NPRG075

Assignment & How to do programming language research

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Lectures: Tuesday 12:20, S6
https://d3s.mff.cuni.cz/teaching/nprg075

Assignment

Requirements & expectations

Assignment

What the course page says

- Complete a small independent project
- Use one of the methodologies discussed
- Study or design an aspect of system
- Produce a brief report about your work

Scope of the project

Formal quantification

- Course is 3 ECTS credits
- Credit is 20-30 hours of work
- $75 - (12 * 1.5 + 10) = 47$

What does this mean

- About a week of actual work
- Includes all stages of the project
- Idea, research, implementation, write-up

Project

Research and implementation

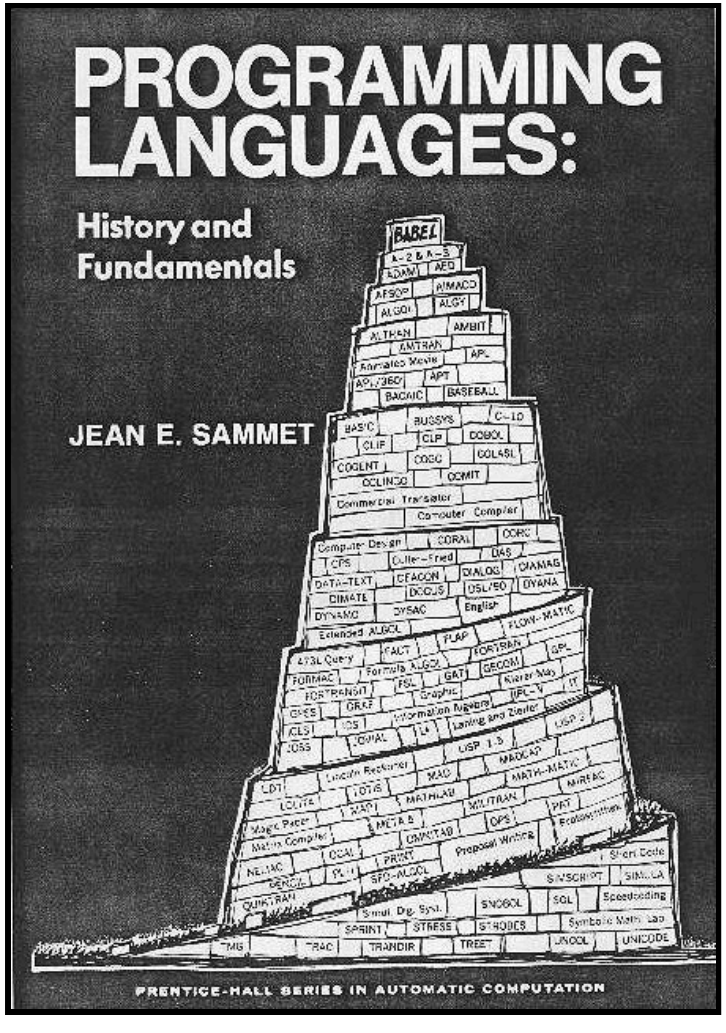

Depends on the methodology!


Writing code, formal models, design patterns


Analysing past or contemporary systems


Sketching a new idea for a design


You cannot write much code in two days!



Programming language?

Anything involved in instructing the computer!

Language, programming environment, runtime system, framework, library, command line tool or AI

Small aspect or a feature!

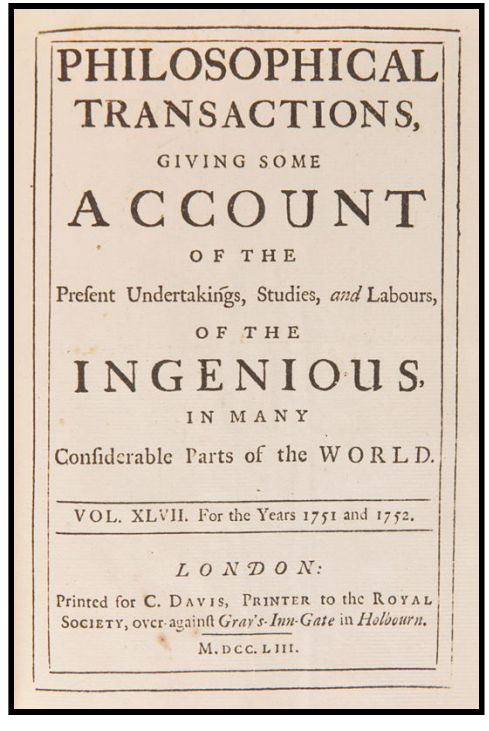
Writing a report

Communicate your work

- What is the main idea?
- What did you do, learn, conclude?
- Think a brief research paper

Research paper

- Contribute a tiny piece of knowledge!
- Shorter for design, longer for analysis
- From lab report to an essay
- How to write a research paper by SPJ


PHILOSOPHICAL
TRANSACTIONS,
GIVING SOME
ACCOUNT
OF THE
Preſent Undertakings, Studies, *and* Labours,
OF THE
INGENIOUS
IN MANY
Conſiderable Parts of the WORLD.
VOL. XLVII. For the Years 1751 and 1752.
LONDON:
Printed for C. DAVIS, PRINTER to the ROYAL SOCIETY, over-againſt *Gray's-Inn-Gate* in *Holbourn.*
M.DCC.LIII.

It is your project

Do something you actually care about

Reuse & overlap is encouraged!

Thesis, other courses, work project, hobby topic, blog post, workshop paper

Programming languages

How to do research?

Programming

Getting research ideas

- Frustration - fix a problem I'm facing!
- Methodology - use a method I like for something
- User-centric - identify what others need
- Analytical - understand something properly

Fix a problem I have

Example problems

- Client-server programming is hard
  Write webs as single F# program?
- Managing large PHP repo is hard
  Add types and an efficient VM to PHP?

How to do this

- Use your knowledge expertise!
- "Look I did this cool thing!" is not research claim
- Describe design, formal model, positioning, evaluation

Spiralling abstraction

Web programming is hard

Write a new language!

Creating languages is hard

Define a formal model!

Defining models is hard

Use category theory!

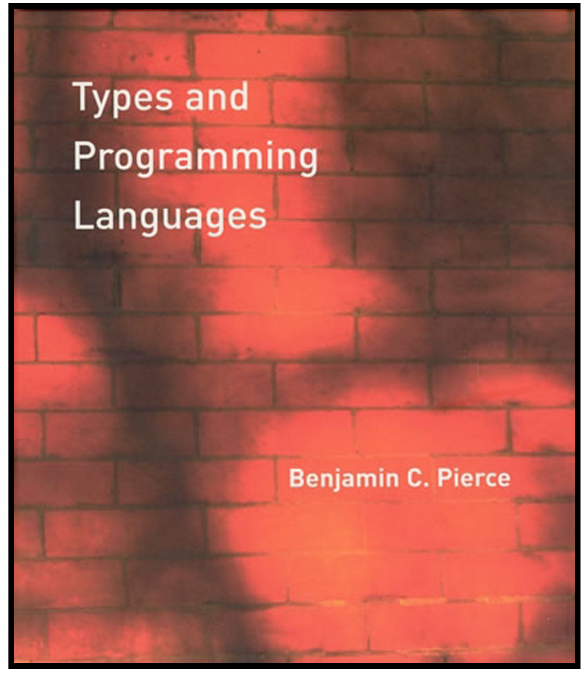
Category theory is hard

Use category theory...?

Use a method I like

Example methods

- Types for correctness
  Check network communication
- Close reading of code
  Look at BASIC, UNIX, etc.



How to do this

- Find problem to fit a method
- Reshape problem so that method applies
- May be hard to motivate for new methods

User-centric programming research

Example areas

- Developer tools
  How programmers search? reCode
- Data journalists
  Interactive documents language Idyll

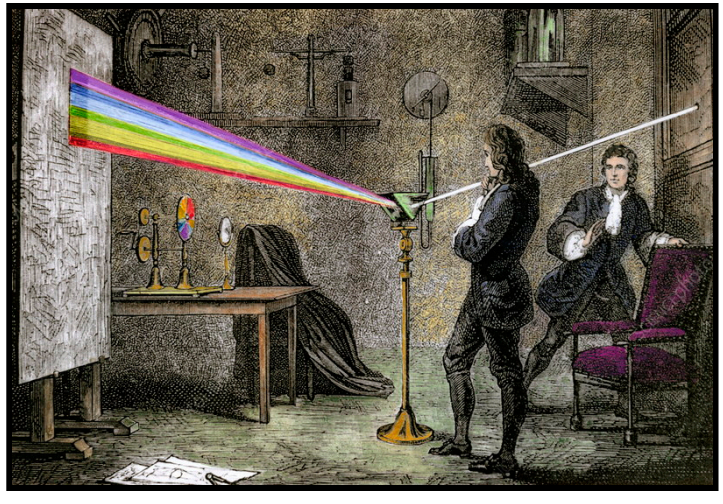
How to do this

- Small-scale formative interviews
- Analyse answers & define design goals
- (Implement and evaluate solution.)

Understand something properly

Example problems

- Modern web frameworks
  A formal semantics of React
- Empirical code studies
  Large-scale analysis of GitHub



How to do this

- Start by being confused or surprised!
- Formalization, reproduction, comparative analysis
- Result should make the matter clear

Research methods

Ways of looking at programming

Methods: Historical study

- Evolution of a programming concept
  How has a concept changed over time?

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- Cultures of programming analysis
  Do different communities talk about a thing differently?

Methods: Historical study

- Evolution of a programming concept
  How has a concept changed over time?
- Cultures of programming analysis
  Do different communities talk about a thing differently?
- Close look at a past system
  In-depth analysis of how something in the past worked

Methods: Design and culture

A Critical study of interesting source
Close look at a clever hack, famous snippet, etc.

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  Close look at a clever hack, famous snippet, etc.
- Design of a pattern language
  How to design a specific kind of application or system

Methods: Design and culture

- Critical study of interesting source
  Close look at a clever hack, famous snippet, etc.
- Design of a pattern language
  How to design a specific kind of application or system
- Exploring a design metaphor
  Programming as architecture, writing, gardening, etc.

Methods: Empirical and formal

Empirical analysis of source code

How do different kinds of source code differ?

Methods: Empirical and formal

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Small experimental user study

Formative interview or small usability study

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Formal semantics or a model

Of something confusing, like React state management

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Formal semantics or a model

Of something confusing, like React state management

Type system design description

Small but confusing feature like overload resolution

Methods: Heuristic analysis

- Notation analysis using cognitive dimensions
  Comparative analysis of two possible notations

Methods: Heuristic analysis

- Notation analysis using cognitive dimensions
  Comparative analysis of two possible notations
- System analysis using technical dimensions
  Evaluation of non-standard programming environment

Methods: Heuristic analysis

Notation analysis using cognitive dimensions

Comparative analysis of two possible notations

System analysis using technical dimensions

Evaluation of non-standard programming environment

Design or explanation using cognitive model

Programmer misconceptions, design for cognitive fit

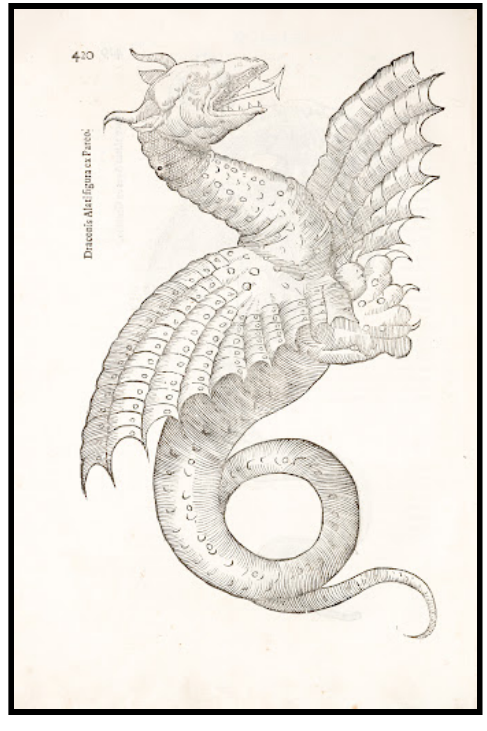
Past projects

Inspiration and ideas

Past projects

Quantitative coding style analysis

- Empirical analysis
- Style of different kinds of Python



Evolution of CLOS system

- History of the LISP object model

Patterns in Package Managers

- Pattern language for designing package managers.

Conclusions

Final tips

Reading

How to write a research paper

- By Simon Peyton-Jones
- tinyurl.com/nprg075-paper (PDF)

Why should you read this?

- Report is like a mini-paper
- Not all advice applies, but...
- Good hints on writing, structure, etc.