Software Systems Verification and Validation

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Lecture 5: Levels of testing

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Cluj-Napoca

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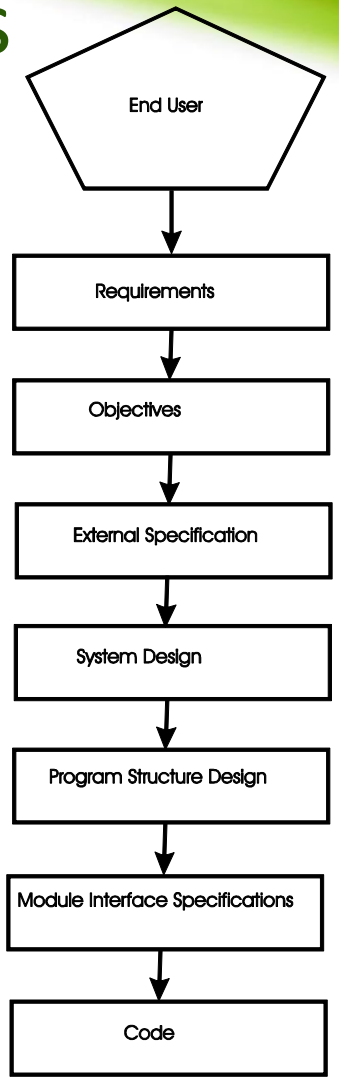
Outline

- Software development process
  - Software development process
  - Development and testing processes
- Levels of testing
  - Unit testing
  - Integration testing
  - Function testing
  - System testing
  - Acceptance testing
- Retesting vs regression testing

- Next lecture:
  - Correctness
- Questions

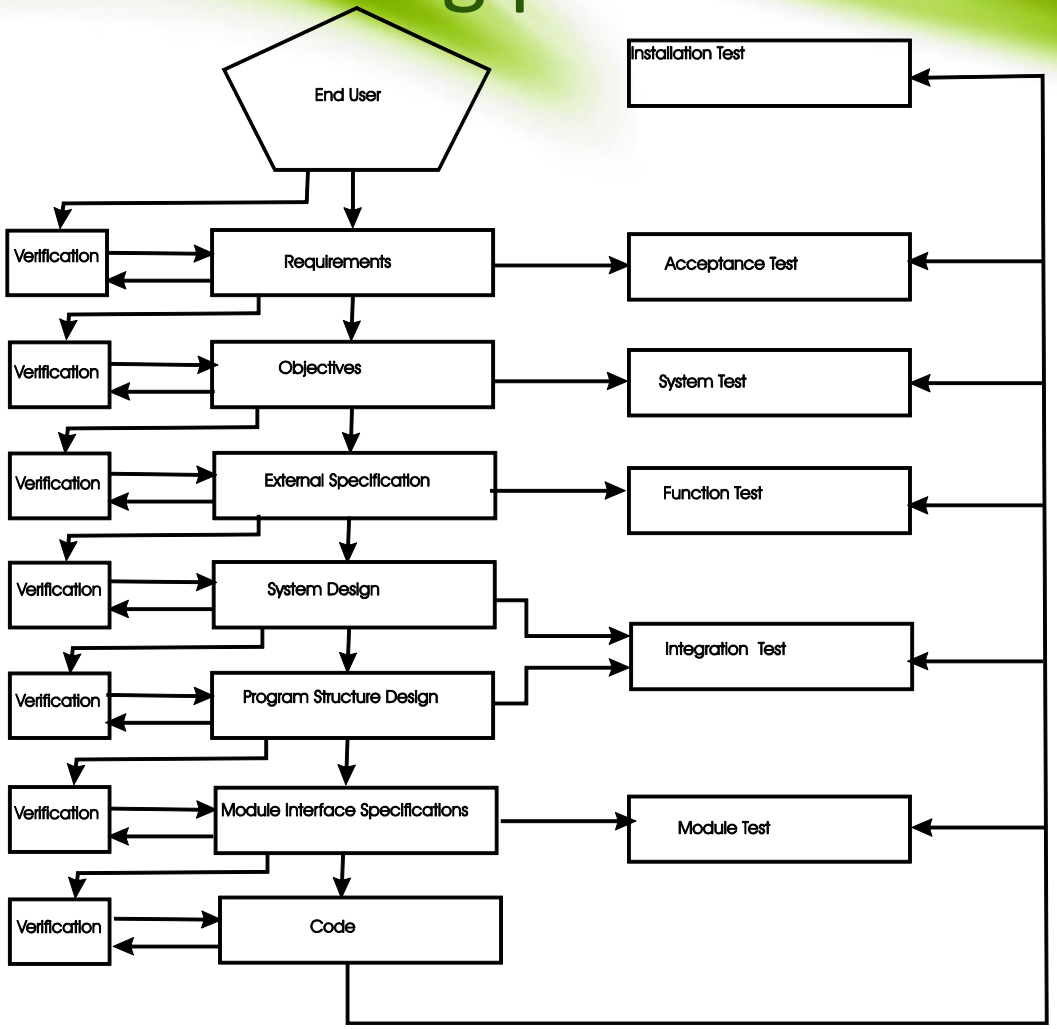
Software development process

- user's needs are translated into requirements
- requirements are translated into objectives
- objectives are translated into external specification
- system design
- program structure design
- module interface specification
- code



Development and testing processes

- Approaches to prevent errors:
  - More precision into the development process.
  - Introduction of a verification step at the end of each process.
  - Orient distinct testing processes toward distinct development processes.



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Levels of testing

1. Unit testing

- Testing individual subprograms, subroutines, procedures, the smaller building blocks of the program.
- **Motivations**:
  - Managing the combined elements of testing.
  - Module testing eases the task of debugging.
  - Module testing introduces parallelism into the program testing process.
- **Points of view**
  - The manner in which test cases are designed.
  - The order in which modules should be tested and integrated.
- Advice about performing the test.

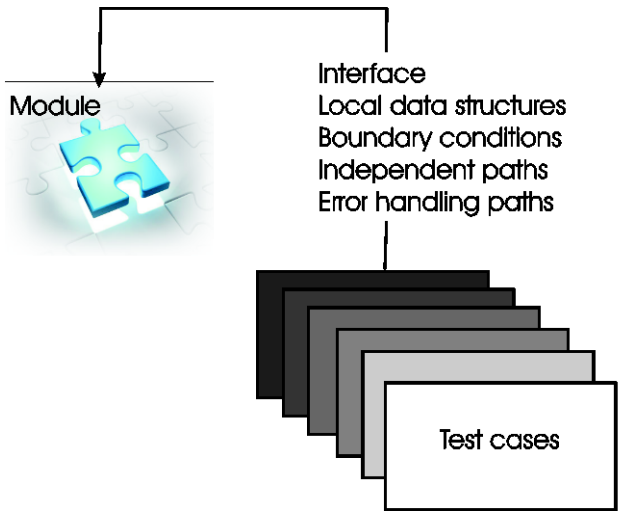
- References: [Mye04] (chapter 5),[NT05] (chapter 3).

Levels of testing

1. Unit testing (cont)

Test case design

- Information needed when designing test cases for a module:
  - specification of the module
  - the module's source code
- Test case design procedure for a module test is:
  - Analyze the logic of the module using white-box methods.
  - Applying black-box methods to the module's specification.

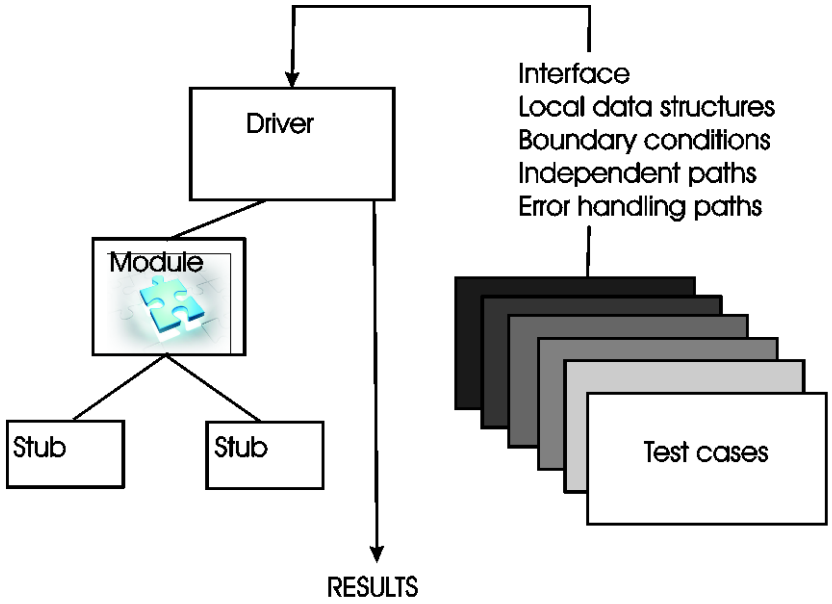


Levels of testing

1. Unit testing (cont)

Unit test procedures

- Unit test environment
  - **driver** - a ”main program” that accepts test case data, passes such data to the component to be tested and prints relevant results;
  - **stub** - serve to replace modules that are subordinate the component to be tested.
    - uses the subordinate module’s interface
    - may do minimal data manipulation
    - prints verification of entry
    - returns control to the module undergoing testing.



Levels of testing

2. Integration testing

- Constructing the program structure while at the same time conducting tests to uncover errors associated with interfacing.
- **Importance** of integration testing:
  - Different modules are generally created by groups of different developers.
  - Unit testing of individual modules is carried out in a controlled environment by using test drivers and stubs.
  - Some modules are more error prone than other modules.
- Objectives:
  - putting the modules together in an incremental manner
  - ensuring that the additional modules work as expected without disturbing the functionalities of the modules already put together.
- Reference: [NT05] (chapter 7).

Levels of testing

2. Integration testing (cont)

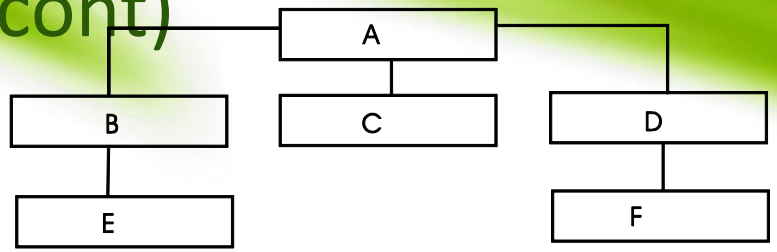
Techniques [Fre10]

- Big-bang
- Incremental
  - Top-down.
  - Bottom-up.
- Sandwich.

Levels of testing

2. Integration testing (cont)

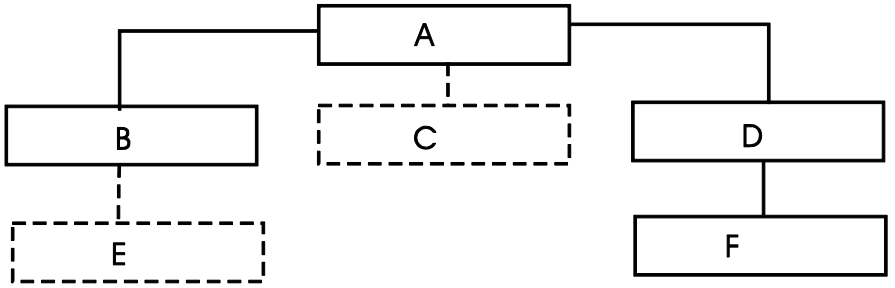
Big-bang testing



- Big-bang procedures:
  - Module test for each individual unit;
    - A driver module;
    - Several stub modules.
  - The modules are combined to form the program.
- **Observations**
  - more work for big-bang
  - mismatching interfaces/incorrect assumptions among modules - detected earlier with incremental
  - Debugging easier - incremental
  - Big-bang - appears to use less machine time
  - parallel activities – opportunity for big-bang

Levels of testing
2. Integration testing (cont)

Top-down incremental testing



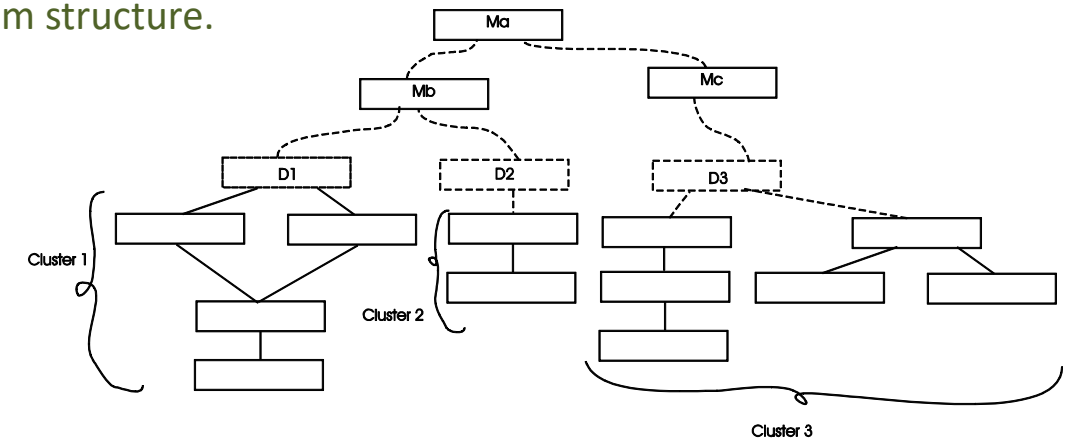
- Top-down integration manner:
  - Depth-first integration;
  - Breadth-first integration.
- Top-down integration process:
  - main control module = driver;
  - stubs=substituted for all components directly subordinate;
  - subordinates stub ← actual components;
  - tests are conducted as each component is integrated;
  - on completion of each set of tests, another stub ← real component;
  - regression testing may be conducted.

Levels of testing

2. Integration testing

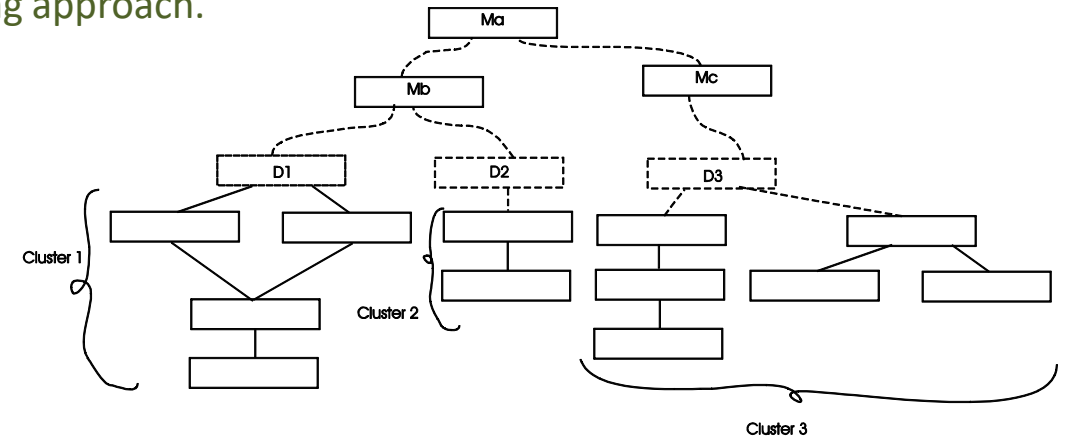
Bottom-up incremental testing

- Bottom-up integration process:
  - low-levels components are combined into clusters;
  - a driver is written to coordinate test case input and output;
  - the cluster is tested;
  - drivers are removed and clusters are combined moving upward in the program structure.



Levels of testing
2. Integration testing
Sandwich testing

- Sandwich procedures:
  - mix of the top-down and bottom-up approaches;
  - layers of a hierarchical system:
    - bottom-layer – using bottom-up module integration;
    - top-layer - using top-down approach integration;
    - middle-layer - big-bang approach.



Levels of testing

3. Function testing

- testing requirements described in the external specification of the system;
- a process of attempting to find discrepancies between the program and the external specification.
- a black-box activity
- uses system specification

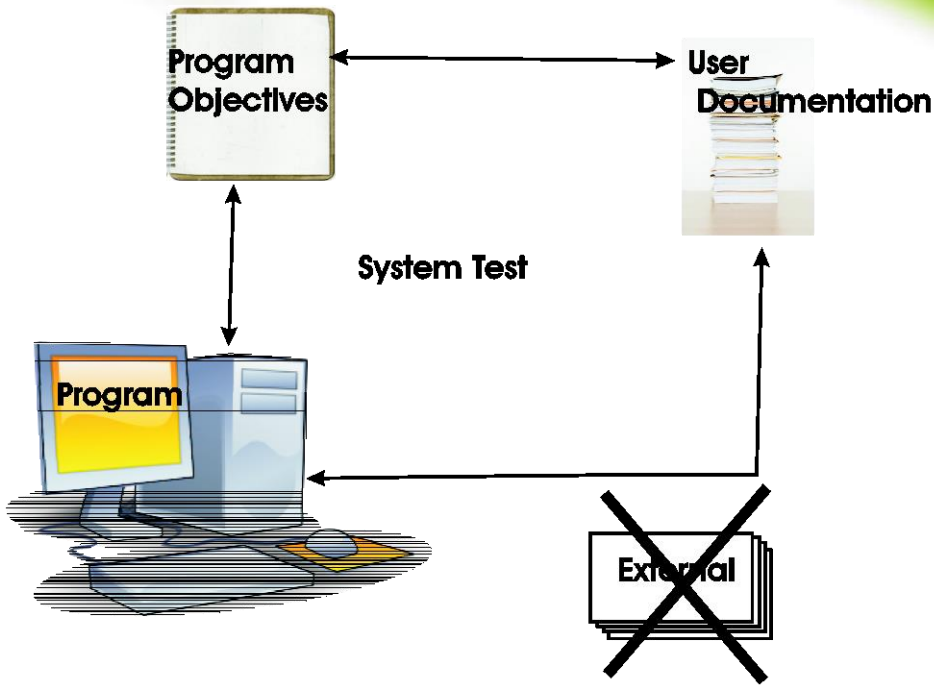
- References: [Mye04] (chapter 6), [NT05] (chapter 9), [PY08] (chapter 10).

Levels of testing

4. System testing

- compare the program - original objectives.
- Use external specification? no, may appear defects during the process of translating the objectives in external specifications;
- Use objectives documents? no, do not contain exact description of the external interfaces of the program;
- Use program's user documentation

- References:[Mye04] (Chapter 6), [NT05] (chapter 8), [PY08] (chapter 22).



Levels of testing

4. System testing (cont)

- the objectives does not offer information about the functionality of the system (interfaces of the modules being tested)
- there is no methodology for created test cases in system testing???
- the process of creating test cases: use imagination, creativity and experience

Levels of testing

4. System testing (cont)

System testing types

- In [Mye04] (Chapter. 6) there are 15 types of system testing:
  - Facility testing
  - Volume testing
  - Usability testing
  - Recovery testing
  - **Security testing – Details in Lecture 11**
  - **Stress testing**
  - **Performance testing – Details in Lecture 7 – IT firm EVOZONE – Lecture invitation**
  - Storage testing
  - Configuration testing
  - Compatibility testing
  - Instability testing
  - Reliability testing
  - Serviceability testing
  - Documentation testing
  - Procedure testing

Levels of testing

5. Acceptance testing

- a process of comparing the program to its initial requirements and the current needs of its end user;
- not the responsibility of the development organization;
- the customer first performs an acceptance test to determine whether the product satisfies its needs.

- References: [NT05] (chapter 14), [PY08] (chapter 22).

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Testing level vs. Testing type

Testing level

- set of activities that are associated to a phase of the software development product

Testing type

- the mean by which an objective of a testing level is achieved

Examples

- Testing a function – unit level or integration level by bbt(domain)/wbt
- Testing of a non-functional characteristic – at system level by performance testing or usability testing
- Testing after eliminating a bug – at any level after debbuging/corrected the bug by appying retesting, confirmation testing
- Testing relating to eliminating a bug – at any level by regression testing to verify is the elimination of the bug doesn't have side-effects

Retesting (confirmation testing)

- Retesting
  - Execution of the test cases that revealed a bug that was reported
  - Goal – confirmation that the bug was eliminated

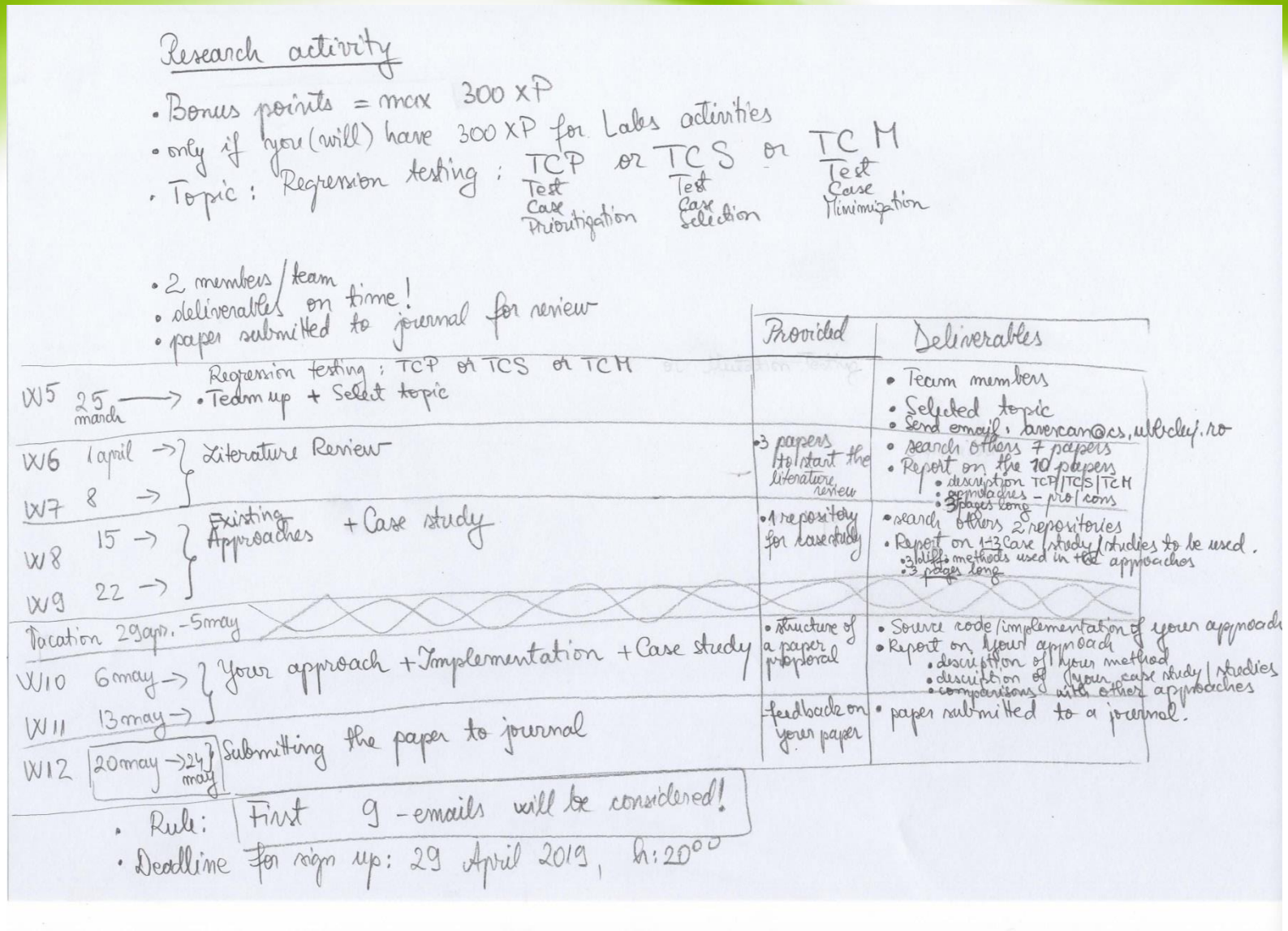
- Test cases – are the same with those already executed

Regression testing

- Regression testing - **the re-execution of some subsets of tests that have already been conducted** to ensure that changes have not propagated unintended side effects.
- Regression test suits - classes of test cases:
  - Tests to exercise all software functions.
  - Tests that focus on software functions that are likely to be affected by the change.
  - Tests that focus on the software components that have been changed.
- Reference: [PY08] (chapter 22).

- Regression testing – **new test cases** (Cem Kaner) [BBST]

Regression testing



Surprise!

Having fun learning about testing

Easter eggs – in testing

- **For students that participated in Lecture 05.**
- **25 XP for each student**

- Each student presents 1 real example of Easter egg in testing.
- Present 1 page information in Lecture 6 in printed format.
  - Definition/description
  - Example
  - Interesting fact(s)

Surprise!

Having fun learning about testing
During Lecture 5 (second hour)

- **Software testing – is a search for information.**
- **Testing strategy is t**he guiding framework for deciding what tests (what test techniques) are best suited to your product.
- **Context** and **information objectives** are (or should be) the drivers of any **testing strategy.**
- **Different objectives require different testing tools and strategies.** And will yield different tests, test documentation and test results.

1. Guerilla testing

2. Dumb monkey testing

3. Smoke testing **4. Bug bashes (in testing)**

5. Scenario testing

6. Tour testing

- https://www.timeanddate.com/timer/
- **Debriefing**
  - **Learning?**
  - **Individual/Team**

1 page information (20 minutes)

And

3 minutes presentation

(6 *3 minutes=18 minutes)

- **Definition/description**
- **Characteristics (5 to 10 points)**
- **Levels of testing**
- **Example = simple + real world application**
- **Interesting fact(s)**

- **Creating/presenting the Poster**
  - **25 XP for each member of the team**
- **Questionnaire about the activity**
  - **25 XP**

Questions

- Thank You For Your Attention!

References

- [Pat05] R. Patton. Software Testing. Sams Publishing, 2005.
- [PY08] M. Pezzand and M. Young. *Software Testing and Analysis: Process, Principles and Techniques*. John Wiley and Sons, 2008.
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