The Beauty and the Beast

collaboration with F. Zappa Nardelli, A. Pelenitsyn J. Belyakova, B. Chung

Don’t build a language, grow it

```
conjGrad⟦Elt extends Number, nat N,
         Mat extends Matrix⟦Elt,N×N⟧,
         Vec extends Vector⟦Elt,N⟧
        ⟧(A: Mat, x: Vec): (Vec, Elt) = do
  cgit_max = 25
  z: Vec = 0
  r: Vec = x
  p: Vec = r
  ρ: Elt = r^T r
  for j ← seq(1:cgit_max) do
     q = A p
     α = ρ / p^T q
     z := z + α p
     r := r - α q
     ρ₀ = ρ
     ρ := r^T r
     β = ρ / ρ₀
     p := r + β p
  end
```

Fortress

$$f(a\colon \text{Object}, b\colon \mathbb{Z})\colon \mathbb{Z} = 1$$

$$f(a\colon \mathbb{Z}, b\colon \text{Object})\colon \mathbb{Z} = 2$$

```
f(Z,Z)?
```

Allen, Hilburn, Kilpatrick, Luchangco, Ryu, Chase, Steele: **Type checking modular multiple dispatch with parametric polymorphism and multiple inheritance.** OOPSLA11

Fortress

$$f(a\colon \mathrm{Object}, b\colon \mathbb{Z})\colon \mathbb{Z} = 1$$
$$f(a\colon \mathbb{Z}, b\colon \mathrm{Object})\colon \mathbb{Z} = 2$$
$$f(a\colon \mathbb{Z}, b\colon \mathbb{Z})\colon \mathbb{Z} = 3$$

```
f(Z,Z)?
```

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Fortress

julia is…

…a dynamic language for high-performance scientific computing

…open source since its inception by Jeff Bezanson circa 2012

	R	julia
Dynamic	yes	yes
Vectorized	yes	yes
Memory management	automatic	automatic
Implementation	interpreted	native
Type declarations	—	user-defined generic types
Meta-programming	`substitute()`	macros
Parameter passing	by promise	by value

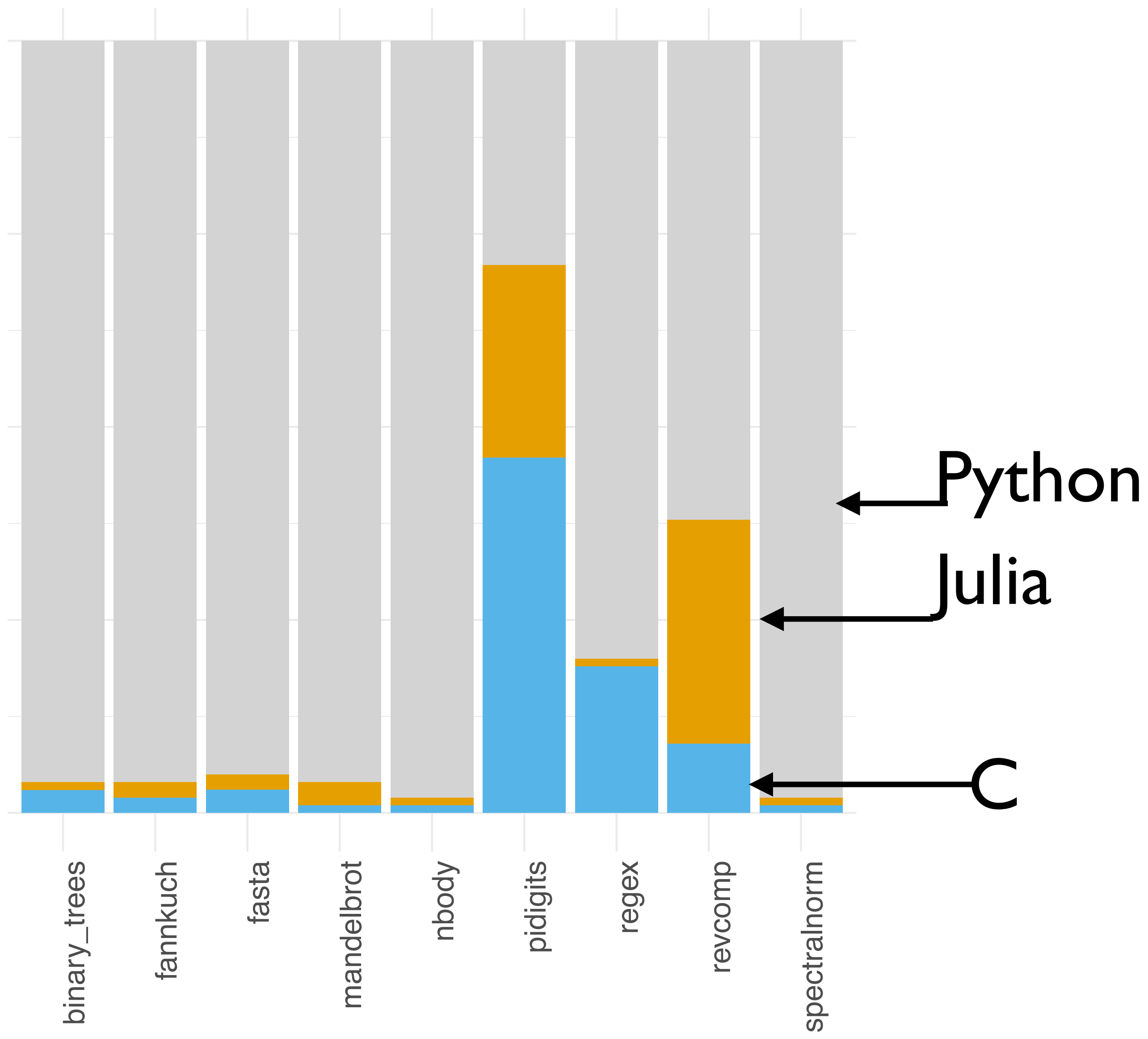
julia is...

```
mutable struct Node
  val
  nxt
end

function insert(list, elem)
  if list isa Void
    return Node(elem, nothing)
  elseif list.val > elem
    return Node(elem, list)
  end
  list.nxt = insert(list.nxt, elem)
  list
end
```

julia is…

…surprisingly fast



julia is...

Questions?

Why is Julia fast?

Why did Fortress fail?

How expressive is Julia?

How is Julia used in practice?

How does Multiple Dispatch work?

Does Julia support Gradual Typing?

Why so many types in Julia programs?