

# Advances in Programming Languages

## APL1: What's so important about language?

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# What matters in a programming language?

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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, composable, . . .

# 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 just 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 = ...
```

- Laziness for infinite datastructures:

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

```
pi = g(1,180,60,2) where      -- Gibbons's spigot
  g(q,r,t,i) =
    let (u,y)=(3*(3*i+1)*(3*i+2),div(q*(27*i-12)+5*r)(5*t))
    in y : g(10*q*i*(2*i-1),10*u*(q*(5*i-2)+r-y*t),t*u,i+1)
```

- [Your suggestion here...]

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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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**Knuth:** Premature optimization is the root of all evil

[Structured Programming with go to Statements, 1974]



# What's in the course?

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

- Specifying and statically checking behaviour of Java code
- Type classes in Haskell can do anything
- Patterns and abstractions for programming concurrent code
- LINQ and cross-language integration in .NET

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

# Time plan

Week 1	Monday 11 January	Thursday 13 January
Week 2	Monday 18 January	Thursday 20 January
Week 3	Monday 25 January	Thursday 28 January
Week 4	Monday 1 February	Thursday 4 February
Week 5	Monday 8 February	Thursday 11 February
Week 6	Monday 15 February	Thursday 13 February
Week 7	Monday 22 February	Thursday 20 February
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This gives 22 slots.

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# 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.

## Lecturers

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

The mailing list [apl-students@inf.ed.ac.uk](mailto: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://blob.inf.ed.ac.uk/aplcourse/>

You should read the course blog. It carries the lecture log, slides, information about further reading and background material expanding on the references in the lectures.

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
- Relaxed memory models
- Quantum computing
- General-purpose computing on GPUs, FPGAs
- Warehouse-scale computing and upwards
- {Cloud,mobile,web} computing
- Dynamic languages
- Language-based security and assurance

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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Synthetic biology and programming languages for life?

see Venter's *Synthia*

## *The Secret Agenda of the Functional Illuminati*

All advances in the design of mainstream programming languages shall arise from existing functional languages.

Everything necessary can be found by contemplation of ML or Haskell.

The exceptionally adept may already discern all these in LISP.

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- ✓ Automatic memory management (everywhere these days)
- ✓ Exceptions (ditto)
- ✓ Parametric polymorphism (see Java/C# generics)
- ✓ Implicit pointers (any OO language)
- ✓ First-class functions (C# delegates)
- ✓ Immutable values (see Java `string`)
- ✓ Closures (lambdas in C#, Visual Basic 9, maybe C, Java 7?)
- ? Algebraic datatypes (still trying, but see Scala)
- ? First-class continuations (...)

# Homework

The next lecture is 9am on Thursday. Before then:

- 1 Read the Wikipedia article on *History of programming languages*. (If you find it's missing something, fix that.)
- 2 What is a *closure*? How does it differ from a *function pointer*? What are closures good for? What languages have them?

Post one or more of the following as comments on the blog entry for this lecture:

- An explanation of closures, or a pointer to an explanation online.
- An example of a closure in use.
- A language that has closures, and how you would represent one of the examples in it.

Please don't duplicate each other's answers — and no more than one language each, leave some for others.