# COMP1531

3.2 - Verification & Validation

# Verification

Verification in a system life cycle context is a set of activities that compares a product of the system life cycle against the required characteristics for that product. This may include, but is not limited to, specified requirements, design description and the system itself.

# Validation

Validation in a system life cycle context is a set of activities ensuring and gaining confidence that a system is able to accomplish its intended use, goals and objectives.

*ISO/IEC/IEEE 29148:2018

# Verification

The system has been built right

# Validation

The right system has been built

*by intuition

# Formal Verification

- Proving (via Mathematics) that a piece of software has certain desirable properties
- Treats the software, or the algorithms implemented in the software, as a mathematical object that can be reasoned about.
- Typically involves tools like proof assistants, model checkers or automatic theorem provers.
- **Not something we cover in this course**

# Formal Verification

- Tends to have a high cost in terms of effort
- E.g. to verify a microkernel
  - it took ~20 person years
  - and ~480,000 lines of proof script
  - for ~10,000 of C

# What is testing anyway?

“Testing shows the presence, not the absence of bugs” – *Edsger W. Dijkstra*

# Unit testing

ISTQB definition:

The testing of individual software components

Method:

White-box

Who:

Software Engineers

# Integration Testing

ISTQB definition:

Testing performed to expose defects in the interfaces and in the interactions between integrated components or systems.

Method:

White-box or Black-box

Who:

Software Engineers or independent testers

# System Testing

ISTQB definition:

The process of testing an integrated system to verify that it meets specified requirements.

Method:

Black-box

Who:

Normally, independent testers

# Acceptance Testing

ISTQB definition:

Formal testing with respect to user needs, requirements, and business processes conducted to determine whether or not a system satisfies the acceptance criteria and to enable the user, customers or other authorized entity to determine whether or not to accept the system.

Method:

Black-box

Who:

User or Customer

# How do we know if our tests are good?

# Coverage

- Test Coverage: a measure of how much of the feature set is covered with tests
- Code coverage: a measure of how much code is executed during testing

# Example: Leap years

```
def is_leap_year(year):
    if year % 4 != 0:
        return False
    elif year % 100 != 0:
        return True
    elif year % 400 != 0:
        return False
    else:
        return True
```

# Coverage.py

- Measure code coverage as a percentage of statements (lines) executed
- Can give us a good indication how much of our code is executed by the tests
- … and most importantly highlight what has **not** been executed.

# Example: Year from day

```
1  def day_to_year(days):
2      '''
3      Given a number of days from January 1st 1970, return the year.
4      '''
5      year = 1970
6
7      while days > 365:
8          if is_leap_year(year):
9              if days > 366:
10                 days -= 366
11                 year += 1
12         else:
13             days -= 365
14             year += 1
15
16     return year
```

# Checking code coverage

- Run Coverage.py for your pytests:

```
python3-coverage run --source=. -m pytest
```

- View the coverage report:

```
python3-coverage report
```

- Generate HTML to see a breakdown (puts report in htmlcov/)

```
python3-coverage html
```

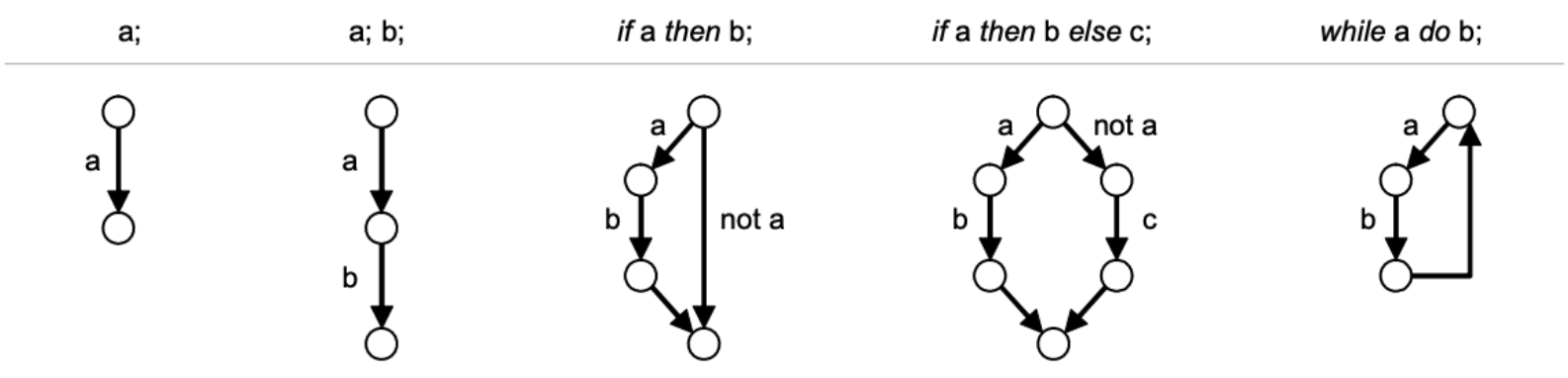
# Case study: Zune Bug

- On December 31st 2008, Microsoft Zunes stopped working for the whole day.
- The bug in the above code caused them to go into an infinite loop
- Hardly catastrophic, but embarrassing for Microsoft

Can we find the Zune bug with testing?

# Branch coverage checking

- For lines that can potentially jump to more than one other line (e.g. if statements), check how many of the possible branches were taken during execution
- Can be done with the --branch option in Coverage.py
- Sometimes referred to as edge coverage



# Does code coverage imply test coverage?

# What is the right level of code coverage?

# Summary

- Code coverage is useful
- It's more important to look at what's not covered than the coverage percentage
- Branch coverage is a more accurate measurement so you should use it instead of statement coverage
- Like all measurements, it's important to understand what meaning to attach to it

# What is good style?

Programs must be written for people to read, and only incidentally for machines to execute – *Abelson & Sussman, "Structure and Interpretation of Computer Programs"*

# Style

- Ultimately about readability and maintainability
- Style guides give rules of thumb and conventions to follow
- ...but good style is ultimately hard, if not impossible, to measure
- That said, tools can be a lot of help

There are a lot of tools in modern software engineering

# Pylint

- An external tool for *statically* analysing python code
- Can detect errors, warn of potential errors, check against conventions, and give possible refactorings
- By default, it is **very** strict
- Can be configured to be more lenient

# Controlling Messages

- Disable messages via the command line

```
$ pylint3 --disable=<checks> <files_to_check>
$ pylint3 --disable=missing-docstring <files>
```

- Disable messages in code; e.g.

```
if year % 4 != 0: #pylint: disable=no-else-return
```

- Disable messages via a config file
  - If a .pylintrc file is in the current directory it will be used
  - Can generate one with:

```
pylint3 <options> --generate-rcfile > .pylintrc
```