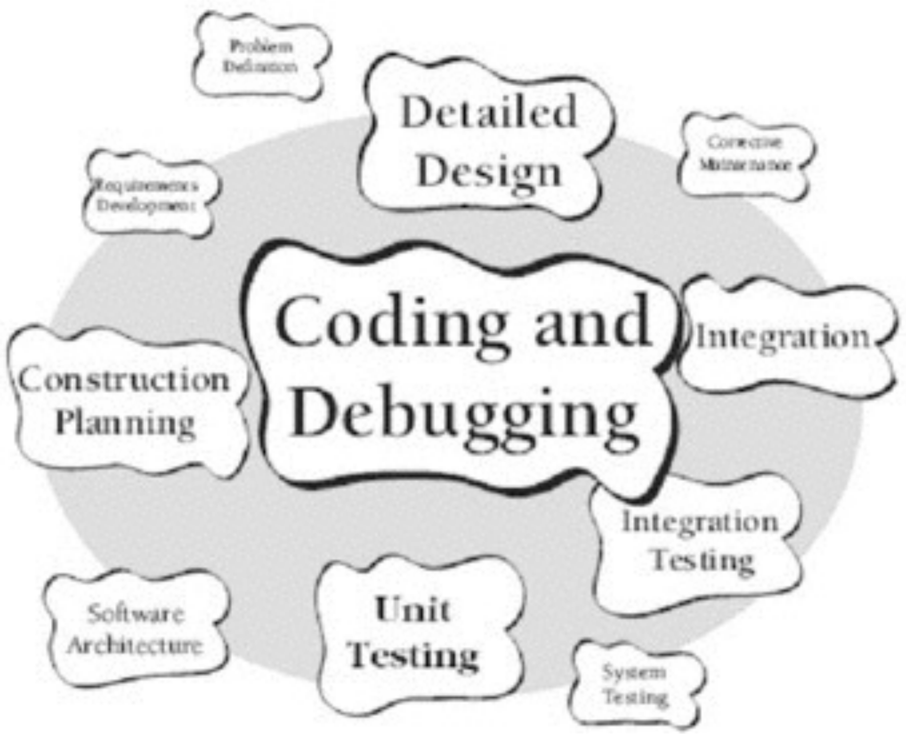


# Software Construction

2015-2016
Tijs van der Storm
(storm@cwi.nl / @tvdstorm / @SoftwCons)

UNIVERSITEIT VAN AMSTERDAM

CWI

## Introduction

Tijs van der Storm
(lectures + labs)

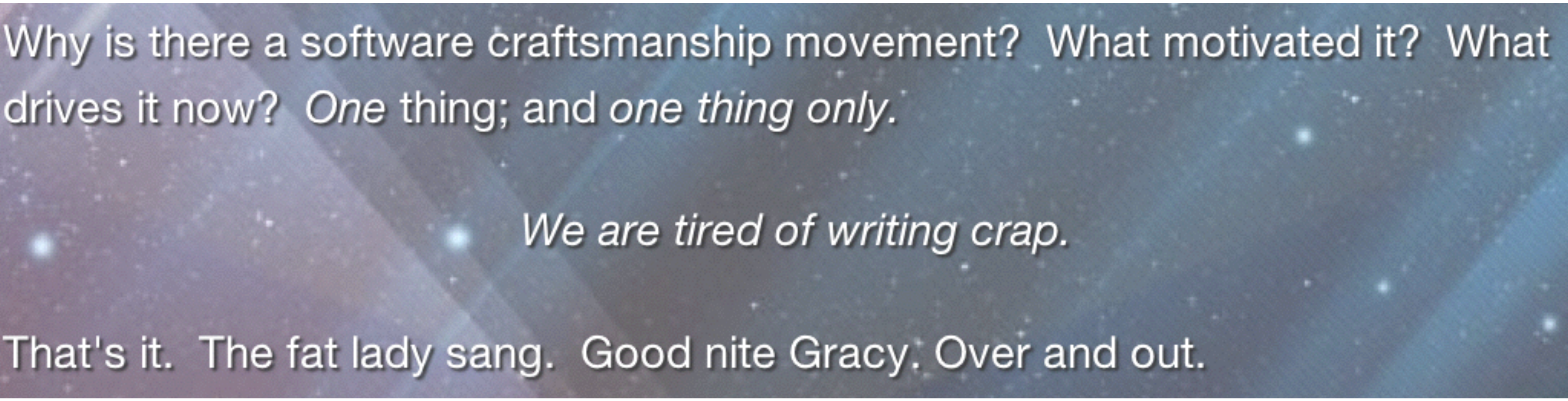
# What this course is about

- You all know programming, right?
- But what is good code?
- How to *reason* about good code?
- What is *beautiful* code?
- Think about it.

# This course is *not* about

- Data structures
- Algorithms
- Programming language X
- Paradigm X (though: OO)
- GUI programming
- Web applications
- Concurrency
- Performance
- Graphics programming
- Mathematics
- Computational complexity
- ...

# Uncle Bob*



Why is there a software craftsmanship movement? What motivated it? What drives it now? *One* thing; and *one thing only.*

*We are tired of writing crap.*

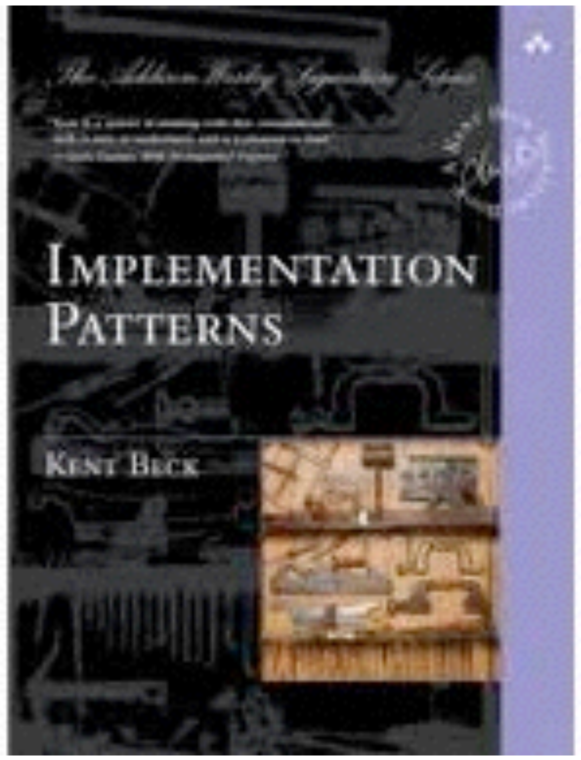
That's it. The fat lady sang. Good nite Gracy. Over and out.

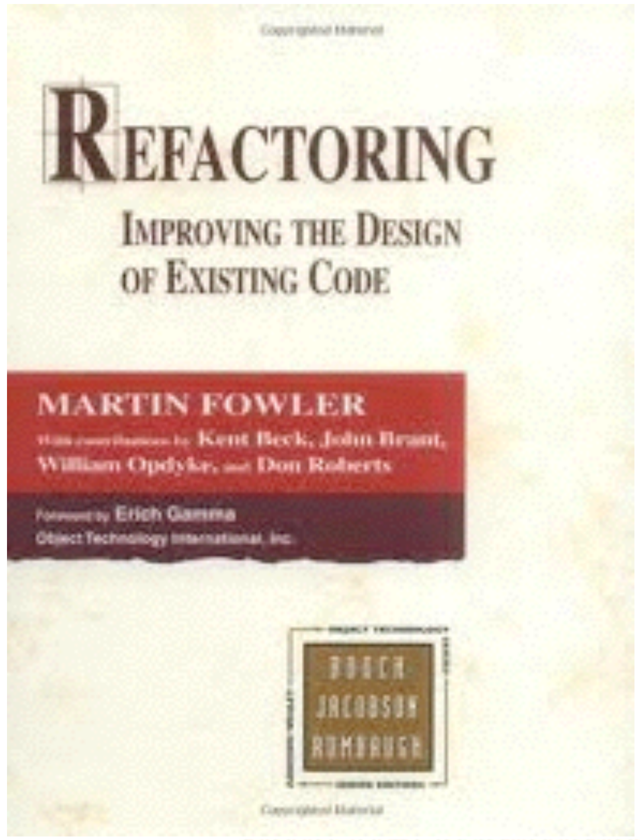
This course is *not* about the software craftmanship movement...

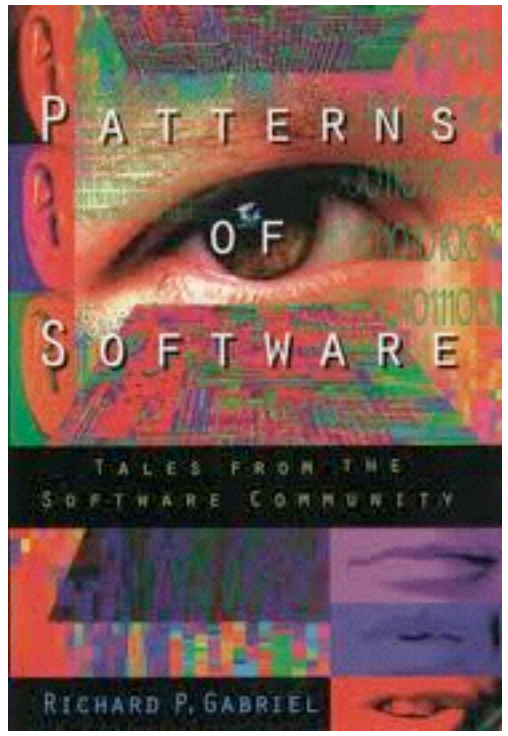
This course *is* about *not* writing crap.

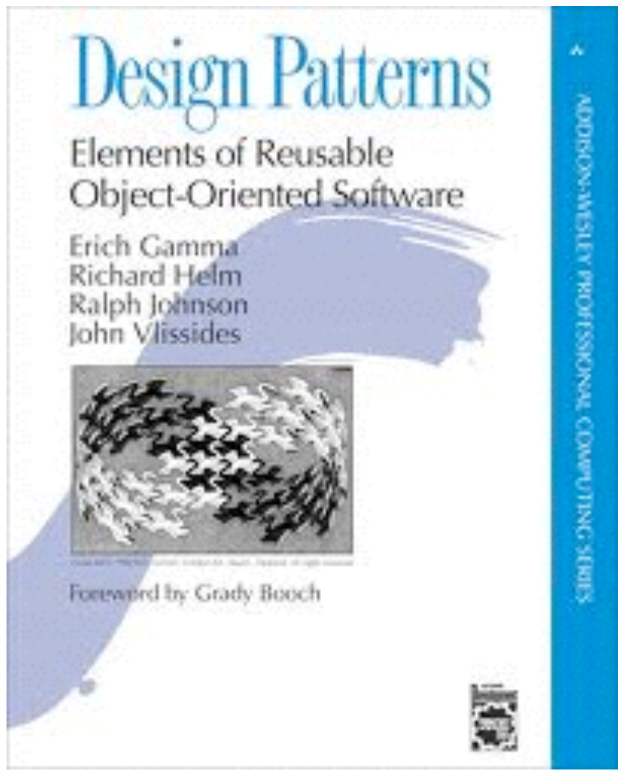
*Robert Martin, http://cleancoder.posterous.com/software-craftsmanship-things-wars-commandmen

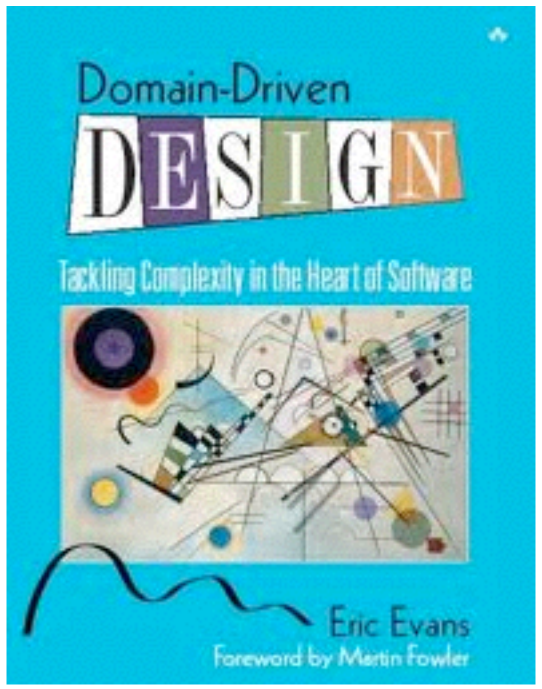
# Representative books

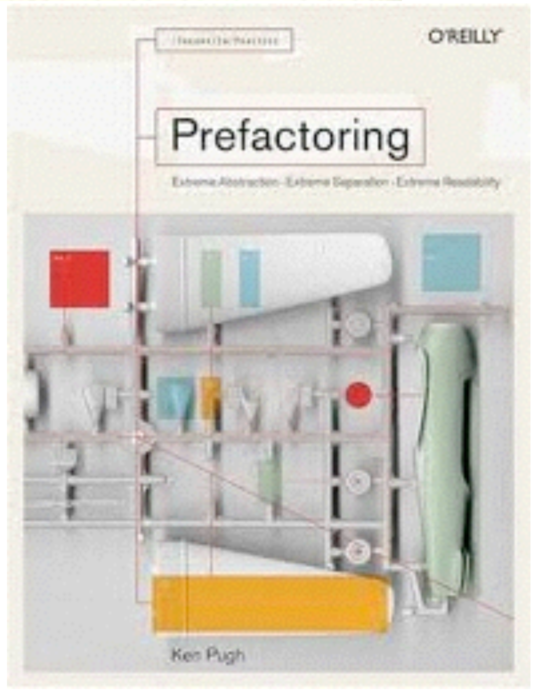


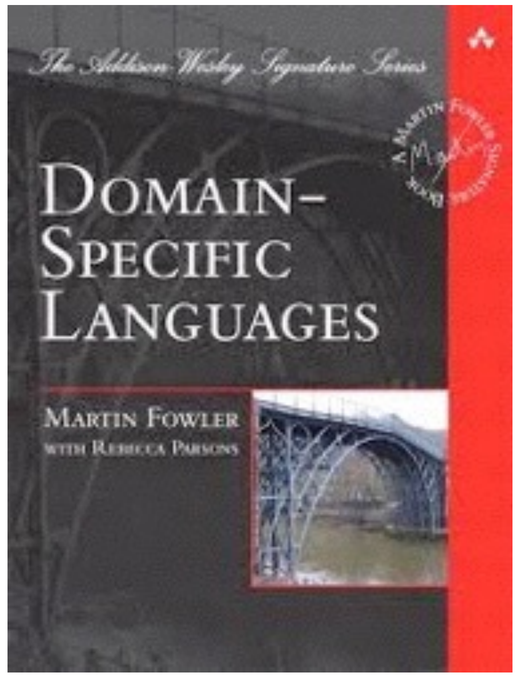

Refactoring
Improving the Design of Existing Code
Martin Fowler
With contributions by Kent Beck, John Brant, William Opdyke, and Don Roberts
Foreword by Erich Gamma
Object Technology International, Inc.
Booch Jacobson Rumbaugh




Design Patterns
Elements of Reusable Object-Oriented Software
Erich Gamma
Richard Helm
Ralph Johnson
John Vlissides
Foreword by Grady Booch
Addison-Wesley Professional Computing Series

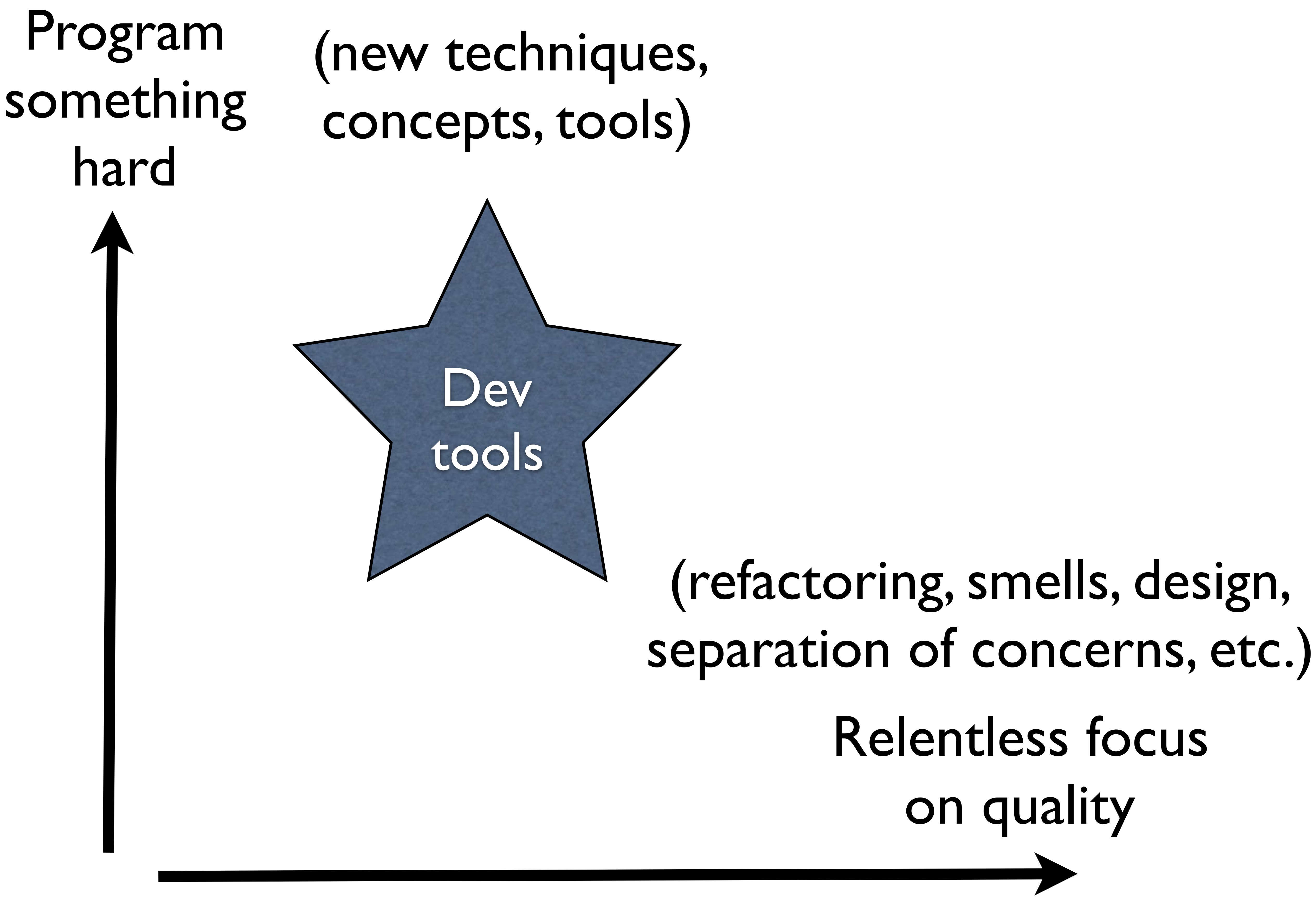

Domain-Driven Design
Tackling Complexity in the Heart of Software
Eric Evans
Foreword by Martin Fowler

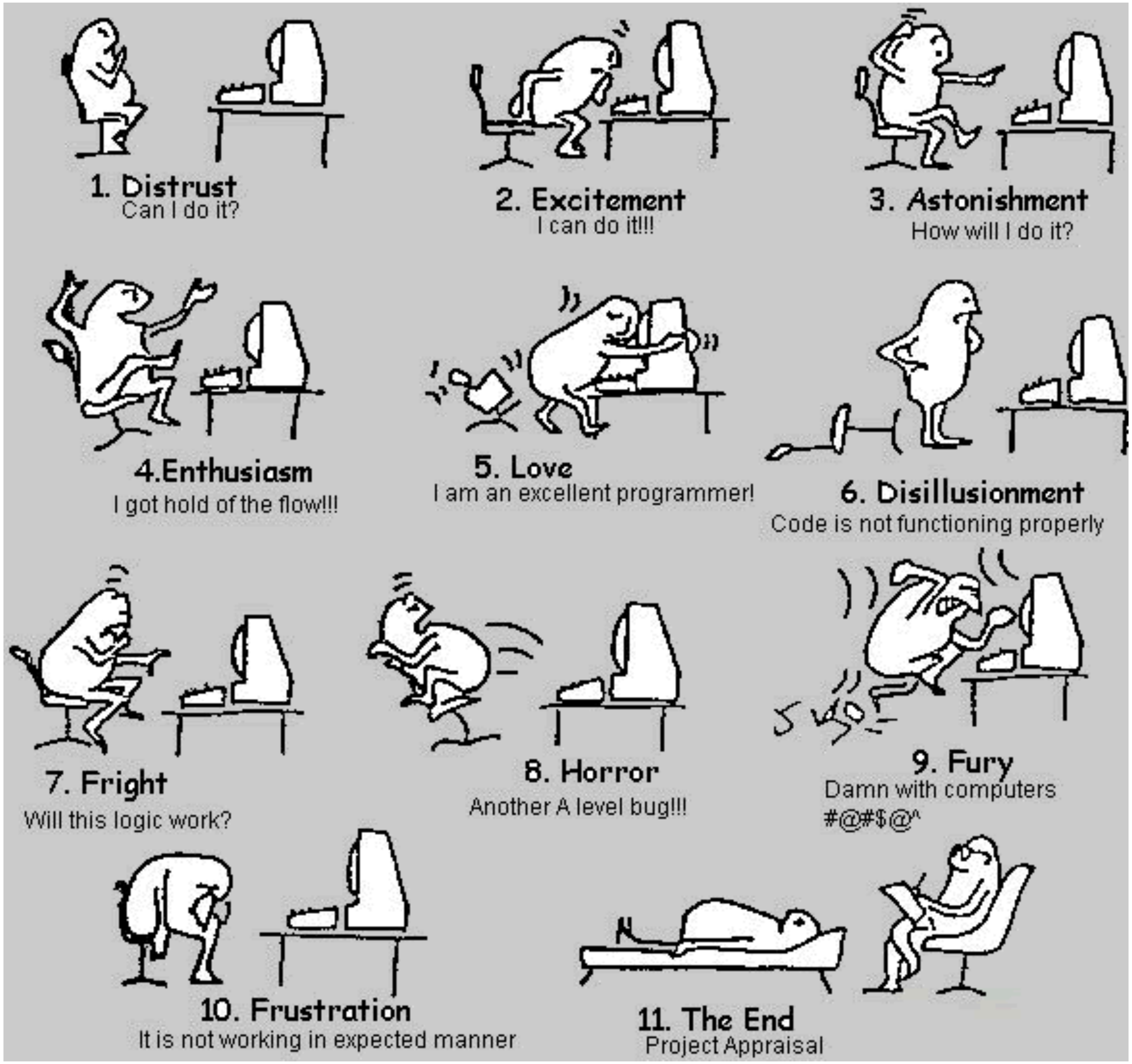

O'Reilly
Prefactoring
Extreme Abstraction · Extreme Separation · Extreme Readability
Ken Pugh


The Addison-Wesley Signature Series
A Martin Fowler Signature Book
Domain-Specific Languages
Martin Fowler
with Rebecca Parsons

## Learning goals

- Create good low level designs
- Produce clean, readable code
- Reflect upon techniques, patterns, guidelines etc.
- Assess the quality of code
- Apply state of the art software construction tools


Program something hard
(new techniques, concepts, tools)
Dev tools
(refactoring, smells, design, separation of concerns, etc.)
Relentless focus on quality



http://candraadi.wordpress.com/2012/10/17/programmer/

JOY
OF
CODING

Celebrating the art, craft, science and *joy* of software development ——

— *Friday 17th June 2016 @ De Doelen, Rotterdam*

joyofcoding.org

# This course

- Quality comes first
- Be your own worst critic
- Refactor mercilessly
- Aim to become code literati
- Better to read code, than to write code
- If it works it’s not good enough

If it works, it’s not good enough

## If it works, it’s not good enough

If it works, it’s not good enough

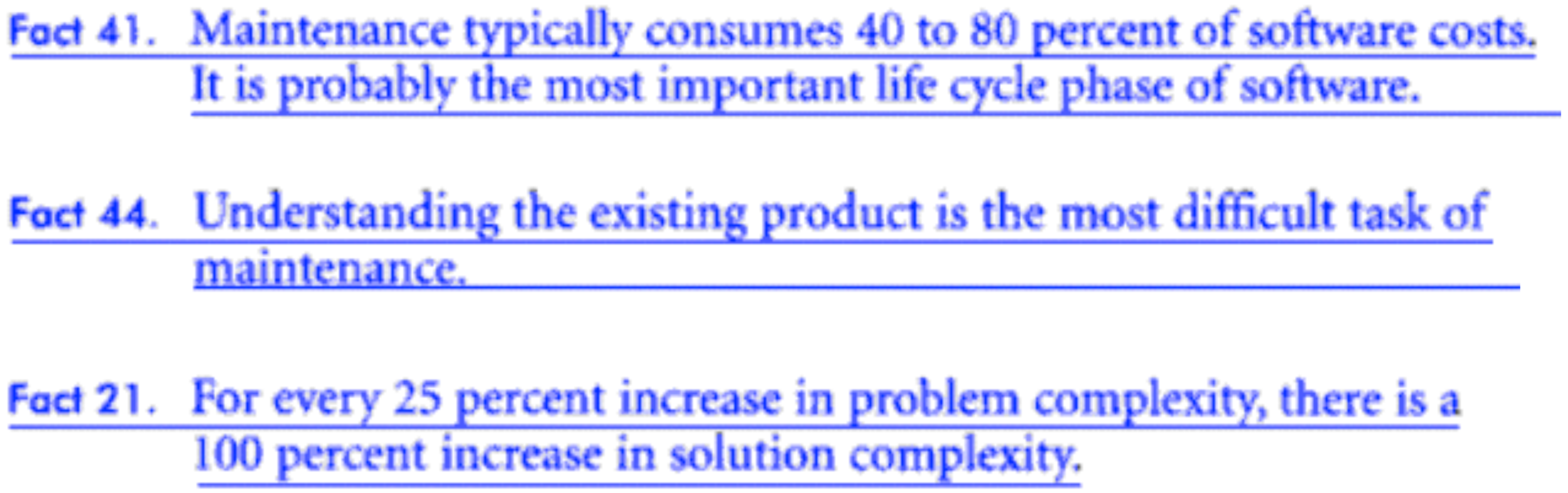
If it works, it’s not good enough

**If it works, it’s not good enough**

If it works, it's not good enough

Working code is necessary, but not sufficient

# Why?



Fact 41. Maintenance typically consumes 40 to 80 percent of software costs. It is probably the most important life cycle phase of software.

Fact 44. Understanding the existing product is the most difficult task of maintenance.

Fact 21. For every 25 percent increase in problem complexity, there is a 100 percent increase in solution complexity.

Robert Glass, *Facts and fallacies of Software Engineering*, Addison-Wesley 2003

## Overview

- Lectures
- Theory: papers + book
- Exam: lectures + papers + book
- Lab assignment: implement a little language
- Concluding

# Lectures

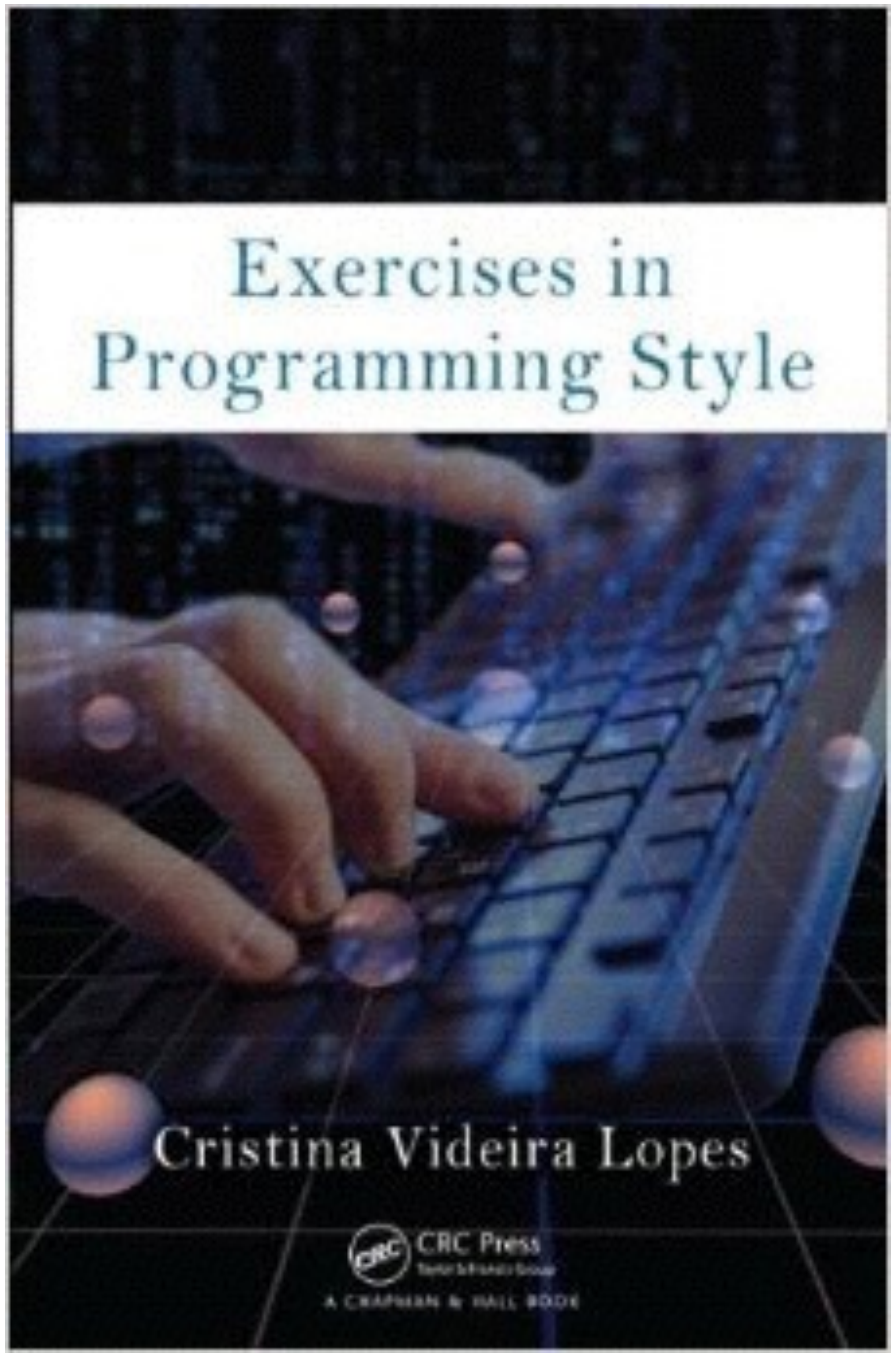
## Topics of the lectures

- Syntax analysis: grammars, parsers
- Programming styles, design principles etc.
- Code quality: tangling, scattering, duplication, smells, refactoring, layout
- Modularity: information hiding, separation of concerns, encapsulation, dependency
- ....

- Karl J. Lieberherr, Ian M. Holland, *Assuring Good Style for Object-Oriented Programs*, 1989, LieberherrHolland8
- D. L. Parnas, *On the criteria to be used in decomposing systems into modules* , 1972, Parnas72
- W. Wulf and Mary Shaw, *Global variable considered harmful*, 1973, WulfShaw84.
- John Hughes, *Why functional programming matters*, 1990 Hughes89
- Robert C. Martin, *Design principles and design patterns*, Martin00.
- Erich Gamma, Richard Helm, Ralpha Johnson, John Vlissides, *Design Patterns: Abstraction and Reuse of Objec Oriented Design*, ECOOP 93 GammaEtAl93
- Kent Beck and Martin Fowler, *Bad Smells in Code* (Chapter 3, *Refactoring*)
- Kent Beck, A theory of programming, (Chapter 3, *Implementation Patterns*)
- Kent Beck, *Aim, fire*, IEEE Software, Beck01
- Jeff Bay, *Object Calisthenics*, Bay.
- Ward Cunningham, *The CHECKS Pattern Language of Information Integrity*, checks
- Kernighan, Plauger, *Programming Style: Examples and Counterexamples*, 1974 kernighanPlauger
- Gregor Kiczales, John Lamping, Anurag Mendhekar, Chris Maeda, Cristina Videira Lopes, Jean-Marc Loingtier, John Irwin, *Aspect-Oriented Programming*, KiczalesEtAl97
- James Noble, *Arguments and Results*, Noble97

**Syllabus**

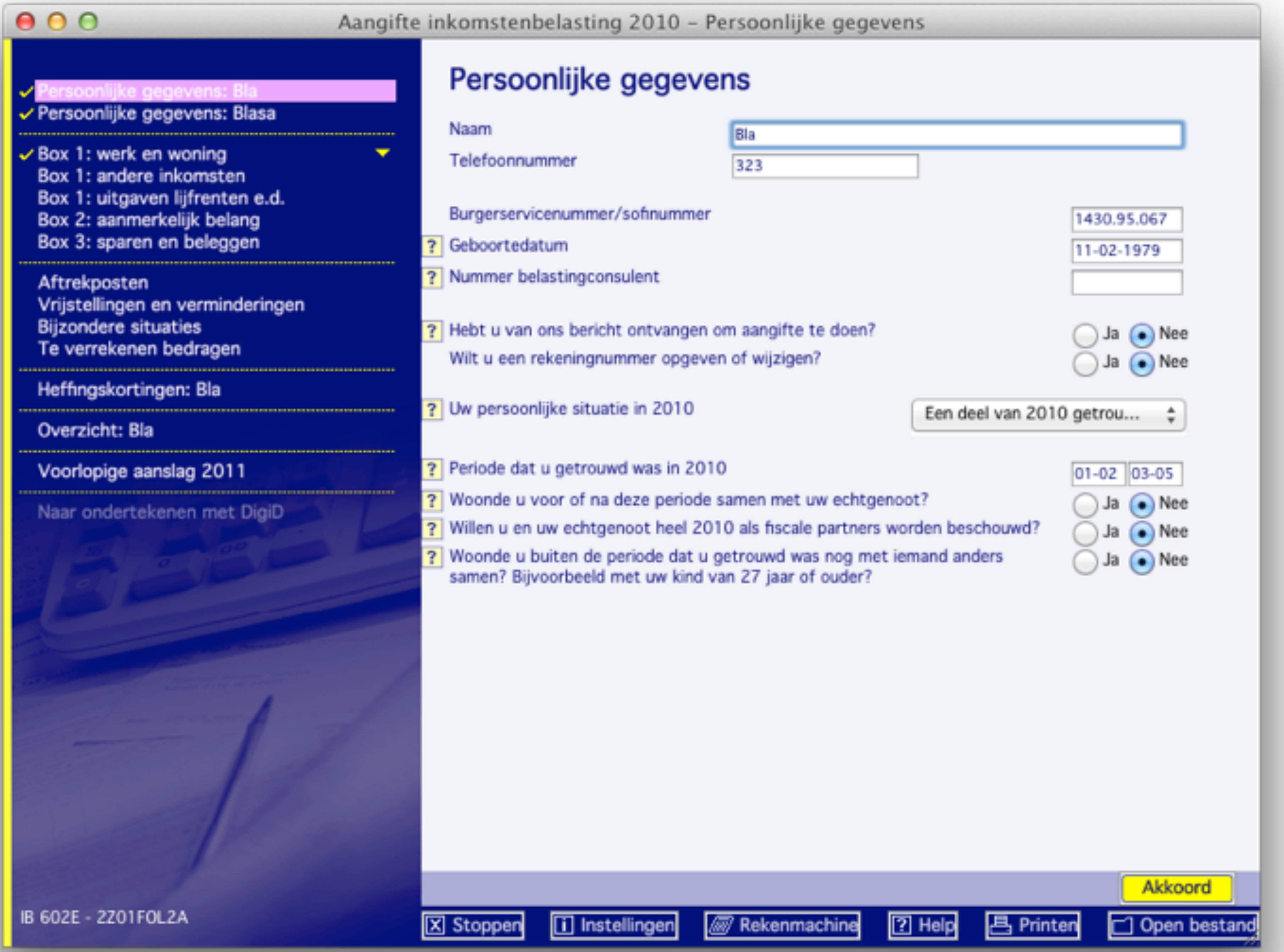
# Book: EiPS


Exercises in Programming Style
Cristina Videira Lopes
CRC Press
A CHAPMAN & HALL BOOK

# Final exam

- Open book exam
- Must have grade > 5.5
- Based on
  - Exercises in Programming Style
  - Lecture material
  - Syllabus

# Lab assignment



Aangifte inkomstenbelasting 2010 – Persoonlijke gegevens

✓ Persoonlijke gegevens: Bla
✓ Persoonlijke gegevens: Blasa
✓ Box 1: werk en woning
Box 1: andere inkomsten
Box 1: uitgaven lijfrenten e.d.
Box 2: aanmerkelijk belang
Box 3: sparen en beleggen
Aftrekposten
Vrijstellingen en verminderingen
Bijzondere situaties
Te verrekenen bedragen
Heffingskortingen: Bla
Overzicht: Bla
Voorlopige aanslag 2011
Naar ondertekenen met DigiD

IB 602E - 2Z01FOL2A

## Persoonlijke gegevens

| | |
|---|---|
| Naam | Bla |
| Telefoonnummer | 323 |
| Burgerservicenummer/sofinummer | 1430.95.067 |
| ? Geboortedatum | 11-02-1979 |
| ? Nummer belastingconsulent | |
| ? Hebt u van ons bericht ontvangen om aangifte te doen? | Ja [✓ Nee] |
| Wilt u een rekeningnummer opgeven of wijzigen? | Ja [✓ Nee] |
| ? Uw persoonlijke situatie in 2010 | Een deel van 2010 getrou... |
| ? Periode dat u getrouwd was in 2010 | 01-02 03-05 |
| ? Woonde u voor of na deze periode samen met uw echtgenoot? | Ja [✓ Nee] |
| ? Willen u en uw echtgenoot heel 2010 als fiscale partners worden beschouwd? | Ja [✓ Nee] |
| ? Woonde u buiten de periode dat u getrouwd was nog met iemand anders samen? Bijvoorbeeld met uw kind van 27 jaar of ouder? | Ja [✓ Nee] |

Form **1040** Department of the Treasury—Internal Revenue Service (99)
# U.S. Individual Income Tax Return
**2012** OMB No. 1545-0074 IRS Use Only—Do not write or staple in this space.

For the year Jan. 1–Dec. 31, 2012, or other tax year beginning , 2012, ending , 20 | See separate instructions.

| | | |
|---|---|---|
| Your first name and initial | Last name | **Your social security number** |
| If a joint return, spouse's first name and initial | Last name | **Spouse's social security number** |
| Home address (number and street). If you have a P.O. box, see instructions. | Apt. no. | ▲ Make sure the SSN(s) above and on line 6c are correct. |
| City, town or post office, state, and ZIP code. If you have a foreign address, also complete spaces below (see instructions). | | **Presidential Election Campaign** Check here if you, or your spouse if filing jointly, want $3 to go to this fund. Checking a box below will not change your tax or refund. ☐ You ☐ Spouse |
| Foreign country name | Foreign province/state/county | Foreign postal code |

## Filing Status

Check only one box.

1 ☐ Single
2 ☐ Married filing jointly (even if only one had income)
3 ☐ Married filing separately. Enter spouse's SSN above and full name here. ▶
4 ☐ Head of household (with qualifying person). (See instructions.) If the qualifying person is a child but not your dependent, enter this child's name here. ▶
5 ☐ Qualifying widow(er) with dependent child

## Exemptions

6a ☐ **Yourself.** If someone can claim you as a dependent, **do not** check box 6a . . . . .
b ☐ **Spouse** . . . . . . . . . . . . . . . . . . . . . . . . .
} **Boxes checked on 6a and 6b**

c **Dependents:**

| (1) First name Last name | (2) Dependent's social security number | (3) Dependent's relationship to you | (4) ✓ if child under age 17 qualifying for child tax credit (see instructions) |
|---|---|---|---|
| | | | ☐ |
| | | | ☐ |
| | | | ☐ |
| | | | ☐ |

If more than four dependents, see instructions and check here ▶ ☐

**No. of children on 6c who:**
**• lived with you**
**• did not live with you due to divorce or separation (see instructions)**
**Dependents on 6c not entered above**

d Total number of exemptions claimed . . . . . . . . . . . . . . . . . **Add numbers on lines above ▶**

## Income

**Attach Form(s) W-2 here. Also attach Forms W-2G and 1099-R if tax was withheld.**

If you did not get a W-2, see instructions.

Enclose, but do not attach, any payment. Also, please use **Form 1040-V.**

| | | | | | |
|---|---|---|---|---|---|
| 7 | Wages, salaries, tips, etc. Attach Form(s) W-2 . . . . . . . . . . . | | | 7 | |
| 8a | **Taxable** interest. Attach Schedule B if required . . . . . . . . . . | | | 8a | |
| b | **Tax-exempt** interest. **Do not** include on line 8a . . . | 8b | | | |
| 9a | Ordinary dividends. Attach Schedule B if required . . . . . . . . | | | 9a | |
| b | Qualified dividends . . . . . . . . . . | 9b | | | |
| 10 | Taxable refunds, credits, or offsets of state and local income taxes . . . . . | | | 10 | |
| 11 | Alimony received . . . . . . . . . . . . . . . . . . | | | 11 | |
| 12 | Business income or (loss). Attach Schedule C or C-EZ . . . . . . . . | | | 12 | |
| 13 | Capital gain or (loss). Attach Schedule D if required. If not required, check here ▶ ☐ | | | 13 | |
| 14 | Other gains or (losses). Attach Form 4797 . . . . . . . . . . . . | | | 14 | |
| 15a | IRA distributions . | 15a | | b Taxable amount . . . 15b | |
| 16a | Pensions and annuities | 16a | | b Taxable amount . . . 16b | |
| 17 | Rental real estate, royalties, partnerships, S corporations, trusts, etc. Attach Schedule E | | | 17 | |
| 18 | Farm income or (loss). Attach Schedule F . . . . . . . . . . . . | | | 18 | |
| 19 | Unemployment compensation . . . . . . . . . . . . . . . | | | 19 | |
| 20a | Social security benefits | 20a | | b Taxable amount . . . 20b | |
| 21 | Other income. List type and amount | | | 21 | |
| 22 | Combine the amounts in the far right column for lines 7 through 21. This is your **total income** ▶ | | | 22 | |

## Adjusted Gross Income

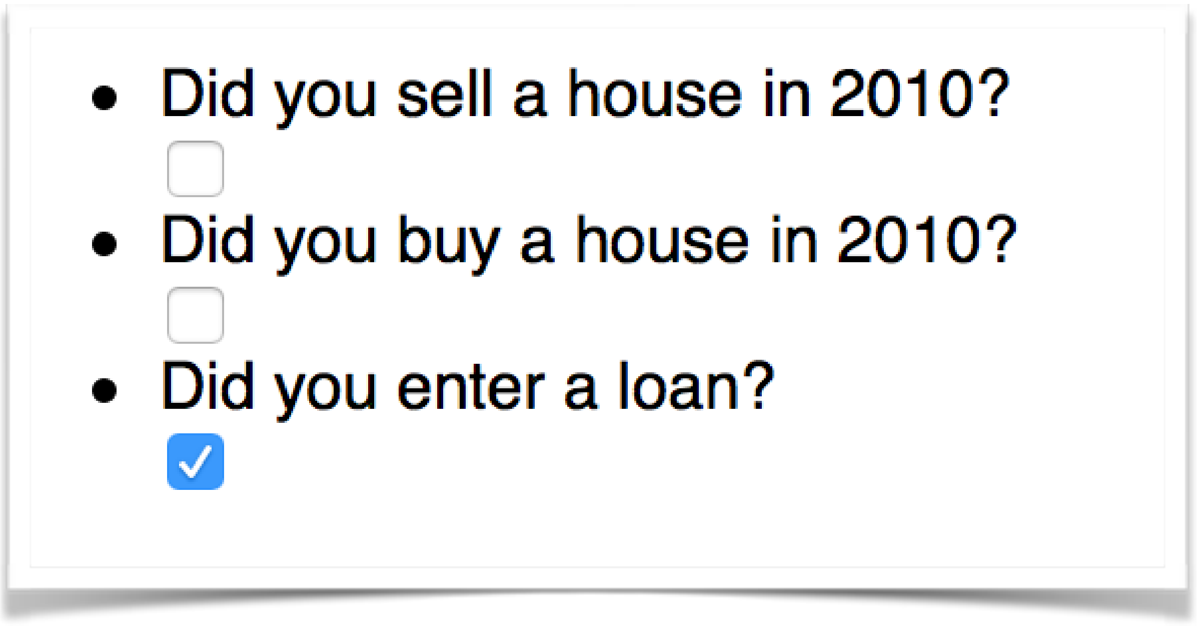
| | | | | | |
|---|---|---|---|---|---|
| 23 | Reserved . . . . . . . . . . . . . . | 23 | | | |
| 24 | Certain business expenses of reservists, performing artists, and fee-basis government officials. Attach Form 2106 or 2106-EZ | 24 | | | |
| 25 | Health savings account deduction. Attach Form 8889 . | 25 | | | |
| 26 | Moving expenses. Attach Form 3903 . . . . . . | 26 | | | |
| 27 | Deductible part of self-employment tax. Attach Schedule SE . | 27 | | | |
| 28 | Self-employed SEP, SIMPLE, and qualified plans . . | 28 | | | |
| 29 | Self-employed health insurance deduction . . . . | 29 | | | |
| 30 | Penalty on early withdrawal of savings . . . . . . | 30 | | | |
| 31a | Alimony paid **b** Recipient's SSN ▶ | 31a | | | |
| 32 | IRA deduction . . . . . . . . . . . . . | 32 | | | |
| 33 | Student loan interest deduction . . . . . . . . | 33 | | | |
| 34 | Reserved . . . . . . . . . . . . . . | 34 | | | |
| 35 | Domestic production activities deduction. Attach Form 8903 | 35 | | | |
| 36 | Add lines 23 through 35 . . . . . . . . . . . . . . . . | | | 36 | |
| 37 | Subtract line 36 from line 22. This is your **adjusted gross income** . . . . . ▶ | | | 37 | |

# Part 1: Questionnaire Language (QL)

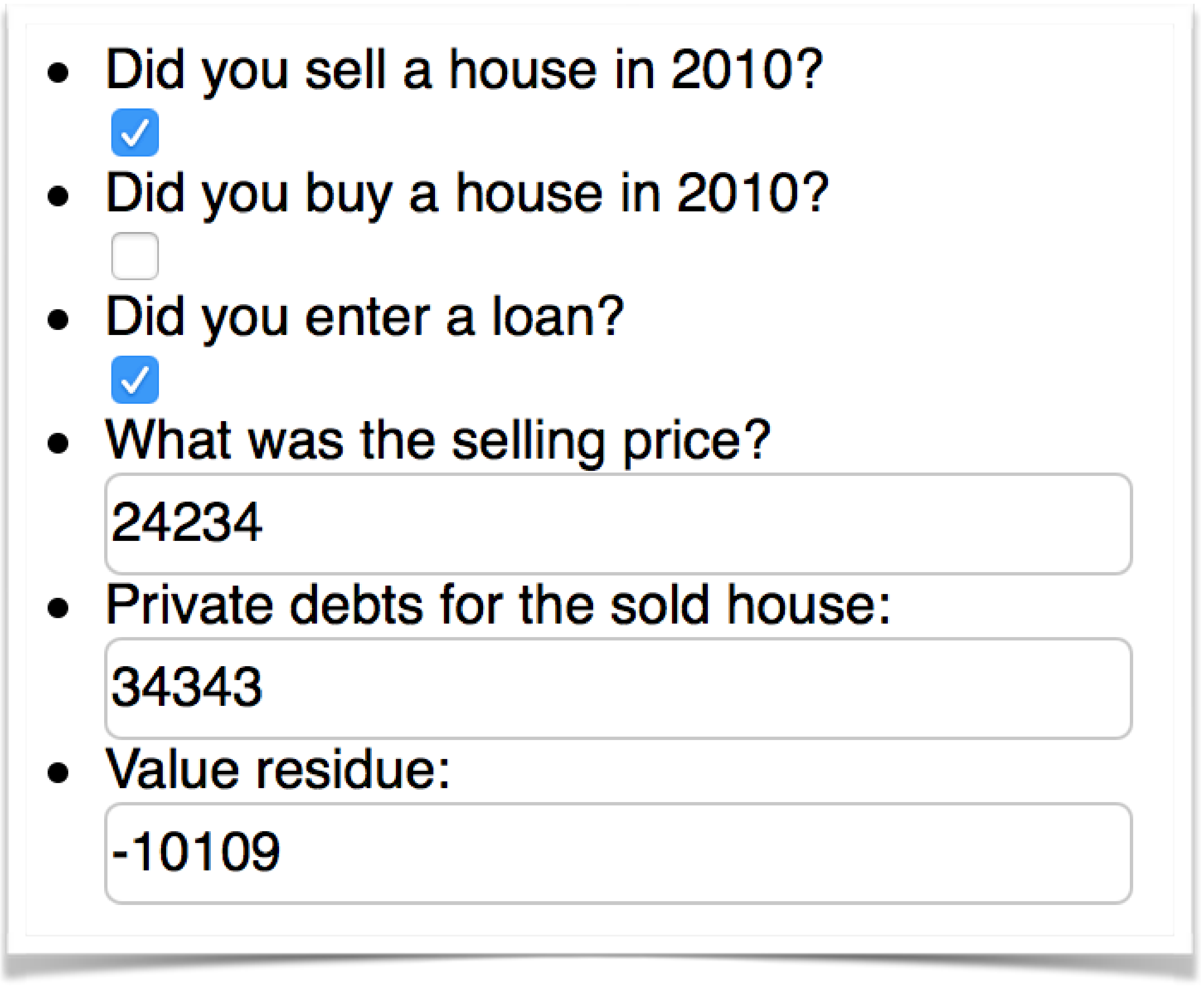
```
form taxOfficeExample {
  "Did you sell a house in 2010?"
    hasSoldHouse: boolean
  "Did you buy a house in 2010?"
    hasBoughtHouse: boolean
  "Did you enter a loan?"
    hasMaintLoan: boolean

  if (hasSoldHouse) {
    "What was the selling price?"
      sellingPrice: money
    "Private debts for the sold house:"
      privateDebt: money
    "Value residue:"
      valueResidue: money =
        (sellingPrice - privateDebt)
  }
}
```

Describe the logic of interactive questionnaires



- Did you sell a house in 2010?
  ☐
- Did you buy a house in 2010?
  ☐
- Did you enter a loan?
  ✓



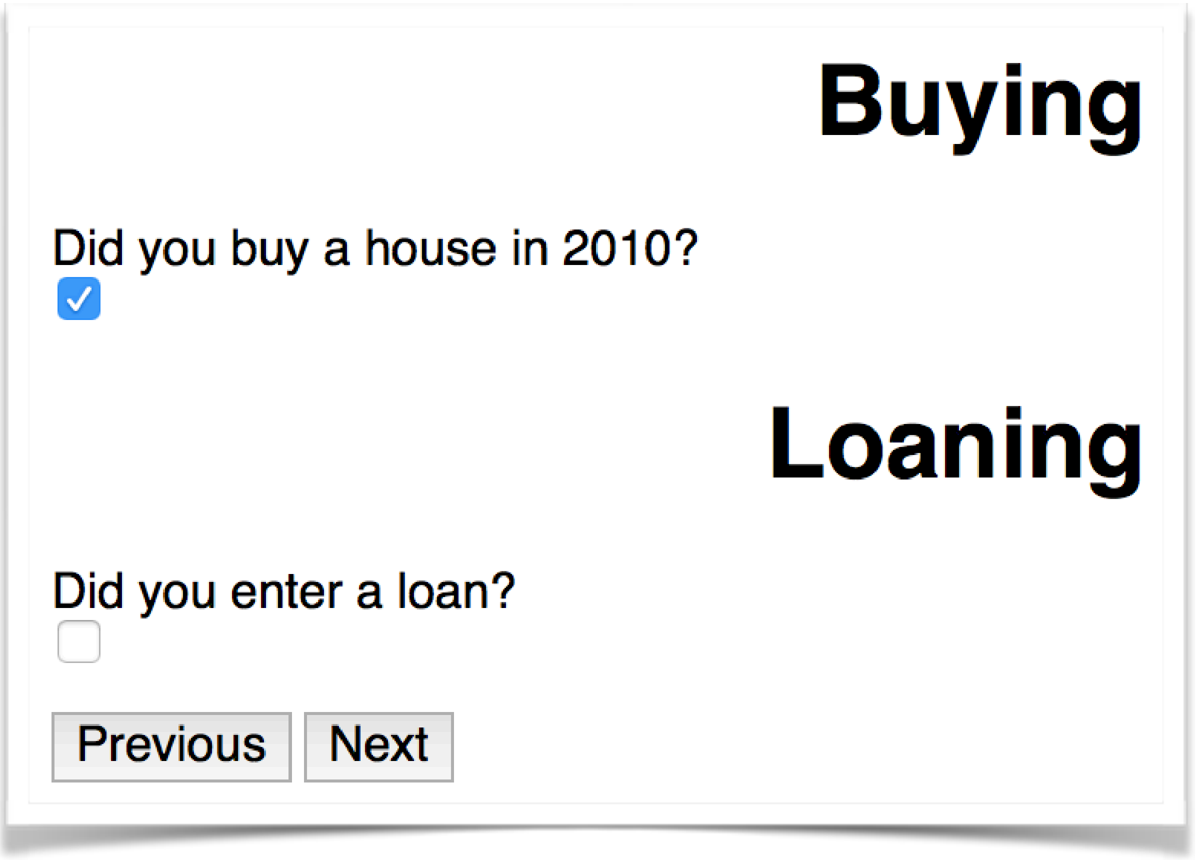
- Did you sell a house in 2010?
  ✓
- Did you buy a house in 2010?
  ☐
- Did you enter a loan?
  ✓
- What was the selling price?
  24234
- Private debts for the sold house:
  34343
- Value residue:
  -10109

# QLS

Language for styling questionnaires

```
stylesheet taxOfficeExample
  page Housing {
    section "Buying"
      question hasBoughtHouse
        widget checkbox
    section "Loaning"
      question hasMaintLoan
  }

  page Selling {
    section "Selling" {
      question hasSoldHouse
        widget radio("Yes", "No")
      section "You sold a house" {
        question sellingPrice
          widget spinbox
        question privateDebt
          widget spinbox
        question valueResidue
        default money {
          width: 400
          font: "Arial"
          fontsize: 14
          color: #999999
          widget spinbox
        }
      }
    }
    default boolean widget radio("Yes", "No")
  }
```

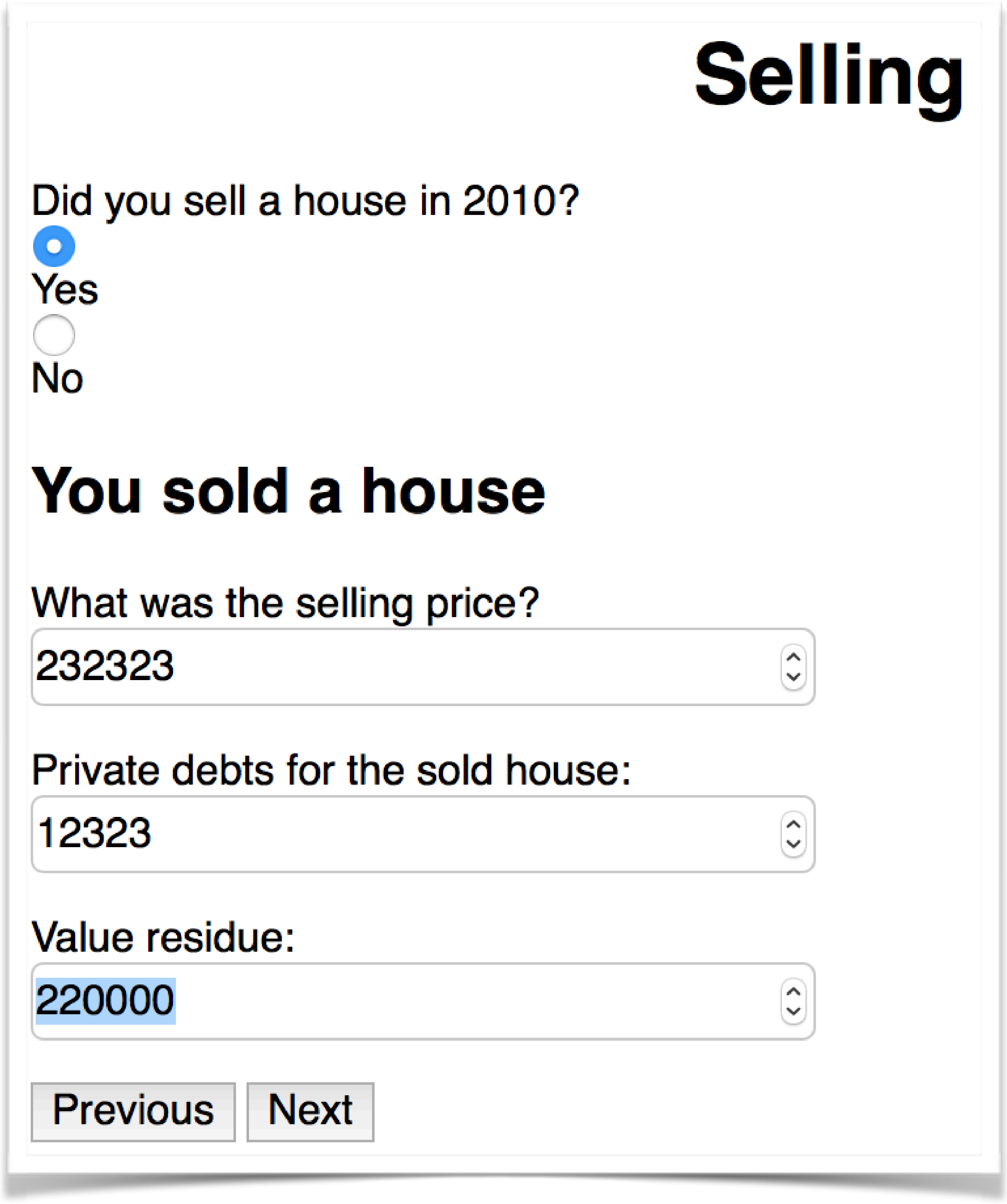


## Buying

Did you buy a house in 2010?
☑

## Loaning

Did you enter a loan?
☐



## Selling

Did you sell a house in 2010?
[✓ Yes] No

## You sold a house

What was the selling price?
232323

Private debts for the sold house:
12323

Value residue:
220000

## Part 1: QL

- Parser: text to abstract syntax tree (AST)
- AST hierarchy
- Type checker/Wellformedness checker
- Expression evaluator
- Renderer as GUI
  (interpreter! Not a compiler)

# Bonus: QLS

- Parser: text to abstract syntax tree (AST)
- AST hierarchy
- Wellformedness checker WRT QL program
- Renderer as stylized GUI
- Challenge: modular implementation
- QL **should** work standalone (w/o QLS)

# No server-side web apps!

- server/client distinction is a distraction
- essentially code generation all over the place

## Programming language

- Java, C#, Javascript, Typescript, Haskell, Scala, Clojure, Erlang, Smalltalk/Pharo, Ruby, Python, Go, Dart, Swift, Objective-C, F#, Rust, …
- Java: you may want to use one of the provided parsing skeletons for expressions in QL
    - *Rats!*, Jacc, ANTLR

## Honor's track: build your own DSL

# Github

- Assignment to be completed *individually*
  - (except honor's track)
- https://github.com/software-engineering-amsterdam/multi-ql
- Use of this repository is **required**!
- Commit often!

# “Hour of code”

- During lab sessions (Wed 14:00/Thur 9:15)
- Convene in single room
- 2 persons per session present their code.
- No slides. Code.
- Constructive feedback and criticism.
- Let’s help each other.

# Grading of lab assignments

- Functionality
- Testing
- Simplicity
- Modularity
- Layout and style
- Separation of concerns

Simplici
ty

# Self pre-assessment

- Before grading moments:
- You fill out an online questionnaire
- This will help us
  - navigate the code
  - ask the right questions

# Some advice up-front

- Naming, layout, indentation
- Encapsulation, modularity, separation of concerns, reuse
- Don’t repeat yourself (DRY)
- Library and tool selection and use
- Unit testing

## More advice

- Use asserts sensibly
- No global, static, non-final variables
- You ain't going to need it (YAGNI)
- Avoid premature optimization
- Use comments for rationale
- *Compiling* ***and*** *working code*

## Grading (ctd.)

- First part: your grade is *indicative*
  - incentive to improve your code
- Second part: we review all code
  - this will be your *final* grade for the lab
- Grading is on-site: *you* show your code
- Grade is less important than personal improvement is

# Passing this course

- Be present at all lectures
- Be present during lab sessions
- Pass the the exam with grade > 5.5
- Pass lab assignment with grade > 5.5
- Final grade: average of lab and exam
- NOTE: both grades need to be > 5.5

# Concluding

- All information is on Github
- Primary contact = storm@cwi.nl
- Please follow @SoftwCons

## What’s next

- For the coming days
  - make up your mind on language
  - start checking out parser generators
  - start coding!