Remote Birding with TensorFlow Lite and Raspberry Pi

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Developer Relations Lead

blues wireless
And just like that I turned into a person that calls people to come look at the bird feeder.
A device

And just like that I turned into a person that calls people to come look at the bird feeder.

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Machine Learning FTW!
However...

- Compute Resources?
- Off-Grid Deployment?
- No Access to Wi-Fi?
✅ Compute Resources?

- Raspberry Pi 4
- TensorFlow Lite
✅ Off-Grid Deployment?

• 30,000 mAh USB-C Power Bank
• 42W Portable Solar Array
No Access to Wi-Fi?

- Blues Wireless Notecard for Cellular
- Notecarrier-Pi Host HAT
- ~8mA when Idle
TensorFlow Hub

- Pre-defined Model for Bird Identification
- Incredible Latency Benchmarks
Remote Birding
Workflow

PIR Motion Sensor
Detect motion from a bird at the bird feeder with infrared

Pi Camera
Snap a quick picture of the bird

TFLite
Use an ML model for birds around the world

To the Cloud
Send data about the bird to Notehub.io

Twilio SMS
Notehub.io securely routes the data to Twilio for an SMS
def set_input_tensor(interpreter, image):
    tensor_index = interpreter.get_input_details()[0]['index']
    input_tensor = interpreter.tensor(tensor_index)()[0]
    input_tensor[:, :, :] = image

def classify_image(interpreter, image, top_k=1):
    """return a sorted array of classification results """
    set_input_tensor(interpreter, image)
    interpreter.invoke()
    output_details = interpreter.get_output_details()[0]
    output = np.squeeze(interpreter.get_tensor(output_details['index']))
    # if model is quantized (uint8 data), then dequantize the results
    if output_details['dtype'] == np.uint8:
        scale, zero_point = output_details['quantization']
        output = scale * (output - zero_point)
    ordered = np.argpartition(-output, top_k)
    return [(i, output[i]) for i in ordered[:top_k]]
def send_note(bird, prob):
    
    # upload the json note to notehub.io
    req = {
        "req": "note.add",
        "file": "bird.qo",
        "start": True,
        "body": {
            "bird": bird,
            "prob": prob,
            "from": sms_from,
            "to": sms_to
        }
    }

    rsp = card.Transaction(req)

    # print(rsp) # debug/print request

while True:
    main()
“60% of the time it works every time”
Sent from your Twilio trial account - Bird spotted! Gallus gallus (Probability: 89.1%)
Future Improvements

- Low-Power MCU (e.g. Raspberry Pi Pico)
- TFLite Model Optimized for Local Birds
Resources

- Hackster Tutorial @ bit.ly/pi-bird
- Cellular IoT @ blues.io
- Rob on Twitter @ RobLauer
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- Connect to high-level frameworks
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- Connect to Runtime

Application

Optimized models for embedded

Runtime (e.g. TensorFlow Lite Micro)

Optimized low-level NN libraries (i.e. CMSIS-NN)

RTOS such as Mbed OS

Arm Cortex-M CPUs and microNPUs

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Resources: developer.arm.com/solutions/machine-learning-on-arm
TinyML for all developers

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- Embedded and edge compute deployment options

Dataset
- Acquire valuable training data securely
- Enrich data and train ML algorithms

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- Test impulse with real-time device data flows

Test

www.edgeimpulse.com
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- **Action**: Reinforcement learning for decision making

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