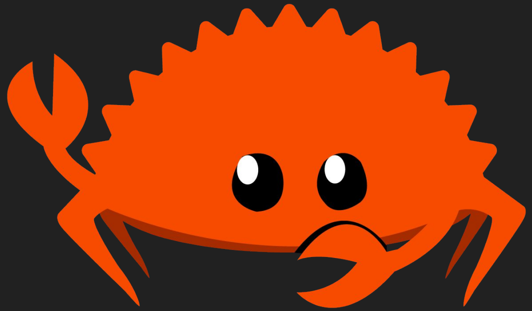
Offline ML with Rust



Daniel Bank

https://github.com/danielbank/offline-ml

Disclaimer

NOTE: Opinions and views on products, services and/or resources expressed in this presentation are mine alone and do not necessarily reflect the views of my employer.

Why Rust?

- Concurrency, Safety, Performance
- Use Cases in Web Assembly, Embedded, Machine Learning, and more
- Easy Package Manager and Dependency System
- Friendly Ecosystem

Connect with Rust Devs in Phoenix

{az}devs:

- Website: https://rust.azdevs.org
- Slack Channel: **#rust**

Meetup:

- Last Wednesday of the Month / HeatSync Labs in Mesa
- Biweekly Booze.rs Drink Up

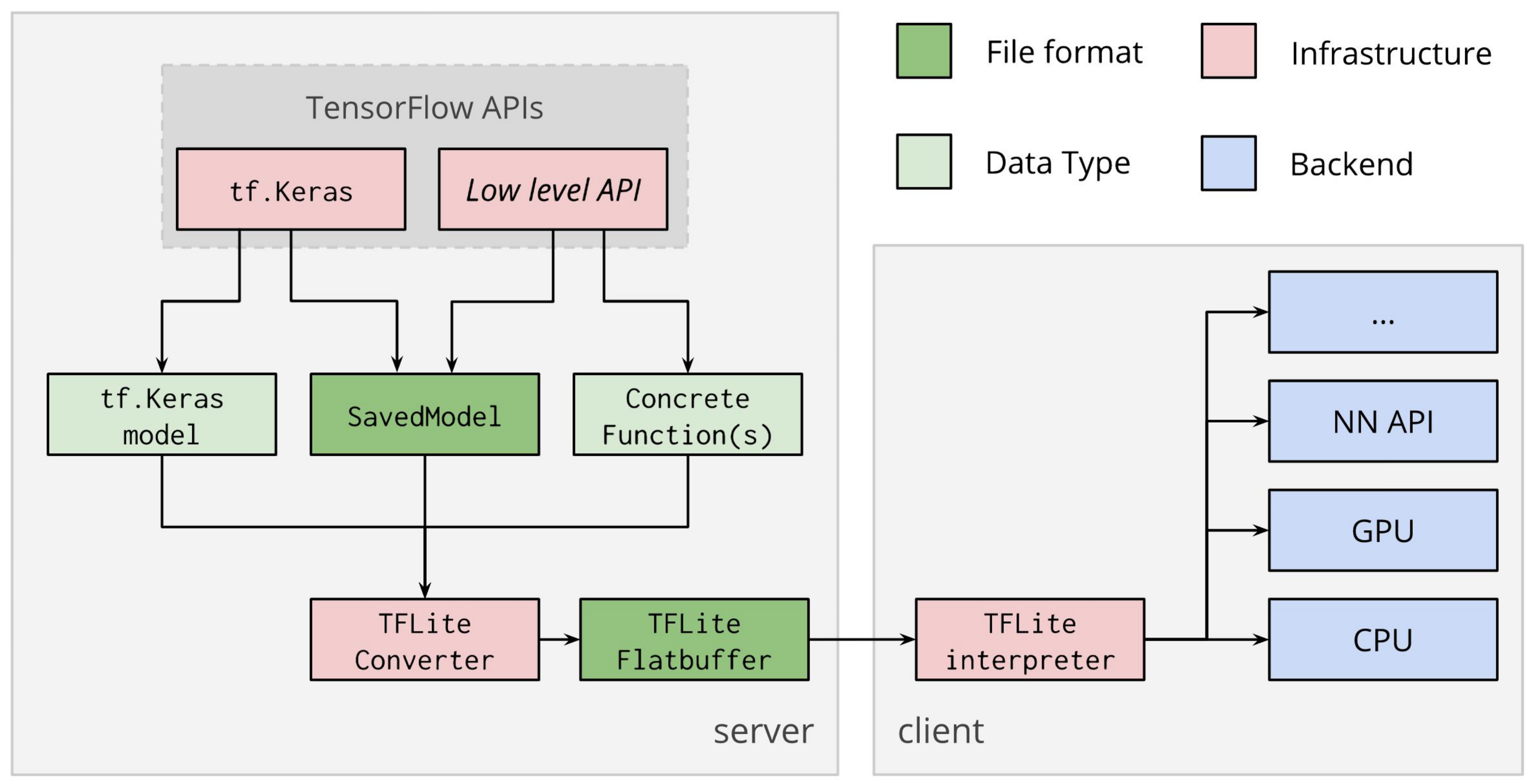
Offline Voice Recognition

Microsoft ONNX Runtime / PyTorch

TensorFlow Lite

- TensorFlow
  - Open Source library that allows expressing arbitrary computations as a graph of data flow
- TensorFlow Lite
  - Set of tools that let developers run TensorFlow models on embedded systems
  - Only supports a subset of TensorFlow operations
  - Uses a precompiler to convert TensorFlow models to its own format
- Convert TensorFlow models to TensorFlow Lite models using CLI tools
  - TensorFlow models saved in .tflite file (FlatBuffer Schema)

TensorFlow Lite Conversion Workflow



TensorFlow Lite for Microcontrollers Demo

- TensorFlow Lite for Microcontrollers
- Pre-trained model recognizes 10 wanted words
- Model is ~20KB with runtime and operators to run speech detection
- Smallest device I have seen a working demo on (MCU)
- Limited performance (it’s not all the crappy microphone’s fault)
- Wanted Words Model running on a SparkFun Edge Development Board:

  http://bit.ly/sparkfunedgedemo

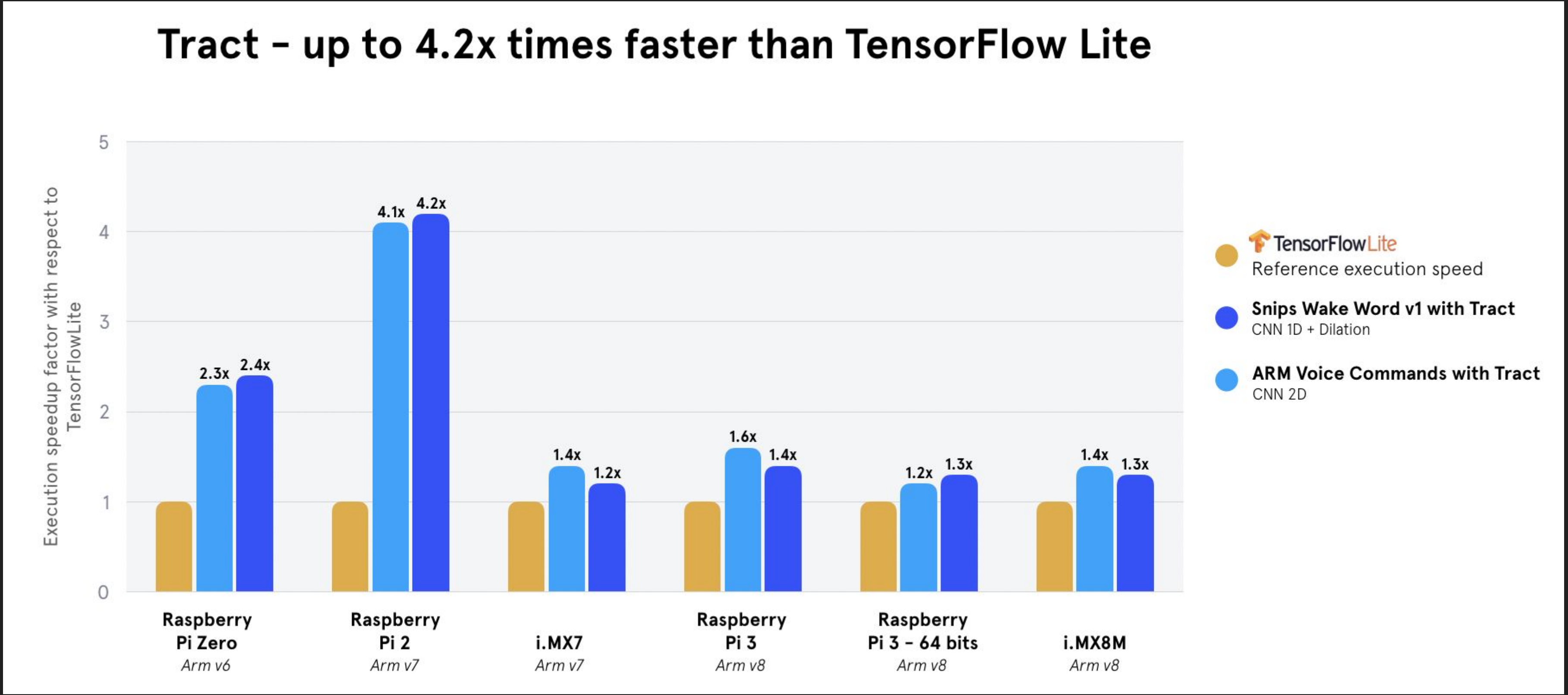
Snips (www.snips.ai)

- Edge-based AI Voice Platform enabling Private by Design voice assistants
  - Targeting any type of hardware: MCU and CPU
  - Simple commands to full NLP
  - On Device / Offline Operability / End User Privacy
- Opensourced Rust Libraries: tract, snips-nlu, and snips-nlu-rs
- Calculator Assistant running on a Snips Seeed Voice Interaction Development Kit: http://bit.ly/snipsseeed

Tract

- TensorFlow / ONNX compatible inference library
- Loads frozen model from ProtoBuf format and flows data through it
- Real time streaming support
- Optimizations done before runtime (not network translation phase)

Tract Performance



Offline ML with Rust

Offline ML with Rust Example

- REST API Server that can receive images via POST and respond with a prediction tuple (score, class) [all classes]
- Uses MobileNetV2, a lightweight image classification model (23MB)
- Cross Builds down to 15MB Rust binary
- Quasi-Offline: Model resides within the Rust App

Install Rust with Rustup

Go to https://rustup.rs

```
rustup update

rustup show

rustup toolchain install nightly

rustup default nightly

rustup default stable

rustup target list
```

Code Walkthrough

- Code: https://github.com/danielbank/offline-ml
- Cargo.toml
  - Image = Image Encoders and Decoders
  - Hyper = Low Level HTTP Library
  - Gotham = Flexible Web Framework
  - Tract = Neural Network Inference Engine
- Main.rs
  - Main Function
  - Router Function
  - Prediction Handler Function
  - Get Image Function

Cross Compilation

- Instructions: https://rust.azdevs.org/2019-07-24
- Rustup Targets
  - `rustup target add armv7-unknown-linux-gnueabihfpwd`
- Cross
  - `cargo install --force --git https://github.com/rust-embedded/cross cross`
  - Docker has to be running!
  - You have to use the cross command instead of cargo (or it will build for your local architecture)
  - `cross build --release --target=armv7-unknown-linux-gnueabihf`

Demo Time

- Curl Command

```
curl -i -X POST -F "image=@<IMAGE_PATH>" http://<IP>
```

- Image Classes

AZ Dev Community Links

- Desert Rust Meetup
- AI/ML DevFest
- IoT DevFest (Coming up in January 2020)
- {az}devs

Rust ML Links

- Are We Learning Yet: State of ML in Rust
- Weld: Parallel Code Generation for Data Analytics Frameworks
- Rust Crates for Numerical Simulation
- Tract Repo
- Snips NLU Rust Repo
- Rusty Machine: General Purpose ML Library

Snips Links

- Snips Open Sources Tract Medium Article
- Deep Dive on Snips at OxidizeConf with Hubert de la Jonquière
- Snips Uses Rust to Build an Embedded Voice Assistant
- Tract Repo
- Snips NLU Rust Repo
- Snips NLU Repo

TensorFlow Lite Links

- TensorFlow Lite on SparkFun Edge Codelab
- TensorFlow Lite Micro Speech Example
- TensorFlow Lite Guide
- TensorFlow for Microcontrollers