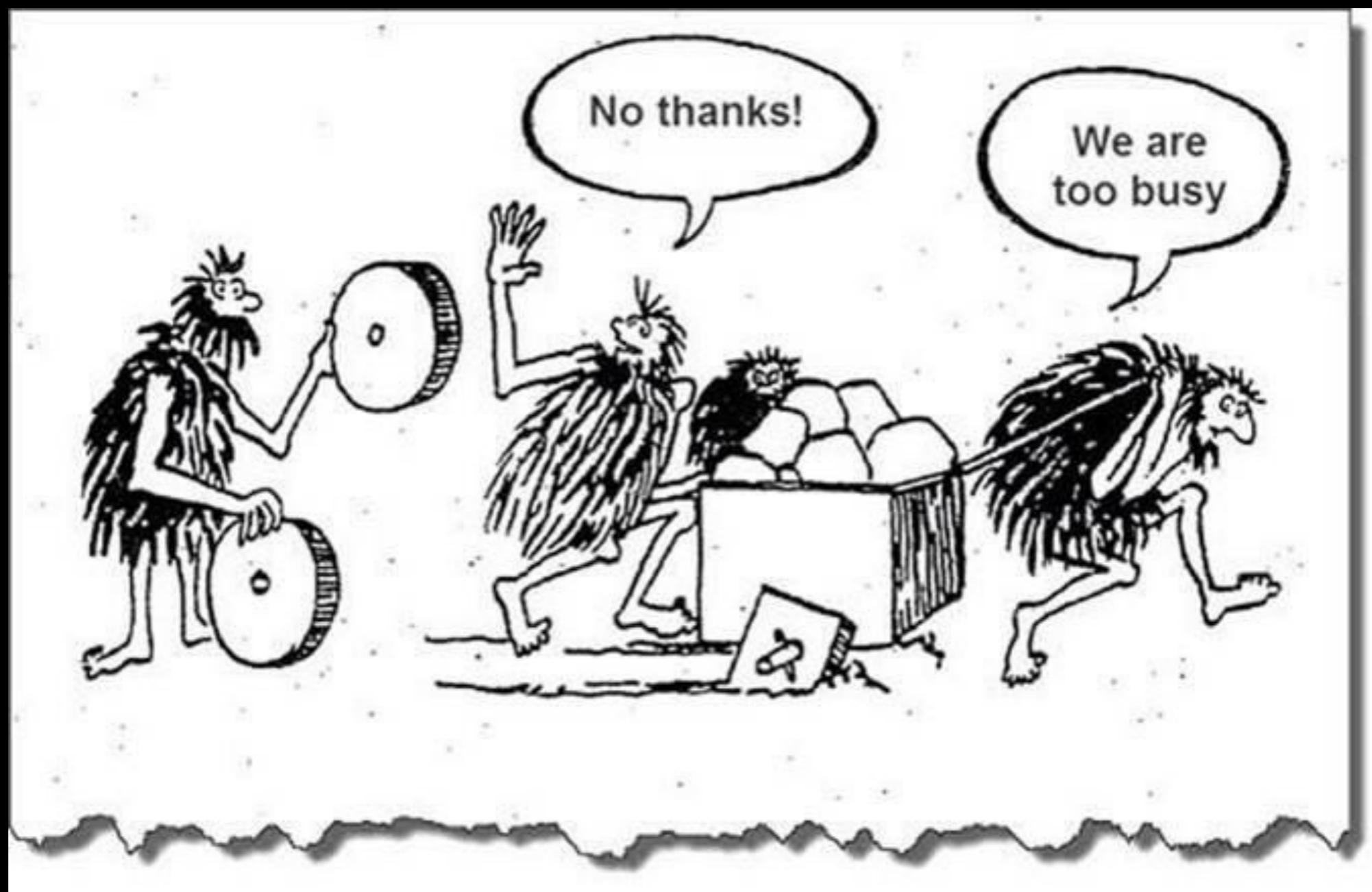
Director of studies?



depends if the
system is going to be used for
many courses

What do the
stakeholders require
from the system?

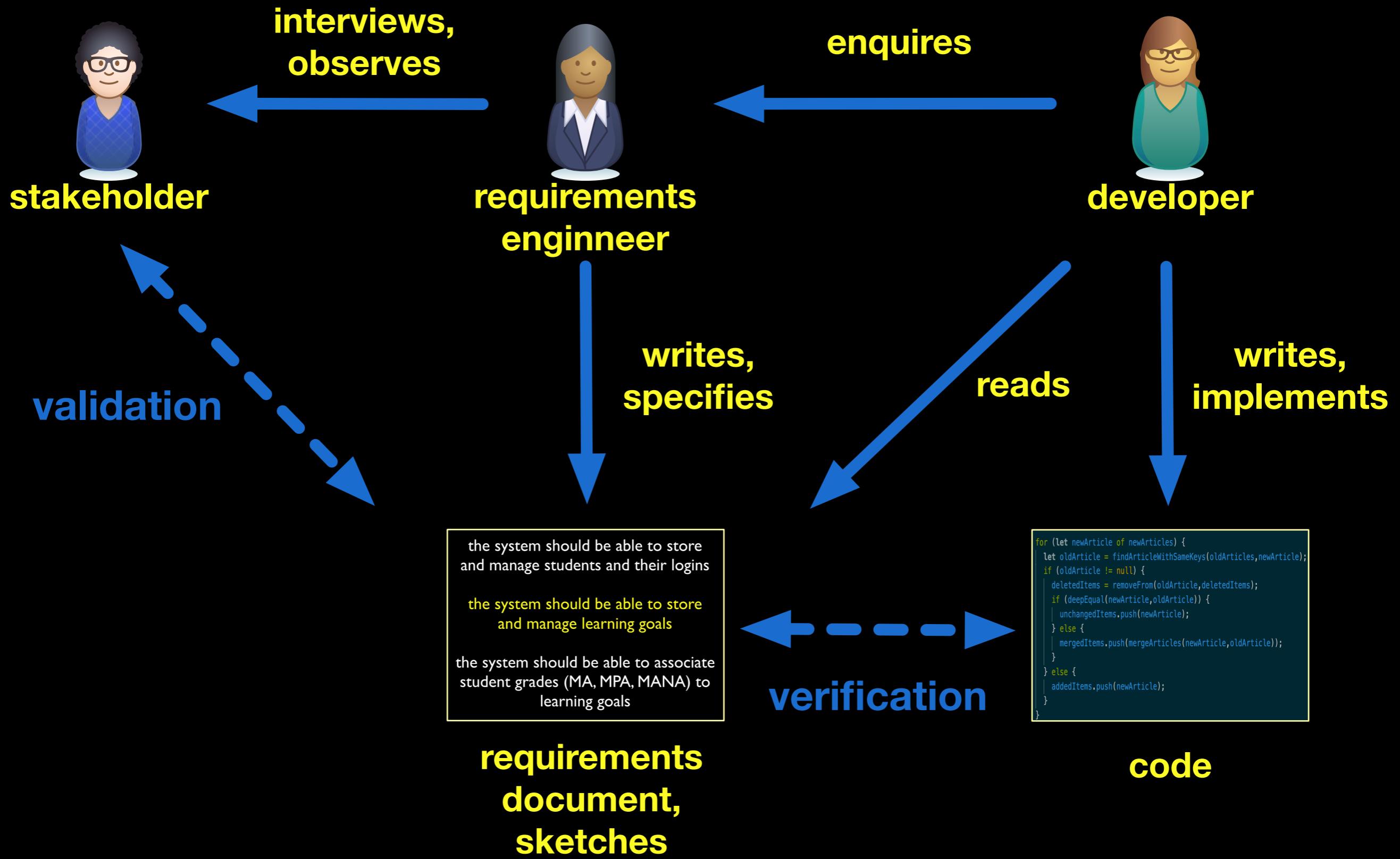
Not properly
answering these
questions often leads
to **productivity** and
quality problems!



<https://www.linkedin.com/pulse/thanks-we-too-busy-daniel-white>

Obtaining and documenting answers are essential for...

- **validating requirements:** making sure we capture the requirements of the desired system (build the right system)
- **verifying requirements:** making sure the created system conforms to the specified requirements (build the system right)



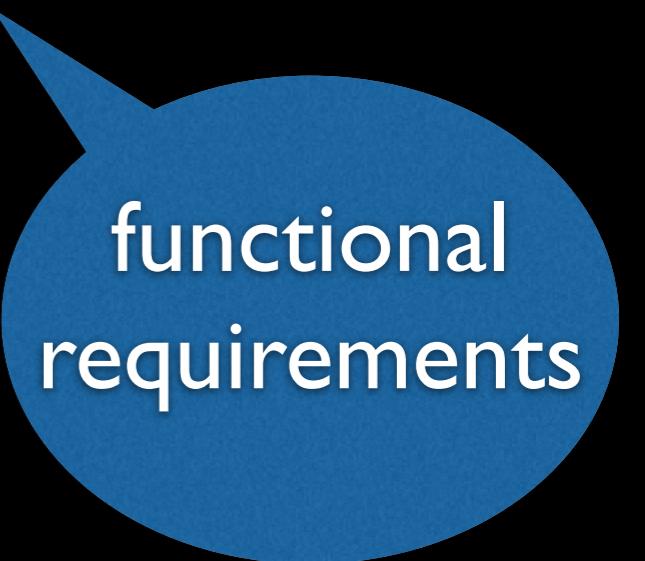
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What do the
stakeholders require
from the system?

What **functionalities** do
the stakeholders
require from the
system?



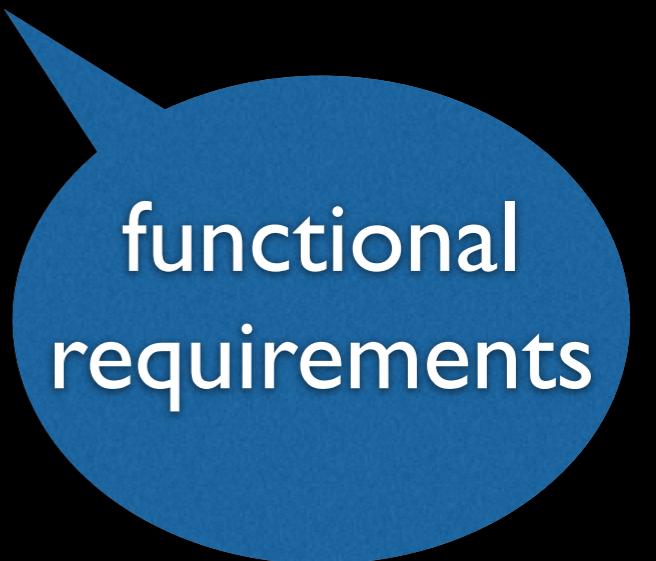
functional
requirements

What quality factors
and other constraints
do the stakeholders
require from such
functionalities?



non-
functional
requirements

What **functionalities** do
the stakeholders
require from the
system?



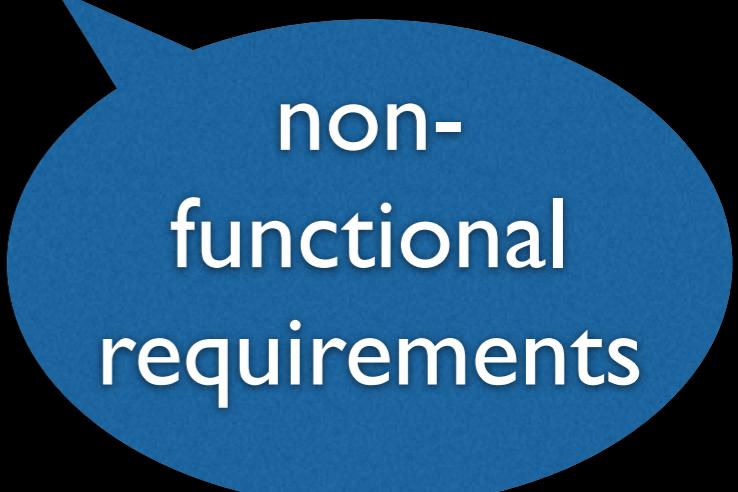
functional
requirements

the system should be able to store
and manage students and their logins

the system should be able to store
and manage learning goals

the system should be able to associate
student grades (MA, MPA, MANA) to
learning goals

What quality factors
and other constraints
do the stakeholders
require from such
functionalities?



non-
functional
requirements

security: students should not be able to change their grades

privacy: students should not be able to see other students grades

scalability: the system should be able to handle 100 simultaneous professors

modularity: the system should be adaptable to different courses

Further constraints

frameworks: Angular 8 and the latest
version of Node.js

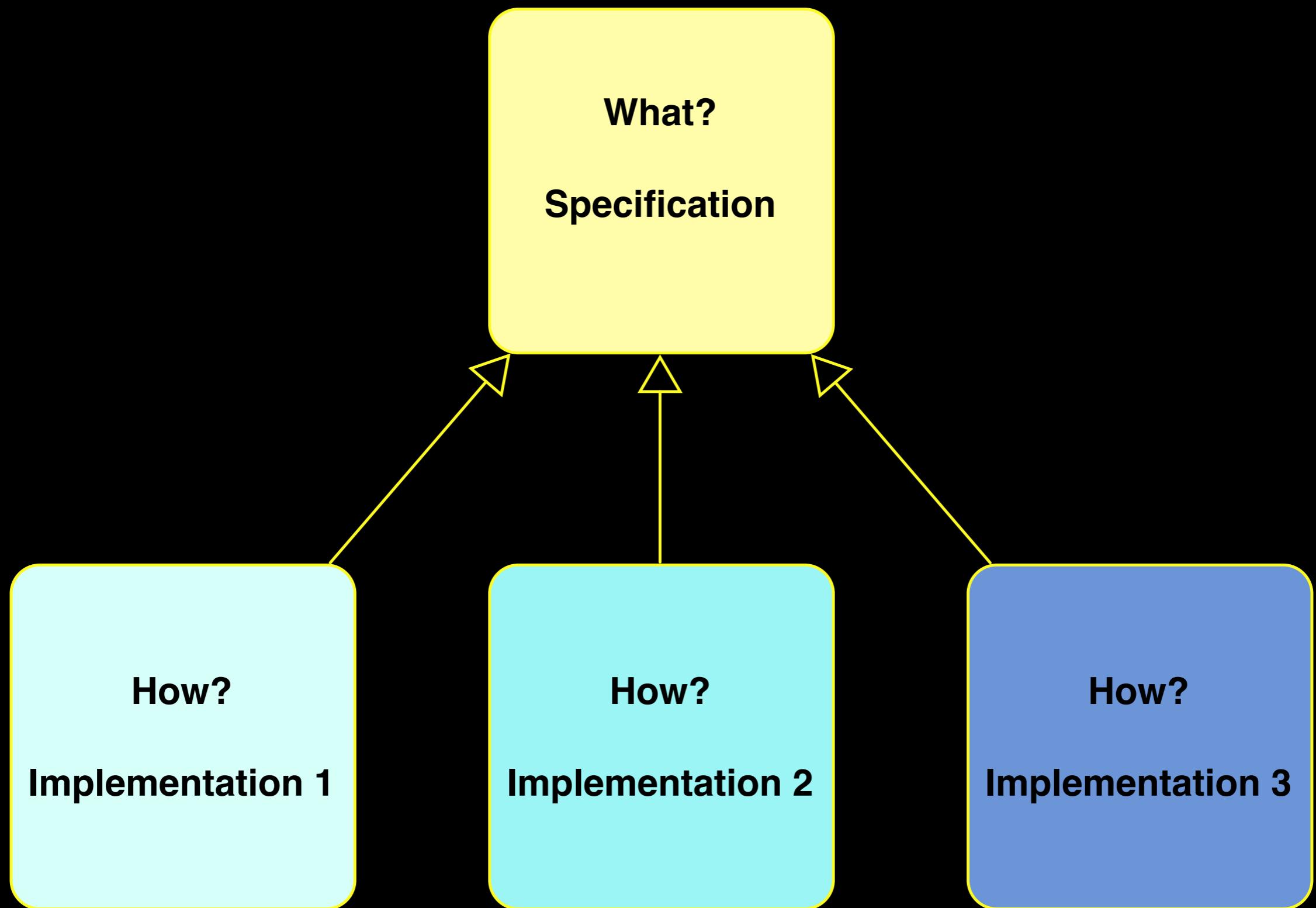
package manager: npm

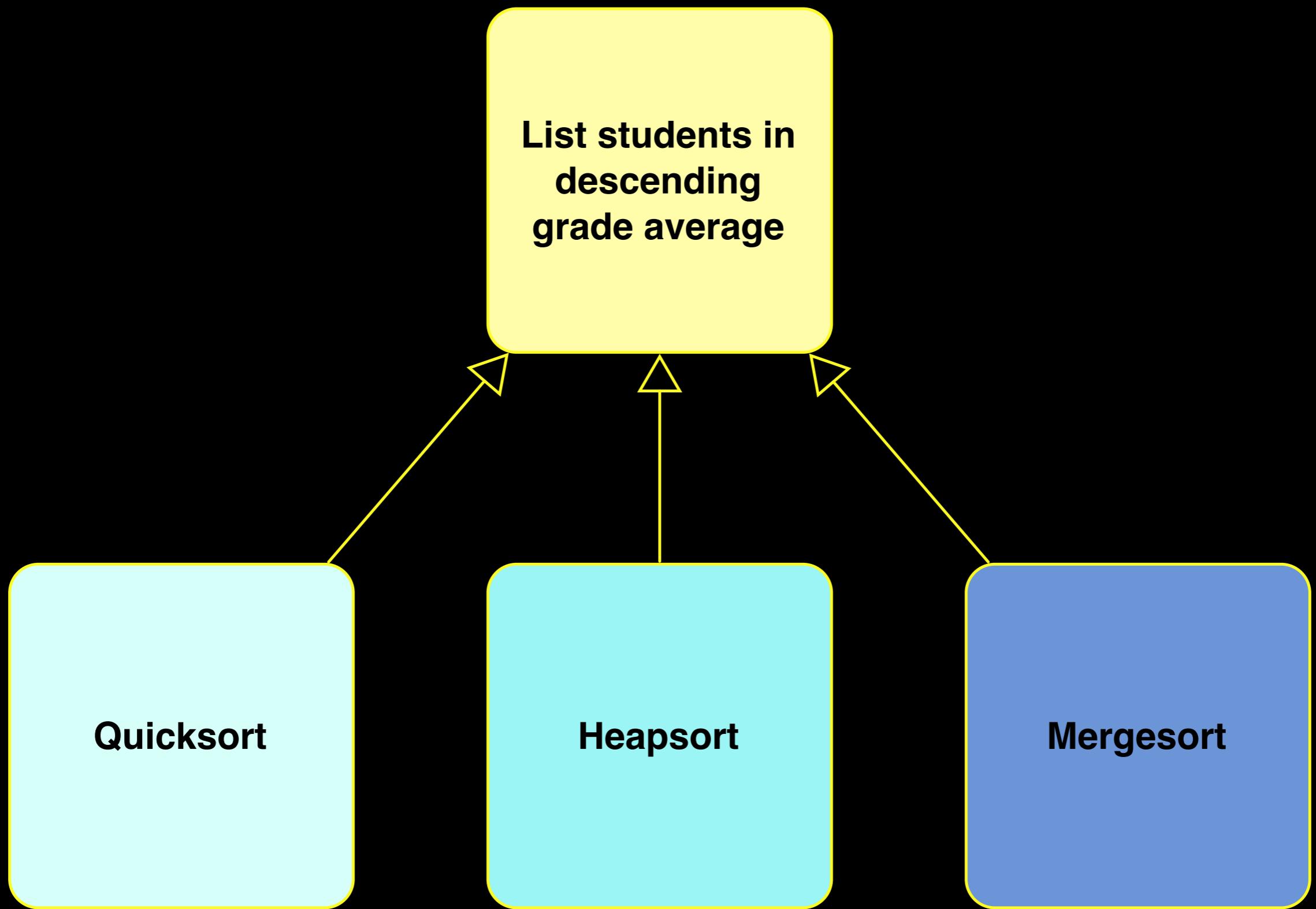
existing systems: integrate with SIG@

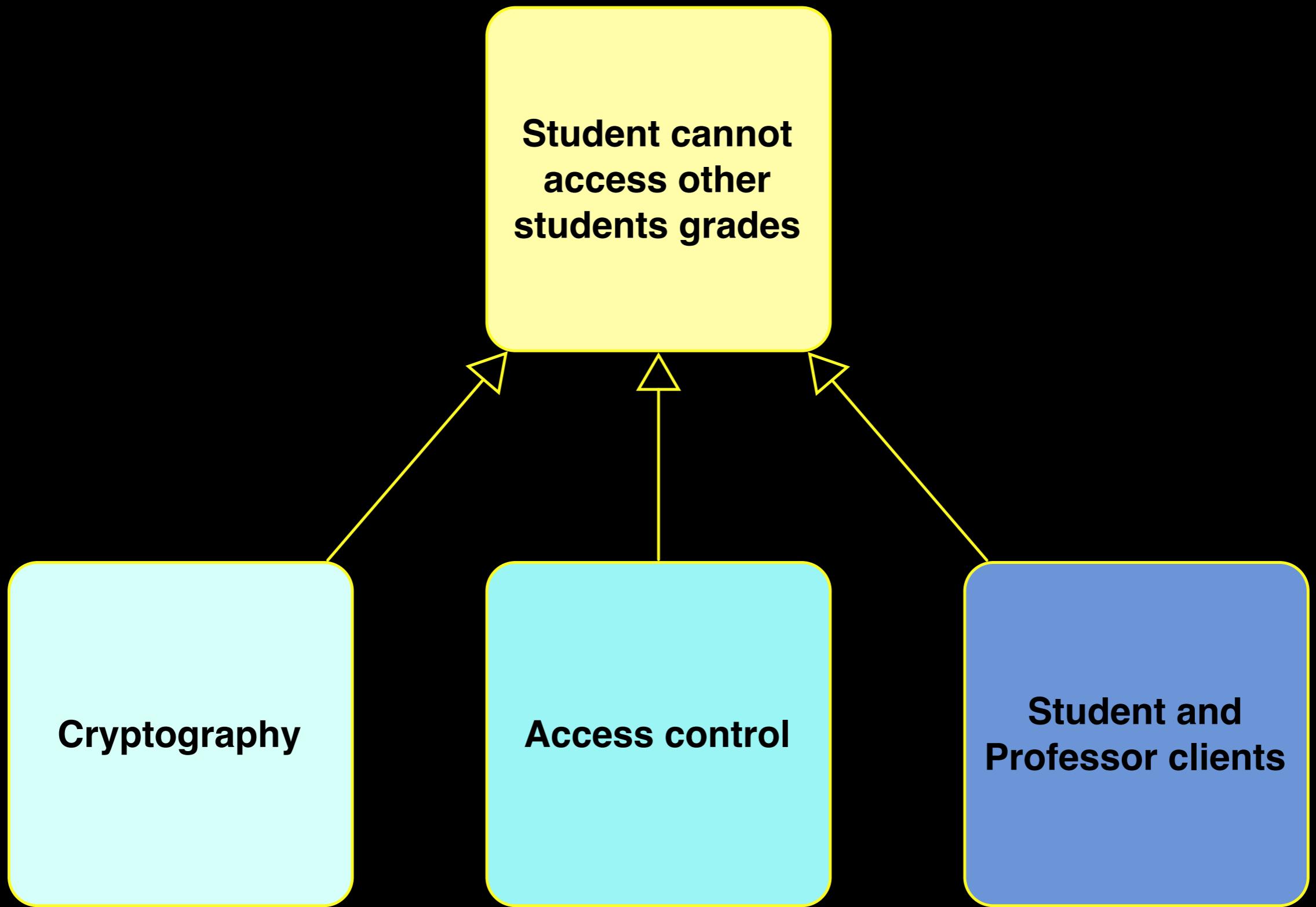
Focus on **what** the system should do, not on **how** it should do!



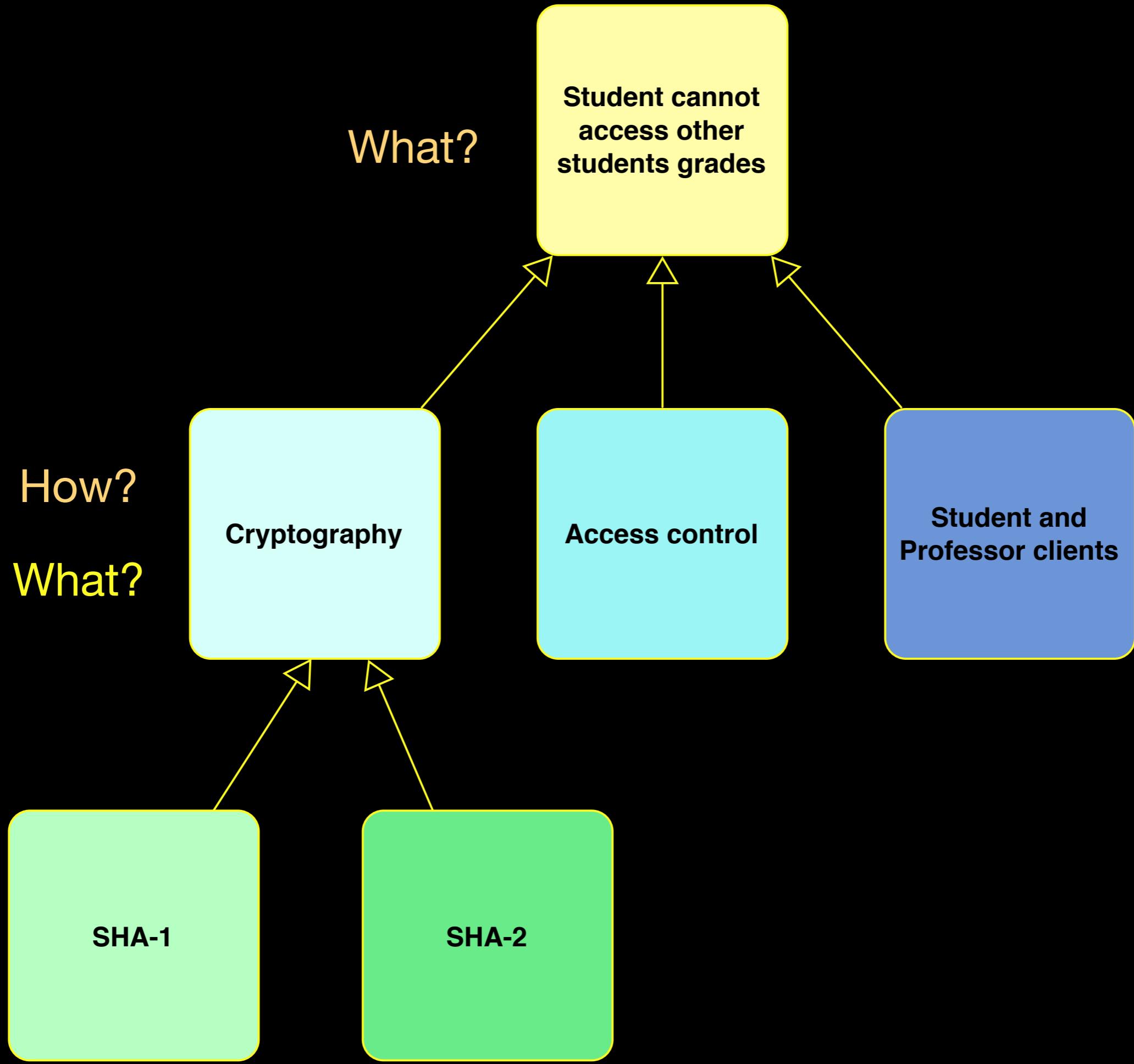
left for design activities







How?
What?



Systems thinking, holistic approach

1. Technical (how handles technical issues?)
2. Managerial (how fits management process?)
3. Operational (how integrates with current operations?)
4. Social (how impacts involved individuals?)
5. Political (how fits current policies?)

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Which requirements
are more **important**
than others?

Understanding
priorities
is essential

the system should be able to store and
manage learning goals

has higher priority than

the system should be able to associate
student grades (MA, MPA, MANA) to
learning goals

has higher priority than

the system should be able to store and
manage students and their logins

Priorities for this particular system,
defined by a group of stakeholders we
interviewed

security

has higher priority than

privacy

has higher priority than

modularity

has higher priority than

scalability

As defining a total
order is often hard,
better to apply a **triage**
process

critical: the system should be able to store and manage learning goals

the system should be able to store and manage students and their logins

important: the system should be able to associate student grades (MA, MPA, MANA) to learning goals

desirable: the system should be able to notify students when they are below average

Useful because trade-offs
are often necessary, and
we can't handle all
requirements in one go,
or with available
resources and deadlines

Stakeholders conflicts
about priorities and
requirements should be
properly negotiated

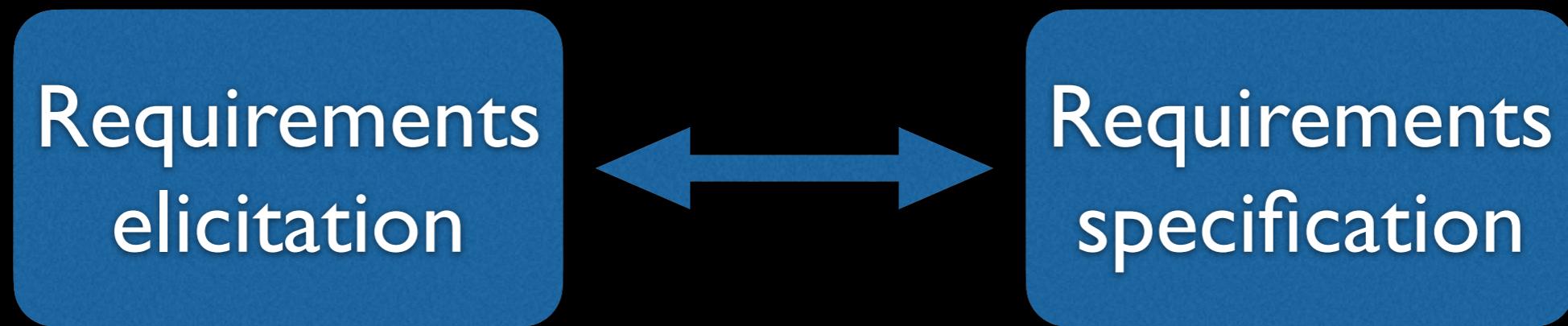
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How to elicit requirements?

Two main activities



Requirements elicitation

Interacting with stakeholders

- Interviews
- Stakeholders as part of the development team
- Lo-Fi GUI sketches and storyboards
- Observing user work (with existing system, if available)

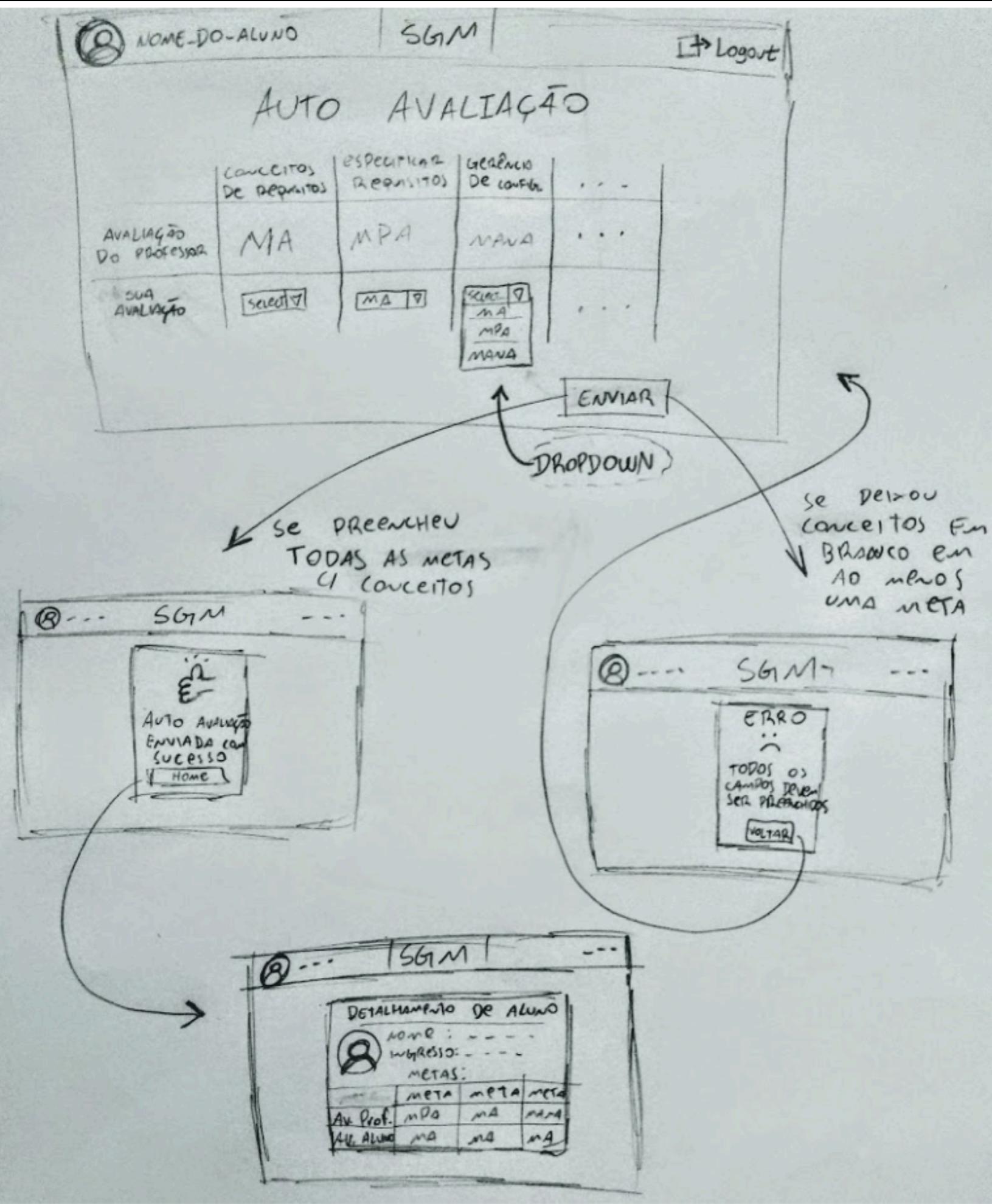
Interviews

- the main goal is to understand stakeholders' needs (including success and failure cases)
- if the idea is to extend or replace an existing system, explore it before the interviews to better understand the context
- take notes and record interviews, if authorised

Guiding principles

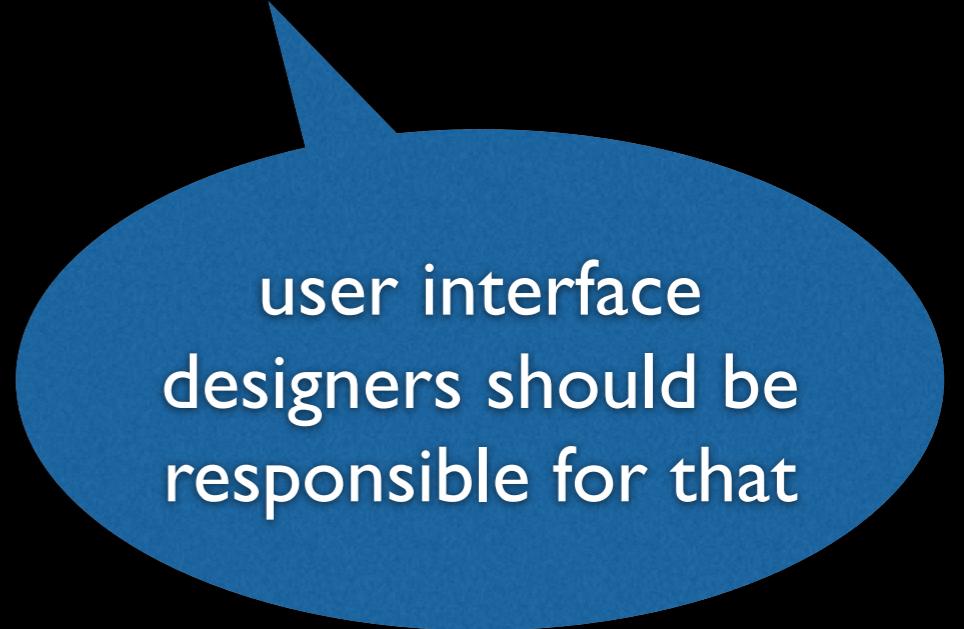
- empathize with the stakeholders!
- imagine that you were in their place
- remember that they might not share your own abilities and cultural background
- adapt to their vocabulary

Lo-Fi GUI sketches and storyboards



This helps stakeholders to
better understand what
they want, and validate that
engineers correctly
captured their needs

The focus should be
more on application
design, not interaction
design

A blue speech bubble shape containing text.

user interface
designers should be
responsible for that

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A basic requirements elicitation process: a practical example

Process, initial phase

- Initial questions:
 - What do you expect from the system?
 - Main functionalities?
 - Involved quality factors and constraints?
- Group functionalities into features
- For each functionality, ask more questions and discuss specific usage scenarios

O interessado diz que o sistema tem que ser capaz de sugerir e alterar o roteiro de coleta de resíduo na UFPE.

Isso é uma **feature**.

Mas o entrevistador precisa saber mais detalhes sobre os **cenários de uso** associados.

Como o usuário solicitaria esse roteiro?

Ele logaria, escolheria a opção de sugestão de roteiro,
e veria a lista de locais a serem visitados?

Depois daria um OK e o sistema avisaria aos locais que
haveria visitas naquele dia?

Ao invés do OK, ele poderia pedir uma outra sugestão
de roteiro?

Ele poderia tirar algum dos lugares, ou mudar a
ordem, antes de dar o OK?

O sistema precisaria armazenar estes roteiros
confirmados?

Process, refinement

- Draw and discuss Lo-Fi GUI sketches and storyboards
- Confirm expectations (validate)
- Ask more questions so that
 - scenarios can be latter detailed, and
 - new (auxiliary) features are identified
- Refine

Mas, para que essas
features sejam
desenvolvidas, que
features e cenários
auxiliares seriam
necessários?

Não seria necessário ter cenários para cadastros dos locais de coleta, do próprio mapa da UFPE, etc., com casos de sucesso e falha?

E cadastro dos resíduos e necessidade de coleta dos mesmos?

Ou seria cadastro dos produtos e prazo de validade dos mesmos, e a partir disso o sistema inferiria a necessidade de coleta?

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Simulating an interview,
and initial requirements
elicitation

Contact stakeholders
and set up a meeting!

Take notes,
now!

Hands on
exercises

Requirements I

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Requirements 2,
specification

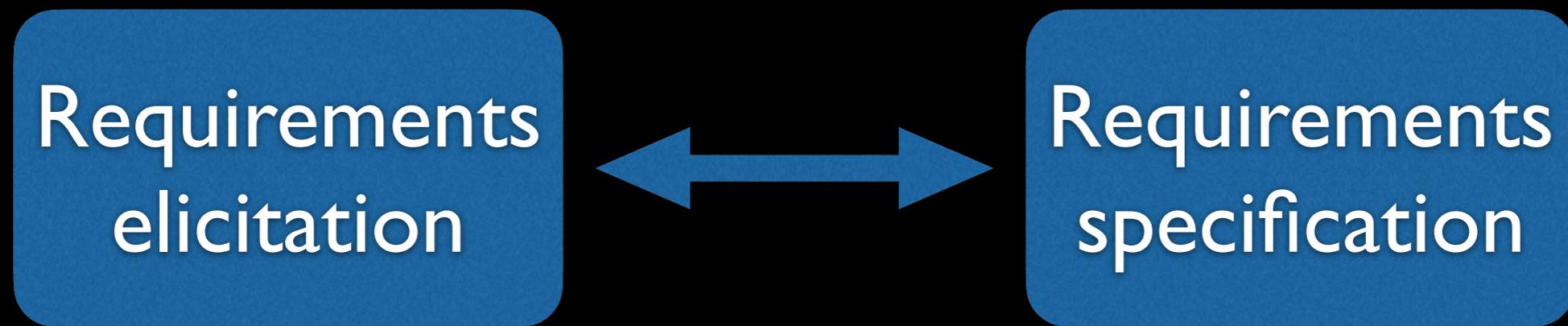
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How to specify
requirements?
Requirements
documents

Two main activities



Requirements specification

Basic approach

Requirements list

- R1: the system should be able to store and manage students and their logins
- R2: the system should be able to import a list of students and their logins from an excel file
- R3: the system should be able to store and manage learning goals
- R4: the system should be able to associate student grades (MA, MPA, MANA) to learning goals

Requirements documents

User Requirements Document (URD)

| | | |
|--------|---|---|
| U3.3.1 | The software should provide code that emulate a hard disk, comparable to a 40GB Maxtor 6E040L0 or 40GB Western Digital WD400BB-60CJA0 | M |
| U3.3.2 | Issues: - The software should provide code that emulates random access memory up to 1 GB. | M |
| U3.3.3 | Issues: - The software should provide code that emulates an optical storage device, comparable to a Compaq JLMS DVD-ROM LTD-1665. | D |
| U3.3.4 | Issues: - The software should provide code that emulates a 3.5" floppy drive, with average seek time. | E |
| | Issues: - | |

3.4 Input devices

| Label | Requirement | Necessity |
|--------|---|-----------|
| U3.4.1 | The software should provide code that emulates a keyboard, comparable to IBM PC 101-key keyboard. | M |
| U3.4.2 | Issues: - The software should provide code that emulates a mouse, supporting the PS/2 protocol. Issues: <ul style="list-style-type: none">This does not specify anything about the mouse, only the protocol | M |

5 Non-functional Requirements

5.1 Speed and Time Requirements

| Label | Requirement | Necessity |
|--------|--|-----------|
| U5.1.1 | The software should be able to emulate the RWS at a reasonable speed. However, this is not a mandatory requirement because it is assumed that computers will continue to become faster (based on Moore's law). As this emulator will be focused on future use, speed is currently not an issue. Issues: How fast is Java? | D |

5.2 Capacity Requirements

| Label | Requirement | Necessity |
|--------|---|-----------|
| U5.2.1 | The software must be able to handle at least 40 GB target disk images. Issues: - | M |

5.3 Reliability Requirements

| Label | Requirement | Necessity |
|--------|---|-----------|
| U5.3.1 | The software should be able to give a correct representation of the test objects. Issues: this requires comparison tests between RWS and emulated environment. | M |

http://dioscuri.sourceforge.net/docs/URD_Dioscuri_KBNA_v1_1_en.pdf

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How to specify
requirements? Scenario
specifications

Alternative approach:
features + scenarios,
towards testing

Feature: group of related functionalities

Feature: grades

**As a professor responsible for a class
I want to add and modify student grades
for a number of learning goals
so that I can calculate and announce students'
final grades**

Feature (user story)

Feature: journal article

As a member of a research group

I want to add, remove and modify journal
articles I have published

so that I can generate reports containing
these articles

Feature template

Feature: [name]

As a [kind of stakeholder]

I want to [do some task]

so that [I can achieve some goal]

Feature functionalities
are detailed by usage
scenarios

GUI based scenario

Scenario: adding new grade

Given I am at the "Grades" page

And I see a student "Maria Silva" with no grade for learning goal "Write quality tests"

When I add grade "MA" for "Maria Silva" goal "Write quality tests"

Then I'm still at the "Grades" page

And I can see student "Maria Silva" has grade "MA" for learning goal "Write quality tests"

Teaching Assistant

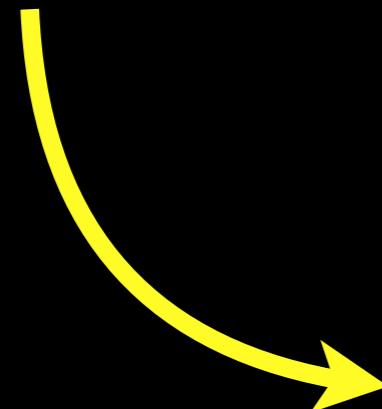
Alunos Metas

| Nome | CPF | e-mail | Requisitos | Gerência de Configuração |
|------|-----|--------|------------|--------------------------|
|------|-----|--------|------------|--------------------------|

Pedro 123 p@cin MANA

Mariana 456 m@cin MPA

State before action



Teaching Assistant

Alunos Metas

| Nome | CPF | e-mail | Requisitos | Gerência de Configuração |
|------|-----|--------|------------|--------------------------|
|------|-----|--------|------------|--------------------------|

Pedro 123 p@cin MANA

MA

Mariana 456 m@cin MPA



State after action

Another GUI based scenario

Scenario: new article web

Given I am at the "New Article Page"

And I see no "A refinement theory" in the list
of existing articles

When I create the article "A refinement theory"

Then I can see a confirmation message

And I am still at the "New Article Page"

And I see "A refinement theory" in the list
of existing articles

Test setup (precondition) steps

Scenario: new article web

Given I am at the "New Article Page"

And I see no "A refinement theory" in the list
of existing articles

When I create the article "A refinement theory"

Then I can see a confirmation message

And I am still at the "New Article Page"

And I see "A refinement theory" in the list
of existing articles

Test action steps

Scenario: new article web

Given I am at the "New Article Page"

And I see no "A refinement theory" in the list
of existing articles

When I create the article "A refinement theory"

Then I can see a confirmation message

And I am still at the "New Article Page"

And I see "A refinement theory" in the list
of existing articles

Test expected result (postcondition) steps

Scenario: new article web

Given I am at the "New Article Page"

And I see no "A refinement theory" in the list
of existing articles

When I create the article "A refinement theory"

Then I can see a confirmation message

And I am still at the "New Article Page"

And I see "A refinement theory" in the list
of existing articles

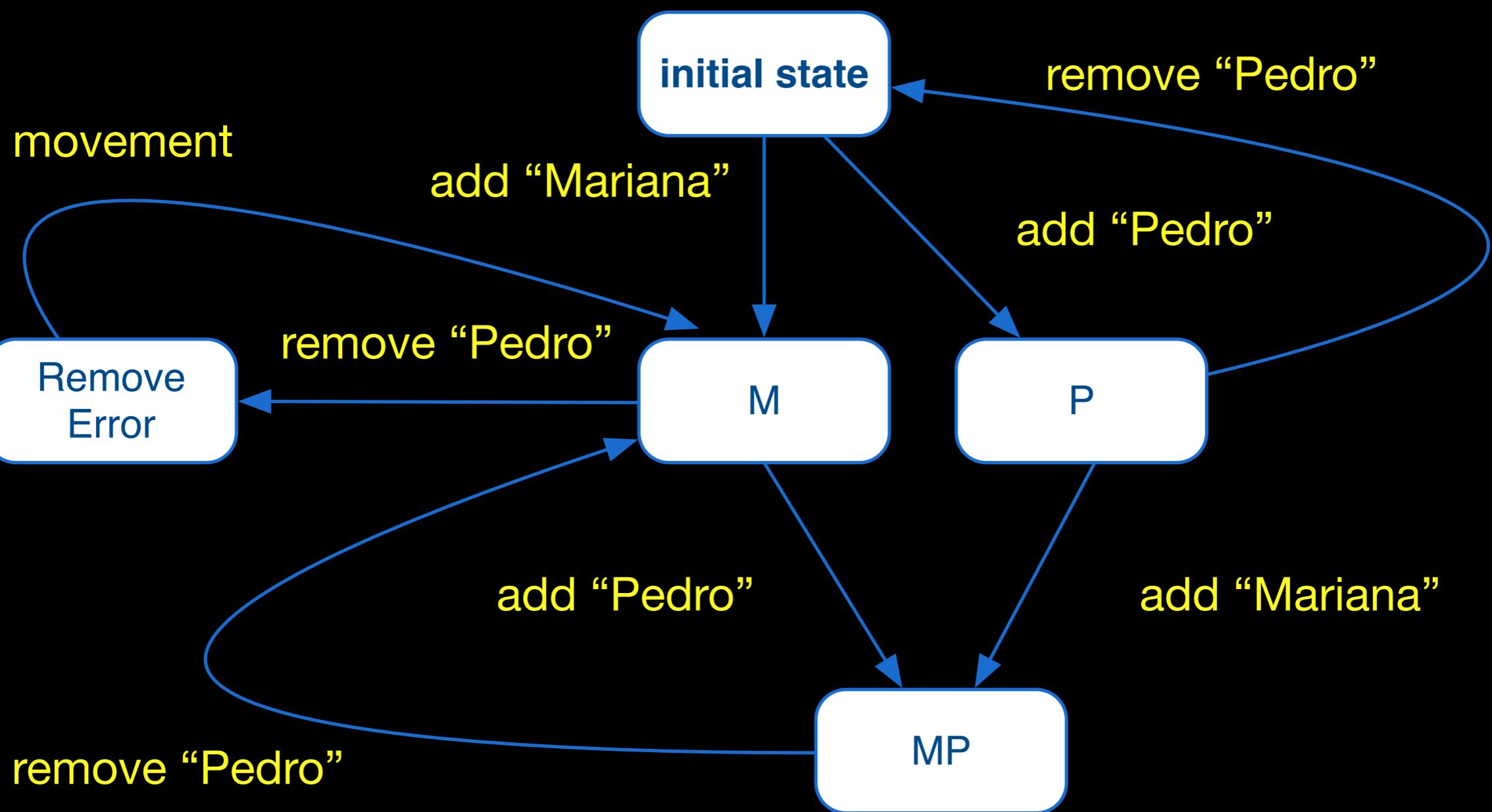
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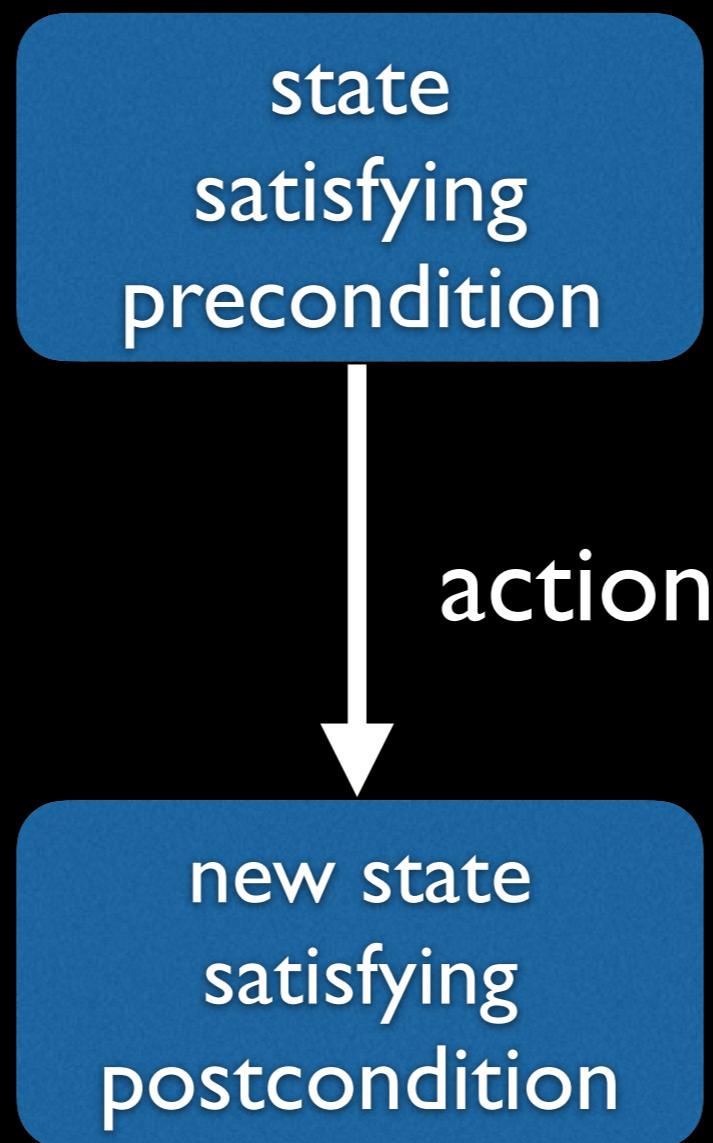
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How to view systems
as state machines?

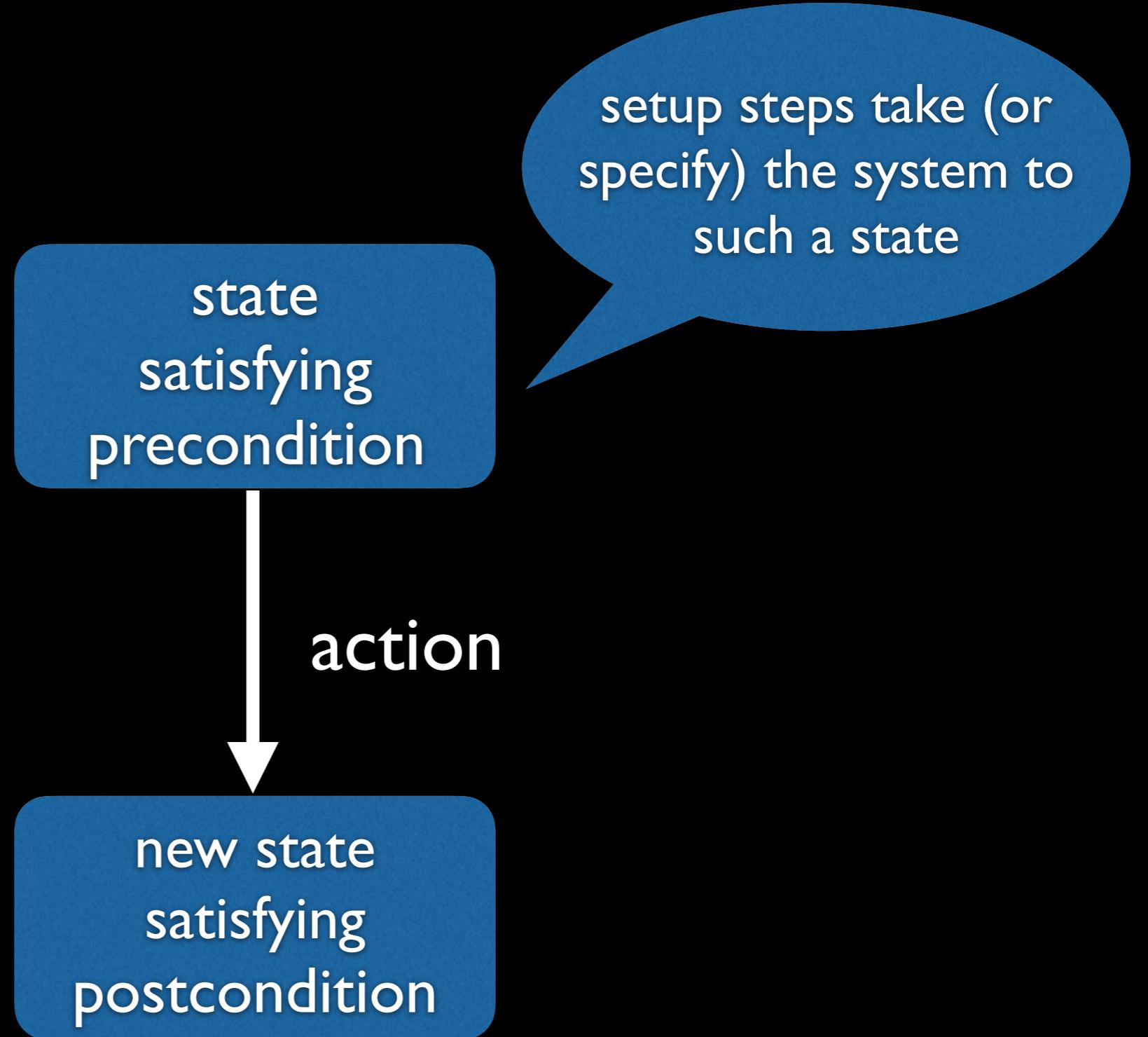
System as a state machine



Scenarios specify how actions change state



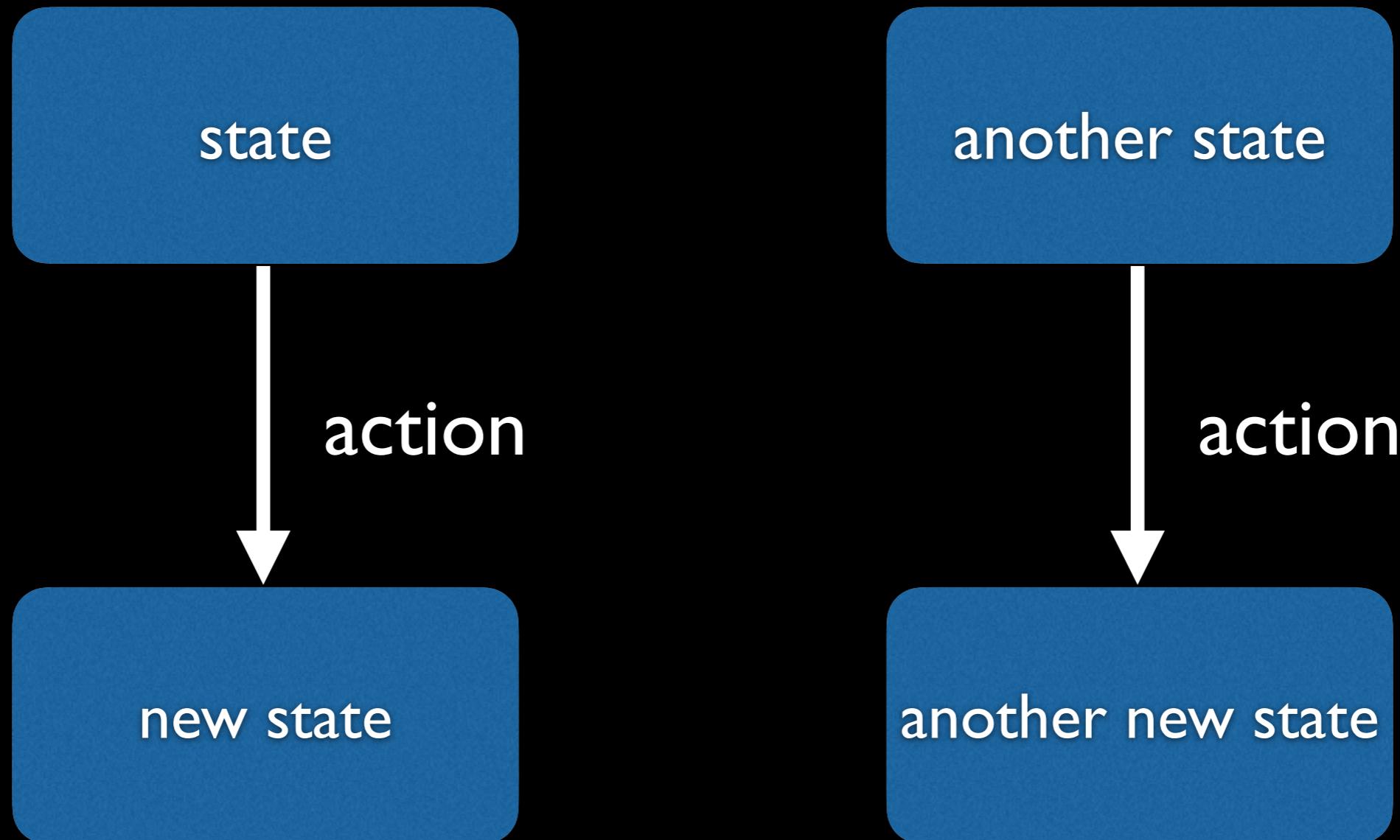
Steps roles



expected results
steps confirm the system
is in such a state

setup steps take (or
specify) the system to
such a state

Different states, possibly different action effects



Scenario as path (often
of size one) in the
corresponding graph

System behavior as set
of traces (sequence of
events in a path)

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How to specify
concrete yet
declarative scenarios?

Parameters = test data

Scenario: adding new grade

Given I am at the "Grades" page

And I see a student "Maria Silva" with no grade for learning goal "Write quality tests"

When I add grade "MA" for "Maria Silva" goal "Write quality tests"

Then I'm still at the "Grades" page

And I can see student "Maria Silva" has grade "MA" for learning goal "Write quality tests"

Focus on concrete execution scenarios

- Concrete steps, with proper data, performed by an user using the system in a practical and relevant situation
- Testing feasibility
- Testing bias
- Scenarios will be latter used as tests

Concrete but
Declarative high level
scenarios!

Use high (abstraction) level steps

Scenario: Add a new article and try to tweet the article using wrong login and password

Given I am logged as "admin"

And I am at the "Article" Page

And I see no article “Refinement...”

When I try to create an article named “Refinement...”

with filename "TCS-I02.pdf"

And Share it in Twitter with "phmb"
and “password-weak”

Then No tweet should be post about "Refinement..."

Imperative low level
scenarios refer to
detailed steps that
add little to the
specification

Avoid low (abstraction) level steps

Given I am at the "login" page

And I see a "login" textfield

And I type "phmb" in the "login" textfield

And ... I click...

all that for a
single step!

avoid
referring to
specific GUI
elements

Given I am logged as "admin"
And I am at the...

Avoid imperative
scenarios!

No need for that in
your project!

User interface scenarios

- Directly refer to user interface elements, events, and navigation, **but in an abstract way**
- Focus on overall, **visible (not internal)**, user related, input/output system behaviour
- Focus on effects to the system **user interface state**, not internal system state
- Often specify **explicit** requirements
- Think about sequence of snapshots of a particular, concrete, use of the system

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How to specify features?

More realistic example,
focus on relevant
scenarios

RQ6: The system should compute average 6.5 for a student that has at least one MANA and 60% MA or MPA.

Scenario: see average for concepts MA, MANA, MA

Given The student "João Vasconcelos" has achieved "MA, MANA, MA" for the evaluated learning goals

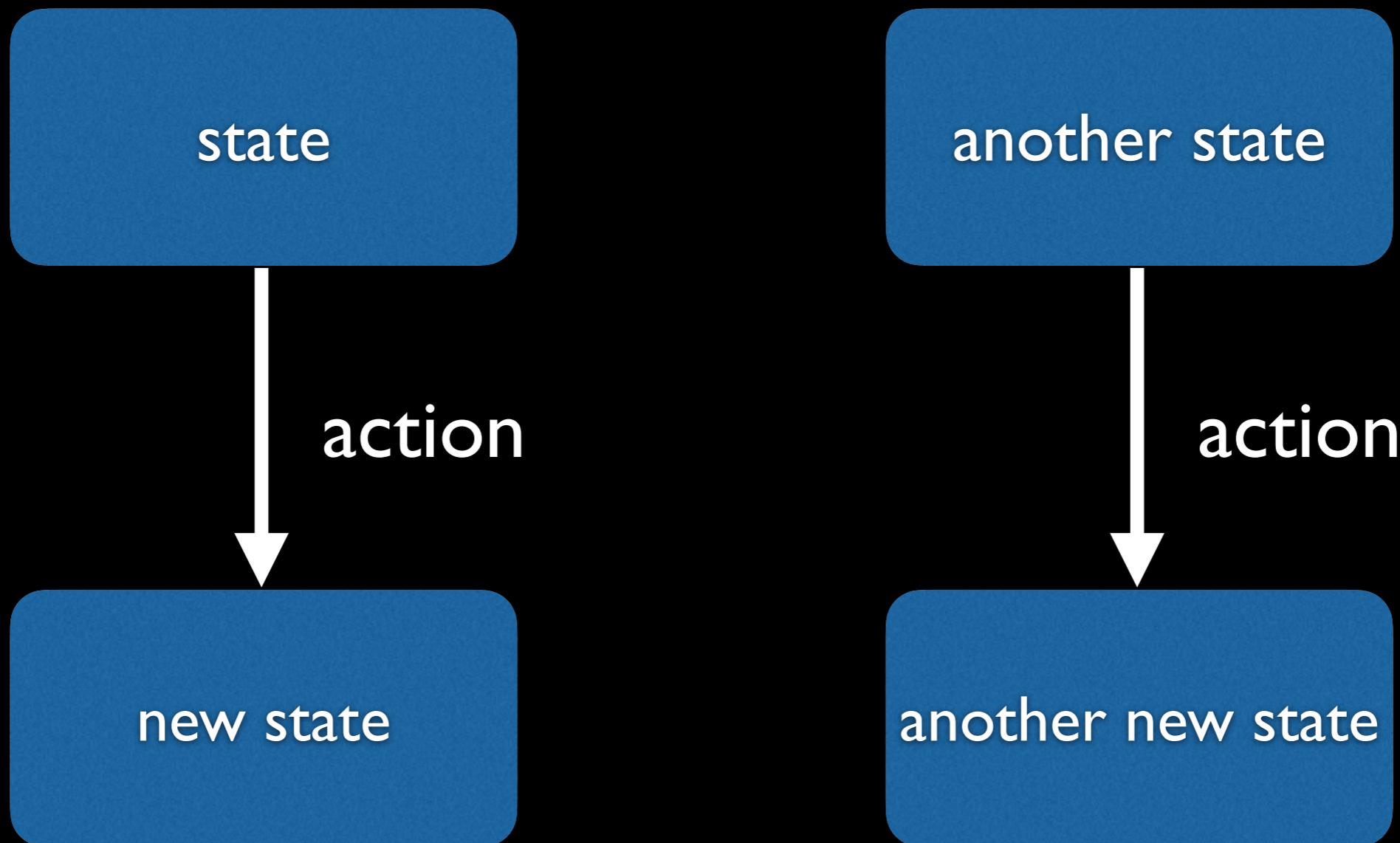
And I'm at the "grades" page

When I ask the system to compute averages

Then I'm still at the "grades" page

And I see "6.5" at row "João Vasconcelos" and column "semester average"

Different states, possibly different action effects



RQ7: The system should compute average 7
for a student that has no MANAs and less than 20% MA.

Scenario: see average for concepts MPA, MPA, MPA

Given The student "João Vasconcelos" has achieved "MPA,
MPA, MPA" for the evaluated learning goals

And I'm at the "grades" page

When I ask the system to compute averages

Then I'm still at the "grades" page

And I see "7" at row "João Vasconcelos" and column
"semester average"

RQ8: The system should not compute average unless a student has grades for all evaluated learning goals.

Scenario: see average for concepts MPA, MPA, -

Given The student "João Vasconcelos" has achieved "MPA, MPA, -" for the evaluated learning goals

And I'm at the "grades" page

When I ask the system to compute averages

Then I'm still at the "grades" page

And I see "Not available" at row "João Vasconcelos" and column "semester average"

Specification of the grade average feature

Scenario: see average for concepts MA, MANA, MA

Given The student "João Vasconcelos" has achieved "MA, MANA, MA" for the evaluated learning goals

And I'm at the "grades" page

When I ask the system to compute averages

Then I'm at the "grades" page

And I see "6.5" at row "João Vasconcelos" and column "semester average"

Scenario: see average for concepts MPA, MPA, MPA

Given The student "João Vasconcelos" has achieved "MPA, MPA, MPA" for the evaluated learning goals

And I'm at the "grades" page

When I ask the system to compute averages

Then I'm at the "grades" page

And I see "7" at row "João Vasconcelos" and column "semester average"

Scenario: see average for concepts MPA, MPA, -

Given The student "João Vasconcelos" has achieved "MPA, MPA, -" for the evaluated learning goals

And I'm at the "grades" page

When I ask the system to compute averages

Then I'm at the "grades" page

And I see "Not available" at row "João Vasconcelos" and column "semester average"

Feature specifications

```
Feature: uploader with file storage
In order to be awesome
As a developer using CarrierWave
I want to upload files to the filesystem
```

```
Background:
Given an uploader class that uses the 'file' storage
And an instance of that class
```

```
Scenario: store a file
When I store the file 'fixtures/bork.txt'
Then there should be a file at 'public/uploads/bork.txt'
And the file at 'public/uploads/bork.txt' should be identical to the file at 'fixtures/bork.txt'
```

```
Scenario: store two files in succession
When I store the file 'fixtures/bork.txt'
Then there should be a file at 'public/uploads/bork.txt'
And the file at 'public/uploads/bork.txt' should be identical to the file at 'fixtures/bork.txt'
When I store the file 'fixtures/monkey.txt'
Then there should be a file at 'public/uploads/monkey.txt'
And the file at 'public/uploads/monkey.txt' should be identical to the file at 'fixtures/monkey.txt'
```

```
Scenario: cache a file and then store it
When I cache the file 'fixtures/bork.txt'
Then there should be a file called 'bork.txt' somewhere in a subdirectory of 'public/uploads/tmp'
And the file called 'bork.txt' in a subdirectory of 'public/uploads/tmp' should be identical to the file at
And there should not be a file at 'public/uploads/bork.txt'
When I store the file
Then there should be a file at 'public/uploads/bork.txt'
And the file at 'public/uploads/bork.txt' should be identical to the file at 'fixtures/bork.txt'
```

```
Scenario: retrieving a file from cache then storing
Given the file 'fixtures/bork.txt' is cached file at 'public/uploads/tmp/1369894322-345-1234-2255/bork.txt'
When I retrieve the cache name '1369894322-345-1234-2255/bork.txt' from the cache
And I store the file
Then there should be a file at 'public/uploads/bork.txt'
And the file at 'public/uploads/bork.txt' should be identical to the file at 'fixtures/bork.txt'
```

https://github.com/carrierwaveuploader/carrierwave/blob/master/features/file_storage.feature

Feature: Admin can work with projects

```
In order to assign materials to projects
As an admin
I need to work with project objects
```

```
Background:
Given The default settings and jnlp resources exist using factories
And the database has been seeded
And I am logged in with the username admin
```

```
Scenario: Admin accesses projects
Given the default projects exist using factories
When I am on the home page
And I follow "Admin"
And I follow "Projects"
Then I should be on the projects index page
And I should see "3 projects"
And I should see "create Project"
```

```
Scenario: Admin creates a new project
When I am on the projects index page
And I click "create Project"
And I fill in "admin_project[name]" with "My new project"
And I fill in "admin_project[landing_page_slug]" with "new-project"
And I fill in "admin_project[landing_page_content]" with "<h1>New project FooBar!</h1>"
And I press "Save"
Then I should be on the projects index page
And I should see "1 project"
And I should see "Project was successfully created."
And I should see "My new project"
When I click "/new-project"
Then I should be on the route /new-project
And I should see "New project FooBar!"
```

```
Scenario: Admin creates a new project providing invalid params
When I am on the projects index page
And I click "create Project"
And I press "Save"
And I should see "there are errors"
And I should see "Name can't be blank"
And I fill in "admin_project[name]" with "My new project"
And I fill in "admin_project[landing_page_slug]" with "slug"
And I press "Save"
Then I should be on the projects index page
And I should see "Project was successfully created."
And I should see "My new project"
When I click "create Project"
And I fill in "admin_project[landing_page_slug]" with "slug"
And I press "Save"
Then I should see "there are errors"
And I should see "Name can't be blank"
And I should see "Landing page slug has already been taken"
```

https://github.com/concord-consortium/rigse/blob/master/features/admin_works_with_projects.feature

Feature: A manager updates account information for another user

In order to correct mistakes a user has made

As a Manager

I want to update a users account information

Background:

Given The default settings and jnlp resources exist using factories

And the database has been seeded

Scenario Outline: Managers can change a users email address

When I am logged in with the username mymanager

And I am on the user preferences page for the user "<username>"

Then I should see "User Preferences"

When I fill in "user_email" with "<changed_email>"

And I press "Save"

When I am on the user preferences page for the user "<username>"

Then I should see "User Preferences"

And the "user_email" field should contain "<changed_email>"

Examples:

| | |
|----------|-----------------------|
| username | changed_email |
| student | test1@mailintator.com |
| teacher | test2@mailintator.com |

@javascript

Scenario Outline: Managers can change a users password

When I am logged in with the username mymanager

And I am on the user list page

And I click "Reset Password" for user: "<userlogin>"

Then I should see "Password for <username> (<userlogin>)"

When I fill in "user_reset_password_password" with "<new_password>"

And I fill in "user_reset_password_password_confirmation" with "<new_password>"

And I press "Save"

Then I should be on user list

When I log out

And I login with username: <userlogin> password: <new_password>

Then I should see "Welcome"

And I should see "SETTINGS"

common
initial steps
for all
scenarios in
a feature

values for
instantiating
variables used
in a
scenario

https://github.com/concord-consortium/rigse/blob/master/features/manager_updates_account_information.feature

imperative, too
sensitive to changes in the
GUI

Scenario Outline: Managers can change a users password

```
When I am logged in with the username mymanager
And I am on the user list page
And I click "Reset Password" for user: "<userlogin>"
Then I should see "Password for <username> (<userlogin>)"
When I fill in "user_reset_password_password" with "<new_password>"
And I fill in "user_reset_password_password_confirmation" with "<new_password>"
And I press "Save"
Then I should be on user list
When I log out
And I login with username: <userlogin> password: <new_password>
Then I should see "Welcome"
And I should see "SETTINGS"
```

Interleaving Whens
and Thens

longer paths,
less reuse

For simplicity, no
branching (OR, if, while)

Scenario as path, not
subgraph

System requirements specification

constraints
and quality
requirements

Grades feature

Scenario: see average for concepts MA, MANA, MA

Given The student "João Vasconcelos" has achieved "MA, MANA, MA" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "6.5" at row "João Vasconcelos" and column "semester average"

Scenario: see average for concepts MPA, MPA, MPA

Given The student "João Vasconcelos" has achieved "MPA, MPA, MPA" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "7" at row "João Vasconcelos" and column "semester average"

feature,
groups related
scenarios

Classes feature

Scenario: see average for concepts MPA, MPA, -

Given The student "João Vasconcelos" has achieved "MPA, MPA, -" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "Not available" at row "João Vasconcelos" and column "semester average"

Scenario: see average for concepts MPA, MPA, MPA

Given The student "João Vasconcelos" has achieved "MPA, MPA, MPA" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "7" at row "João Vasconcelos" and column "semester average"

Scenario: see average for concepts MPA, MPA, MPA

Given The student "João Vasconcelos" has achieved "MPA, MPA, MPA" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "7" at row "João Vasconcelos" and column "semester average"

functionalities,
specified by one or
more scenarios

NFRs

security: students should not be able to change their grades

privacy: students should not be able to see other students grades

scalability: the system should be able to handle 100 simultaneous professors

modularity: the system should be adaptable to different courses

Students feature

Scenario: see average for concepts MPA, MPA, -

Given The student "João Vasconcelos" has achieved "MPA, MPA, -" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "Not available" at row "João Vasconcelos" and column "semester average"

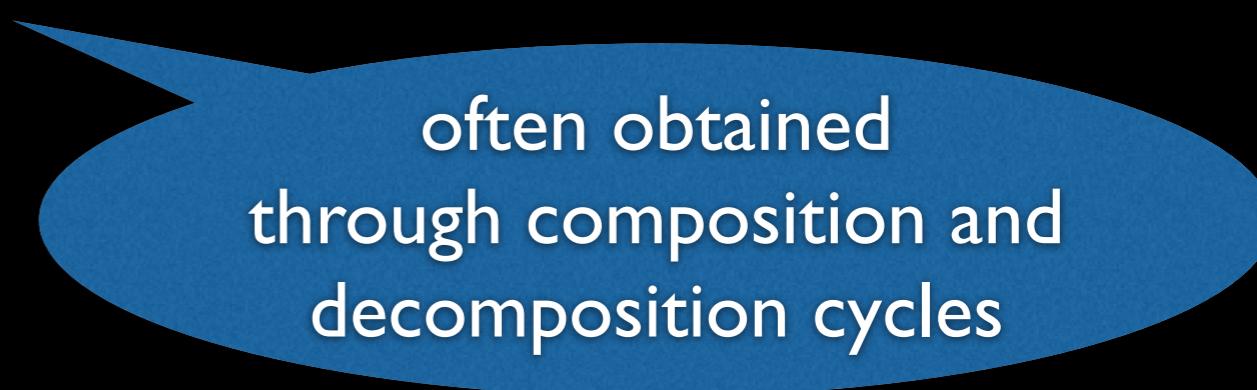
Scenario: see average for concepts MPA, MPA, MPA

Given The student "João Vasconcelos" has achieved "MPA, MPA, MPA" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "7" at row "João Vasconcelos" and column "semester average"

scenario,
specifies one or more
requirements

Feature as an organisational
structure, defined by the
engineer but perceived by
users

Feature granularity depends
on organisational needs



often obtained
through composition and
decomposition cycles

Avoid redundant
scenarios

RQ8: The system should not compute average unless a student has grades for all evaluated learning goals.

Scenario: see average for concepts MPA, MPA, -

Given The student "João Vasconcelos" has achieved "MPA, MPA, -" for the evaluated learning goals

And I'm at the "grades" page

When I ask the system to compute averages

Then I'm still at the "grades" page

And I see "Not available" at row "João Vasconcelos" and column "semester average"

RQ8: The system should not compute average unless a student has grades for all evaluated learning goals.

Scenario: see average for concepts MPA,-, MPA

Given The student "João Vasconcelos" has achieved "MPA, -, MPA" for the evaluated learning goals

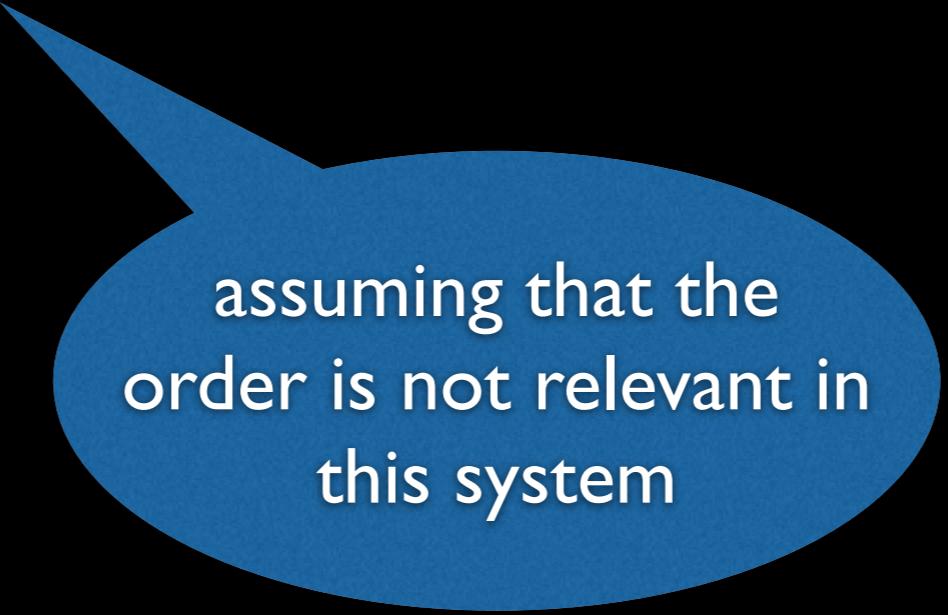
And I'm at the "grades" page

When I ask the system to compute averages

Then I'm still at the "grades" page

And I see "Not available" at row "João Vasconcelos" and column "semester average"

Redundancy comes
from just changing the
order of the grades



assuming that the
order is not relevant in
this system

But no problem if the
same step appears in a
number of scenarios

Better specifying system behavior

- Note the need to complement
 - success cases with failure cases, and
 - corner cases with typical cases
- We could also better specify the effect to other state elements
 - other students grades
 - overall class average

The more constraints
in the **Then** clauses of a
scenario, the stronger
the scenario
requirements

The more constraints
in the expected results
of a test, the stronger
the test

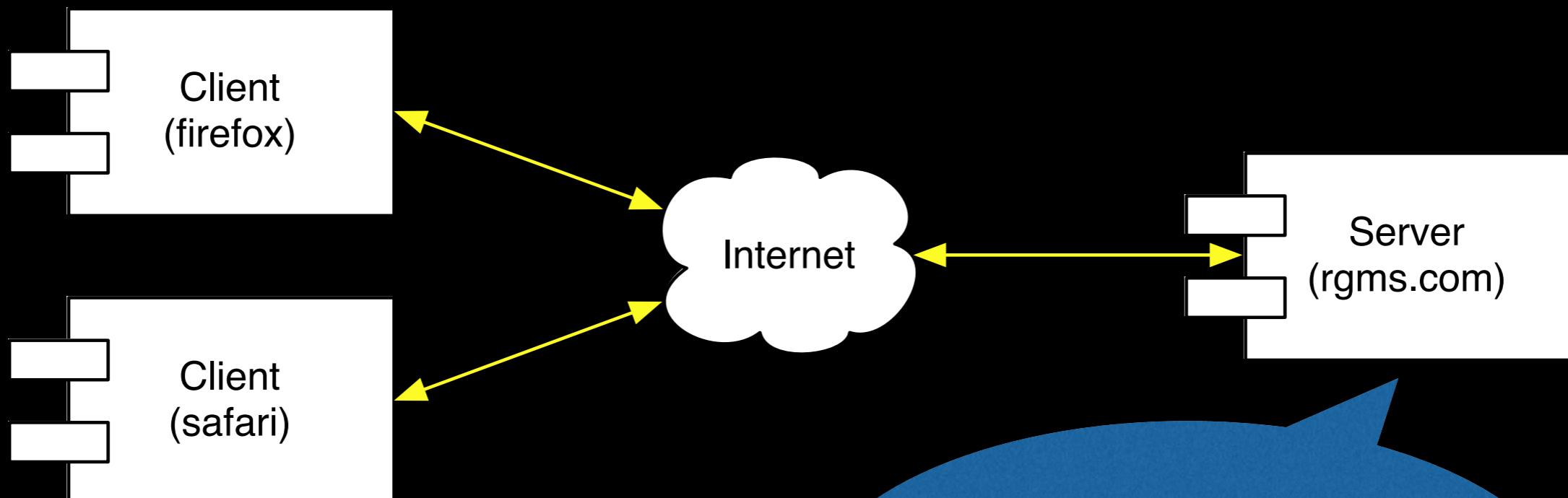
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How to specify service scenarios?

GUI scenarios, and service scenarios



GUI scenarios specify behavior observed by interacting with clients

service scenarios specify behavior observed by interacting with servers

Service scenarios

Scenario: get student average

Given the student "João Vasconcelos" is stored in the system with "MPA, MPA, MPA" for the evaluated learning goals

When I ask the system for "João Vasconcelos" average

Then the system returns "7"

And the student "João Vasconcelos" is stored in the system with "MPA, MPA, MPA" for the evaluated learning goals

Redundancy? Not exactly!

Similar GUI scenario does not constrain service behavior

Scenario: get student average

GUI could hide service error

Given the student "João Vasconcelos" is stored in the system with "MPA, MPA, MPA" for the evaluated learning goals

When I ask the system for "João Vasconcelos" average

Then the system returns "7"

And the student "João Vasconcelos" is stored in the system with "MPA, MPA, MPA" for the evaluated learning goals

average operation could change data; **shouldn't** does not imply **doesn't**

Last step makes sure that the action does not change stored data

Service scenarios

Scenario: new article

Given the system has no article entitled

"A theory of software product line refinement"

When I create the article "A theory of software
product line refinement" with file name "TCS.pdf"

Then the article "A theory of software product line
refinement" is properly stored by the system

Service (or controller) scenarios

- No mention to user interface elements, abstractions, or navigation
- Focus on system services, actions
- Focus on queries and effects to the internal system state, not to the system user interface state
- Often specify implicit requirements, or explicit API-specific scenarios
- Complement user interface scenarios

Take notes,
now!

Hands on
exercises

Requirements 2

Requirements 3, best
practices

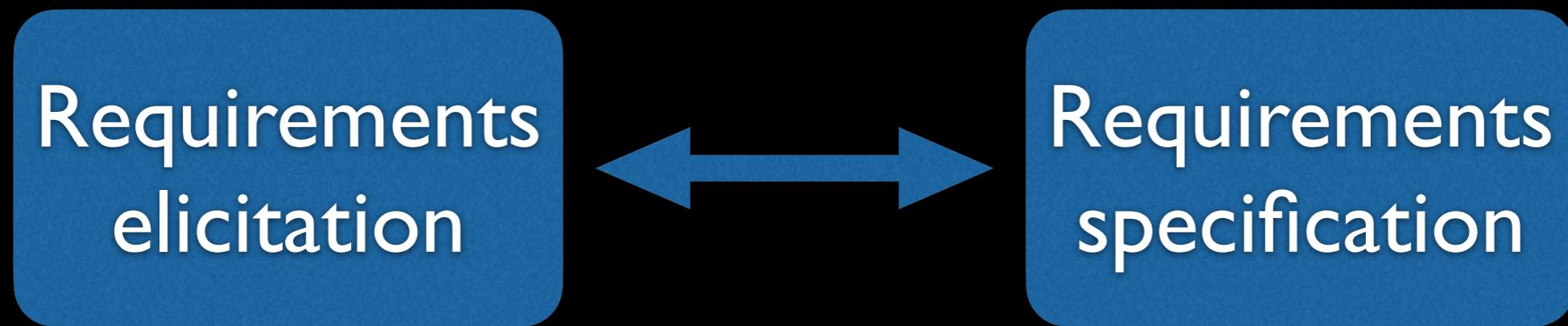
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Which practices help
to direct requirements
specification?

Two main activities



Requirements specification

- Set of features + non-functional requirements
- Each feature has
 - a set of user interface scenarios
 - a set of service scenarios (mainly in case of server API exposure)

Classes feature

Scenario: see average for concepts MPA, MPA, -

Given The student "João Vasconcelos" has achieved "MPA, MPA, -" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "Not available" at row "João Vasconcelos" and column "semester average"

Scenario: see average for concepts MPA, MPA, -

Given The student "João Vasconcelos" has achieved "MPA, MPA, -" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "Not available" at row "João Vasconcelos" and column "semester average"

Grades feature

Scenario: see average for concepts MPA, MPA, -

Given The student "João Vasconcelos" has achieved "MPA, MPA, -" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "Not available" at row "João Vasconcelos" and column "semester average"

Scenario: see average for concepts MPA, MPA, MPA

Given The student "João Vasconcelos" has achieved "MPA, MPA, MPA" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "7" at row "João Vasconcelos" and column "semester average"

Scenario: see average for concepts MPA, MPA, MPA

Given The student "João Vasconcelos" has achieved "MPA, MPA, MPA" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "7" at row "João Vasconcelos" and column "semester average"

Scenario: see average for concepts MPA, MPA, MPA

Given The student "João Vasconcelos" has achieved "MPA, MPA, MPA" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "7" at row "João Vasconcelos" and column "semester average"

NFRs

security: students should not be able to change their grades

privacy: students should not be able to see other students grades

scalability: the system should be able to handle 100 simultaneous professors

modularity: the system should be adaptable to different courses

Students feature

Scenario: see average for concepts MPA, MPA, -

Given The student "João Vasconcelos" has achieved "MPA, MPA, -" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "Not available" at row "João Vasconcelos" and column "semester average"

Scenario: see average for concepts MPA, MPA, MPA

Given The student "João Vasconcelos" has achieved "MPA, MPA, MPA" for the evaluated learning goals
And I'm at the "grades" page
When I ask the system to compute averages
Then I'm at the "grades" page
And I see "7" at row "João Vasconcelos" and column "semester average"

Practices

This typically does not contain enough information for development

Assumes further interaction with stakeholders

Do not focus on trivial usage scenarios

- Focus on more relevant (for both the stakeholders and the project) and complicated
 - requirements, rules,
 - constraints, event sequences,
 - cases, etc.

You won't have time to
specify scenarios covering
all functionality that should
be implemented

So invest your time on
scenarios that are relevant
to test

So how many, and which, scenarios?

- Aim for **coverage** of more **relevant** scenarios
- A few basic scenarios for **smoke tests**
- Aim for **consistency**
- **Completeness** is hard, often impossible

SMART scenarios (and features/user stories)

Specific

Measurable (testable)

Achievable (feasible)

Relevant

Timeboxed (cost/schedule)

Scenarios focus on functional requirements

- Robustness is often hard

When ...

And there is a connection error ...

Then ...

- Performance (with precision) too

When ...

Then ... shows the average "9.3" in less than "1" second

- It's also difficult to capture concurrency situations

When two users try to simultaneously add "John" to the system...

Then ...

- But it is easy to specify either positive or negative constraints

When ...

Then the system should not ...

And the system should ...

no matter if this is in success or failure scenario

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Which kinds of errors
are often found in
scenario specifications?

Examples of common
basic problems with
scenarios

What is wrong here?

Scenario: Adicionar Atleta novo web

Given estou no menu de Atletas

When eu seleciono a opcao "Adicionar"

And eu preencho os dados do atleta

And o atleta nao esta armazenado no sistema

And eu seleciono a opcao "Cadastrar"

Then eu posso ver uma mensagem de confirmacao

OK now!

Scenario: Adicionar Atleta novo web

Given estou no menu "Atletas"

And o atleta de CPF “08976898765” não aparece
na lista de atletas cadastrados

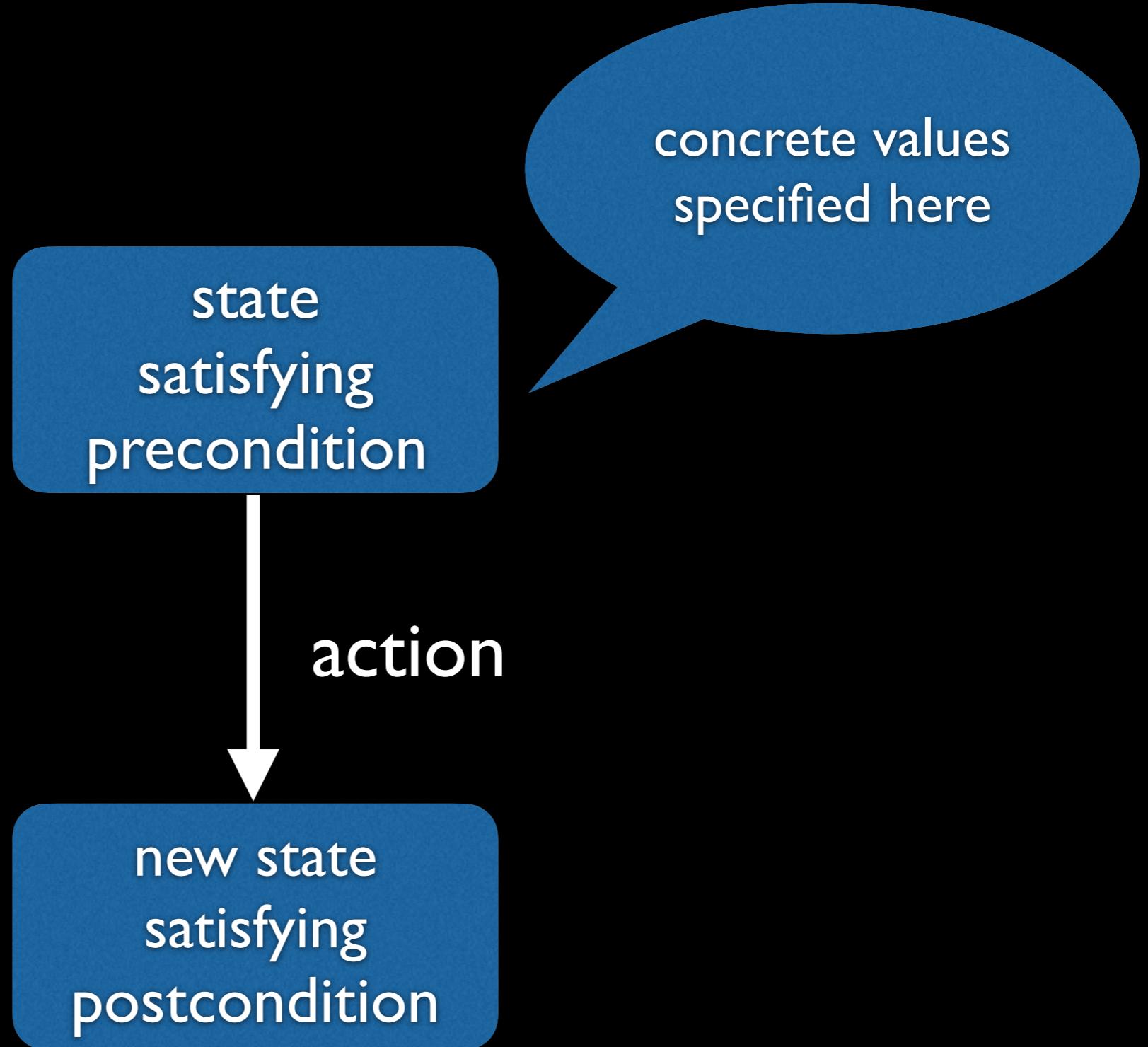
When eu seleciono a opcao "Adicionar"

And eu tento cadastrar o atleta “João”
com CPF “08976898765”

Then eu posso ver uma mensagem de confirmação

And eu vejo o nome “João” e CPF “08976898765” na
lista de atletas do sistema

Linking conditions with concrete values



expected
results expressed in
terms of concrete values
specified before

concrete values
specified here

What is wrong here?

Scenario: cadastrar notas dos alunos web

Given Eu loguei no sistema com um login e uma senha

And Eu estou na página de disciplinas ministradas este semestre

When Eu tico o radio button de nota única

And Eu clico no botão de preencher notas

And Eu vejo o campo para preencher a nota de um aluno

Then A nota digitada é gravada no sistema e o meu login é associado a ela

OK?

Scenario: cadastrar notas dos alunos web

Given Eu estou logado como "Professor" com o login
"pcosv" e a senha "1234"

And Eu estou na página "Disciplinas ministradas este semestre"

When Eu seleciono "nota única"

And eu preencho a nota "9" de "Mariana" em "ESS"

And eu preencho a nota "8" de "Pedro" em "ESS"

Then eu vejo na tela uma mensagem de sucesso no procedimento

And vejo a nota "9" de "Mariana" em "ESS"

And vejo a nota "8" de "Pedro" em "ESS"

OK now!

Scenario: cadastrar notas dos alunos web

Given Eu estou logado como "Professor" com o login
"pcosv" e a senha "1234"

And os alunos "Mariana" e "Pedro" estão matriculados em
"ESS"

And Eu estou na página "Disciplinas ministradas este semestre"
e vejo "ESS"

When Eu seleciono "nota única" para "ESS"

And eu preencho a nota "9" de "Mariana" em "ESS"

And eu preencho a nota "8" de "Pedro" em "ESS"

Then eu vejo na tela uma mensagem de sucesso no
procedimento

And vejo a nota "9" de "Mariana" em "ESS"

And vejo a nota "8" de "Pedro" em "ESS"

What is wrong here?

Scenario: Clonar Metas de outra Turma

Given que o sistema tem a Turma "ESS - 2016.2" com as Metas "Meta1" e "Meta2"

And eu cadastrei a Turma "ESS - 2017.1"

When eu clonar as Metas da Turma "ESS - 2016.2" para a Turma "ESS - 2017.1"

Then a turma "ESS - 2017.1" tem as metas "Meta1" e "Meta2"

OK now!

Scenario: Clonar metas de outra turma

Given que o sistema tem a turma "ESS - 2016.2" com apenas as metas "escrever requisitos" e "escrever testes"

And a turma "ESS - 2017.I" está cadastrada e sem metas

When eu tento clonar as metas da turma "ESS - 2016.2" para a Turma "ESS - 2017.I"

Then a turma "ESS - 2017.I" tem apenas as metas "escrever requisitos" e "escrever testes"

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How to review scenario specifications?

Checklist

Scenarios should be
SMART

Scenarios should reflect the stakeholders needs

Scenario: Generate member details report in XML

Given the system has some member details

When I request to export to XML those details

Then a formatted XML containing the member details in appropriate tags named "c.xml" will be generated and stored in the computer



useless if
stakeholders
need no XML
report!

Scenario description should strictly correspond to scenario semantics

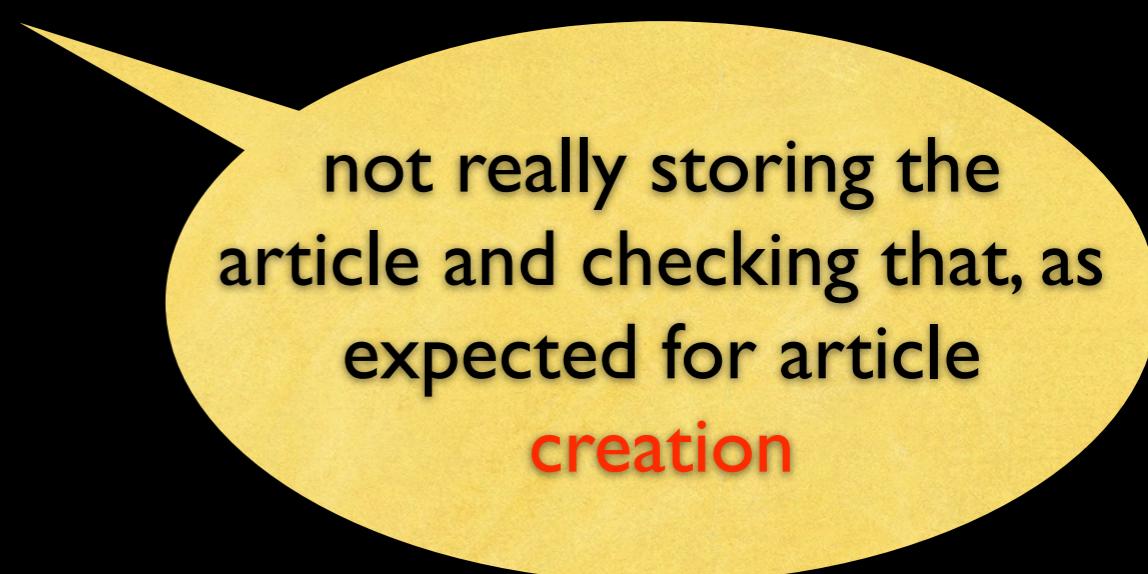
Scenario: **create** new article web

Given I am at the "publications" menu

When I select the "Periodico" option...

And I select the "new article" option ...

Then I can fill the article details



not really storing the article and checking that, as expected for article creation

Look for short scenario steps sentences (use And as needed)

~~Scenario: remove existing article web~~

~~Given I am at the "articles" page **and** the article "..."~~

~~is stored in the system **with** file name "..."~~

~~When I select to view ...~~

~~Then the article ... **and** I can
select the option to remove~~

~~And the message...~~

Gherkin And should be
used to split the Given and
Then steps

Better version, with reusable steps

Scenario: remove existing article web

Given I am at the "articles" page

And the article "..." is stored in the system
with file name "..."

When I select to view ...

Then the article ...

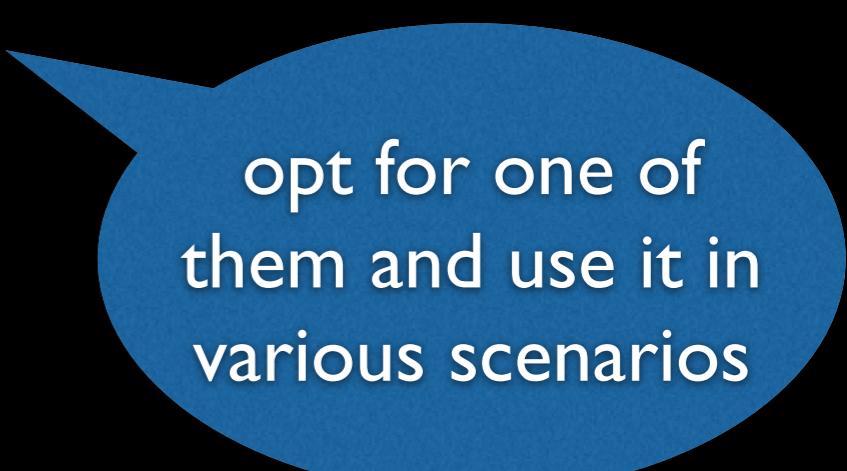
And I can select the option to remove

And the message...

Do not duplicate scenario steps

Given the system has article entitled "A theory of software product line refinement" with file name "TCS-44.pdf"

Given the article "A theory of software product line refinement" is stored in the system with file name "TCS-0.pdf"

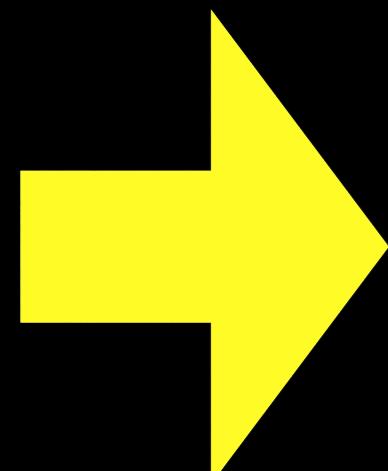


opt for one of them and use it in various scenarios

Do not duplicate scenarios

Scenario: export multiple members to XML link not enabled when there are no member selected

Scenario: export multiple members to PDF link not enabled when there are no member selected



Scenario: export multiple members link not enabled when there are no member selected

Given I am at the "member list" page

And the system has no checked member

Then I cannot select the "XML" export option

And I cannot select the "PDF" export option

Scenario should not be vague or incomplete

~~Scenario: upload publications with a file~~

~~Given the system has some publications stored~~

~~When I upload the publications of "c.xml"~~

~~Then the system has all the publications of
the "c.xml" file~~

Fixing vagueness

Scenario: upload publications with a file

Given the system has publication
"Semistructured merge"...

And the system has publication
"A refinement theory"...

And the file "c.xml" has publication
"Structured merge"...

When I upload the publications of "c.xml"

Then the system has publication
“Structured merge”...

Fixing incompleteness

Scenario: upload publications with a file

Given the system has publication

"Semistructured merge"...

And the system has publication

"A refinement theory"...

And the file "c.xml" has publication

"Structured merge"...

When I upload the publications of "c.xml"

Then the system has publication

"Structured merge"...

And the system has publication

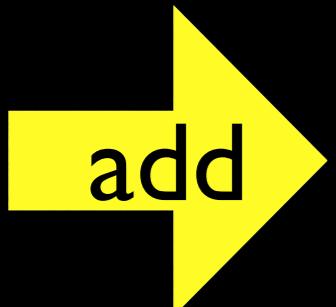
"A refinement theory"...

Scenario should not be vague or incomplete

When I select the "view details" option at the "Member list"

And I select the option "Export to PDF" at the "Member view"

Then I can generate a PDF report about the selected Member details



And View a PDF file with the member personal details, including age "48", ...

Scenarios should parametrize steps

When I select the view details option at the Member list

And I can select the option **Export to PDF** at the Member view

Then I can generate a **PDF** report about the selected Member details

And View a **PDF** file with the member personal details



Specify actions, not non actions or empty actions

When I do not upload any file

Given I am at any page

Then I see student name "X" and a logout link



don't use
unrealistic values for
parameters

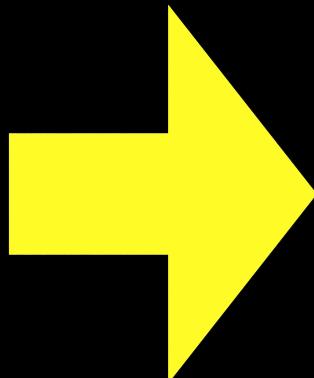
Scenarios should not have language errors

~~And View a PDF file with all memeber's personal
details~~

Use high level actions

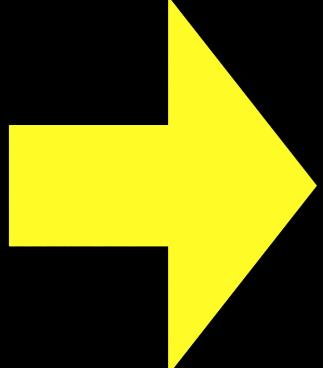
~~When I select the XML file "c.xml" containing a publication entitled "A theory of software product line refinement" through the button "Escolher arquivo"~~

~~And I click the button "Enviar"~~

 When I ask the system to load the XML file "c.xml" containing a publication entitled "A theory of software product line refinement"

Write platform independent scenarios

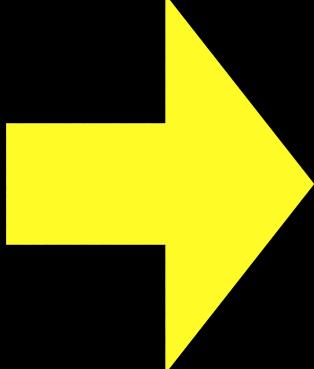
**Then no publications are stored by the system
And the system shows the message
"No valid XML file was uploaded."**

 **Then no publications are stored by the system
And the system shows an error message**

Focus on testing situation, direct to the point

Given I created one article named "A theory of software product line refinement"

And the article "A theory of software product line refinement" is stored with the file name "TCS.pdf"

 **Given** The article "A theory of software product line refinement" is stored with the file name "TCS.pdf"

Focus on testing situation, not general requirement

Given I am at any page

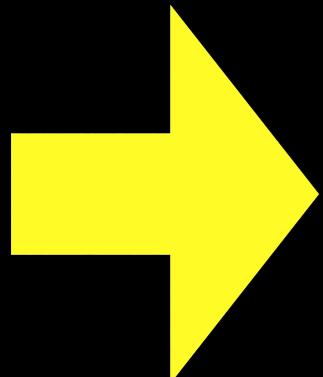
When I double click

Then I can see a help message

Given I am at the "Article" page

When I ask for help

Then I can see a "help" message related to
"article creation"



Take notes,
now!

Hands on
exercises

Requirements 3

Requirements 4

Scenario
writing studio

Service based scenario

Scenario: cadastrar aluno sem email

Given

When eu tento cadastrar o aluno "Paulo"
com CPF "683", mas sem e-mail

Then

Scenario: cadastrar aluno sem email

Given

When eu tento cadastrar o aluno "Paulo"
com CPF "683", mas sem e-mail

Then o servidor retorna uma mensagem
de erro

Scenario: cadastrar aluno sem email

Given eu acesso o sistema como "professor"

When eu tento cadastrar o aluno "Paulo"
com CPF "683", mas sem e-mail

Then o servidor retorna uma mensagem
de erro

Scenario: cadastrar aluno sem email

Given eu acesso o sistema como "professor"

And o sistema não tem um aluno "Paulo"
com CPF "683"

When eu tento cadastrar o aluno "Paulo"
com CPF "683", mas sem e-mail

Then o servidor retorna uma mensagem
de erro sobre ausência de email

Scenario: cadastrar aluno sem email

Given eu acesso o sistema como "professor"

And o sistema não tem um aluno "Paulo"
com CPF "683"

When eu tento cadastrar o aluno "Paulo"
com CPF "683", mas sem e-mail

Then o servidor retorna uma mensagem
de erro sobre ausência de email

And o sistema não tem um aluno "Paulo"
com CPF "683"

Scenario: cadastrar aluno sem email

Given eu acesso o sistema como "professor"

And o sistema não tem um aluno "Paulo"
com CPF "683"

And o sistema tem uma aluna "Mariana"
com CPF "965"

When eu tento cadastrar o aluno "Paulo"
com CPF "683", mas sem e-mail

Then o servidor retorna uma mensagem
de erro sobre ausência de email

And o sistema não tem um aluno "Paulo"
com CPF "683"

And o sistema tem uma aluna "Mariana"
com CPF "965"

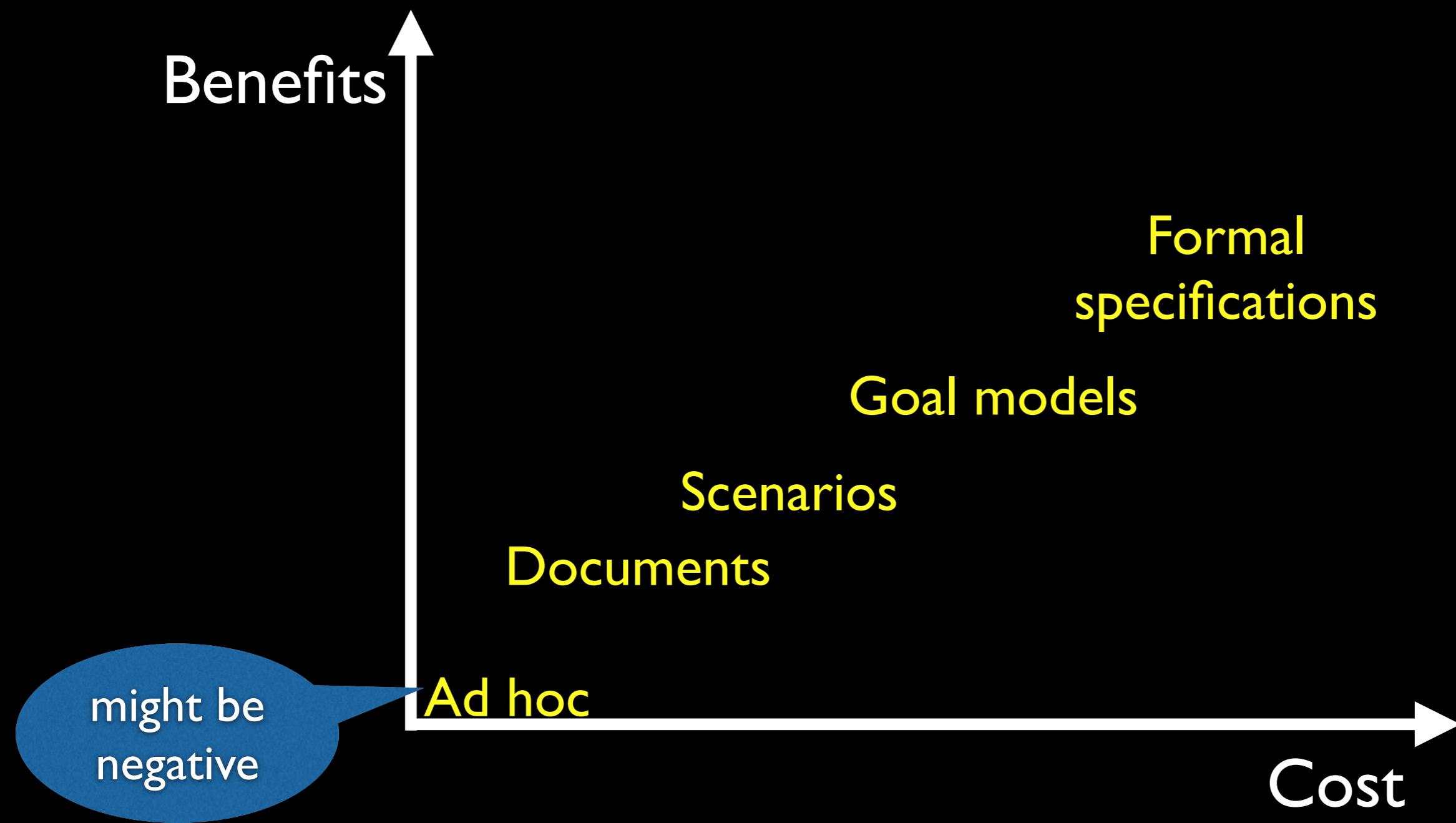
Requirements, going beyond

- Functional versus non-functional
- Elicitation versus specification
- Specification approaches
 - goal model
 - feature model
 - requirement list
 - use case model
 - formal methods
 - scenarios

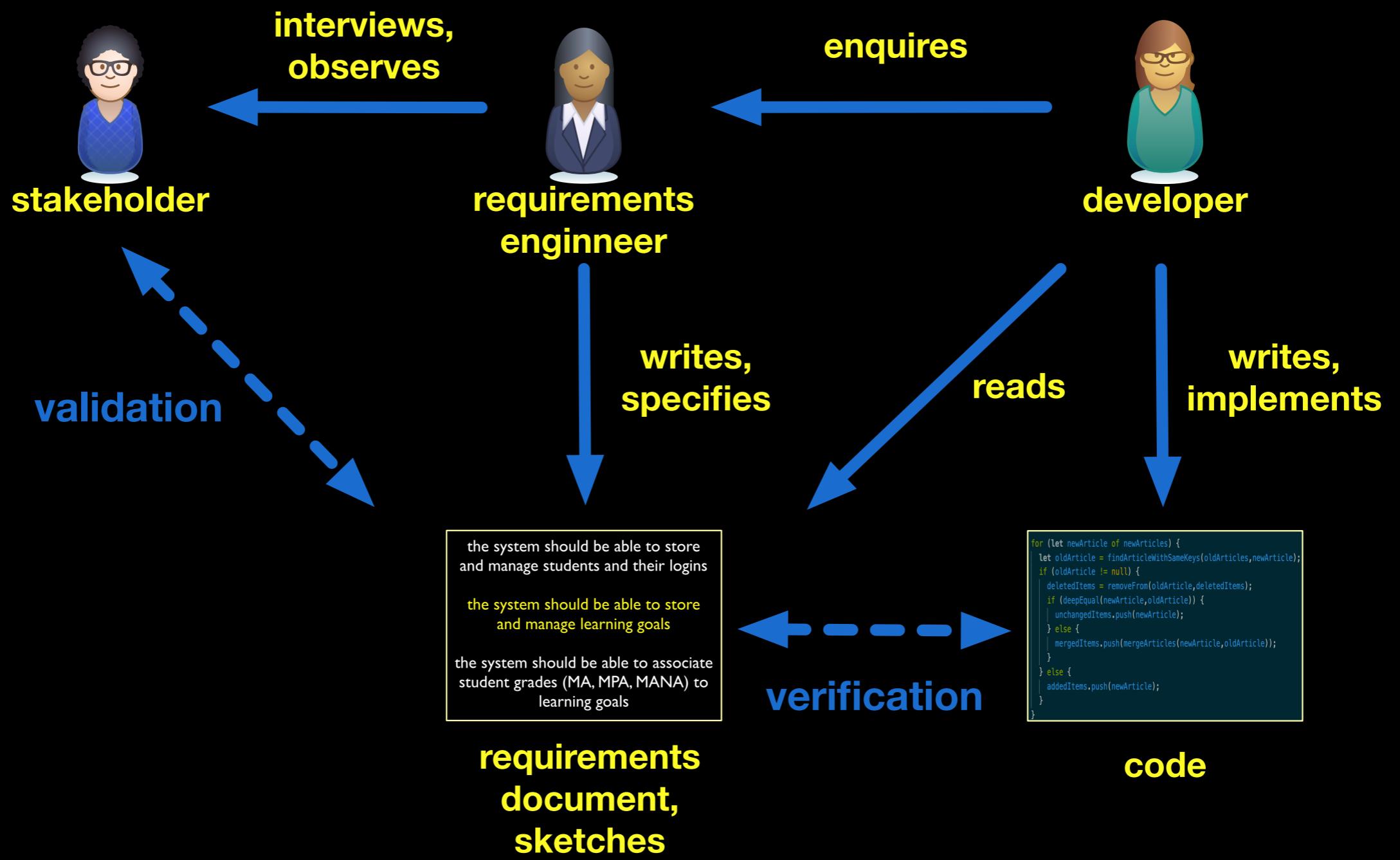
Expertise Levels

- Basic interviewing skills and requirements documents
- Scenarios and features
- NFR and more advanced interviewing and ethnomethodological skills
- Goal models

Comparing techniques?



Requirements conceptual model



Requirements research at CIn

- Goal models: Jaelson, Carla
- Software product lines and ecosystems:
Jaelson, Carla, Carina
- Business process modelling: Carina

Hands on
project

Requirements 4

Requirements 5

Hands on
project

Requirements 5

To do after class

- Answer questionnaire (check classroom assignment), **study correct answers**
- Finish exercise (check classroom assignment), **study correct answers**
- Read, again, chapter 7 in the textbook
- Evaluate classes
- Study questions from previous exams

Questions from previous exams

- Explique brevemente qual o principal problema com o cenário a seguir, e mostre como resolver esse problema em linhas gerais (não precisa reescrever todo o cenário, só uma parte dele).

Scenario: cadastrar notas dos alunos web

Given Eu loguei no sistema com um login e uma senha

And Eu estou na página de disciplinas ministradas este semestre

When Eu tico o radio button de nota única

And Eu clico no botão de preencher notas

And Eu vejo o campo para preencher a nota de um aluno

Then A nota digitada é gravada no sistema e o meu login é associada a ela

Questions from previous exams

- Escreva, no formato visto no curso, um cenário de GUI do SIGA para matrícula em uma disciplina da UFPE. Siga as recomendações para escrita de cenários com qualidade.
- Explique brevemente (a) a diferença entre requisitos funcionais e não funcionais, (b) dê um exemplo de cada um desses dois tipos de requisitos no contexto do seu projeto, e (c) discuta a aplicabilidade de cenários como os vistos no curso para especificar os dois tipos de requisitos.

Questions from previous exams

- Explique brevemente qual o principal problema com o cenário a seguir (tirado do livro texto), e mostre como resolver esse problema em linhas gerais (não precisa reescrever todo o cenário, só uma parte dele).

```
1 Feature: movies should appear in alphabetical order, not added order
2
3 Scenario: view movie list after adding 2 movies (imperative and non-DRY)
4
5 Given I am on the RottenPotatoes home page
6 When I follow "Add new movie"
7 Then I should be on the Create New Movie page
8 When I fill in "Title" with "Zorro"
9 And I select "PG" from "Rating"
10 And I press "Save Changes"
11 Then I should be on the RottenPotatoes home page
12 When I follow "Add new movie"
13 Then I should be on the Create New Movie page
14 When I fill in "Title" with "Apocalypse Now"
15 And I select "R" from "Rating"
16 And I press "Save Changes"
17 Then I should be on the RottenPotatoes home page
18 Then I should see "Apocalypse Now" before "Zorro" on the RottenPotatoes h
ome page sorted by title
```

Software and systems engineering

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