

Why Machine Learning needs Marine Robotics

petewarden@google.com

Who am I?

What is TensorFlow?

Why am I here?

TensorFlow is already on over two billion phones!



Photos



GBoard



Gmail



Nest



Assistant



NetEase



iQiyi



AutoML



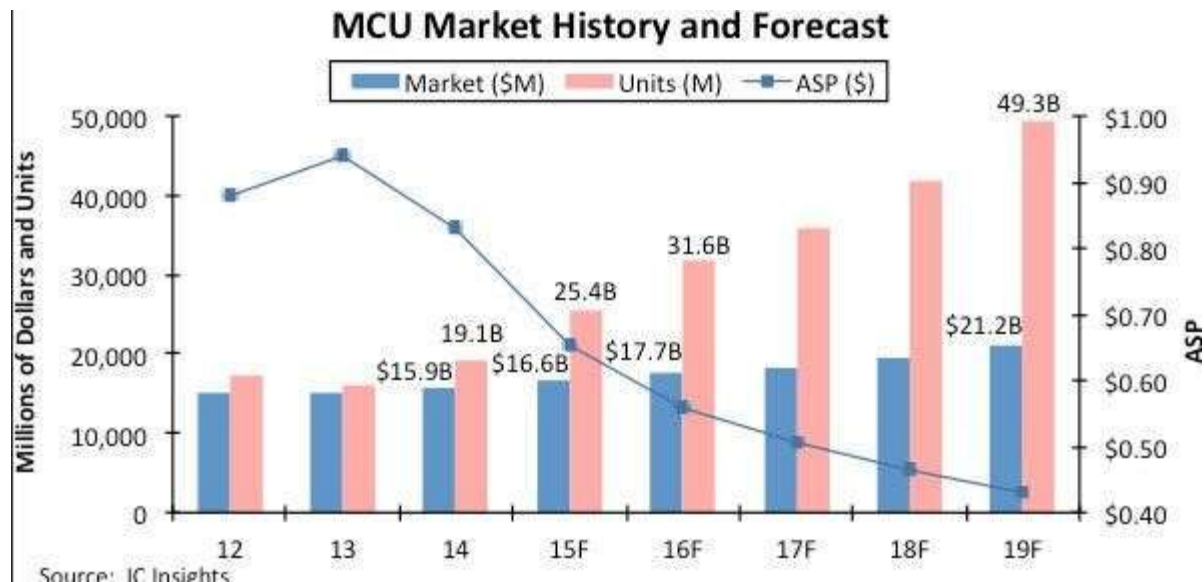
ML Kit

And
many
more...

But two billion is just the start

There are over 40 billion microcontrollers sold every year, and growing.

Their average price is 50 cents, and falling.



Picture courtesy of IC Insights, *The 2015 McClean Report*, via <https://www.embedded.com/electronics-blogs/break-points/4441588/The-shape-of-the-MCU-market>

Energy is the Limiting Factor

CPUs are approximately free.

Mains powered devices are expensive and hard to install, even indoors.

Phones require daily recharging.

The limit for what we can do with maintenance-free devices that can live anywhere is how long we can run for on a battery.

CPUs and Sensors Use Almost No Power, Radio Lots

Active cell radio might use 800 milliwatts. Low-power wifi and bluetooth still use tens of milliwatts. *

Microphones can use tens or hundreds of microwatts.

Image sensors can use under a milliwatt**, or even harvest energy. ***

CPUs can use microwatts.

This gap will only widen, data movement faces physical limitations that don't affect sensors.

* <https://www.eecs.umich.edu/courses/eecs589/papers/06215496.pdf>

** <https://www.qualcomm.com/invention/research/projects/computer-vision/always-on>

*** <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4435193/>

We Capture Much More Sensor Data Than We Use

Satellites can take many more high-resolution videos than they can download.

Accelerometers on factory machinery throw most of their data away.

Cameras on phones are only used for taking photos.

Broadband is the limit for many home camera systems.

Pedometers only spot steps.

What This All Means For Machine Learning

There's a massive untapped market waiting to be unlocked with the right technology.

We need something that:

- Works on cheap microcontrollers.
- Uses very little energy.
- Relies on compute not radio.
- Can turn all our wasted sensor data into something useful.

This is the gap that machine learning, and specifically deep learning, fills.

Why is Marine Robotics so interesting?

- You're extremely constrained on communication, far more than any terrestrial or even space applications
- But you have large amounts of power available, compared to battery or energy harvesting
- You have a lot of sensor data coming in

This means you can be ahead of the curve in capabilities, pushing machine learning ahead with innovative applications.

The innovations in this space can lead the way for mass adoption across embedded applications.

What could this mean in practice?

You tell me, but after February's Oceanology conference here were some suggestions:

- Long-lasting tracker tags with added cameras, able to take and store photos when 'something interesting' is spotted
- Autonomous grasping and retrieval of objects
- Ocean floor searching with many small, cheap robots able to spot anomalies
- Floating sensors able to recognize wildlife and shipping, and report back