Swift for TensorFlow

Bluegrass Data Science Group

Swift

1. Safety

ARC managed memory

Value semantics

Compiler guidance & code-gen

Strong type systems

2. Clarity

Type inference

Multi-paradigm

Generics & protocols

3. Speed

LLVM-powered

Interpreter & Notebook workflows

Zero-cost abstractions

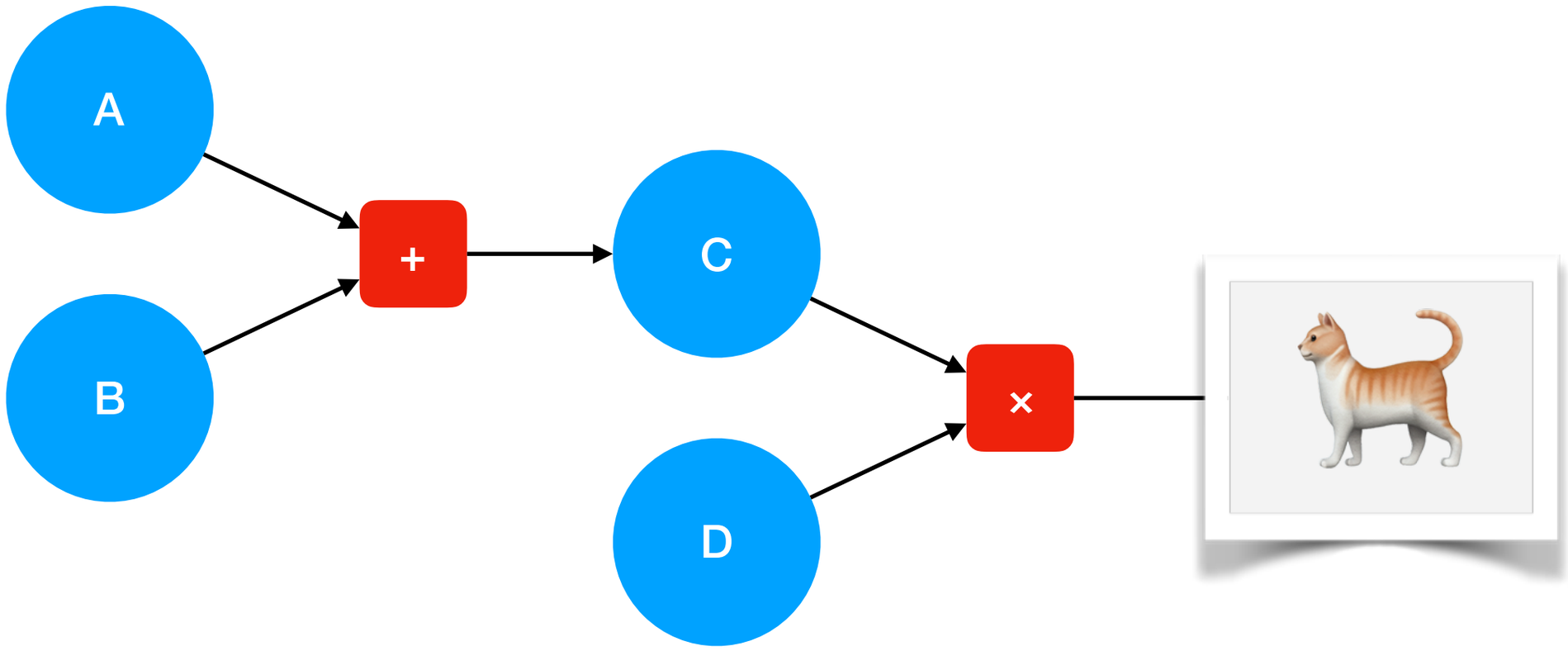
Copy-on-write

TensorFlow

11.5 petaflops!

Google Cloud TPU

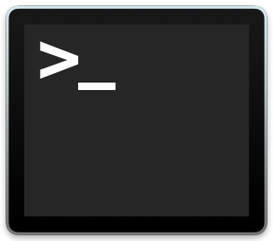
27262.31	89809.66	27262.31	35033.77	27262.31	35033.77	98359.87	27262.31	35033.77	27262.31	54692.26	98359.87
82859.73	89097.59	82859.73	61491.51	82859.73	61491.51	79495.93	82859.73	61491.51	82859.73	12296.18	79495.93
12659.63	84387.58	12659.63	93242.06	12659.63	93242.06	32531.58	12659.63	93242.06	12659.63	78253.69	32531.58
75445.86	27400.03	75445.86	44458.71	75445.86	44458.71	54692.26	75445.86	44458.71	75445.86	87224.69	54692.26
99103.28	95846.18	99103.28	97894.75	99103.28	97894.75	12296.18	99103.28	97894.75	99103.28	18102.49	12296.18
58750.21	98359.87	58750.21	89809.66	58750.21	89809.66	78253.69	58750.21	89809.66	58750.21	36115.37	78253.69
83907.89	79495.93	83907.89	89097.59	83907.89	89097.59	87224.69	83907.89	89097.59	83907.89	71486.34	87224.69
25656.26	32531.58	25656.26	84387.58	25656.26	84387.58	18102.49	25656.26	84387.58	25656.26	35066.93	18102.49
80509.66	54692.26	80509.66	27400.03	80509.66	27400.03	36115.37	80509.66	27400.03	80509.66	38280.78	36115.37
28021.39	12296.18	28021.39	95846.18	28021.39	95846.18	71486.34	28021.39	95846.18	28021.39	95327.12	71486.34
21285.76	78253.69	21285.76	98359.87	21285.76	98359.87	95846.18	21285.76	98359.87	21285.76	47749.33	95846.18
89714.03	78253.69	89714.03	42679.39	89714.03	42679.39	18102.49	89714.03	42679.39	89714.03	20644.88	18102.49
10641.04	87224.69	10641.04	35033.77	10641.04	35033.77	36115.37	10641.04	35033.77	10641.04	90028.56	36115.37
67503.51	97894.75	67503.51	61491.51	67503.51	61491.51	71486.34	67503.51	61491.51	67503.51	90272.25	71486.34
98699.57	89809.66	98699.57	93242.06	[illegible]	93242.06	95846.18	98699.57	93242.06	98699.57	35936.32	95846.18
52830.96	89097.59	52830.96	44458.71	[illegible]	44458.71	98359.87	52830.96	44458.71	52830.96	63095.28	98359.87
14014.59	84387.58	14014.59	97894.7[illegible]	[illegible]	[illegible]	79495.93	14014.59	97894.75	14014.59	32531.58	79495.93
72198.23	32531.58	72198.23	12296.1[illegible]	[illegible]	[illegible]	[illegible]	72198.23	12296.18	72198.23	90272.25	95846.18
73359.58	54692.26	73359.58	78253.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	78253.69	73359.58	35936.32	98359.87
42679.39	12296.18	42679.39	87224.69	42[illegible]	[illegible]	[illegible]	[illegible]224.69	42679.39	63095.28	79495.93	
35033.77	78253.69	35033.77	18102.49	35033.77	[illegible]	[illegible]	[illegible]8102.49	35033.77	32531.58	32531.58	
61491.51	87224.69	61491.51	36115.37	61491.51	36115.37	[illegible]	[illegible]36115.37	61491.51	54692.26	54692.26	
44458.71	89809.66	44458.71	42679.39	44458.71	42679.39	78253.69	[illegible]	42679.39	44458.71	78253.69	78253.69
97894.75	89097.59	97894.75	35033.77	97894.75	35033.77	87224.69	97894.7[illegible]	35033.77	97894.75	87224.69	87224.69
89809.66	84387.58	89809.66	61491.51	89809.66	61491.51	18102.49	89809.66	61491.51	89809.66	18102.49	18102.49
89097.59	27400.03	89097.59	93242.06	89097.59	93242.06	36115.37	89097.59	93242.06	89097.59	36115.37	36115.37
84387.58	95846.18	84387.58	44458.71	84387.58	44458.71	71486.34	84387.58	44458.71	84387.58	71486.34	71486.34
27400.03	98359.87	27400.03	97894.75	27400.03	97894.75	95846.18	27400.03	97894.75	27400.03	35066.93	95846.18
95846.18	79495.93	95846.18	89809.66	95846.18	89809.66	98359.87	95846.18	89809.66	95846.18	38280.78	98359.87
98359.87	32531.58	98359.87	89097.59	98359.87	89097.59	79495.93	98359.87	89097.59	98359.87	95327.12	79495.93
79495.93	54692.26	79495.93	84387.58	79495.93	84387.58	32531.58	79495.93	84387.58	79495.93	47749.33	32531.58
32531.58	12296.18	32531.58	27400.03	32531.58	27400.03	54692.26	32531.58	27400.03	32531.58	20644.88	54692.26
54692.26	78253.69	54692.26	95846.18	54692.26	95846.18	12296.18	54692.26	95846.18	54692.26	90028.56	12296.18
12296.18	87224.69	12296.18	98359.87	12296.18	98359.87	78253.69	12296.18	98359.87	12296.18	90272.25	78253.69
78253.69	97894.75	78253.69	79495.93	78253.69	79495.93	87224.69	78253.69	79495.93	78253.69	35936.32	87224.69
87224.69	89809.66	87224.69	32531.58	87224.69	32531.58	18102.49	87224.69	32531.58	87224.69	63095.28	18102.49
18102.49	89097.59	18102.49	54692.26	18102.49	54692.26	36115.37	18102.49	54692.26	18102.49	32531.58	36115.37
36115.37	84387.58	36115.37	12296.18	36115.37	12296.18	71486.34	36115.37	12296.18	36115.37	54692.26	71486.34

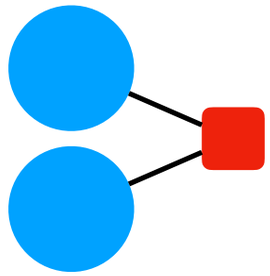


"Compute Graph"

1. Graph Program Extraction


SWIFT





```
import TensorFlow

var x = Tensor<Float>([[1, 2], [3, 4]])

for i in 1...5 {
  x += x • x
}

print(x)

```

2. Automatic Differentiation

"Vector-Jacobian Products"

```swift
// Differentiable with respect to
// all parameters using reverse-mode AD.
// The corresponding adjoint to call is `dTanh`.
@differentiable(reverse, adjoint: dTanh)
func tanh(_ x: Float) -> Float {
    // ...
}

// d/dx tanh(x) = 1 - (tanh(x))^2
//
// Here, y is the original result of tanh(x), and x is
// the input parameter of the original function.
func dTanh(x: Float, y: Float, seed: Float) -> Float {
    return (1.0 - y * y) * seed
}
```

“This is great and all, but I ❤️ Numpy.”

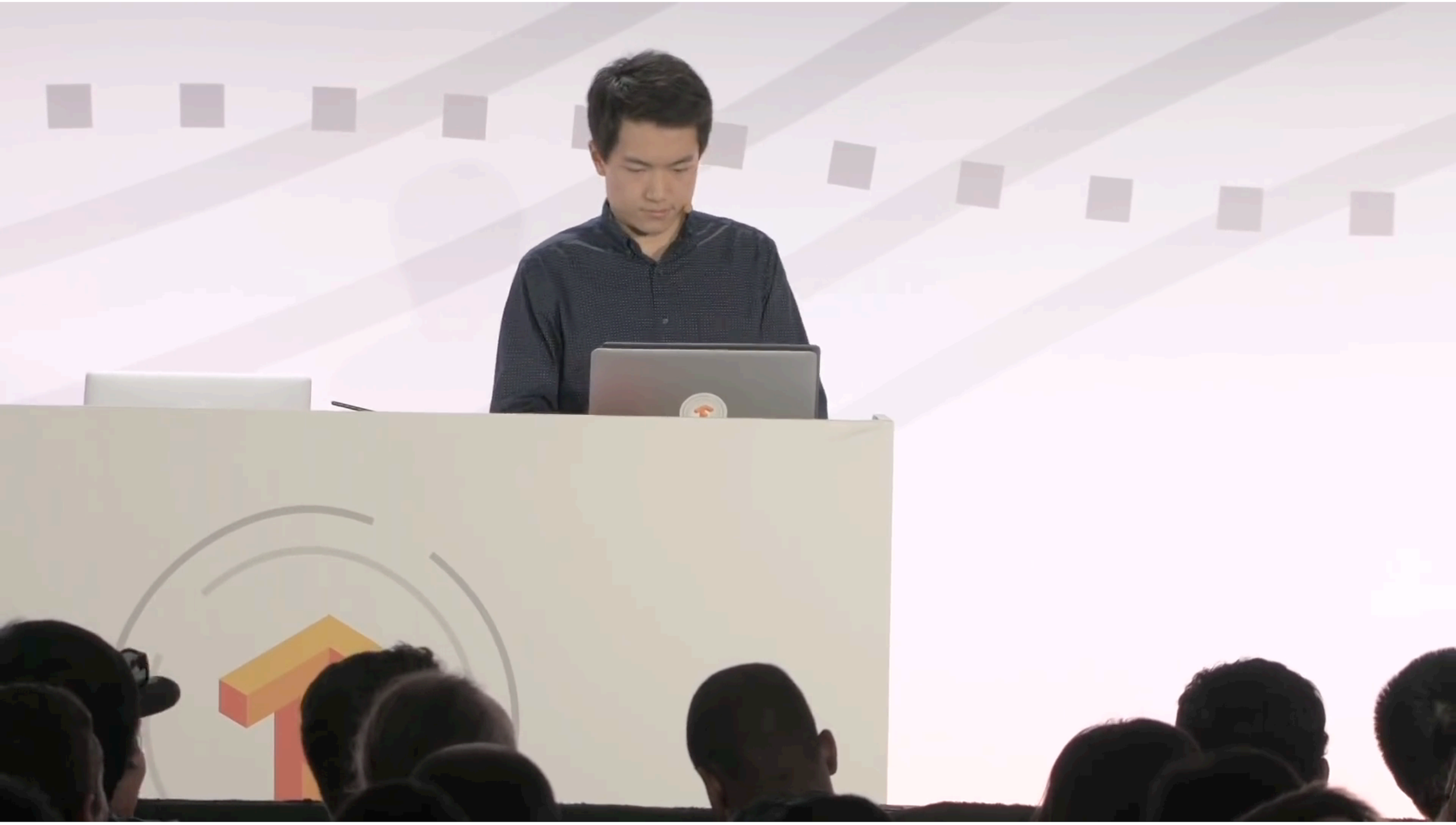
–You right now

3. Python Interoperability

```python
# Python
import numpy as np
a = np.arange(15).reshape(3, 5)
b = np.array([6, 7, 8])
```

```swift
// Swift
let np = Python.import("numpy")
let a = np.arange(15).reshape(3, 5)
let b = np.array([6, 7, 8])
```

Demo Video



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TensorFlow
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Resources

- github.com/tensorflow/swift
- tensorflow.org/api_docs/swift
- tensorflow.org/community/swift

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