Advances in Programming Languages

APL1: What's so important about language?

Ian Stark

School of Informatics
The University of Edinburgh

Tuesday 17 September 2013
Semester 1 Week 1

Vital Statistics

Course: Advances in Programming Languages

Lecturer: Ian Stark

Level: Undergraduate year 4 and MSc students (10 credit points at level 10)

When: 1510–1600 Tuesday & Friday

Where: Forrest Hill 3.D02

Web: http://www.inf.ed.ac.uk/teaching/courses/apl

Blog: http://blog.inf.ed.ac.uk/apl13

Problem

Family illness means that I am not able to lecture this semester.

(If you are doing a UG4/UG5 project with me, I'm hoping to keep those up.)

The Director of Teaching is consulting other staff who might possibly take on APL as an additional course, but given the specialist nature of the course and the extraordinarily late notice this is a rather long shot.

Final confirmation as to whether the course is running (and if so, how) will come by Friday. For the rest of this lecture I propose to:

- Enthuse about advances in programming languages, as I was planning to do anyway;
- Suggest other excellent courses running in Semester 1 which have some relation to APL and you might take instead.

My sincere apologies for the disruption.

Formalities: http://www.drps.ed.ac.uk/13-14/regulations/disclaimer.php

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Programmability

The computer is *protean*, capable of assuming many forms.

All three are significant, but are mutually dependent for their effectiveness.

Exercises

1. Write down three programming languages.
2. Write down three language paradigms or characteristics.
3. Write down three reasons to choose a particular language.

What matters in a programming language?

We might like a language that is:

- Easy to learn, quick to write, expressive, concise, powerful, supported, well-provided with libraries, cheap, popular, ...

It might help us to write programs that are:

- Readable, correct, fast, reliable, predictable, maintainable, secure, robust, portable, testable, verifiable, composable, ...

It might help us address challenges in:

- Multicore architectures, distributed computing, warehouse-scale computation, programming the web, quantum computing, ...

Shaping the conceivable

Languages frame the way we think, and the programs we can imagine.

Sapir-Whorf Hypothesis

We dissect nature along lines laid down by our native language

This claim is not without controversy; both in its original domain of linguistics, and as more recently applied to programming languages.

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Perlis: A language that doesn't affect the way you think about programming, is not worth knowing [Epigrams on Programming, 1982]

That's a bit philosophical

Does this really happen? Can programming languages help us write new kinds of program? Or even manage to stop us from writing bad ones?

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Does this really happen? Maybe.

- LISP S-expressions, metaprogramming, treating code as data.
- Higher-order functions. For example, *parser combinators*:

```
expr = (expr `then` opn `then` expr) `or` term
opn  = (char '+') `or` (char '-')
term = ...
```

- Objects: packaging private state with methods to act on it.
- Laziness for infinite datastructures:

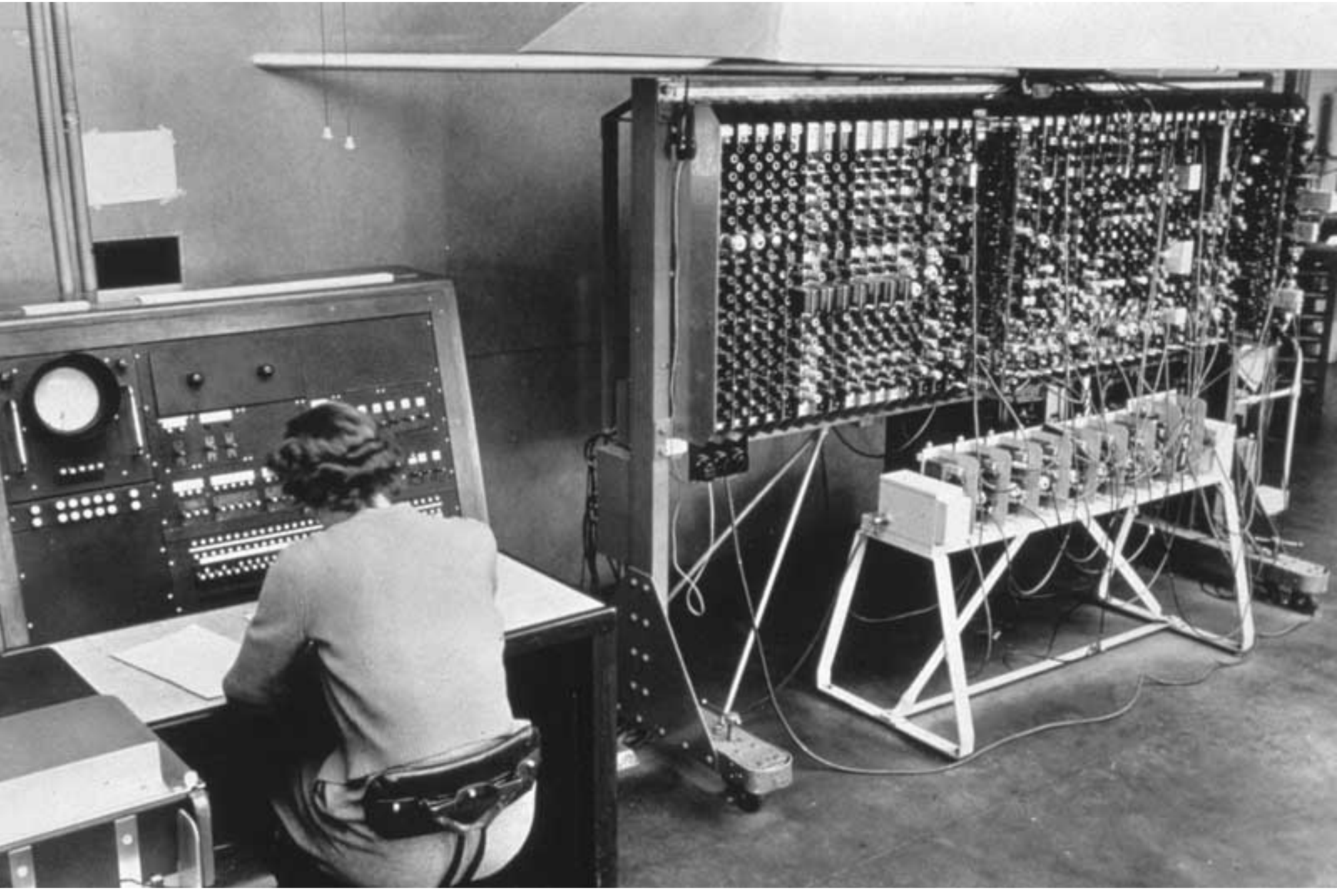
```
odds = 3 : map (+2) odds
fibs = 1 : 1 : [ a+b | (a,b) <- zip fibs (tail fibs) ]
```

- [Your suggestion here...]

Properties

One of the defining feature of computers is that they are *programmable*.

Programmability means that computers can always do more. Best of all, you can program new ways to program.



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That is:

> If you don't like the computer you have, you can create a better one

[Miller, LtU, 2009-05-11]

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Whitehead: Civilization advances by extending the number of important operations which we can perform without thinking about them. Operations of thought are like cavalry charges in a battle — they are strictly limited in number, they require fresh horses, and must only be made at decisive moments. [Introduction to Mathematics, 1911]

What's in the course?

The lectures will cover four sample areas of "advances in programming languages":

- Programming for concurrent code
- Dependent types
- LINQ and cross-language integration in .NET
- Augmented languages for correctness and certification

Lectures also specify reading and exercises on the topics covered. This homework is not assessed, but it is essential in order to fully participate in the course.

There is substantial piece of written coursework which contributes 20% of your course grade. This requires investigation of a topic in programming languages and writing a 10-page report with example code.

Communication

Web

http://www.inf.ed.ac.uk/teaching/courses/apl/

The course web page gives basic information, and through the semester will carry lecture slides, details of coursework and exams.

Lecturer

The most effective way to contact the lecturer is by personal email, from your University email address. However, many questions are even better posed through comments on the course blog or discussion forum.

The mailing list apl-students@inf.ed.ac.uk reaches all APL students and staff. Check http://lists.inf.ed.ac.uk/ to see that you are listed correctly.

Blog

http://blog.inf.ed.ac.uk/apl13

You should read the course blog. It carries the lecture log, slides, and information about homework exercises.

It also has a discussion forum. You can add comments, and respond to the questions of others. Please do.

Crystal ball gazing

Some areas to watch, and possible drivers of future language design:

- Multicore
- Weak memory models
- General-purpose computing on GPUs, FPGAs
- Warehouse-scale computing and upwards
- {Cloud,mobile,web} computing
- Dynamic languages
- Trustworthy code
- Quantum computing

Don't take this too seriously: some of these have been on the "soon to be hot" list for decades. What would you put on your list?

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e.g., the *Biological Computation* group at Microsoft Research UK work on programming languages for living cells and their DNA

Homework

If there is a next lecture, then it will be at 1510 on Friday and about programming for concurrency. I shall post a note on the blog confirming the course status before then.

Regardless of whether or not the course continues, I still recommend you go and learn interesting things about programming languages. Some very easy starters:

1. Read the Wikipedia article on *History of programming languages*. (If you find it's missing something, fix that.)

2. Find out about the *Blub Paradox*.

Some Excellent Semester 1 Courses

Year 4:

- Automated Reasoning
- Introduction to Quantum Computing
- Machine Learning and Pattern Recognition
- Communication and Concurrency

Year 5

- Design and Analysis of Parallel Algorithms
- Information Theory