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Building AI Units in Rust

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About Me.

I am Vigneshwer

I work on AI & Rust

Author of Rust CookBook

Founder of DeepRust

Overview

Demystifying Artificial Intelligence

- Fundamental units
- Maths behind AI

Rust is great for building AI

- Properties of Rust
- Different AI crates
- Code snippets of Mathematical model

Template for mathematical crates

- Project structure

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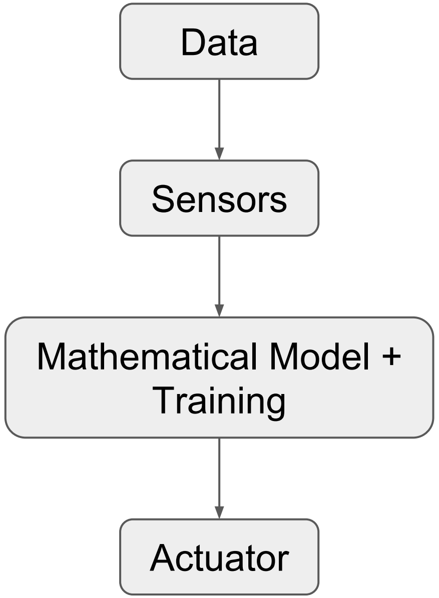
What is Artificial Intelligence (AI)?

AI is defined as the science of making computers behave like humans

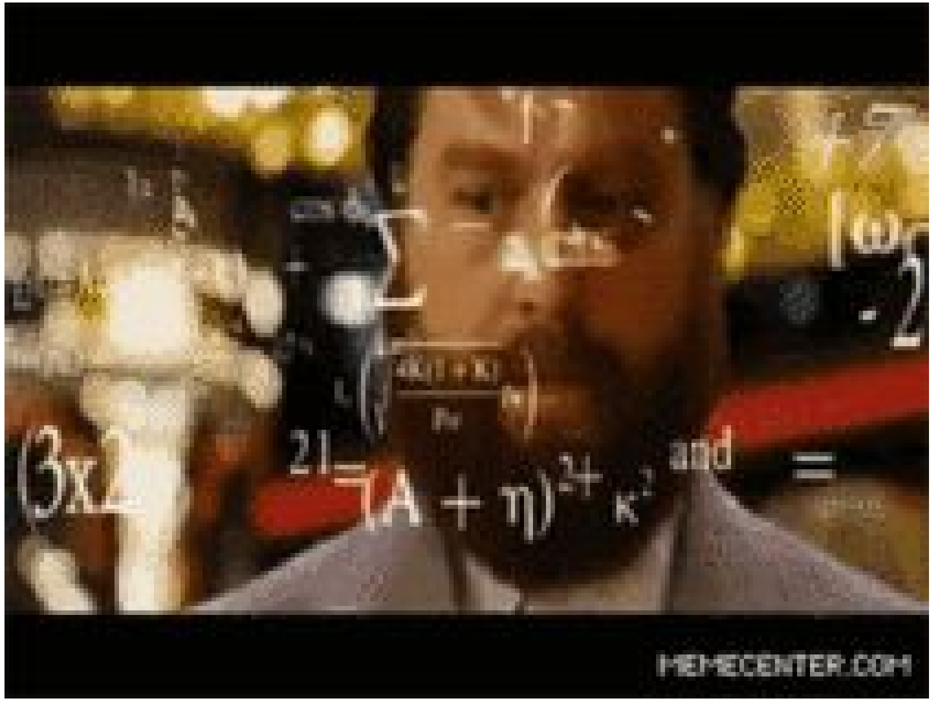
Voice Search

Self driving cars

Fundamental units of AI system



Basic AI System



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Maths Behind AI

Without mathematics, there's nothing you can do. Everything around you is mathematics. Everything around you is numbers.

- Shakuntala Devi

Let’s Understand

y = f(x)

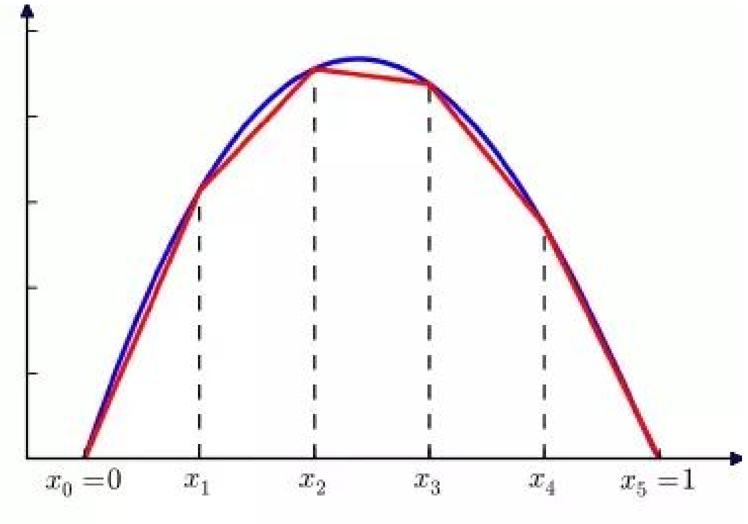
- Function to learn the curve (Activation fn)

y = w1*a + w2*b + w3*c +....

- Inputs (a, b, c)
- Weights (w1, w2, w3 ...)

y = w1*a + w2*b + w3*c +.... + b

- Bais (b)



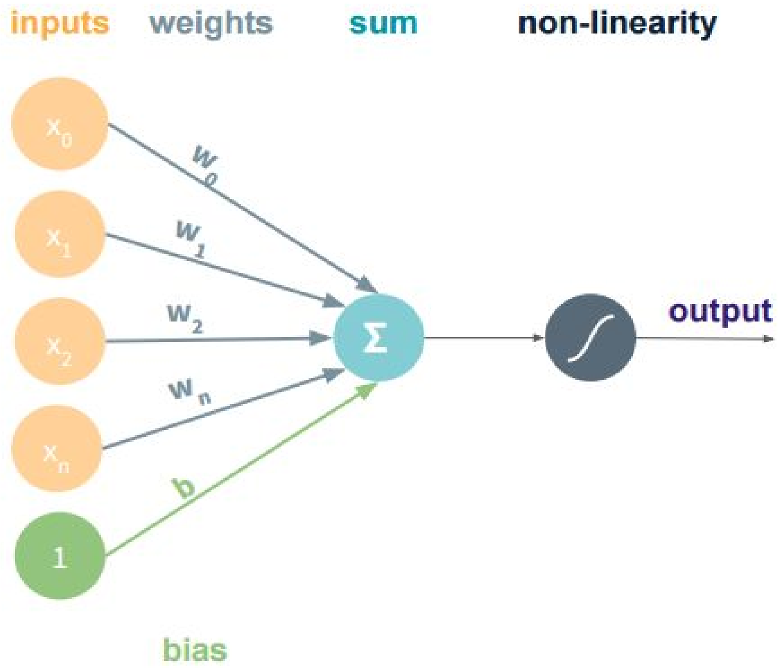
Artificial Neural Network

Activation Function

$$output = \boxed{g}(XW + b)$$

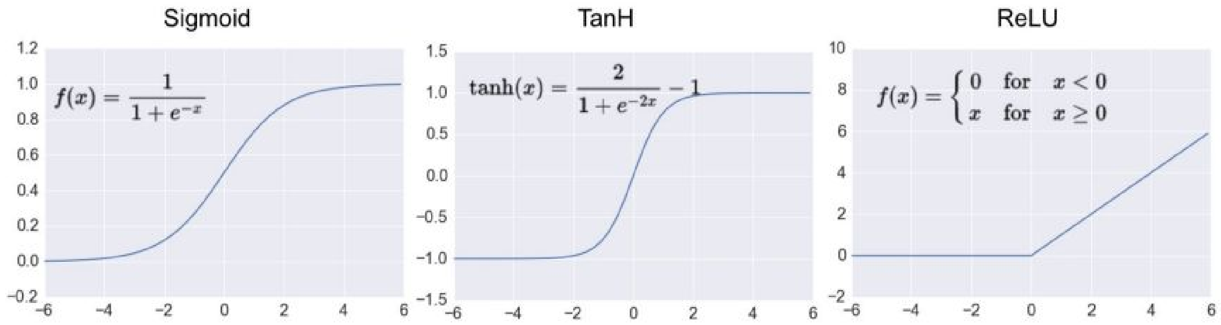
$$X = x_0, x_1, \ldots x_n$$

$$W = w_0, w_1, \ldots w_n$$

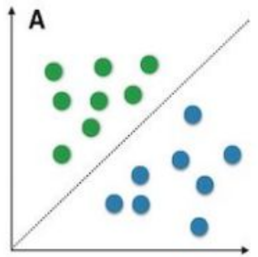


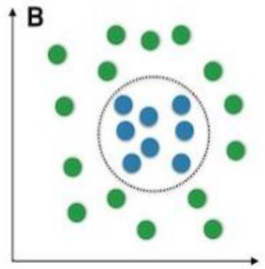
Activation function

Activation functions add nonlinearity to our network's function



Most real-world problems + data are non-linear





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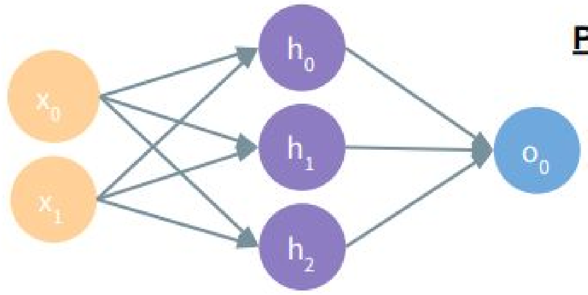
Example: Placing an order in stock market

Input

[
[-20, 45],
[80, 0],
[4, 15],
[45, 60],
]



Predicted	**Actual**
0.05	1
0.02	0
0.96	1
0.35	1

$$\text{total loss} := J(\theta) = \frac{1}{N}\sum_{i}^{N} loss(\underbrace{f(x^{(i)};\theta)}_{\text{Predicted}}, \underbrace{y^{(i)}}_{\text{Actual}}))$$

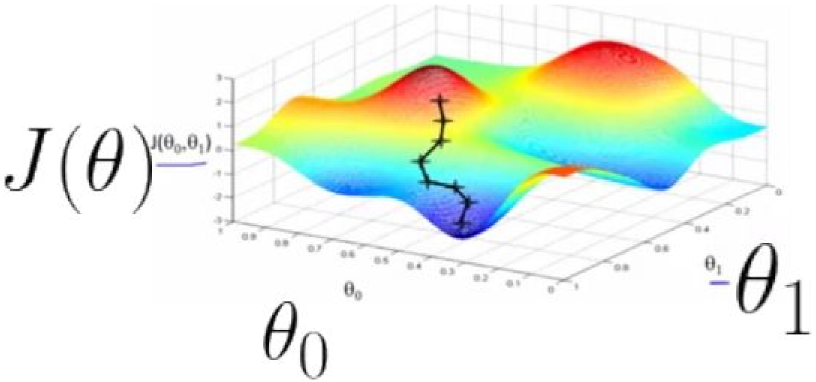
Training Neural networks

Loss is a function of the model's parameters

- Aim is to minimize loss and find the best parameters

$$\underbrace{arg_{\theta}\ \min \frac{1}{N}\sum_{i}^{N} \text{loss}(f(x^{(i)};\theta), y^{(i)})}_{J(\theta)}$$

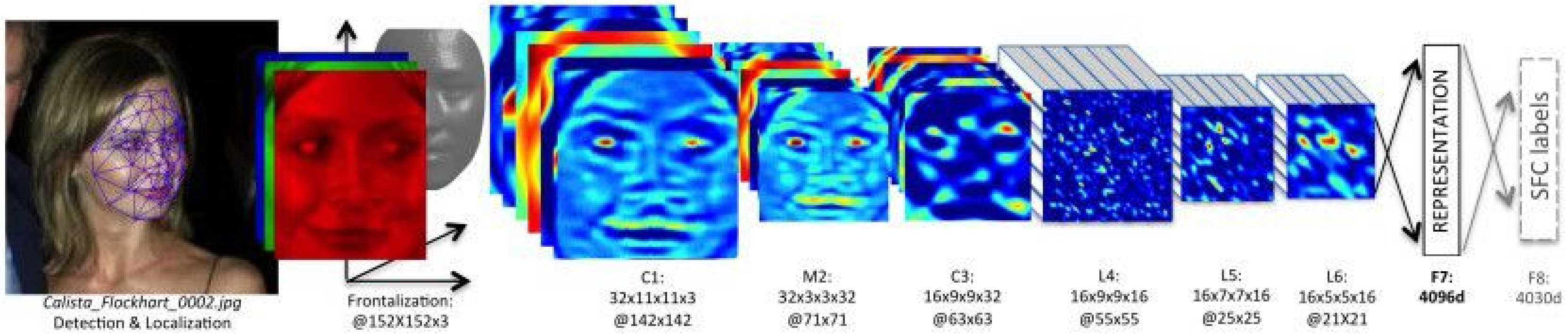
$$J(\theta) \leftarrow \theta = W_1, W_2 \ldots W_n$$



Deep Learning (Mathematical Model)

Convolutional neural networks(CNN)

- Feature engineering



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Evaluation metrics

Accuracy: Overall, how often is the classifier correct?

(TP+TN)/total = (100+50)/165 = 0.91

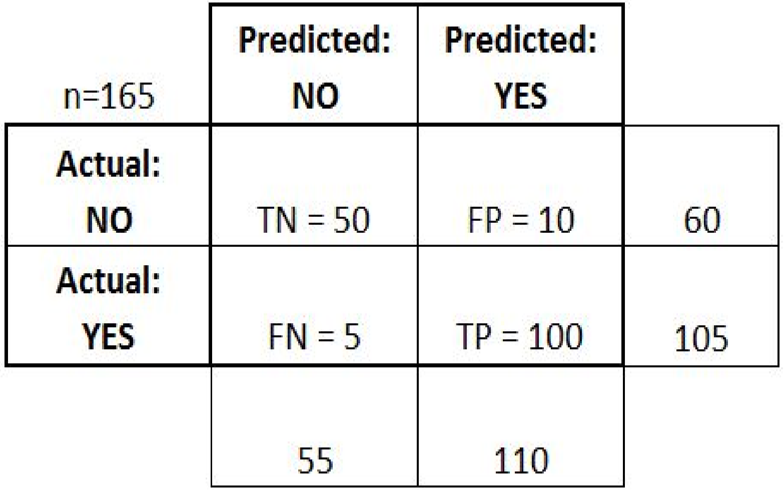
True Positive Rate (Recall) : When it's actually yes

how often does it predict yes?

TP/actual yes = 100/105 = 0.95

Precision: When it predicts yes, how often is it cor

TP/predicted yes = 100/110 = 0.91



n=165	**Predicted: NO**	**Predicted: YES**	
Actual: NO	TN = 50	FP = 10	60
Actual: YES	FN = 5	TP = 100	105
	55	110	

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Rust is great for building AI

Needs:

- AI has a lot of maths and is iterative in nature
- Great scope for parallel programming

Features:

- Threads without data races
- Advanced parallel programming
- Minimal runtime
- Guaranteed memory safety
- Zero-cost abstraction

Structs

Structs

```
struct Point {
    x: i32,
    y: i32,
}


fn main() {
    let origin = Point { x: 0, y: 0 }; // origin: Point

    println!("The origin is at ({}, {})", origin.x, origin.y);
}
```

Method calls

```
struct Circle {
    x: f64,
    y: f64,
    radius: f64,
}

impl Circle {
    fn area(&self) -> f64 {
        std::f64::consts::PI * (self.radius * self.radius)
    }
}

fn main() {
    let c = Circle { x: 0.0, y: 0.0, radius: 2.0 };
    println!("{}", c.area());
}
```

Traits

```
struct Circle {
    x: f64,
    y: f64,
    radius: f64,
}

trait HasArea {
    fn area(&self) -> f64;
}

impl HasArea for Circle {
    fn area(&self) -> f64 {
        std::f64::consts::PI * (self.radius * self.radius)
    }
}
```

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Crates and Module

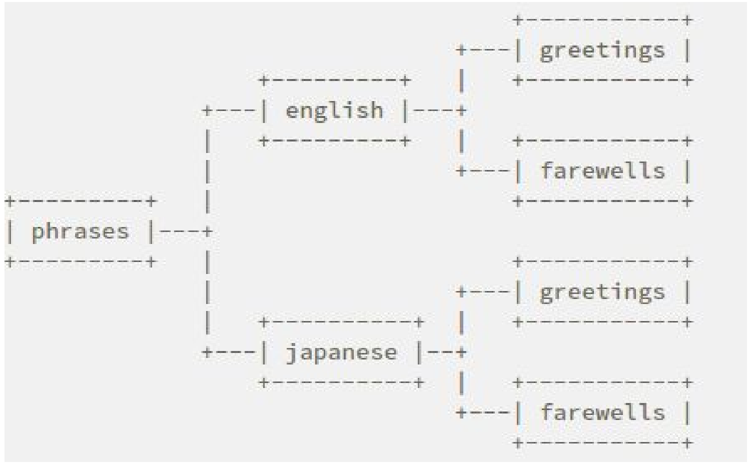
- cargo new phrases
- src/lib.rs

  -
    ```
    mod english {
        mod greetings {
        }

        mod farewells {
        }
    }

    mod japanese {
        mod greetings {
        }

        mod farewells {
        }
    }
    ```



```
                                                      +-----------+
                                                  +---| greetings |
                                +---------+       |   +-----------+
                            +---| english |---+
                            |   +---------+   |   +-----------+
                            |                 +---| farewells |
+---------+                 |                     +-----------+
| phrases |---+
+---------+                 |                     +-----------+
                            |                 +---| greetings |
                            |   +----------+  |   +-----------+
                            +---| japanese |--+
                                +----------+  |   +-----------+
                                              +---| farewells |
                                                  +-----------+
```

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Rust Units

```
$ tree .
.
├── Cargo.lock
├── Cargo.toml
├── src
│   ├── english
│   │   ├── farewells.rs
│   │   ├── greetings.rs
│   │   └── mod.rs
│   ├── japanese
│   │   ├── farewells.rs
│   │   ├── greetings.rs
│   │   └── mod.rs
│   └── lib.rs
└── target
    └── debug
        ├── build
        ├── deps
        ├── examples
        ├── libphrases-a7448e02a0468eaa.rlib
        └── native
```

Template for AI crates

```
extern crate phrases;

fn main() {
    println!("Hello in English: {}", phrases::english::greetings::hello());
    println!("Goodbye in English: {}", phrases::english::farewells::goodbye());

    println!("Hello in Japanese: {}", phrases::japanese::greetings::hello());
    println!("Goodbye in Japanese: {}", phrases::japanese::farewells::goodbye());
}
```

Rayon

Features:

- Data parallelism library in Rust
- Easily converts a sequential computation into a parallel one
- Guarantees data-race freedom

Code Snippet:

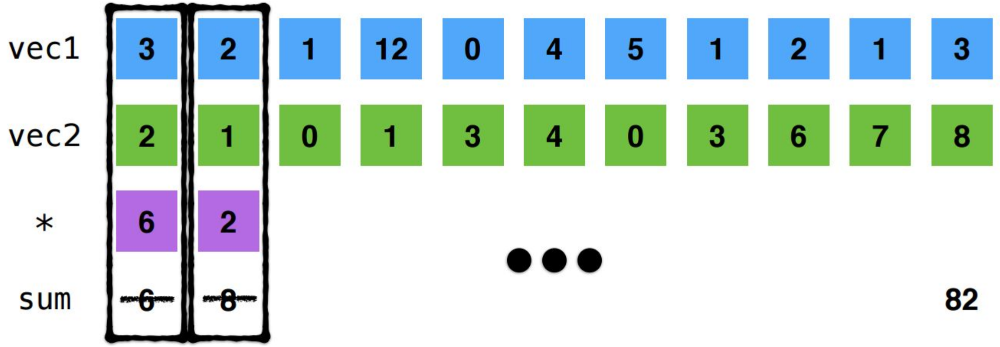
```
// import the traits
use rayon::prelude::*;

// compute the sum of the squares of a sequence of integers
fn sum_of_squares(input: &[i32]) -> i32 {
    input.par_iter()
         .map(|&i| i * i)
         .sum()
}
```

Reading an Image

```
fn load_images(paths: &[PathBuf]) -> Vec<Image> {
    paths.par_iter()
    .map(|path| Image::load(path))
    .collect() // returns a vector
}
```

Dot Product

```
fn dot_product(vec1: &[i32], vec2: &[i32]) -> i32 {
        vec1.iter()
        .zip(vec2)
        .map(|(e1, e2)| e1 * e2)
        .fold(0, |a, b| a + b)        // aka .sum()
}
```



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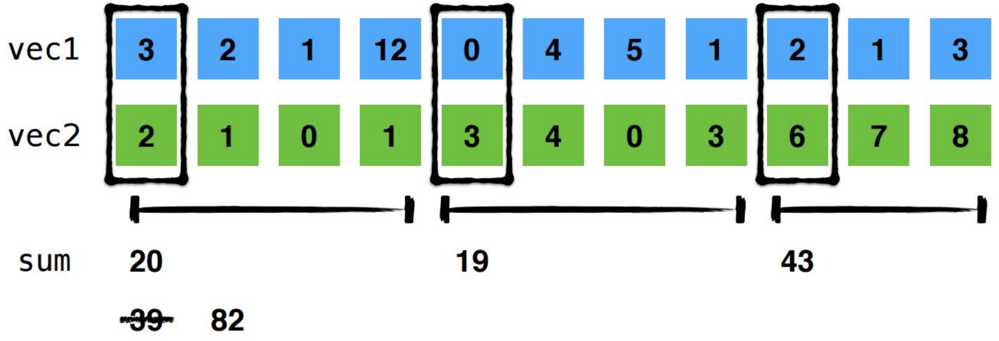
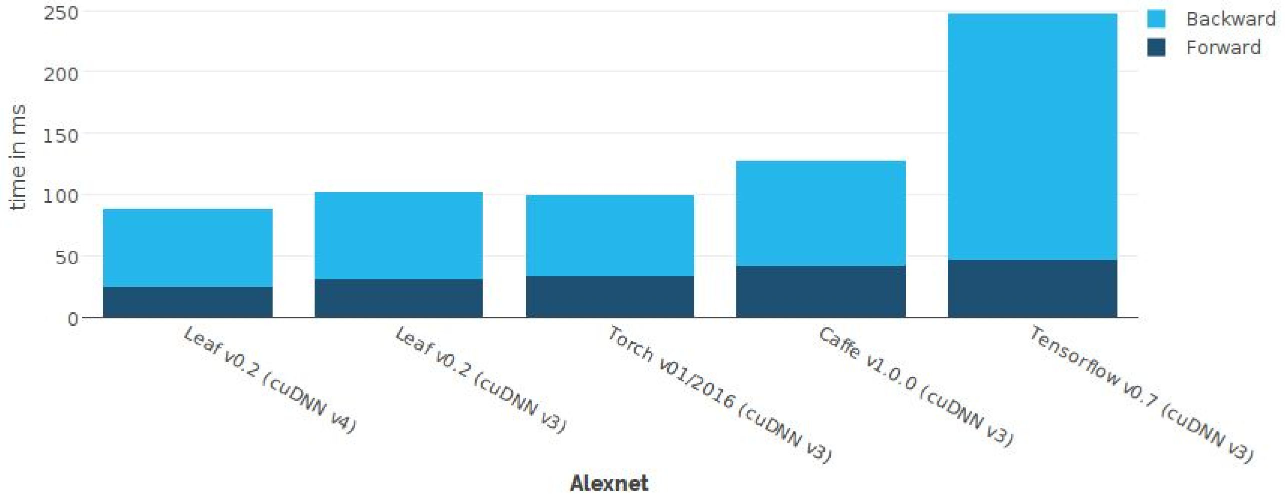
Dot product

```
fn dot_product(vec1: &[i32], vec2: &[i32]) -> i32 {
          vec1.par_iter()
           .zip(vec2)
          .map(|(e1, e2)| e1 * e2)
           .reduce(|| 0, |a, b| a + b) // aka .sum()
}
```



Different AI crates

- Leaf
- Rustlearn
- DeepRust



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Live Demos

Thanks!

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Q&A