

# Software Engineering and Architecture

## Lecture 4: Continuous Delivery (2)

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MASTER OF SCIENCE  
IN ENGINEERING

# Today.

**Agile testing**

15h - 16h

**OO Reengineering Patterns (3 x 10')**

16h - 16h30

**Open Affect, API specification and validation**

16h30 - 17h20

Week	Theory	OO Reengineering	Practice
#1	Agile, Scrum		Intro to Docker
#2	Software evolution	Introduction	Specify and implement a micro-service
#3	Continuous delivery (1)	<i>Setting Directions</i>	Intro to Jenkins & Travis
#4	Continuous delivery (2)	<i>First Contact</i>	Our first build pipeline
<b>#5</b>	<b>Agile testing (1)</b>	<b><i>Initial Understanding</i></b>	<b>Intro to Cucumber</b>
#6	Agile testing (2)	<i>Detailed Model Capture</i>	Add tests to pipeline
#7	Agile metrics	<i>Tests: Your Life Insurance!</i>	Add Sonar to pipeline
#8	Continuous improvement	<i>Migration Strategies I</i>	Add non-functional tests
#9	Wrap-up	<i>Migration Strategies II</i>	

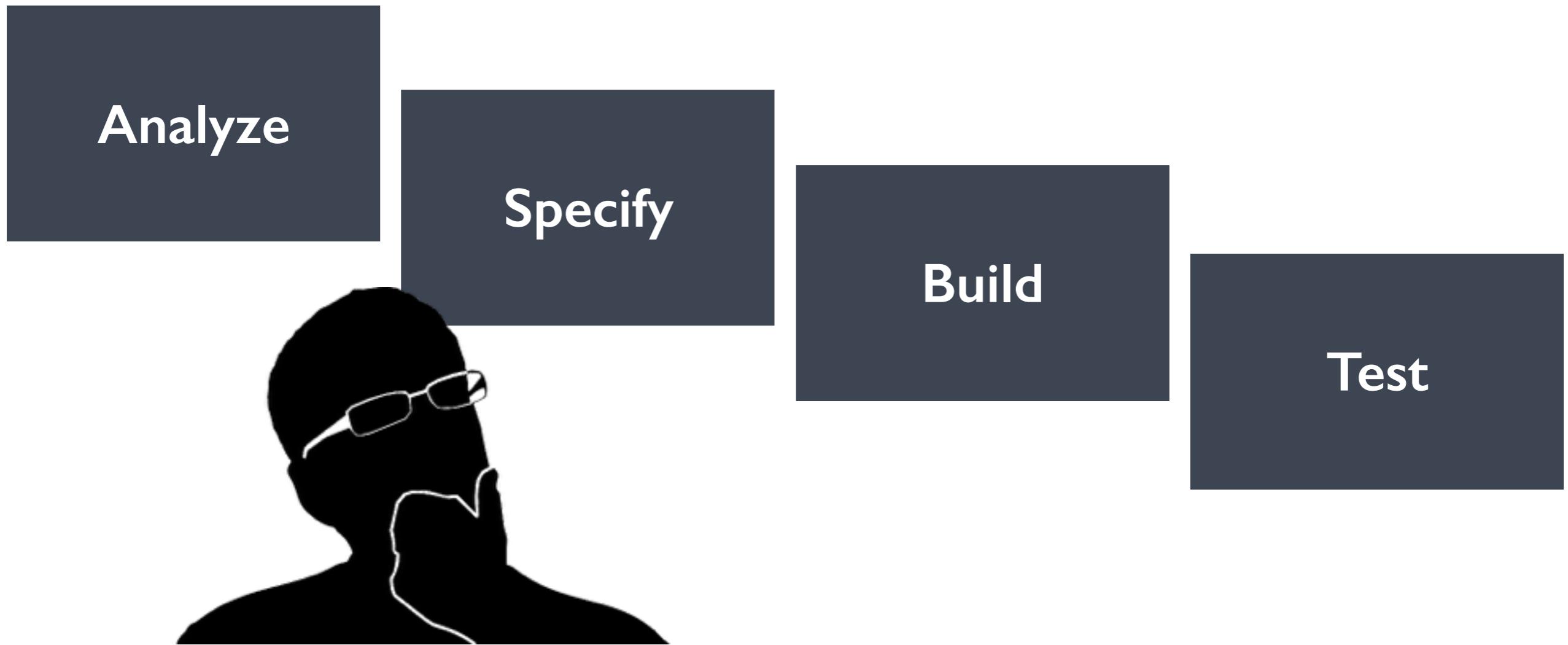
# Agenda

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- **Testing in software development process**
  - Is it done as the **last phase** of the development cycle?
  - Is it done by an **independent organization**, which enforces quality levels?
- **Agile testing & quality**
  - How do testing activities fit in agile development methods?
  - What is the role of test engineers in agile organizations? Where do they fit?
  - How can we get apprehend the vast topic of “testing” and “validation”?
- **Agile testing quadrants**
  - Selected topics: unit tests, integration tests, automated acceptance tests, systemic tests

# Product development cycle (waterfall?)

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So... anything wrong with that?

# Product development cycle

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- How much **time** do we need to go through all the phases?
- How often do we go through these phases (is it a **cycle**)?
- How much “**functionality**” is moving through these phases?
- **Who** is working in each phase?
- How do people **collaborate**?



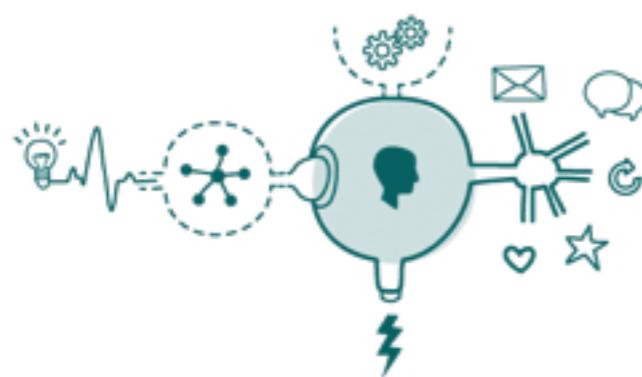
# Product development cycle

Analyze

Specify

Build

Test

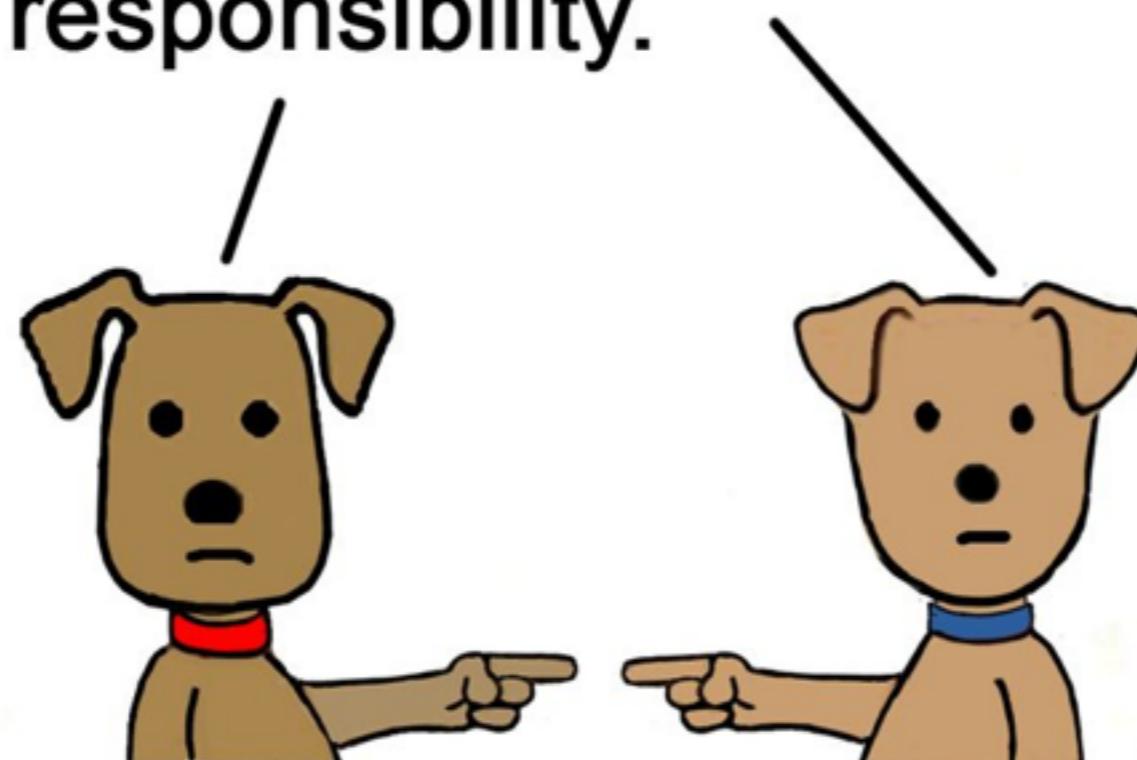








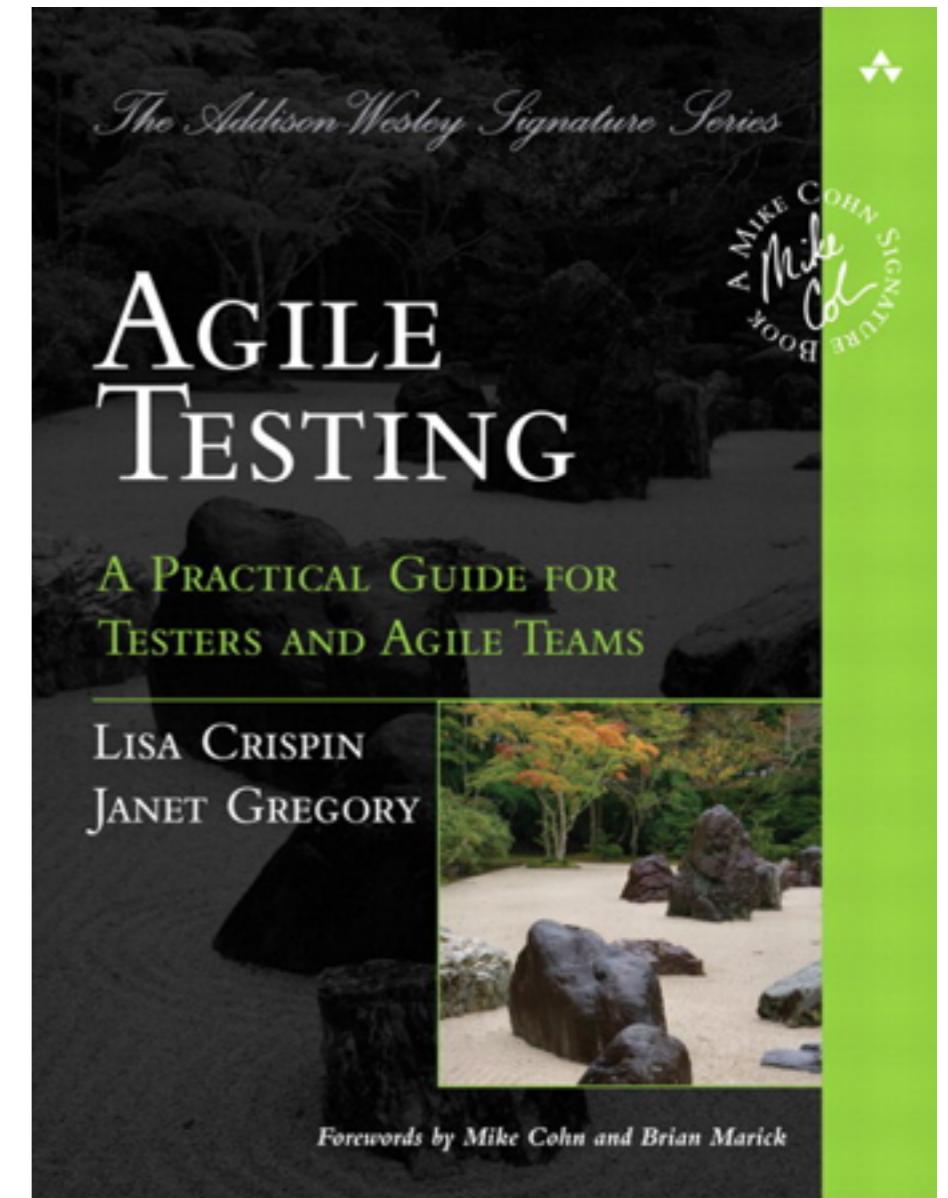
**Don't look at me, it's his  
responsibility.**



# Agile Testing

“One of the biggest differences in agile development versus traditional development is the “**whole team**” **approach**.

With agile, it’s not only the testers or a quality assurance team who feel responsible for quality. [...]. **Everyone on an agile team gets “test-infected”.** Tests, from the unit level on up, drive the coding, help the team learn how the application should work, and let us know when we’re “done” with a task or story.”



Janet Gregory and Lisa Crispin

<http://www.informit.com/articles/article.aspx?p=1316250&seqNum=5>



**Small autonomous teams**, which are given the responsibility of a complete “product” are very effective.

Communication, collaboration and coordination are much easier than across **organizational silos**.

People are much more likely to feel **empowered** and **accountable**.

If you can't feed a team with two pizzas, it's too large.

Startup Quote!



JEFF BEZOS  
FOUNDER, AMAZON

## Elisabeth Hendrickson, Google Tech Talks



<https://www.youtube.com/watch?v=bqrOnIECCSg>

# Agile Testing Quadrants

“**Software quality**” is a **broad concept** and has many aspects (reliability, efficiency, usability, maintainability, etc.).

“**Software testing**” refers to methods and techniques for **assessing** certain aspects of the quality of a software system. **There are many, many of them.**

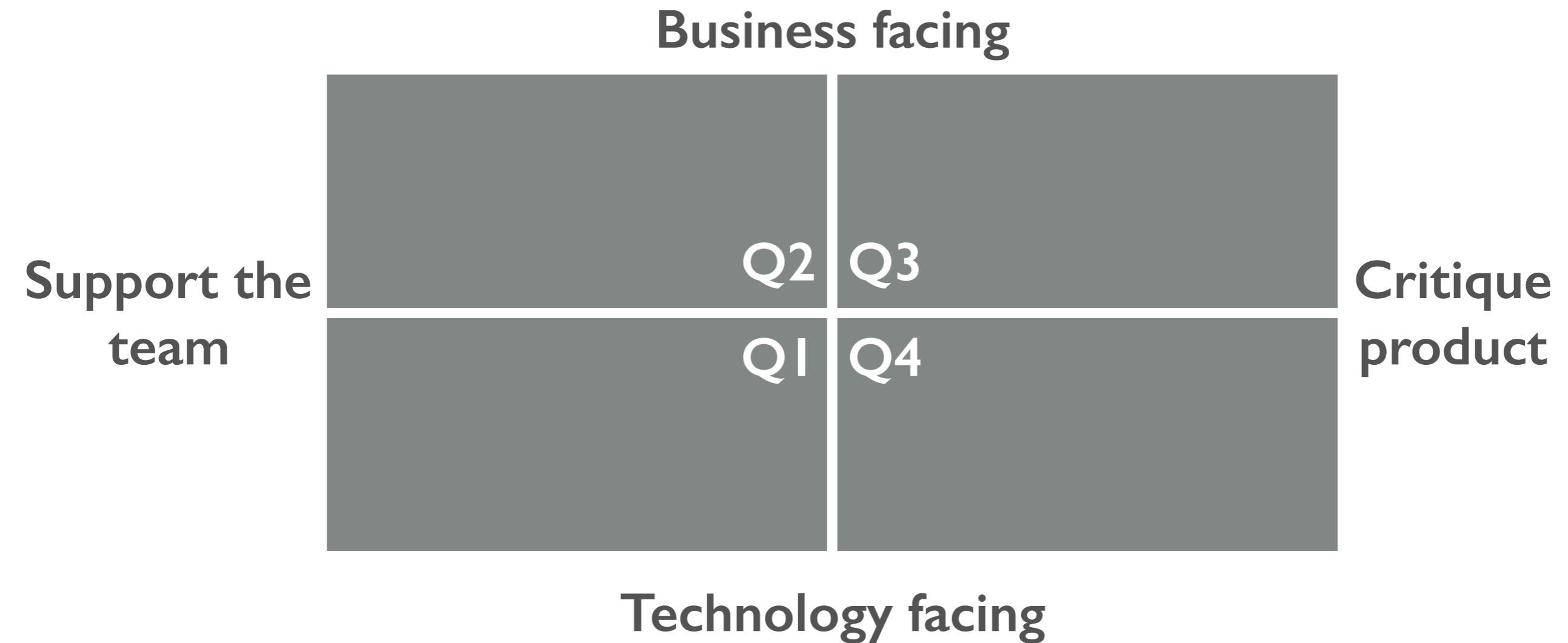
Some “**software testing**” techniques do not only measure quality after the fact, but **help the team to proactively** maintain the quality of the software to an appropriate level.

Is there a way to **classify** all these methods, so that we can see how they relate to each other?

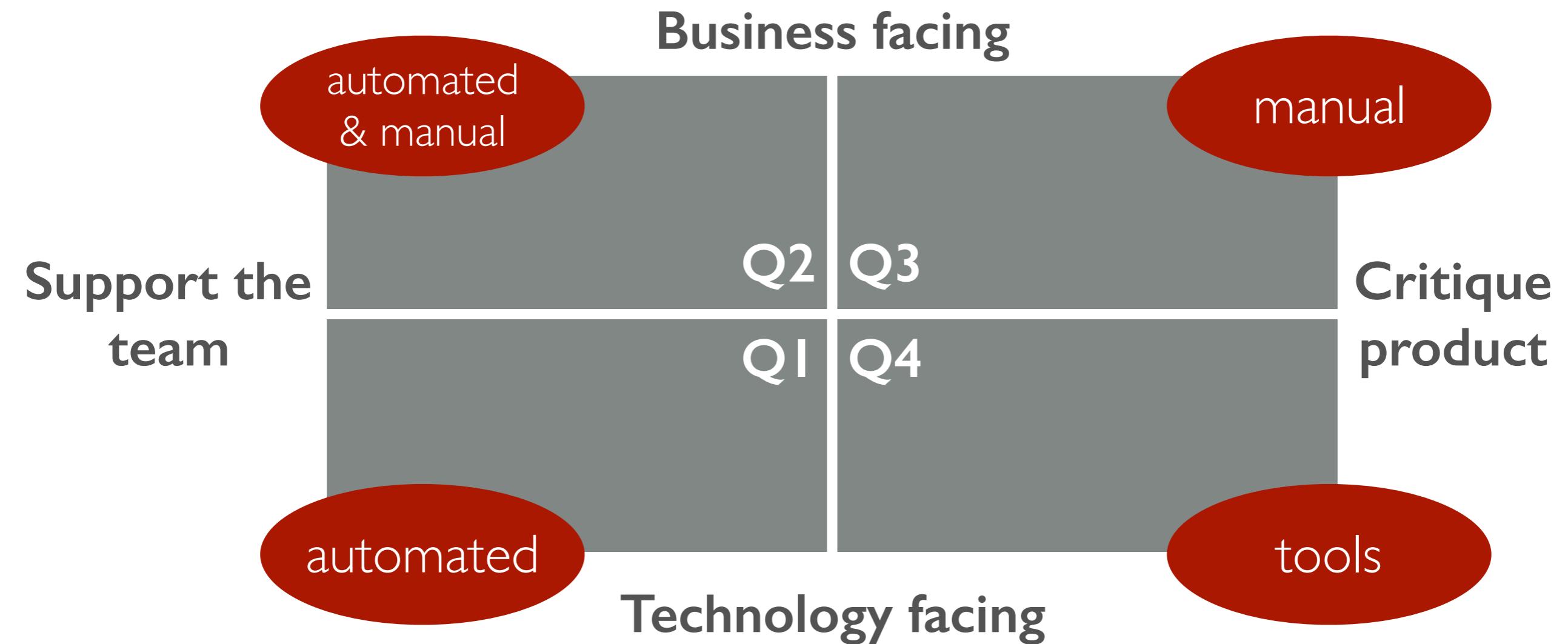
These techniques are aligned with the principles of **agile** software development.

# Agile testing quadrants

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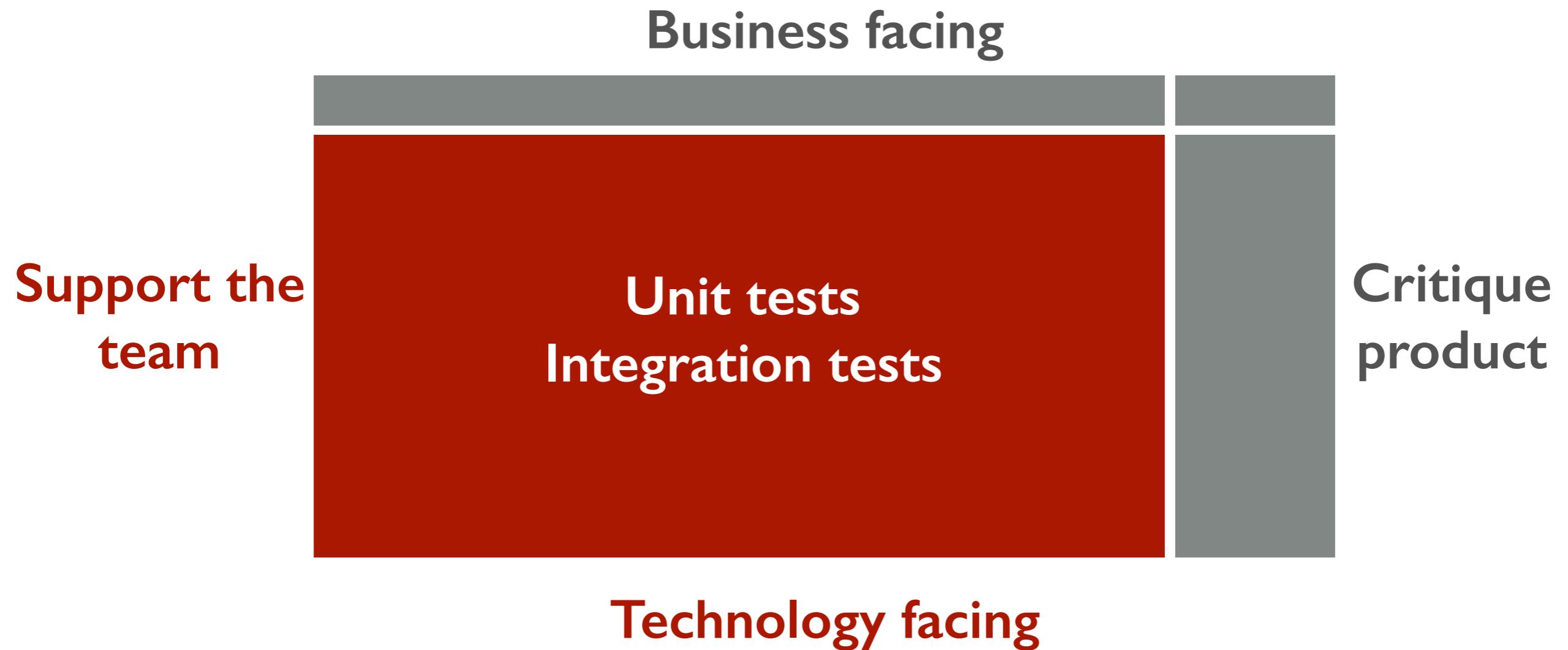


Support the team	Some of these tests <b>help individual team members</b> while they do their job. Sometimes, creating a “test” helps me <b>specify and/or design</b> the product. Other tests <b>facilitate team collaboration</b> , especially between “business” and “technical” people (shared language).
Critique product	Some of these tests allow humans to evaluate the quality of a software from the <b>users point of view</b> (is it easy to use? is it easy to learn? does it solve the user’s problem?). Other tests aim to detect issues with <b>non-functional (systemic) qualities</b> .
Technology facing	Some tests are created and executed by <b>technical team members</b> . They are highly automated. They relate to the “Are we building the product right?” question.
Business facing	Some tests are created by (or at least with) <b>business-oriented team members</b> . They also relate to the “Are we building the right product?” question.



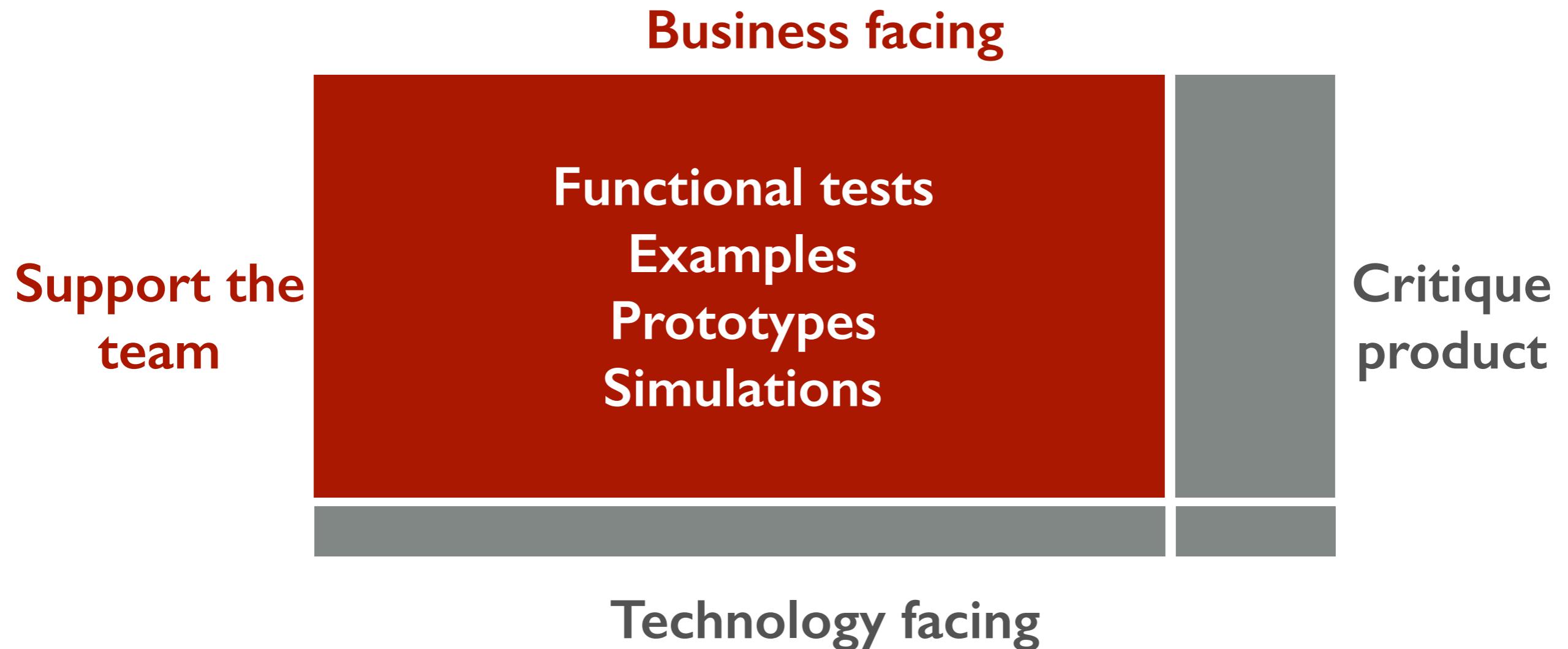
# Agile testing quadrants: Q1

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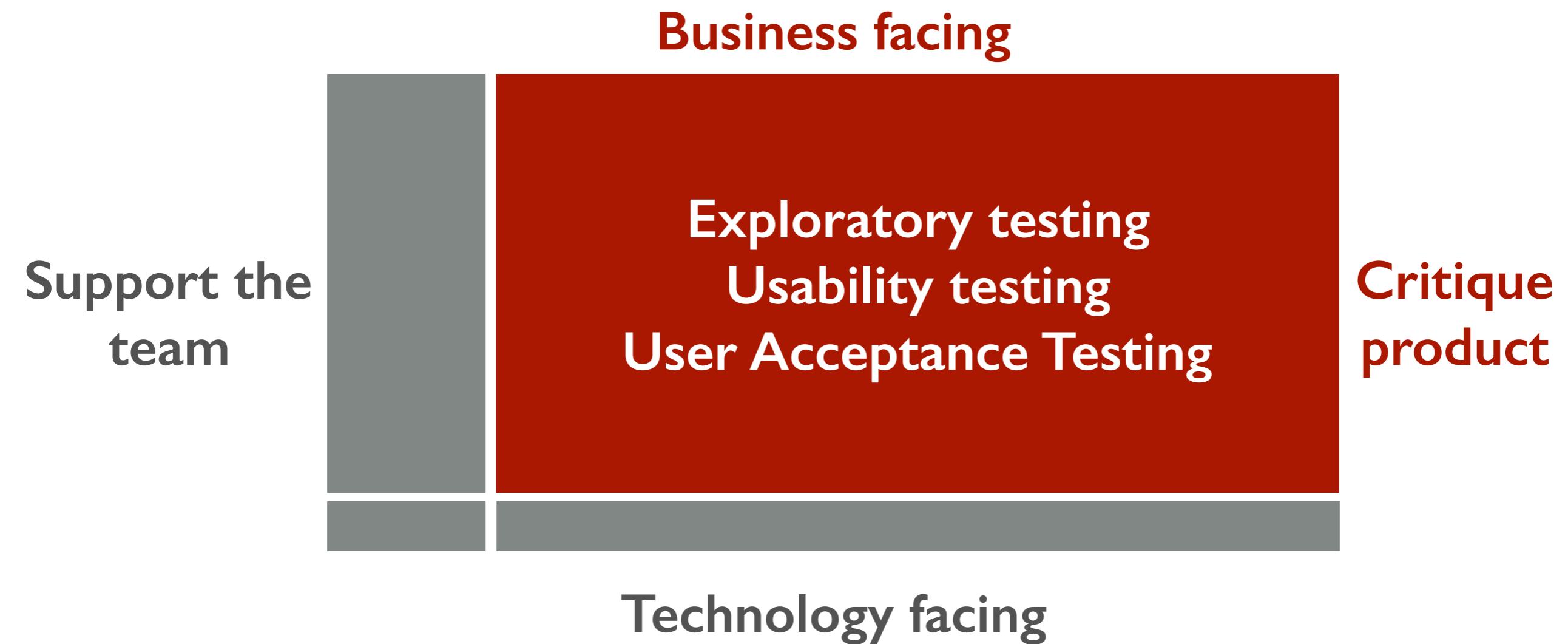


# Agile testing quadrants: Q2

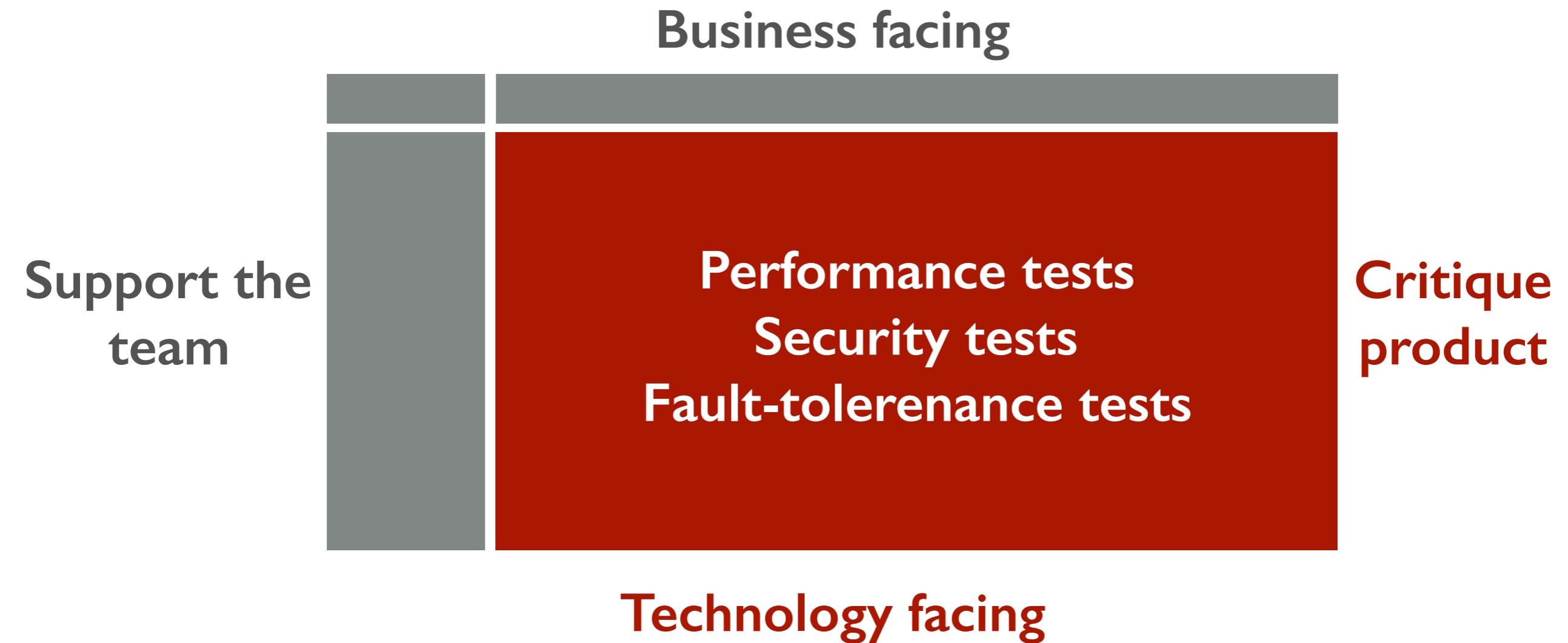
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# Agile testing quadrants: Q3

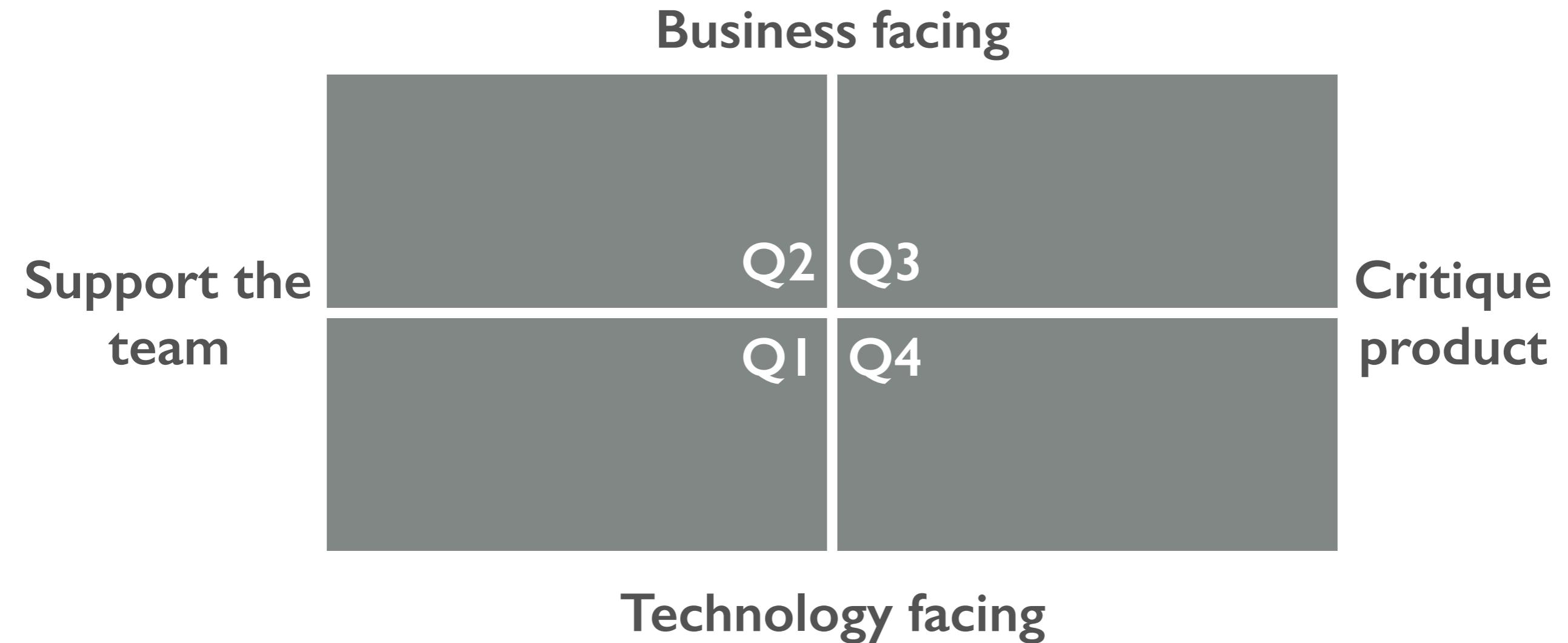


# Agile testing quadrants: Q4



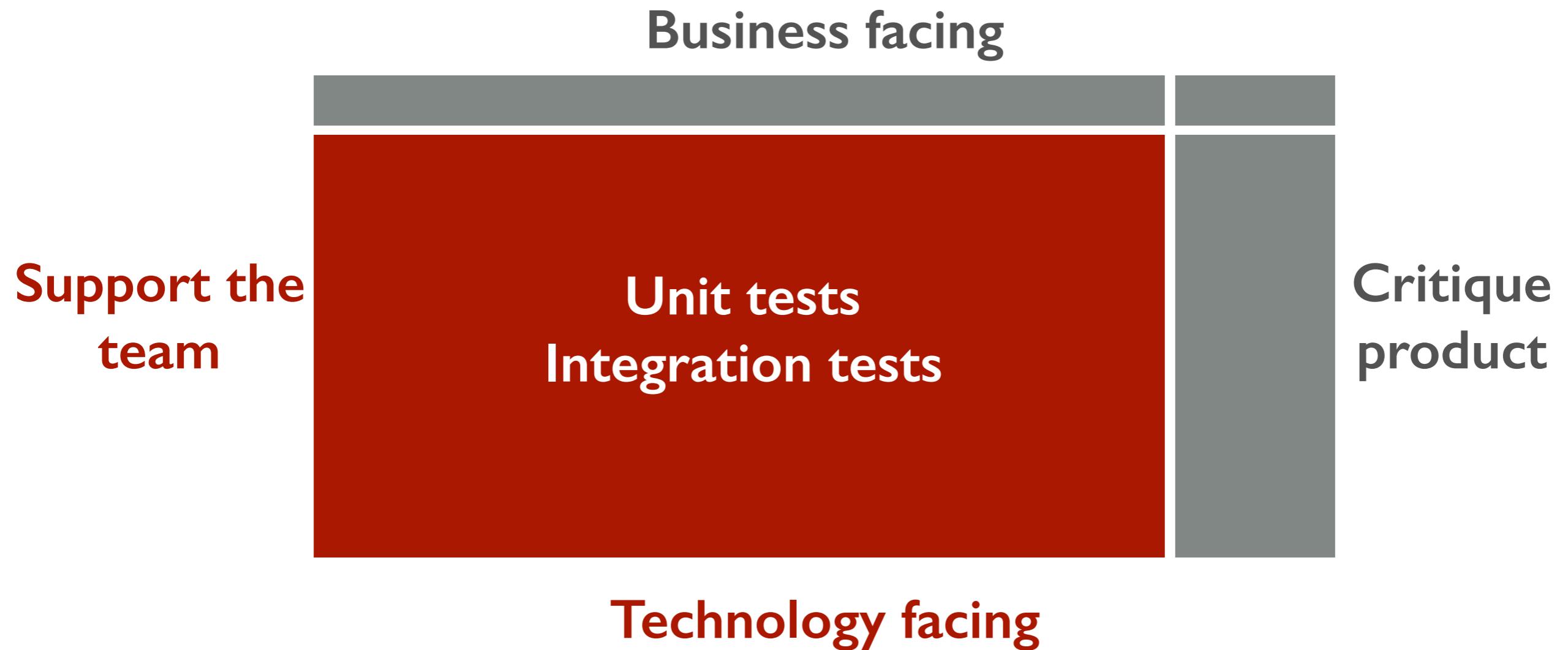
# Agile testing quadrants

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# Agile testing quadrants: Q1

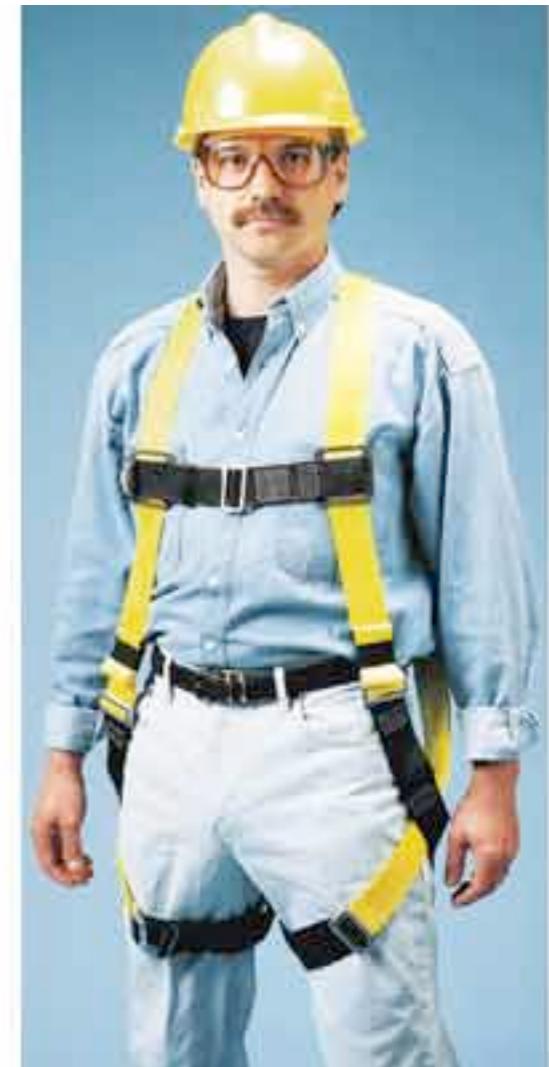
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# Unit tests: testing is not an after-the-fact activity

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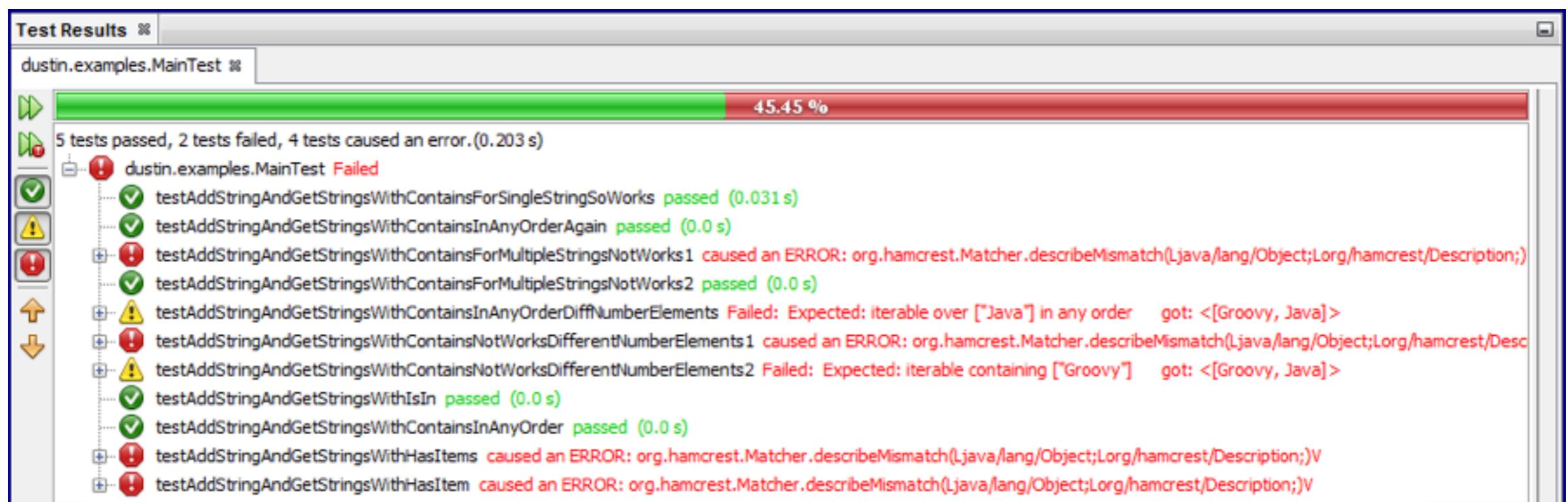
- **Writing tests** is not only about checking that a piece of code is doing what it is supposed to do.
- **Writing unit tests** helps us **design** better software (more modular, easier to maintain, easier to evolve). This is the core idea of Test-Driven Development (TDD).
- Writing unit tests, i.e. building a **test harness**, allows us to **refactor** our code with confidence.
- **If unit tests help us design, could other tests help us specify the... behaviour of our system? Could they also give us confidence that we don't impact end-users with our changes?**



*A harness can be useful and cool.*

Whenever they modify their code, developers can re-run the tests and get a “**green light / red light**” status in **milliseconds or seconds**. Even if there are thousands of unit tests.

A unit test **MUST BE extremely fast**. For this reason, a unit test **MUST NOT** do slow IO operations (no network calls, very few file operations).



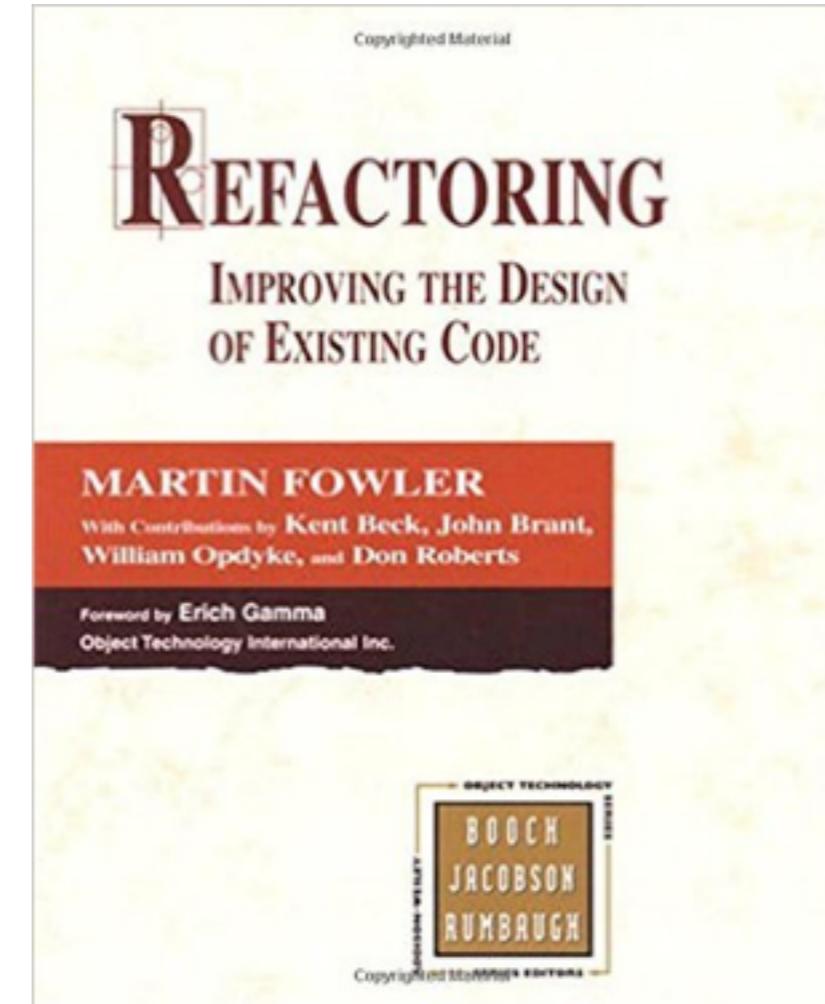


# Unit tests enable refactoring

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*“Refactoring is a disciplined technique for **restructuring an existing body of code**, altering its internal structure **without changing its external behavior.**”*

<http://www.refactoring.com/>



The **code works** (all tests are green) **but is a mess**. It is difficult to maintain and makes the development of new feature slow.



The code is now **nicely structured**. It is meant to do the same thing as before (no behavior change). Because all my unit tests are still green, I have some confidence that this is true.



```
✓ testArguments passed (3.592 s)
✓ testInputOutput passed (0.924 s)
✓ testWelcome passed (2.208 s)
✓ testQuote passed (8.346 s)
✓ testSubProjects passed (3.608 s)
✓ testPi passed (0.598 s)
✓ testFreeway passed (0.012 s)
✓ testFractal passed (15.9 s)
✓ testLexYacc passed (1.363 s)
✓ testMP passed (4.338 s)
✓ testHello passed (0.012 s)
✓ testHelloQtWorld passed (0.009 s)
✓ testProfilingDemo passed (0.025 s)
```

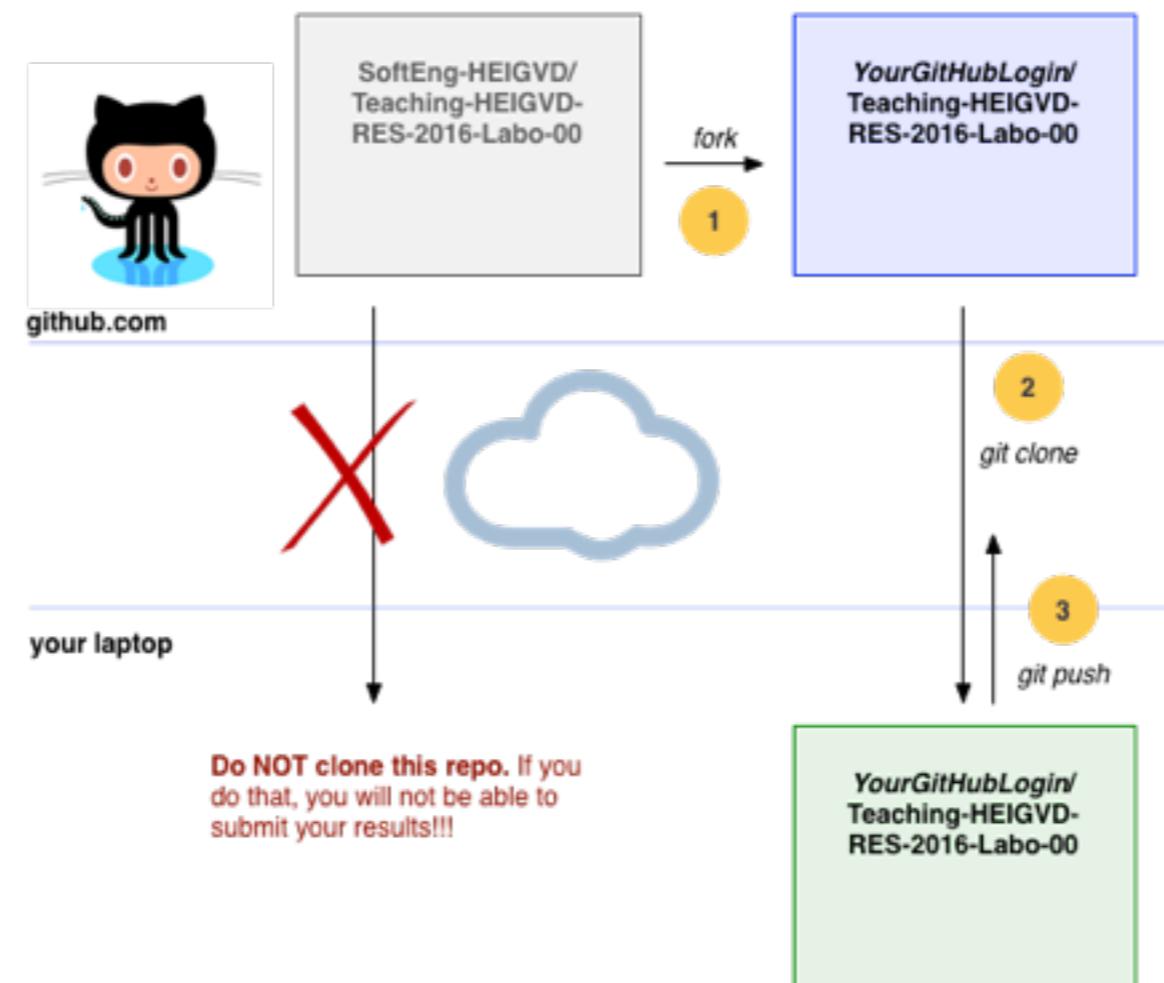
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✓ testHelloQtWorld passed (0.009 s)
✓ testProfilingDemo passed (0.025 s)
```

# Integration tests

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- Integration Tests are another type of **automated tests**.
- They validate the **interactions between several units**.
  - Does my “prediction algorithm” work with my “database service”?
  - Does my “web front-end” work with my “REST API”?
- Integration tests are **slower than unit tests**. We do not run them as often as unit tests (not to slow developers down), but we run them very often (at least before sharing one’s code with the team).

# Do you want to see/try it in practice?



<https://github.com/SoftEng-HEIGVD/Teaching-MSE-SEA-2017-Instruments>

# Description of the lab - first round

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- Students have to **fork**, then **clone** a **GitHub** repository.
- The repository contains very little code (interfaces and some classes with partial implementations).
- The repository contains an **executable specification**: a list of **unit tests** that describe the behaviour that the application should have at the end of the implementation.
- Students implement the required classes.
- They use **apache maven** and **JUnit** to build the code and run the tests. You can think of that as a “mini continuous integration pipeline” (it is actually the “commit” phase of a full pipeline).
- In the end, they have a list of green unit tests.

```
@Test
public void thereShouldBeAnIInstrumentInterfaceAndATrumpetClass() {
    IInstrument trumpet = new Trumpet();
    assertNotNull(trumpet);
}

@Test
public void itShouldBePossibleToPlayAnInstrument() {
    IInstrument trumpet = new Trumpet();
    String sound = trumpet.play();
    assertNotNull(sound);
}

@Test
public void aTrumpetShouldMakePouet() {
    IInstrument trumpet = new Trumpet();
    String sound = trumpet.play();
    Assert.assertEquals("pouet", sound);
}

@Test
public void aTrumpetShouldBeLouderThanAFlute() {
    IInstrument trumpet = new Trumpet();
    IInstrument flute = new Flute();
    int trumpetVolume = trumpet.getSoundVolume();
    int fluteVolume = flute.getSoundVolume();
    Assert.assertTrue(trumpetVolume > fluteVolume);
}
```

```
@Test
public void thereShouldBeAMethodToAddIntegers() {
    Application application = new Application();
    int sum = application.add(40, 2);
    assertEquals(42, sum);
}
```

Tests passed: 80.00 %

4 tests passed, 1 test failed.(0.016 s)

- ▼ ! ch.heigvd.res.lab00.ApplicationTest Failed
  - ✓ thereShouldBeAClassNamedApplication passed (0.012 s)
  - ✓ thereShouldBeAGetterForMessage passed (0.0 s)
  - ✓ theDefaultValueForMessageShouldBeDefined passed (0.0 s)
  - ✓ theGetterForMessageShouldReturnTheCorrectValue passed (0.0 s)
- ▼ ! thereShouldBeAMethodToAddIntegers Failed: expected:<42> but was:<80>  
expected:<42> but was:<80>  
java.lang.AssertionError  
at org.junit.Assert.fail(Assert.java:88)  
at org.junit.Assert.failNotEquals(Assert.java:834)  
at org.junit.Assert.assertEquals(Assert.java:645)  
at org.junit.Assert.assertEquals(Assert.java:631)  
at ch.heigvd.res.lab00.ApplicationTest.thereShouldBeAMethodToAddIntegers(ApplicationTest.java:53)

```
public int add(int a, int b) {  
    return a * b;  
}
```

Tests passed: 80.00 %

4 tests passed, 1 test failed.(0.016 s)

- ▼ ! ch.heigvd.res.lab00.ApplicationTest Failed
  - ✓ thereShouldBeAClassNamedApplication passed (0.012 s)
  - ✓ thereShouldBeAGetterForMessage passed (0.0 s)
  - ✓ theDefaultValueForMessageShouldBeDefined passed (0.0 s)
  - ✓ theGetterForMessageShouldReturnTheCorrectValue passed (0.0 s)
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at org.junit.Assert.assertEquals(Assert.java:631)  
at ch.heigvd.res.lab00.ApplicationTest.thereShouldBeAMethodToAddIntegers(ApplicationTest.java:53)

# Next week

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**Support the  
team**

**Business facing**

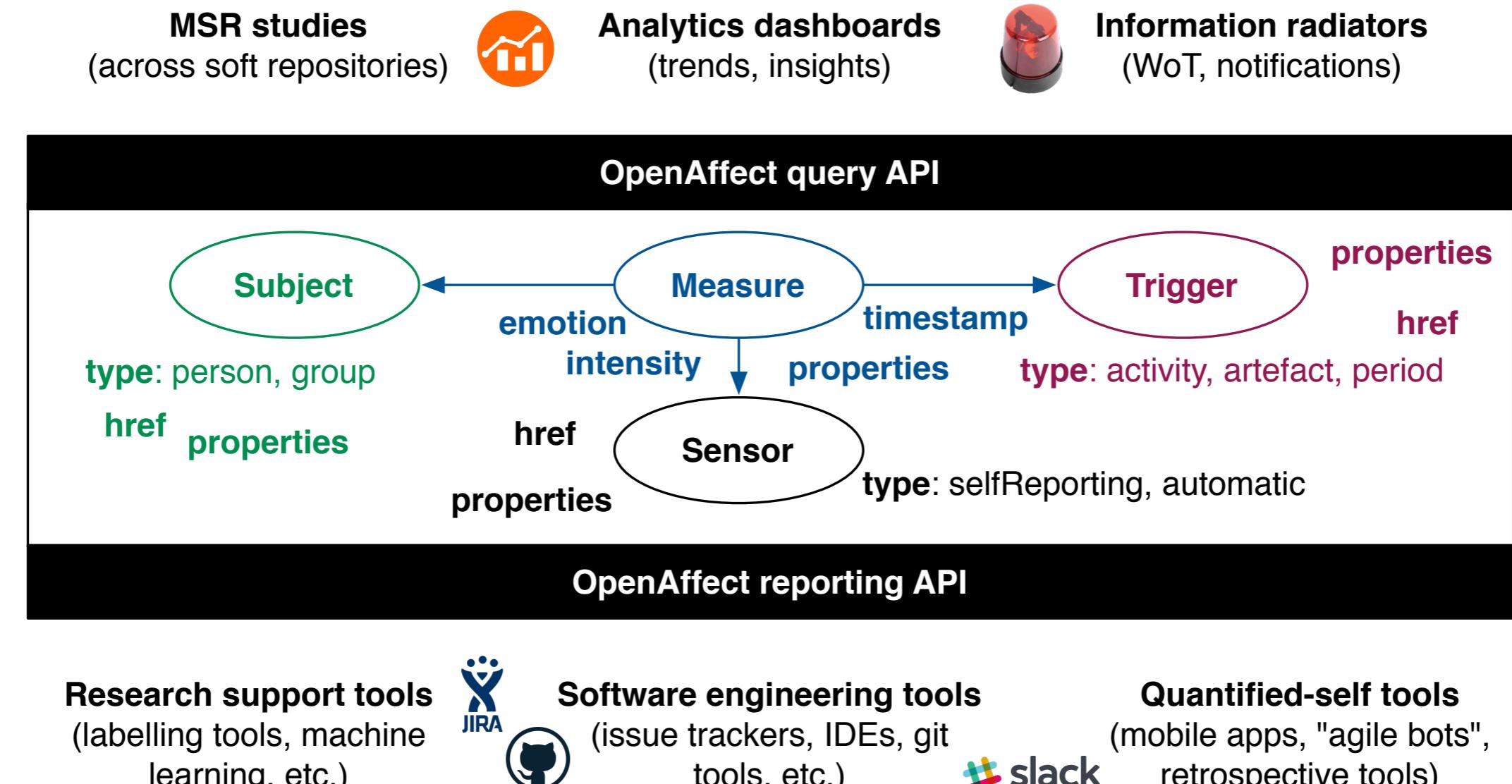
Functional tests  
Examples  
Prototypes  
Simulations

**Critique  
product**

**Technology facing**

# Open Affect





- **Sensors** report **measures** indicating that **subjects** have felt **emotions** about **triggers**.
- A **git plugin** reports a **measure** indicating that **Bob** has felt **pride** about **commit e77f23**.
- A **mobile app** reports a **measure** indicating that **Alice** has felt **joy** about the **sprint 32**.
- A **Jira plugin** reports a **measure** indicating that the **John** has felt **anger** about **bug OA-283**.

```
{  
    "timestamp": now,  
    "emotion": {  
        "category": "joy",  
        "intensity": 1.0,  
        "properties": {}  
    },  
    "subject": {  
        "href": "http://people",  
        "type": "",  
        "properties": {}  
    },  
    "trigger": {  
        "href": "https://avalia.atlassian.net/rest/api/latest/issue/AVA-2",  
        "type": "story",  
        "properties": {}  
    },  
    "sensor": {  
        "href": "http://emotion4jira.io/plugins/jira",  
        "type": "selfReporting",  
        "properties": {}  
    },  
    "properties": {}  
}
```

- **Sensors, subjects** and **triggers** are “**resources**”, identified by a URL.
- They are typically **managed by external systems** (GitHub, Jira, etc.)
- **Descriptive properties** can be attached to resources, so that they can be **queried directly** on the Open Affect server.
- The initial list of **emotions (categories)** has been defined as: *admiration, anger, disappointment, distress, fear, fears-confirmed, gloating, gratification, gratitude, happy-for, hate, hope, joy, love, pity, pride, relief, remorse, reproach, resentment, satisfaction, shame*.

openaffect/openaffect-server: x Swagger UI x Olivier  
192.168.99.100:8080/api/swagger-ui.html#/

swagger default (/api-docs) api\_key Explore

## Open Affect API

API to record emotions

[Contact the developer](#)  
[MIT](#)

**measures-api-controller** : the measures API

Show/Hide | List Operations | Expand Operations

GET /measures	listMeasures
POST /measures	reportMeasure

[ BASE URL: /api , API VERSION: 0.1.0 ]

- I have an online, interactive documentation of the REST API exposed by the Open Affect server. It has been generated during the build process.

The screenshot shows the Postman application interface. On the left, there's a sidebar with a 'Collections' tab selected, displaying a list of projects and their requests. A red arrow points from the text below to the 'Open Affect API' entry in this list. The main workspace is titled 'Send sample measure' and shows a POST request to 'http://{{docker\_host}}:8080/api/measures/'. The 'Body' tab is active, showing a JSON payload. The 'Headers' tab indicates '(2)' entries.

```
1  {
2    "timestamp": "2017-03-09T11:18:23Z",
3    "emotion": {
4      "category": "agreement",
5      "intensity": 1.0
6    },
7    "trigger": {
8      "href": "https://github.com/openaffect/openaffect-server/issues/1",
9      "type": "GitHub issue",
10     "properties": {
11       "createdAt": "2017-03-09T11:16:13Z",
12       "author": {
13         "login": "wasadigi"
14       }
15     }
16   },
17   "subject": {
18     "href": "https://github.com/wasadigi",
19     "type": "person",
20     "properties": {
21       "login": "wasadigi",
22       "name": "Olivier Liechti"
23     }
24   },
25   "sensor": {
26     "href": "https://www.aetostman.com/"
27   }
}
```

- I can use Postman and the provided sample collection (in the git repo, look for examples/OpenAffectAPI.postman\_collection) to send API requests.

# Getting started with Swagger

# API specification with Swagger

The screenshot shows the official Swagger website. At the top, there is a navigation bar with links: SPECIFICATION, TOOLS (with a dropdown arrow), SUPPORT (with a dropdown arrow), BLOG, DOCS, and SWAGGERHUB. The main title "SWAGGER" is displayed in large white letters next to a green icon containing three dots. Below the title, the text "THE WORLD'S MOST POPULAR API TOOLING" is written in white. A descriptive paragraph follows, stating: "Swagger is the world's largest framework of API developer tools for the OpenAPI Specification(OAS), enabling development across the entire API lifecycle, from design and documentation, to test and deployment." At the bottom, there are two green buttons: "OPEN SOURCE TOOLS" and "TRY SWAGGERHUB".

SPECIFICATION    TOOLS ▾    SUPPORT ▾    BLOG    DOCS    SWAGGERHUB

**SWAGGER**

THE WORLD'S MOST POPULAR API TOOLING

Swagger is the world's largest framework of API developer tools for the OpenAPI Specification(OAS), enabling development across the entire API lifecycle, from design and documentation, to test and deployment.

OPEN SOURCE TOOLS    TRY SWAGGERHUB

# Interactive documentation

The screenshot shows the Swagger Editor interface. On the left, there is a code editor window displaying a JSON-based API definition. The code defines two endpoints for the '/teams' resource: a GET method for retrieving teams and a POST method for creating a team. The POST method requires an 'Authorization' header and a 'team' body parameter. The right side of the interface displays the generated API documentation. It shows the 'GET /teams' and 'POST /teams' operations. For the POST operation, it provides a description ('create a team'), parameters ('Parameters' section with 'Authorization' and 'team' fields), and an example value ('Example Value: Model' with a JSON object). A 'Try it out' button is also present.

```
01 type: 'string'
02
03 /teams:
04   get:
05     description: get teams
06     operationId: getTeams
07     produces:
08       - application/json
09     parameters:
10       - name: Authorization
11         in: header
12         type: string
13     responses:
14       '200':
15         description: success
16         schema:
17           type: array
18           items:
19             $ref: '#/definitions/Team'
20
21   post:
22     description: create a team
23     operationId: createTeam
24     consumes:
25       - application/json
26     parameters:
27       - name: Authorization
28         in: header
29         type: string
30       - name: team
31         in: body
32         required: true
33         schema:
34           $ref: '#/definitions/TeamInfo'
35
36     responses:
37       '201':
```

**GET /teams**

**POST /teams**

create a team

Parameters

Name Description

Authorization

string  
(header)

team \* required

Example Value: Model

(body)

```
{
  "name": "string",
  "description": "string"
}
```

Parameter content type

application/json

# Top-Down

code generation

VS

# Bottom-Up

annotations

# **Editor v2**

VS

# **Editor v3**

VS

# **codegen**



# Step 1: describe

# Let's look at an example

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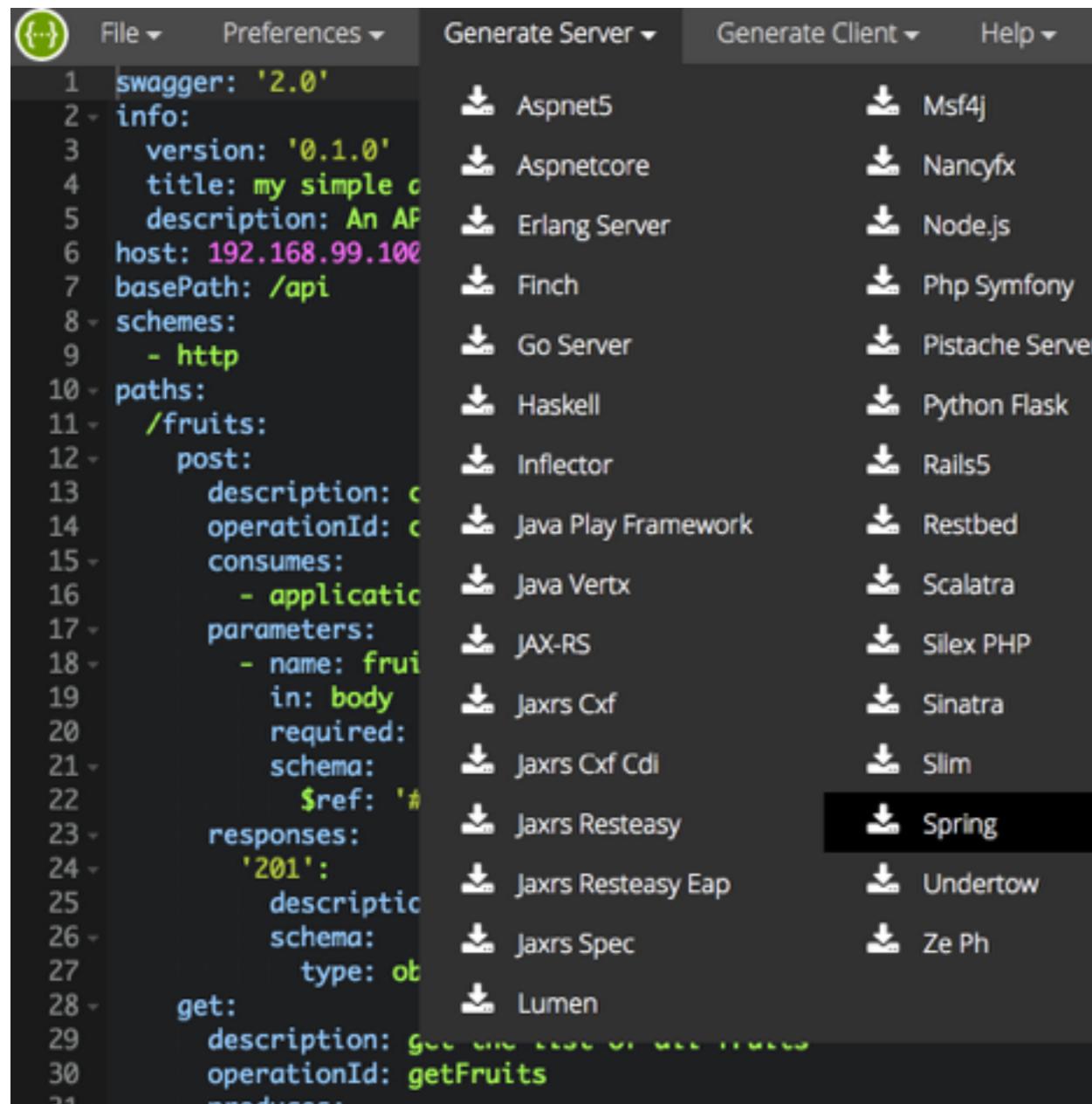
- **Clone our repo:** <https://github.com/AvaliaSystems/TrainingREST>
  - Checkout the **swagger-intro** branch
  - Open the **./swagger/examples/fruits-api.yml** file, copy content
- Open the **Swagger Editor v2:** <http://editor2.swagger.io>, paste content
- Read the **specification**, look at the interactive documentation

# Resources, operations and types

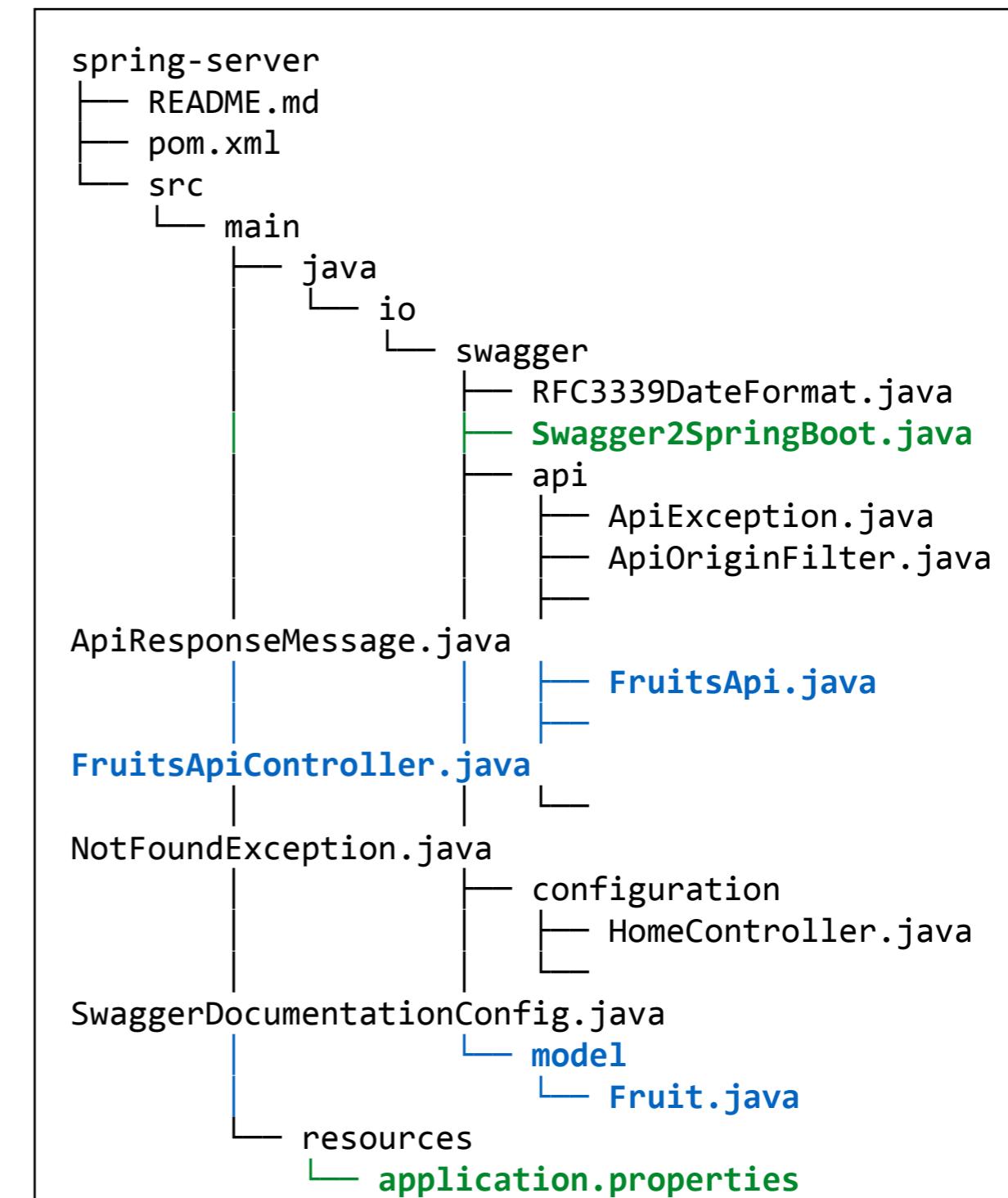
```
paths:  
  /fruits:  
    post:  
      description: create a fruit  
      operationId: createFruit  
      consumes:  
        - application/json  
      parameters:  
        - name: fruit  
          in: body  
          required: true  
      schema:  
        $ref: '#/definitions/Fruit'  
    responses:  
      '201':  
        description: created  
        schema:  
          type: object
```

```
definitions:  
  Fruit:  
    type: object  
    properties:  
      kind:  
        type: string  
      colour:  
        type: string  
      size:  
        type: string
```

# Step 2: implement



```
1 swagger: '2.0'
2 info:
3   version: '0.1.0'
4   title: my simple c
5   description: An AP
6 host: 192.168.99.100
7 basePath: /api
8 schemes:
9   - http
10 paths:
11   /fruits:
12     post:
13       description: c
14       operationId: c
15       consumes:
16         - applicati
17       parameters:
18         - name: frui
19         in: body
20         required:
21         schema:
22           $ref: '#
23       responses:
24         '201':
25           descriptio
26           schema:
27             type: ob
28       get:
29         description: get the list of all fruits
30         operationId: getFruits
31         produces:
```



9 directories, 14 files

# Let's generate Java from the spec

- In the editor, go to "**Generate Server**", "**Spring**"
- Unzip the skeleton and open the project in your **IDE**
- Fix **dependencies** in the **pom.xml** file
- Configure the **maven plugin** in the **pom.xml** (depends on your IDE)
- **Run**, either from command line (mvn spring-boot:run) or the IDE.

```
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-devtools</artifactId>
  <optional>true</optional>
</dependency>
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-tomcat</artifactId>
  <!--<scope>provided</scope>-->
</dependency>
```

```
<plugin>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-maven-plugin</artifactId>
  <configuration>
    <fork>true</fork>
  </configuration>
</plugin>
```

```
public class Fruit {  
    @JsonProperty("kind")  
    private String kind =  
null;  
  
    @JsonProperty("colour")  
    private String colour =  
null;  
  
    @JsonProperty("size")  
    private String size =  
null;  
    ...  
}
```

<https://docs.spring.io/spring/docs/current/spring-framework-reference/html/mvc.html#mvc-ann-requestmapping>

```
@Controller  
public class FruitsApiController implements FruitsApi {  
  
    public ResponseEntity<Object> createFruit(@ApiParam(value = "", required=true) @Valid  
@RequestBody Fruit fruit) {  
        // do some magic!  
        return new ResponseEntity<Object>(HttpStatus.OK);  
    }  
  
    public ResponseEntity<List<Fruit>> getFruits() {  
        // do some magic!  
        return new ResponseEntity<List<Fruit>>(HttpStatus.OK);  
    }  
}
```

# Access documentation in the browser

- In the editor, go to **"Generate Server"**, **"Spring"** <http://localhost:8080/api/swagger-ui.html>
- Unzip the skeleton and open the project in your **IDE**
- Fix **dependencies** in the **pom.xml** file
- Configure the **maven plugin** in the **pom.xml** (depends on your IDE)

The screenshot shows the Swagger UI interface for a "my simple api". The title is "my simple api" and the subtitle is "An API to demonstrate Swagger". The main section is titled "fruits-api-controller : the fruits API". It shows a GET operation for "/fruits" with the method name "getFruits". The "Implementation Notes" field contains the text "get the list of all fruits". The "Response Class (Status 200)" field shows "success". Below it, there are tabs for "Model", "Example", and "Value". The "Value" tab displays a JSON schema for a fruit object:

```
{  
  "colour": "string",  
  "kind": "string",  
  "size": "string"  
}
```

The "Response Content Type" is set to "application/json". The "Response Messages" table lists HTTP status codes and their reasons:

HTTP Status Code	Reason	Response Model	Headers
401	Unauthorized		
403	Forbidden		
404	Not Found		

At the bottom, there are "Try it out!" and "Hide Response" buttons.

# Add persistence with Spring Data

- [https://spring.io/guides/gs/  
accessing-data-jpa/](https://spring.io/guides/gs/accessing-data-jpa/)
- Update dependencies in pom.xml
- Add a Fruit entity (DTO vs Entity!!)
- Add a Repository
- Inject dependency on Repository  
into API controller

```
<dependency>
    <groupId>org.springframework.boot</
groupId>
    <artifactId>spring-boot-starter-data-
jpa</artifactId>
</dependency>
<dependency>
    <groupId>com.h2database</groupId>
    <artifactId>h2</artifactId>
</dependency>
```

```
public interface FruitRepository extends
CrudRepository<FruitEntity, Long>{}
```

```
@Entity
public class FruitEntity implements
Serializable {

    @Id
    @GeneratedValue(strategy =
GenerationType.IDENTITY)
    private long id;

    private String kind;
    private String size;
    private String colour;

    public long getId() {
        return id;
    }

    public String getKind() {
        return kind;
    }
    ...
}
```