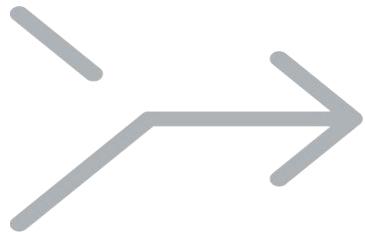
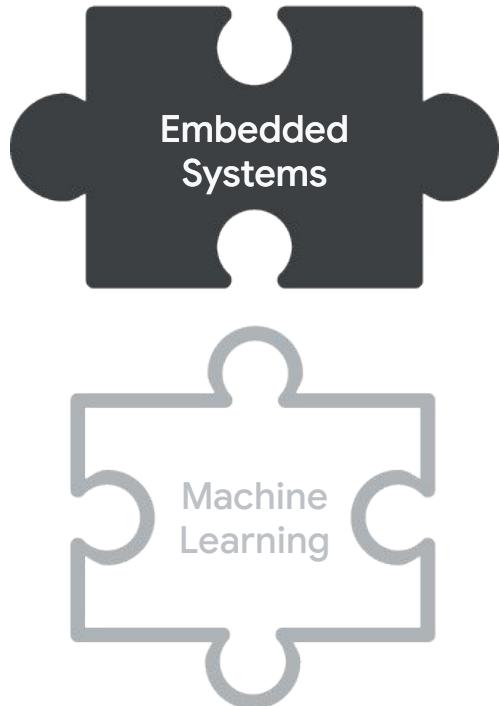


What are the Challenges for TinyML?

Part B



TinyML

Hardware



Software

Software

Hardware

Software

Applications

Libraries

Operating System

Hardware

Software

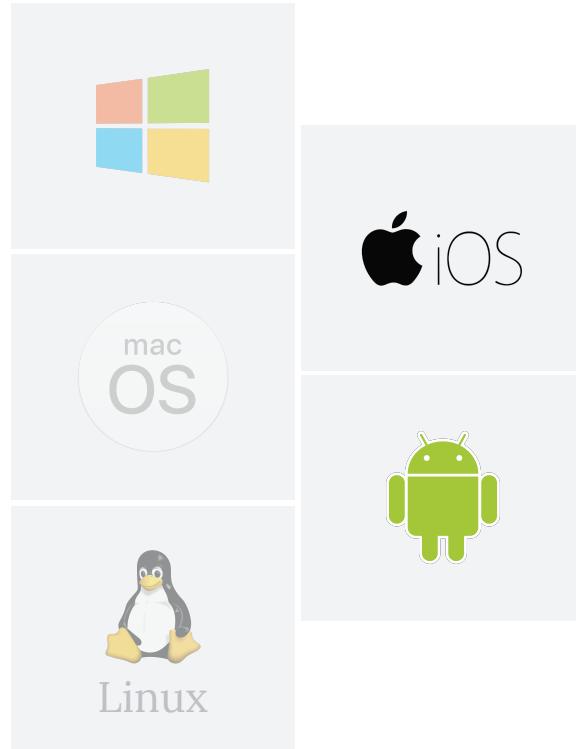
Applications

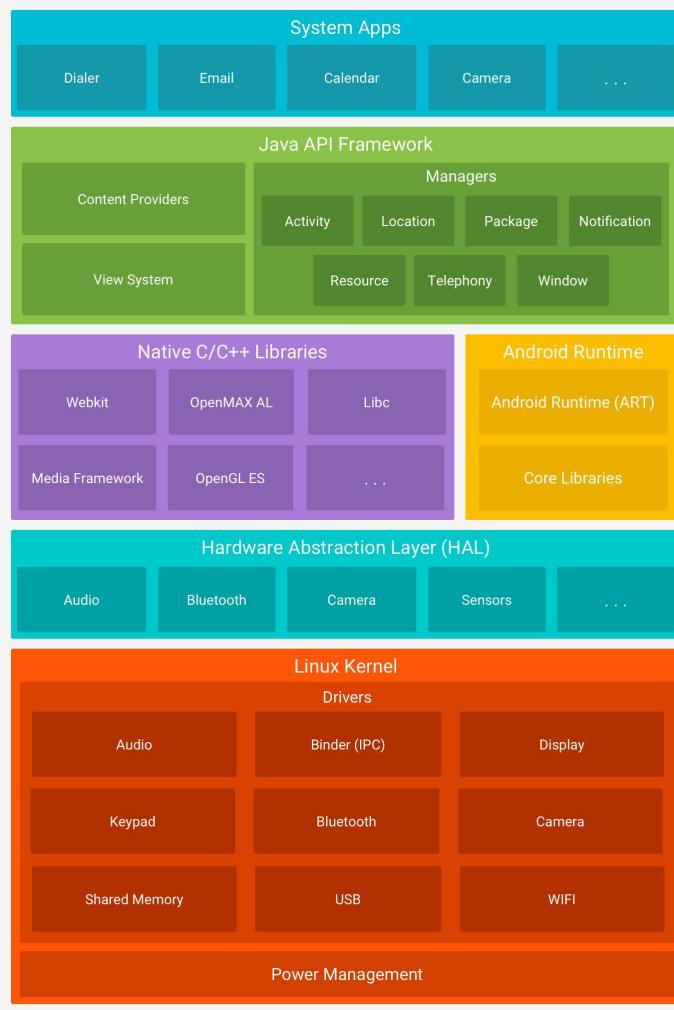
Libraries

Operating System

Hardware

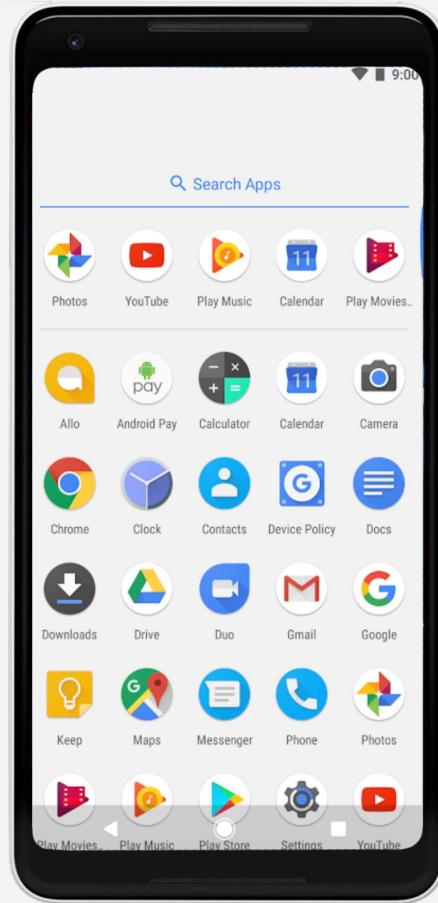
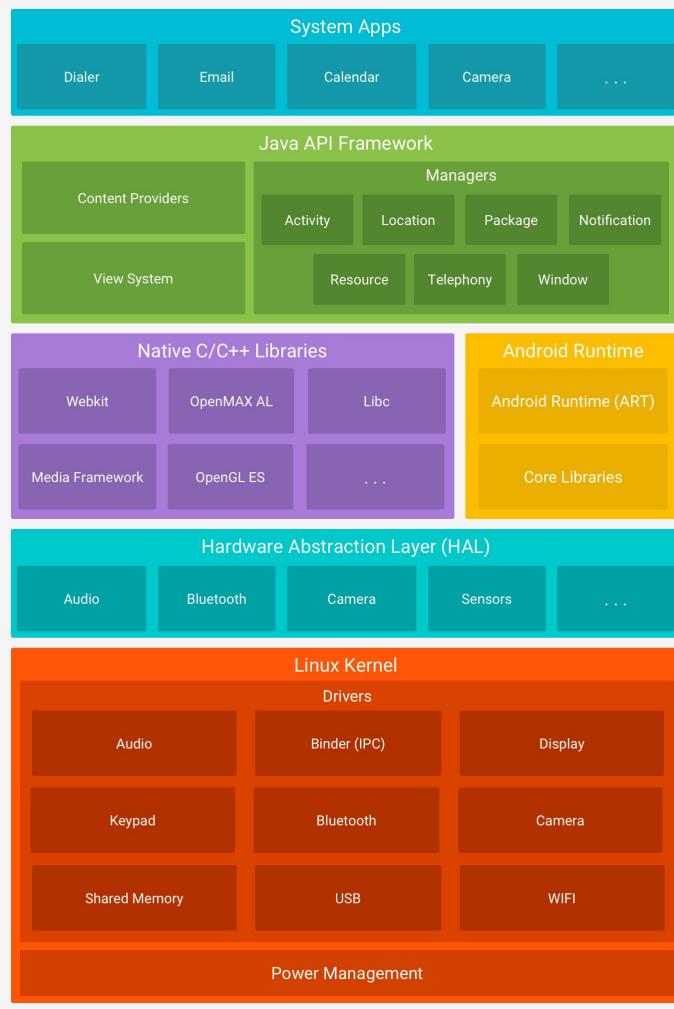
Widely Used Operating Systems





Platform Architecture



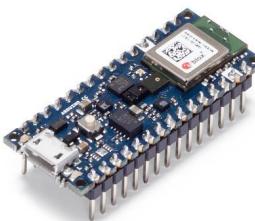


Widely Used Operating Systems



Mobile OS

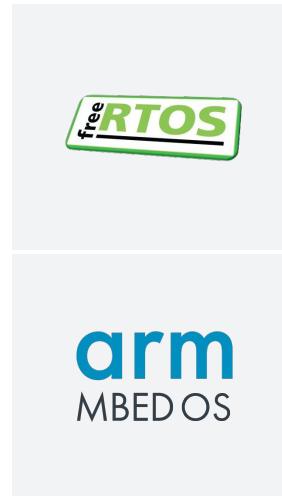
Embedded Systems



Widely Used Operating Systems



Mobile OS



Embedded Sys.

Software

Applications

Libraries

Operating System

Hardware

Software

Applications

Libraries

Operating System

Hardware

```
import numpy as np  
  
for x in range(10):  
    np.SaveTheWorld()
```

Software

Applications

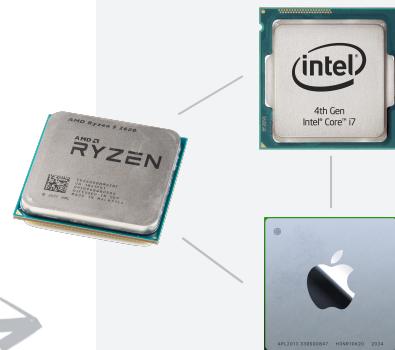
Libraries

Operating System

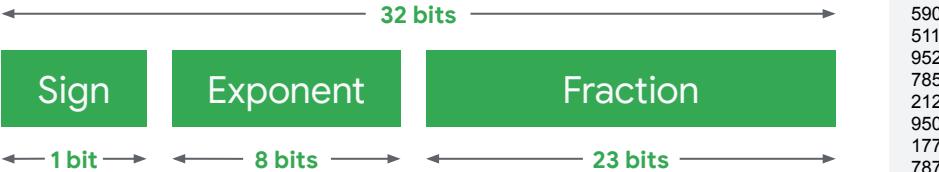
Hardware

Portability Opportunity

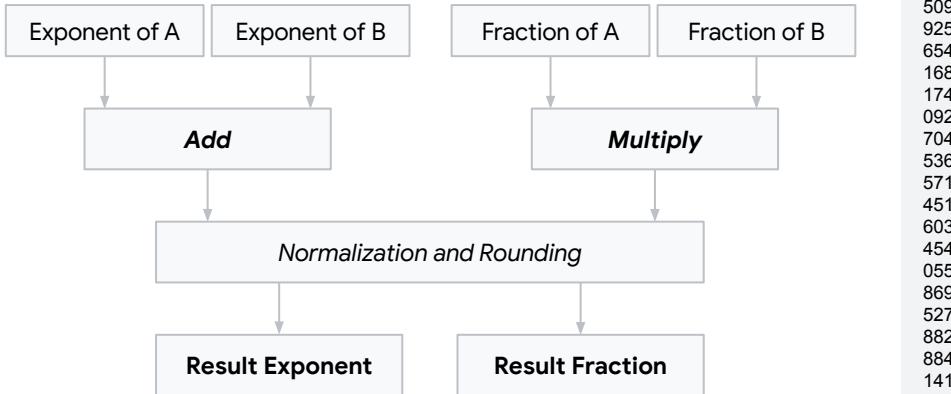
Able to execute the same code on different microprocessor hardware and architectures.



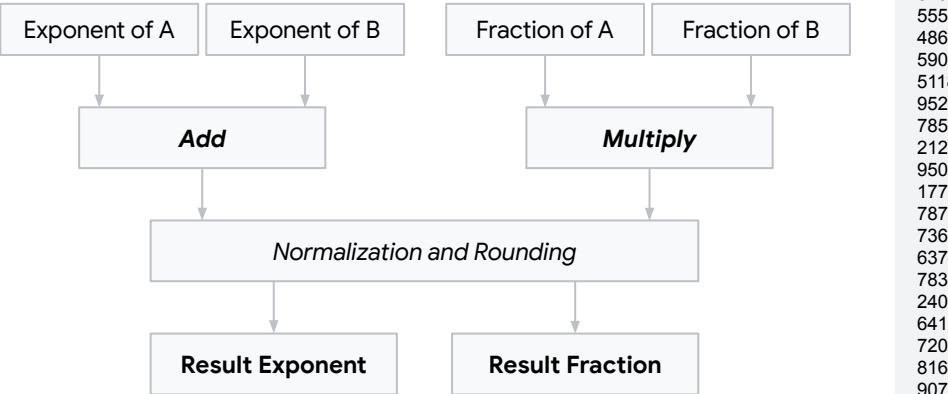
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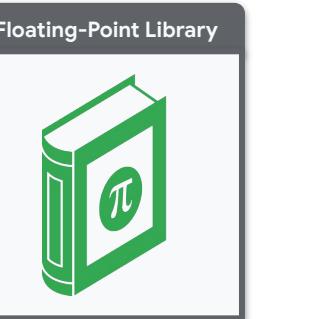
Single Precision IEEE 754 Floating-Point Standard

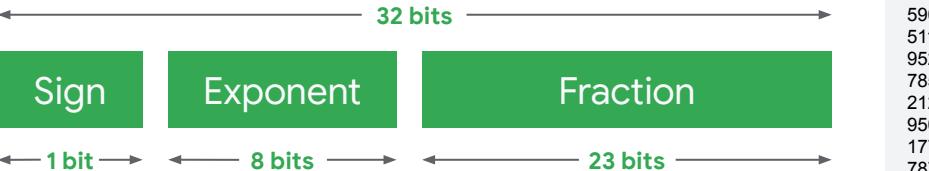


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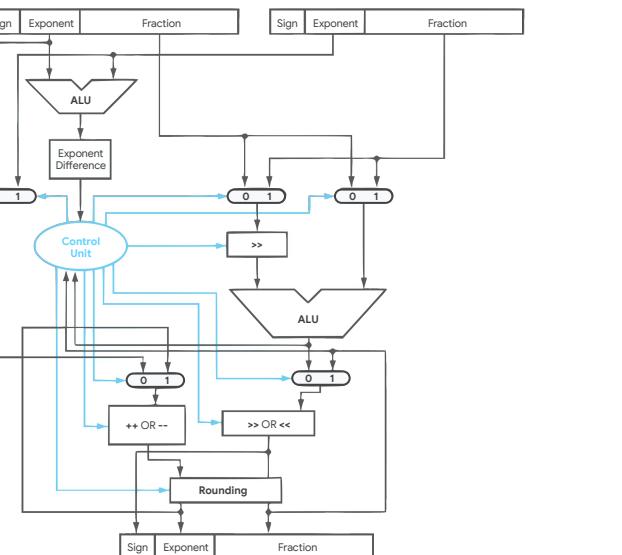


libraries

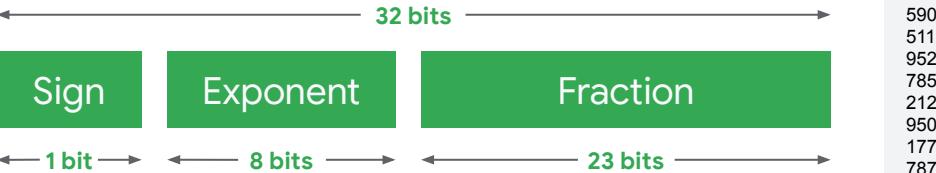




Single Precision IEEE 754 Floating-Point Standard



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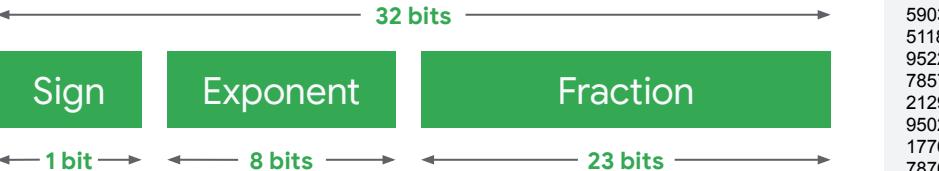


Single Precision IEEE 754 Floating-Point Standard

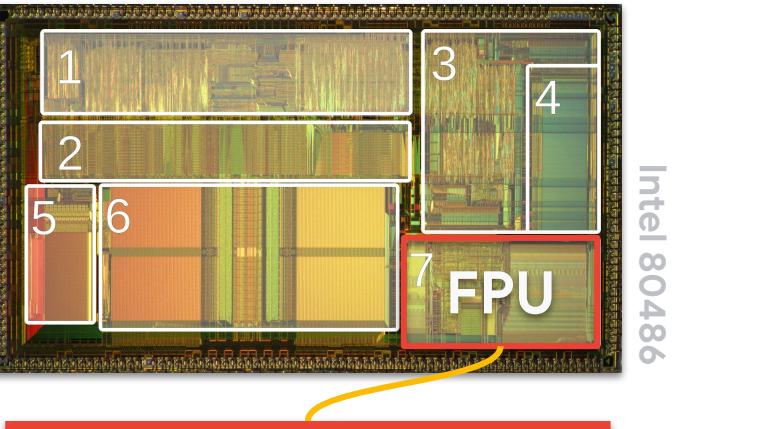


Hardware

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Single Precision IEEE 754 Floating-Point Standard



Hardware

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Portability Trade-offs

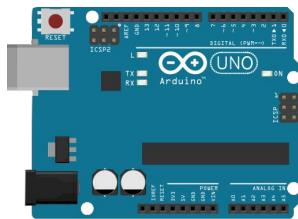
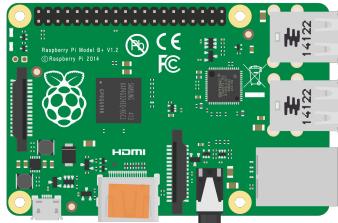
	Universal Code Portability/Compatibility	Cost (\$)	Power Consumption (W)	Engineering Effort
Option 1	✓	✗	✗	✗
	Lower Code Portability	✓		
Option 2		✓		
	Cost (\$)	✓		
	Power (W)	✓		
	Eng. Effort	✓		

Portability Trade-offs

	Universal Code Portability/Compatibility	Cost (\$)	Power Consumption (W)	Engineering Effort
Option 1	✓	✗	✗	✗
Option 2	✗	✓	✓	✓
	Lower Code Portability			

Portability Trade-offs

Sacrifice portability across systems for efficiency in system performance and power efficiency



Specific HW Implementation of a Library

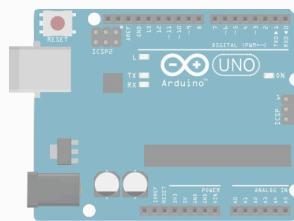
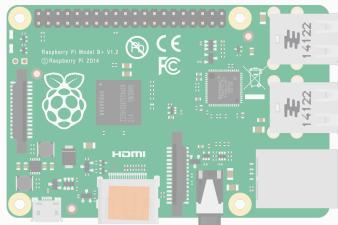
Option 2

Lower Code Portability	✗
Cost (\$)	✓
Power (W)	✓
Eng. Effort	✓



Portability Trade-offs

Sacrifice portability across systems for efficiency in system performance and power efficiency



Specific HW Implementation of a Library

Question:

How do we enable **TinyML** uniformly across these different systems if there is **lower** platform portability?

Summary

- **Embedded hardware** is extremely limited in performance, power consumption and storage
- **Embedded software** is not as portable and flexible as mainstream computing