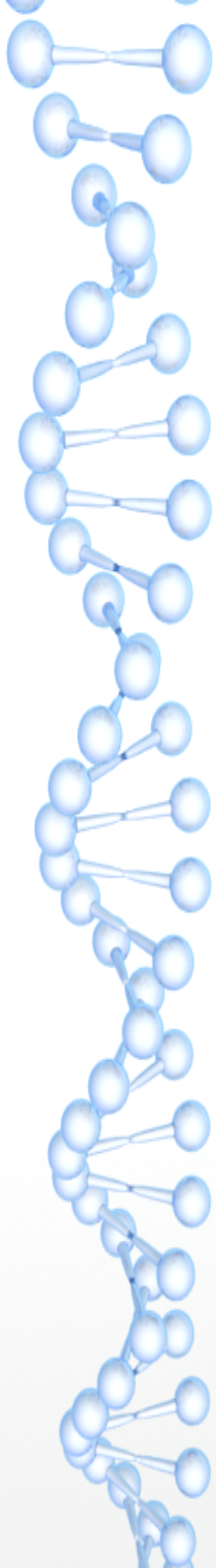
The Shape of Languages to Come



A (Brief) History of ME

Formed the company in 1982.

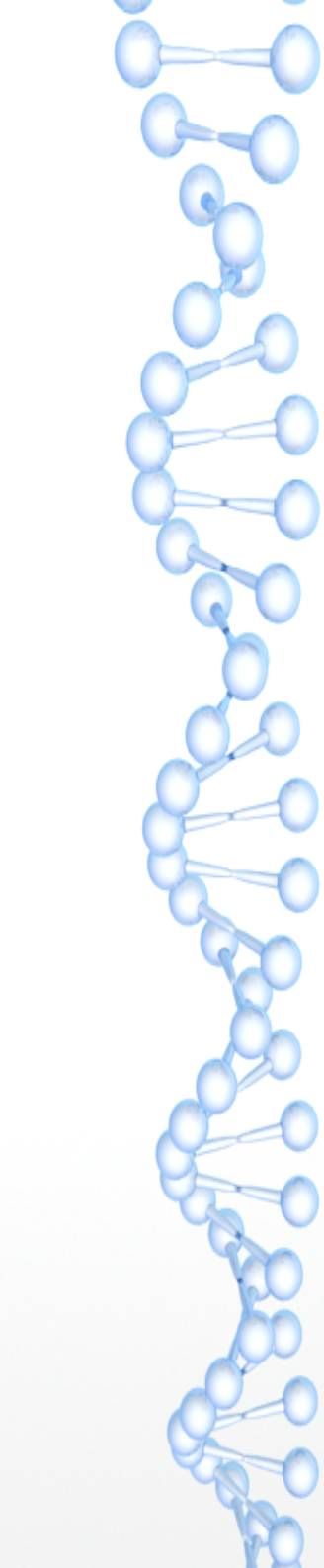
Previously teaching Engineering in Brighton.

Met the DEC PDP-11 and was hooked.

Over the years used between 20-30 different computer languages …..

….. but real passion is High Performance Computing (HPC).

Run a number of “meetup” groups.



Synopsis of the Talk

Taxonomy of programming languages.

What is this LLVM about anyway?

How quick is quick?

A demo using Julia

New Languages for Old

Q & A

Community Experience Distilled

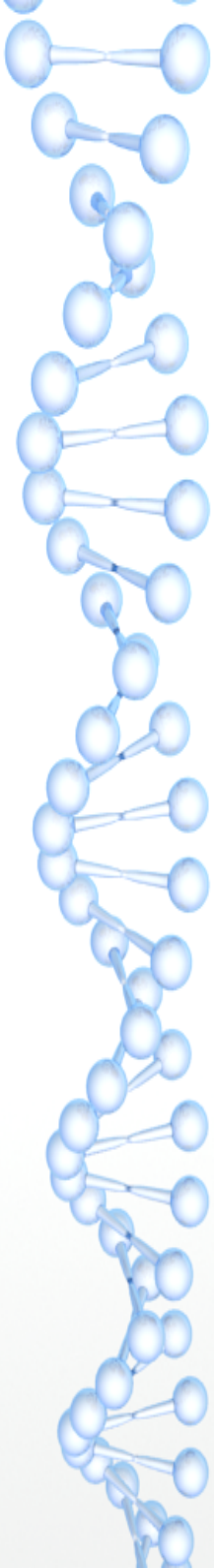
Mastering Julia

Master your analytical and programming skills in Julia to solve complex data processing problems

Dr Malcolm Sherrington

[PACKT] PUBLISHING open source* community experience distilled

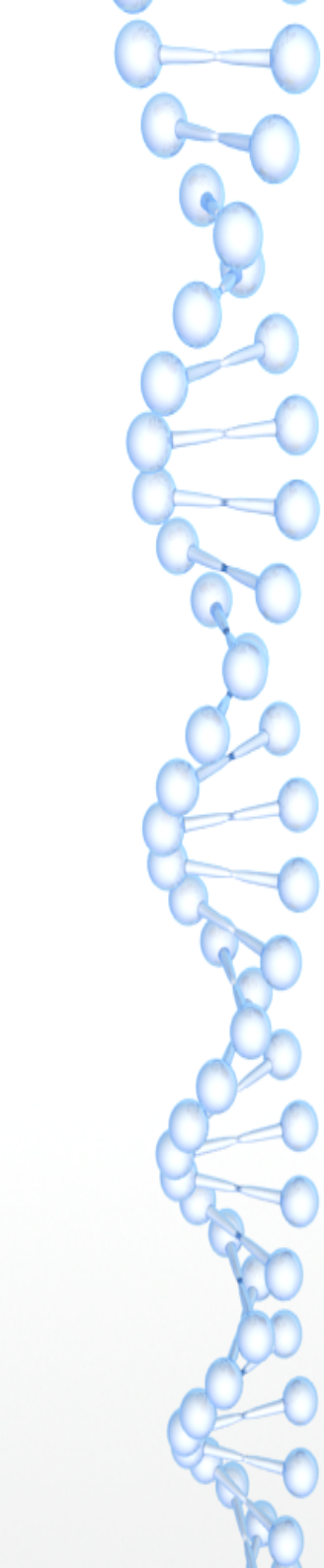
Taxonomy of programming languages



A programmer's perspective

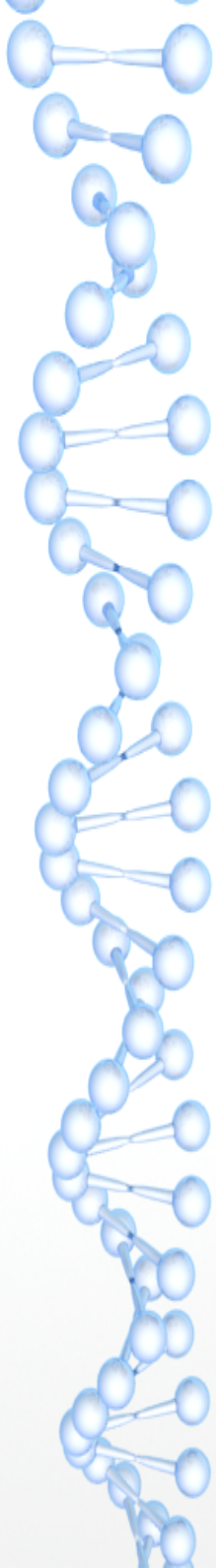
By application area

Systemic viewpoint



Systemic viewpoint

- Assembly languages
- Compilers
- Interpreters
- Intermediate code
- LLVM (Jitterring)



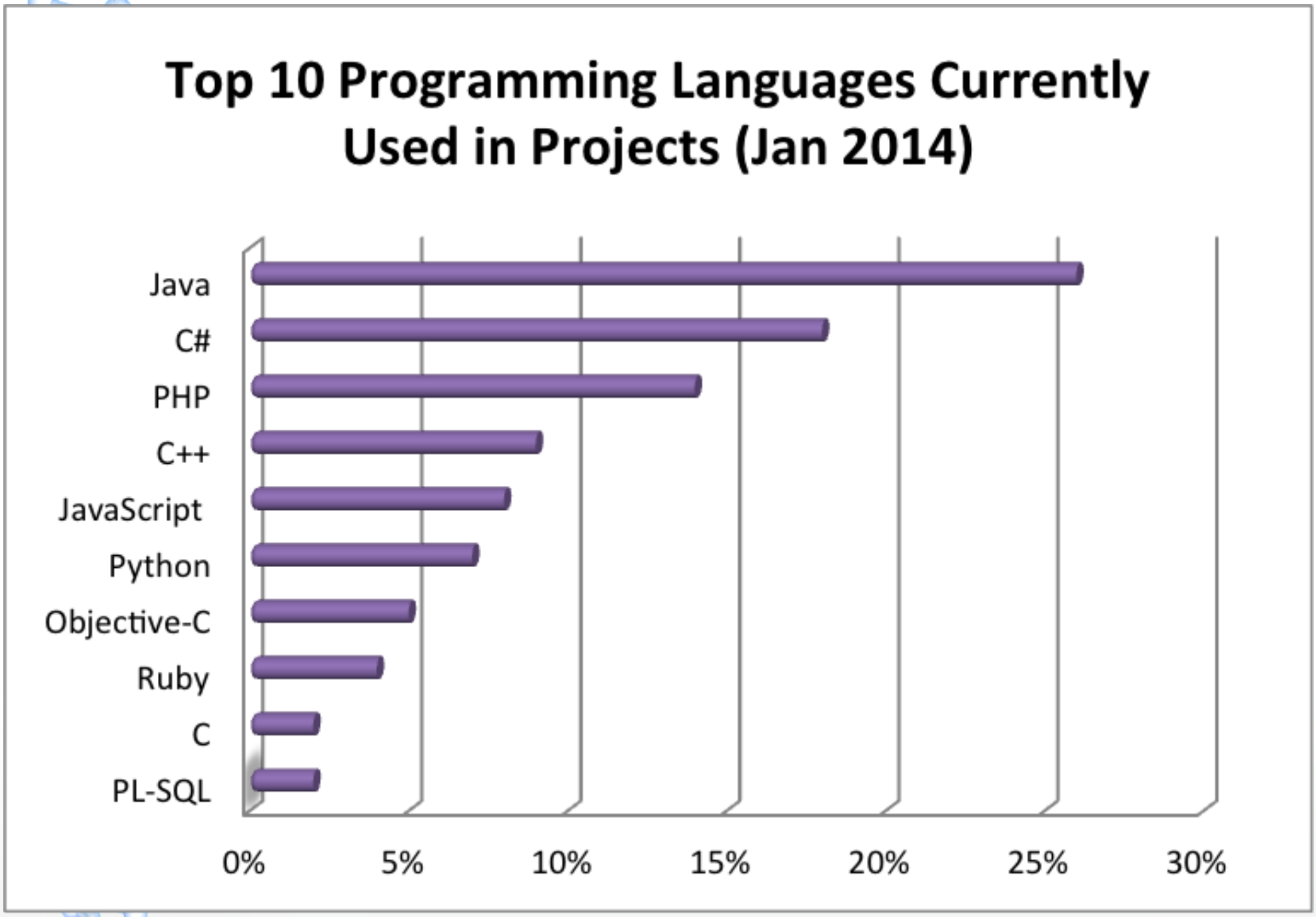
Assembly Languages

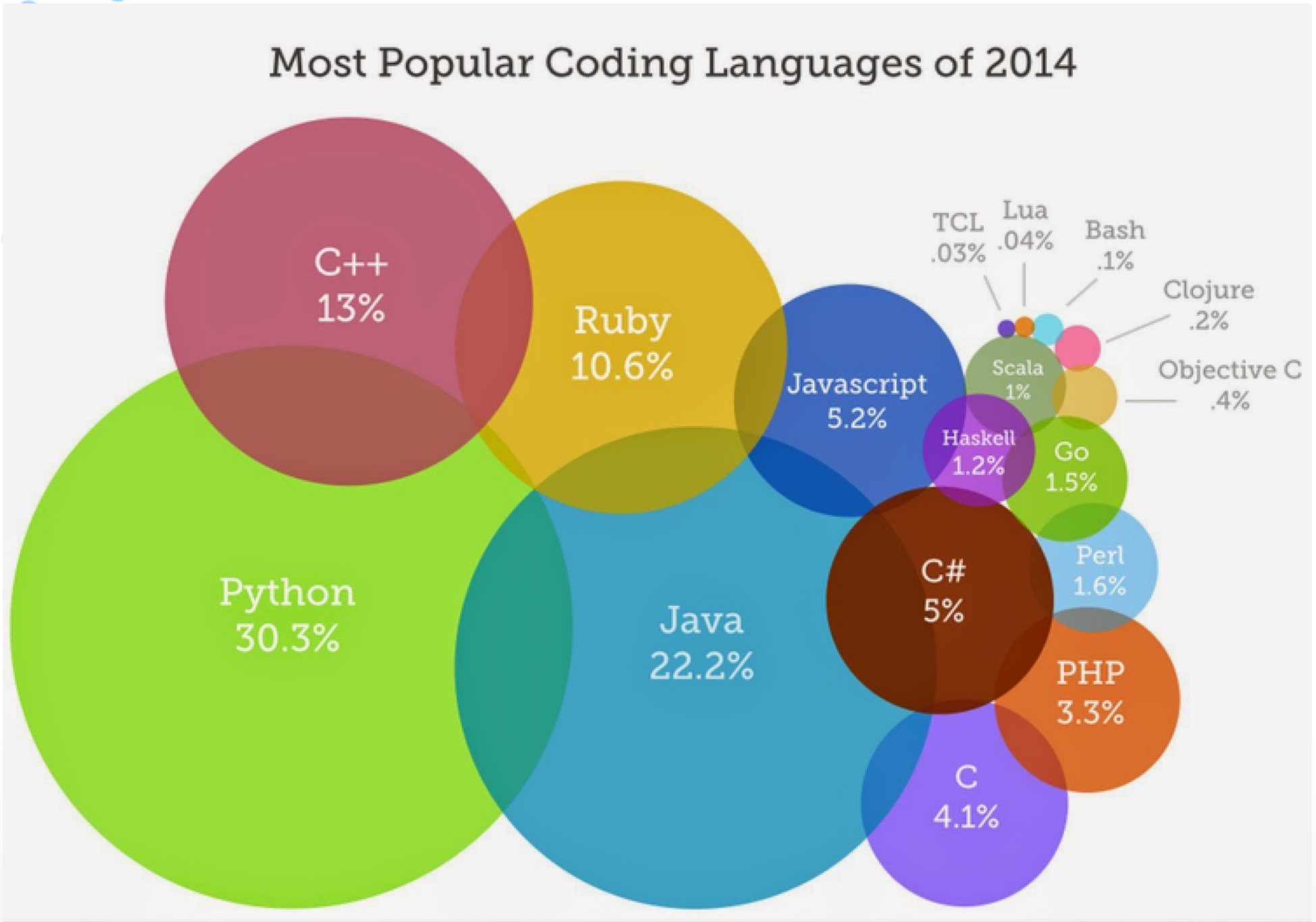
- Machine specific
- 1-to-1 correspondence between the computer architecture and the code
- Typically two passes through the code
- Used for on-board systems and operating system kernels
- Still common with FPGA's

1950's Languages

- FORTRAN (1954)
- LISP (1957)
- ALGOL (1958)
- COBOL (1959)
- JOVIAL (1959)

The computer language paradox


Top 10 Programming Languages Currently Used in Projects (Jan 2014)
Java
C#
PHP
C++
JavaScript
Python
Objective-C
Ruby
C
PL-SQL
0%
5%
10%
15%
20%
25%
30%


Most Popular Coding Languages of 2014
C++
13%
Ruby
10.6%
Javascript
5.2%
TCL
.03%
Lua
.04%
Bash
.1%
Clojure
.2%
Scala
1%
Objective C
.4%
Haskell
1.2%
Go
1.5%
Perl
1.6%
C#
5%
PHP
3.3%
Python
30.3%
Java
22.2%
C
4.1%

The LLVM project
started at UIUC in 2003

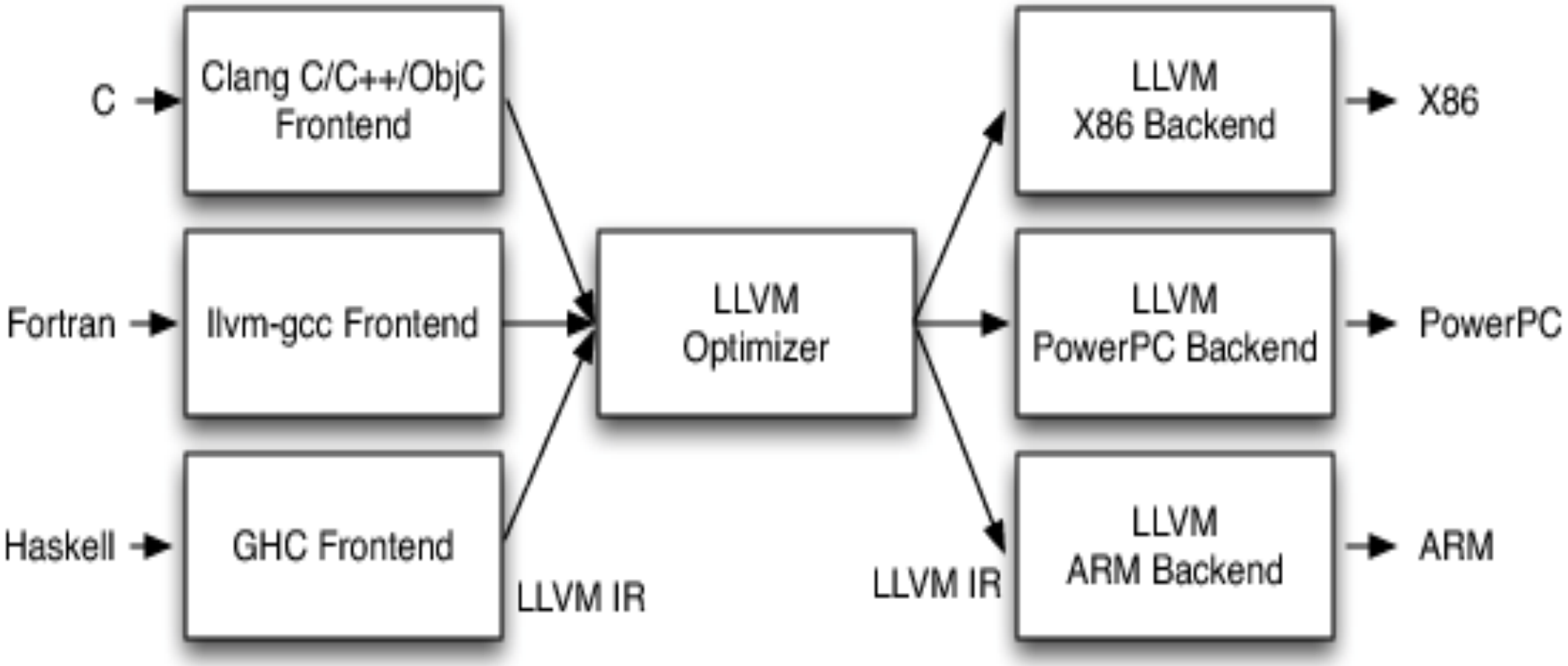
Main architect was Chris Lattner, now with Apple

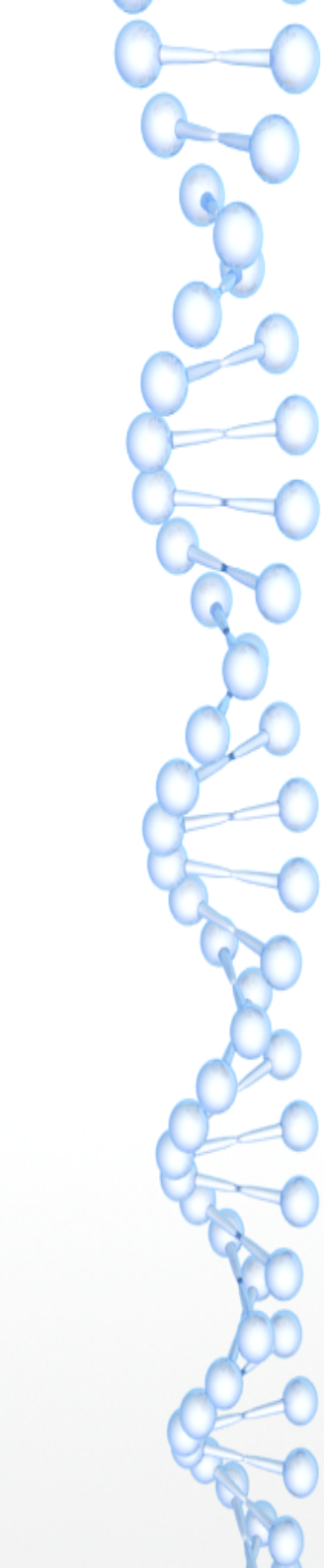
Is a JIT-tering system which converts IR code to specific assembly/machine code

Currently supports: X86, X86-64, ARM, AArch64, Mips, SystemZ, PowerPC

http://www.llvm.org

LLVM processing chain





What systems are now using LLVM?

As a compiler:

Clang, Swift, GNU, Haskell, Ruby
LDC, Clasp, LLgo

As a “bolt-on” module / extension

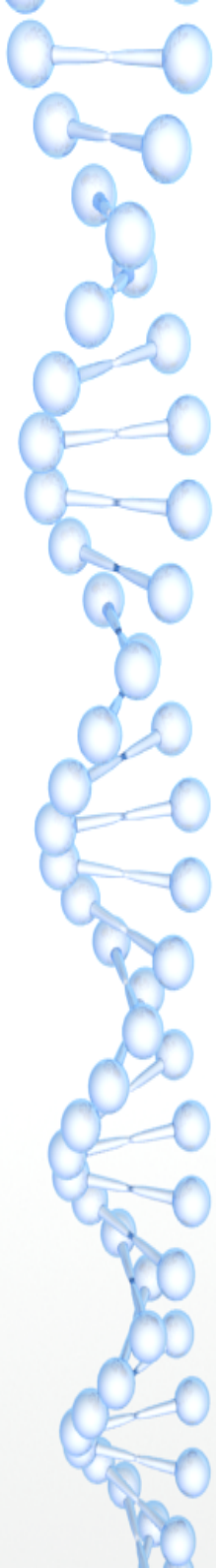
Python (Numba), Tcl

As a complete system

Julia, Javascript (V8), LuaJIT, Rust
SML, Pure

http://llvm.org/devmtg/2016-01/slides/fosdem-2016-llvm.pdf

How Fast is Fast?



Regular derivative (stock option) pays out at the termination of the contract.

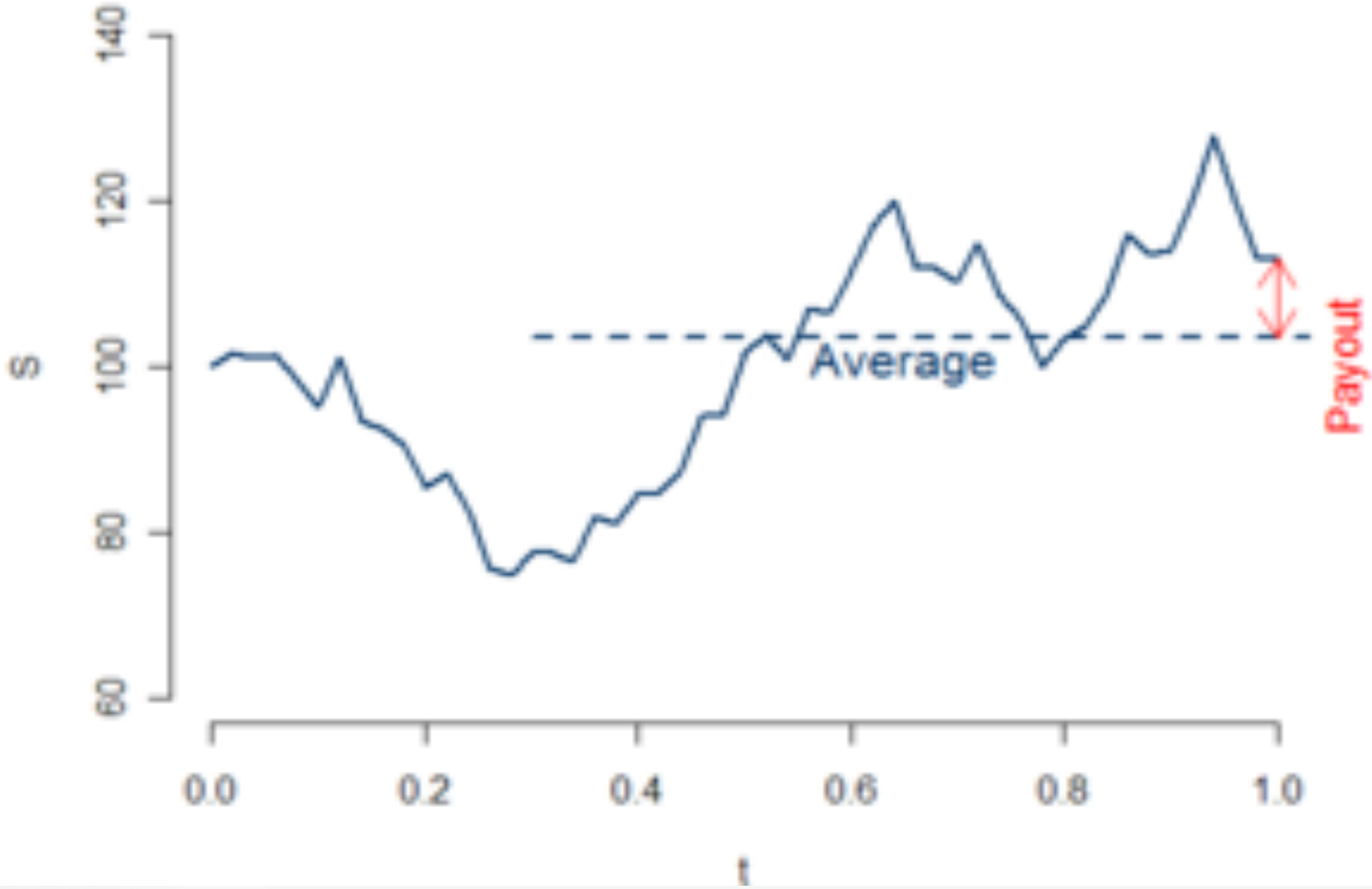
There is a formula based on the work of Black & Scholes in the 1970's

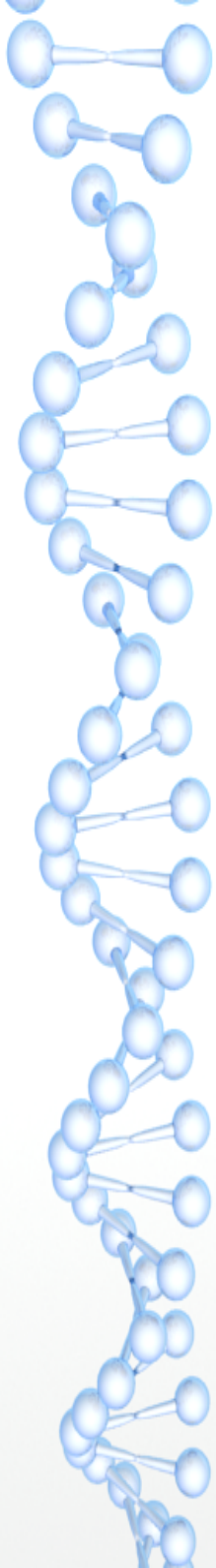
A up or down turn at the end of the contract period can be disastrous

The Asian option uses an average price over the contract rather than the final one

This is computationally intense

“Simple” Asian Option





```
S = zeros(Float64,N,T)
A = zeros(Float64,N)

for n=1:N
  S[n,1] = S0
  dW = randn(T)*sqrt(dt)
  for t=2:T
     z0 = (r - q - 0.5*v*v)*S[n,t-1]*dt
     z1 = v*S[n,t-1]*dW[t]
     z2 = 0.5*v*v*S[n,t-1]*dW[t]*dW[t]
     S[n,t] = S[n,t-1] + z0 + z1 + z2
  end
  A[n] = mean(S[n,:])
end

P = zeros(Float64,N)
[ P[n] = max(A[n] - K, 0) for n = 1:N ]
price = exp(-r*tma)*mean(P)
```

Asian Benchmarks

Results for 100,000 runs of 100 steps, (c ~ 0.73 s)

Language	Timing (c = 1)	Asian Option
c	1.0	1.681
julia	1.41	1.680
python (v3)	32.67	1.671
R	154.3	1.646
Octave	789.3	1.632

Samsung RV711 laptop with an i5 processor and 4Gb RAM running Centos 6.5 (Final)


DEMO TIME


DRaWing
ConCLuSIons

Once establised programming languages are long lived but the time at the top is short!

Advances in hardware and software may new approaches possible.

Emergence of new environments such as cloud computing.

Changes in application areas, such as big data and mobile apps.

Shift to analyst coding rather than specialist programmers.

The Two Language Problem?

Because of this dichotomy, a two-tier compromise is standard:

- for **convenience**, use a scripting language (Matlab, R, Python)
- but do all the **hard stuff** in a systems language (C, C++, Fortran)

Pragmatic for many applications, but has drawbacks

- aren't the **hard parts** exactly where you need an **easier** language?
- forces **vectorization** everywhere, even when awkward or wasteful
- creates a **social barrier** – a wall between users and developers

Quo Vadis LLVM?

http://llvm.org

- Dragonegg (code generation for GCC)
- LLDB (native debugger)
- Libc++ ABI (including C++11)
- OpenMPI support
- Vmkit (JVM and .NET)
- Libclc (OpenCL)
- Kee (intelligent bug finder)


OLD WAY
NEW WAY

The Genie is out of the bottle, things will not be the same again.

All (new) major languages in the last five years incorporate some form of JIT-tering.

LLVM project is the main O/S and has an exciting agenda planned.

Parallelism and HPC is becoming increasing important.

Never again will languages as slow as Matlab, R and (even) Python be created and certainly **not** paid for.


merci
thank you
grazie
gracias
efharisto
danke
arigato
spasiba
hvala
cheers
dziakuju
merkzi
kiitos
buznyg
spas
menlau
kinisou
chokrane
dziekuje
multumesc
saðol
paldies
rahmat
tenki
soolong
tashakor
matondo
welalin
bedankt
sobodi
salamat
marahaba
omol
takk
maururu
shukran
barkal
ngiyabonga
waita
manjuthe
bayarlalaa
grassie
mahalo
shakkran
saha
dèkoju
vinaka
dekuji
waybale
meharbani
modupe
yekeniele
shukriyaa
dankegon
obrigada
dakujem
tanemirt
akiba
tack
zikomo
tanmirt
misaotra
wado
dankie
gràcies
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ahsante
manana
madlobt
nuhun
trugéré
dankewol
köszönöm
murakoze
obrigado
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aitäh
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nkosi
aabar
shukria
tänan
matondi
stuutiyi
blagodaria
danki
sulpáy
blagodaram