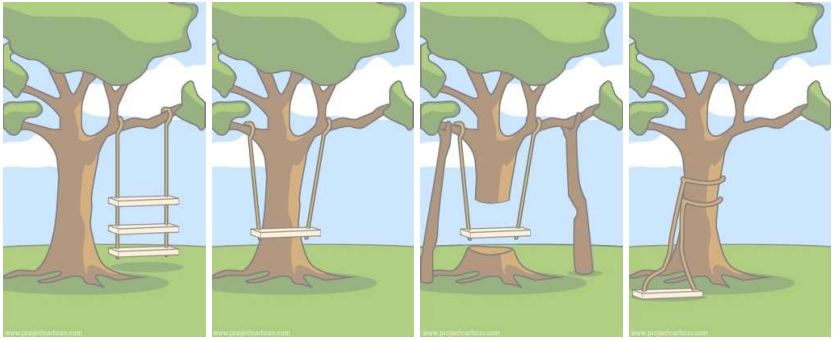
Software Engineering

6. Implementation | Thomas Thüm | November 24, 2021

Implementation in Software Projects



how the customer explained it | how the project leader understood it | how the analyst designed it | how the programmer implemented it

Lecture Overview

1. Programming Languages
2. Coding Conventions
3. Tools and Environments

Lecture Contents

Questionnaire Results

1 Warst du jemals betroffen von einer Softwarepanne?

Antworten	relative Häufigkeit	absolute Häufigkeit
Ja	82%	59
Nein	18%	13

2 Hast du dich im letzten Semester über Softwarefehler geärgert?

Antworten	relative Häufigkeit	absolute Häufigkeit
Ja	88%	61
Nein	12%	8

3 Hast du selbst Programmiererfahrung?

Antworten	relative Häufigkeit	absolute Häufigkeit
Ja	93%	65
Nein	7%	5

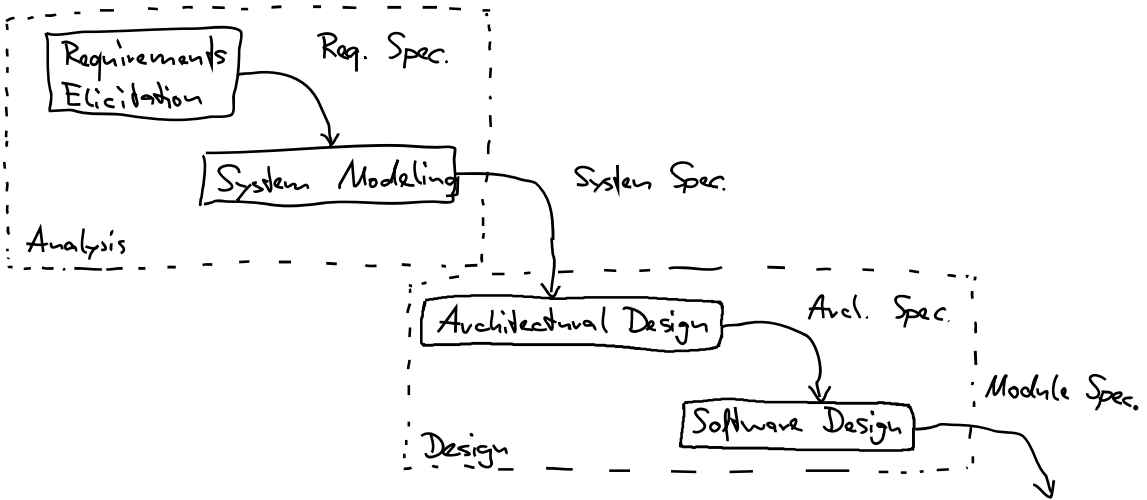
4 Hast du bereits Software getestet?

Antworten	relative Häufigkeit	absolute Häufigkeit
Ja	53%	38
Nein	47%	34

5 Hast du schon mal Programmierfehler verursacht?

Antworten	relative Häufigkeit	absolute Häufigkeit
Ja	87%	60
Nein	13%	9

Analysis and Design



History of Programming Languages

Languages [Jones + Krypczyk/Bochkor]

- 1945: first high-level language Plankalkül by Konrad Zuse (compiler written in 1998)
- 1954: first professional high-level language FORTRAN (Formula Translator) by IBM
- 1963: Basic as general-purpose language
- 1959: functional language Lisp
- 1970: first object-oriented lang. Smalltalk-80
- 1970: declarative langugage SQL
- 1971: Pascal by Niklaus Wirth for teaching
- 1974: very common procedural language C
- 1977: logical language Prolog
- 1980: C++ as object-oriented extension of C
- 1990: object-oriented language Java
- 1990: functional language Haskell
- 1991: multi-paradigm language Python
- 1995: scripting language JavaScript

Milestones [Jones]

- controlling behavior of mechanical devices by wiring or with punchcards (Lochkarten)
- machine languages used during World War II
- assembly languages: distinction between human-readable instructions (source code) and executable instructions (object code)
- birth of compilers and interpreters having a one-to-many mapping between source and object code (opposed to one-to-one mapping in assemblers)
- structured programming pioneered by David Parnas and Edsger Dijkstra
- high-level programming languages: high number of executable for each human-readable instruction
- domain-specific languages, later general-purpose programming languages

Programming Languages Today

Today [Jones + Krypczyk/Bochkor]

- 2002: C# by Microsoft
- 2009: Go by Google
- 2010: Rust by Mozilla Research
- 2014: Swift by Apple
- thousands of programming languages
- very few programming languages used for more than 10 years
- languages used for more than 25 years: Ada, C, C++, COBOL, Java, Objective C, PL/I, SQL, Visual Basic, ...

Many Languages [Jones]

- good: fit for every use case
- bad: developer training for new and dead languages, expensive tool support

Choice of Programming Languages

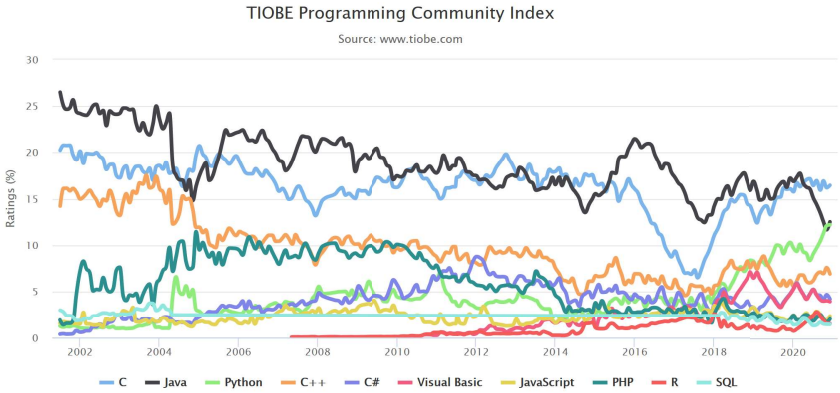
Desired Properties [Ludewig and Lichter]

- modular implementation
- separation of inferfaces and implementations
- type system: strongly/weakly typed languages
- readable syntax (FORTRAN vs ALGOL60)
- automatic pointer management (C vs Java)
- exception handling

Criteria in Practice

- language required by the company or customer?
- existing infrastructure?
- domain-specific languages available?
- language known/liked by developers?
- available libraries?
- available tool support?
- language popularity?
- what may change in the future?

Popularity of Programming Languages



Popularity of Programming Languages

Programming Language	2020	2015	2010	2005	2000	1995	1990	1985
C	1	2	2	1	1	1	1	1
Java	2	1	1	2	3	29	-	-
Python	3	5	6	7	22	13	-	-
C++	4	3	3	3	2	2	2	8
C#	5	4	5	6	10	-	-	-
JavaScript	6	8	10	10	7	-	-	-
PHP	7	6	4	4	19	-	-	-
SQL	8	-	-	-	-	-	-	-
R	9	14	46	-	-	-	-	-
Swift	10	15	-	-	-	-	-	-
Lisp	29	26	14	13	9	6	4	2
Fortran	31	21	24	14	13	14	3	5
Ada	34	23	21	16	17	3	9	3

Excursion: Windows Calc

Patrick McKenzie [twitter.com]

"Every great developer you know got there by solving problems they were unqualified to solve until they actually did it."

Bill Gates [code.org]

"Learning to write programs stretches your mind, and helps you think better, creates a way of thinking about things that I think is helpful in all domains."

Programming Languages

Lessons Learned

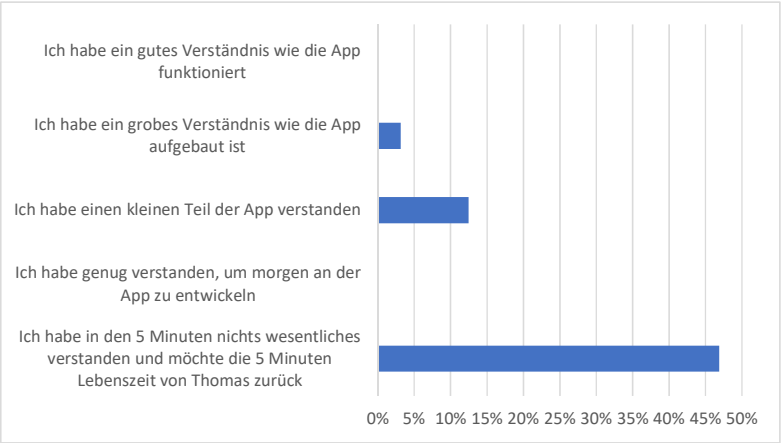
- Historical perspective on programming
- Criteria for choosing languages
- Popularity of programming languages
- Further Reading on Programming Languages: Jones, Chapter 8 Programming and Code Development + Krypczyk/Bochkor, Chapter 2.4 Programming Languages

Practice

- See Moodle
- Look at the code of my calculator and think about possible improvements to the code quality
- Share your thoughts with your colleagues in Moodle (before watching Part 2)

Lecture Contents

Understanding the Corona-Warn-App



Douglas Crockford [Crockford 2008]

"It turns out that style matters in programming for the same reason that it matters in writing. It makes for better reading."

François Chollet [twitter.com]

"In software, naming matters, because names reflect how you think about a problem. Code is also communication, and naming is a big part of making it work."

Code Formatting

Code Formatting

- motivation: code is read much more often and by more developers than written
- avoid differences by each programmer
- indentation: typically 4 characters per level
- length of a line: often 80 or 100 characters
- extra indentation: typically 8 characters when breaking extra long lines
- empty lines between methods and attributes
- automated code formatters available (on demand or when saving the editor)
- typical formatting rules for each language
- automated code formatters are configurable (handle with care)

Rules on Naming

Unwanted Names

- single character as a name
- very long names
- names consisting only of special chars
- synonyms: delete, remove, clear
- abbreviations (unless very common)

Wanted Names

- nouns for class names: Calculator
- nouns for attribute names: calculateButton
- verbs for method names: getCalculator(), evaluate(), isZero(), hasChildren(), setValue()
- CamelCaseNotation for classes, attributes, methods, local variables, parameters
- UPPER_CASE_NOTATION for constants
- lowercasenotation for package names

Martin Fowler (1999) [Fowler's Refactoring]

"Any fool can write code that a computer can understand. Good programmers write code that humans can understand."

Cory House [twitter.com]

"Code is like humor. When you have to explain it, it's bad."

Code Documentation

Comments . . .

- in source code are easier to maintain (than in external documents)
- should be written while editing the code
- can be used to generate documentation (e.g., JavaDoc, Doxygen)
- are used to specify classes and public methods (e.g., parameters, exceptions, dependencies)
- document hacks, side effects and unfinished parts (e.g., TODO)
- should not paraphrase the code

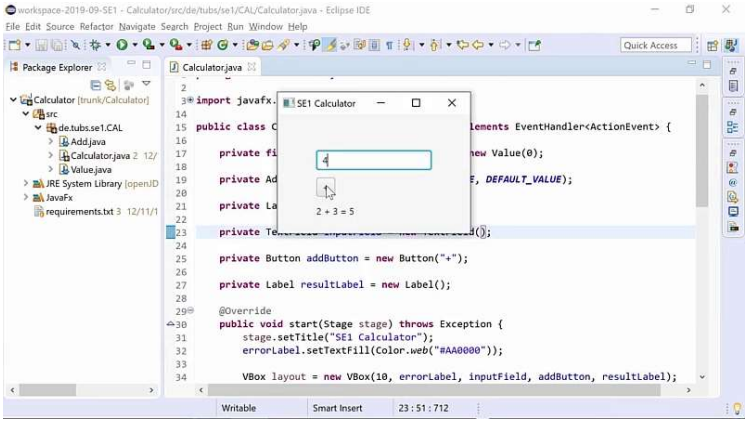
Ryan Campbell [problemsolving.io]

"Commenting your code is like cleaning your bathroom - you never want to do it, but it really does create a more pleasant experience for you and your guests."

Steve McConnell (2004) [Code Complete]

"Good code is its own best documentation. As you're about to add a comment, ask yourself, "How can I improve the code so that this comment isn't needed?" Improve the code and then document it to make it even clearer."

Excursion: Revising Thomas' Calculator



Coding Conventions

Lessons Learned

- Coding conventions (Programmierrichtlinien)
- Formatting, naming, comments, and documentation
- Further Reading: Google 's Java Style Guide

Practice

- See Moodle
- Optional: inspect changes of the live coding
- The resulting code does not contain any comments. Give an example comment.
- Argue for one other comment whether it is useful or not?

Lecture Contents

1. Programming Languages

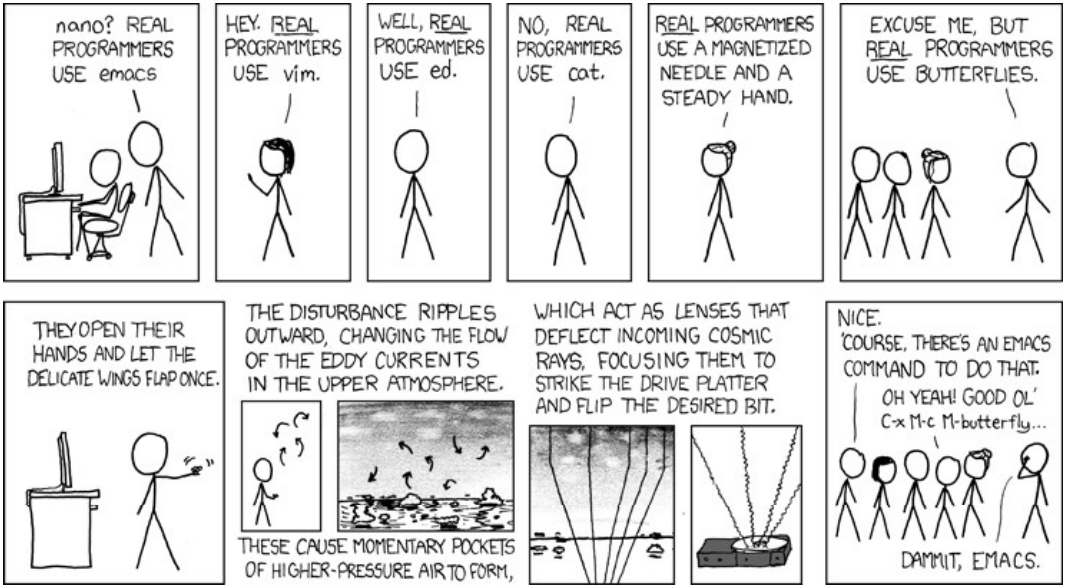
2. Coding Conventions

3. Tools and Environments
   - Computer-Aided Software Engineering
   - Overview on Development Tools
   - Excursion: Extending Thomas' Calculator
   - Lessons Learned

Computer-Aided Software Engineering

Terms [adapted from Ghezzi/Jazayeri/Mandrioli]

A **tool** is an application that supports a particular activity. An **environment** is a collection of related tools. Tools and environments aim at automating some of the activities that are involved in software engineering. The generic term for this field of study is **computer-aided software engineering**.

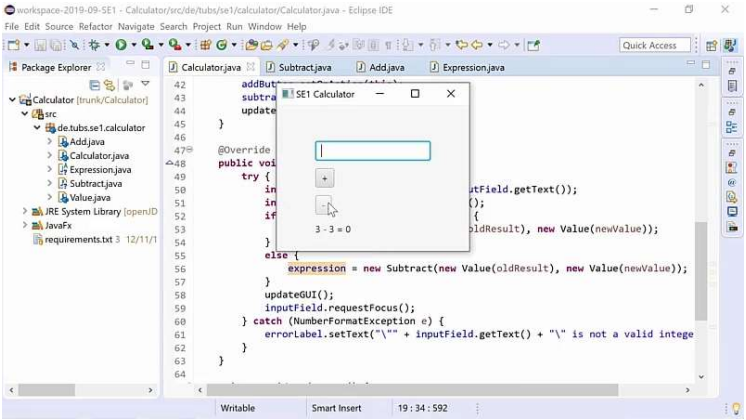

nano? REAL PROGRAMMERS USE emacs
HEY. REAL PROGRAMMERS USE vim.
WELL, REAL PROGRAMMERS USE ed.
NO, REAL PROGRAMMERS USE cat.
REAL PROGRAMMERS USE A MAGNETIZED NEEDLE AND A STEADY HAND.
EXCUSE ME, BUT REAL PROGRAMMERS USE BUTTERFLIES.
THEY OPEN THEIR HANDS AND LET THE DELICATE WINGS FLAP ONCE.
THE DISTURBANCE RIPPLES OUTWARD, CHANGING THE FLOW OF THE EDDY CURRENTS IN THE UPPER ATMOSPHERE.
THESE CAUSE MOMENTARY POCKETS OF HIGHER-PRESSURE AIR TO FORM,
WHICH ACT AS LENSES THAT DEFLECT INCOMING COSMIC RAYS, FOCUSING THEM TO STRIKE THE DRIVE PLATTER AND FLIP THE DESIRED BIT.
NICE.
'COURSE, THERE'S AN EMACS COMMAND TO DO THAT.
OH YEAH! GOOD OL' C-x M-c M-butterfly...
DAMMIT, EMACS.

Overview on Development Tools

Variety of Tools [Ghezzi/Jazayeri/Mandrioli]

- text(ual) editors: emacs, vim, ed, Word, ...
- graphical editors: UML editors, Powerpoint, ...
- assembler, compiler, interpreter
- configuration management tools: git, SVN, CVS, ...
- tracking tools (issue trackers): Github, Gitlab, ...
- tools for code navigation and refactoring
- tools for test specification, generation, execution, reporting
- tools for static and dynamic code analysis (e.g., debugger), reverse/reengineering, project management
- integrated development environments (IDEs): Eclipse, IntelliJ, Android Studio, Visual Studio

Excursion: Extending Thomas' Calculator



Tools and Environments

Lessons Learned

- Tool supports by means of tools, environments, and IDEs
- Further Reading: Ghezzi/Jazayeri/Mandrioli, Chapter 9 Software Engineering Tools and Environments

Practice

- See Moodle
- Choose a tool or an IDE.
- Tryout tooling that you have learned about in this video but never used before (e.g., automated code formatting or code navigation).
- Post a screenshot and brief description in Moodle.