2021 embedded VISION summit®

VIRTUAL | MAY 25-28

Developing Edge Computer Vision Solutions for Applications with Extreme Limitations on Real-World Testing

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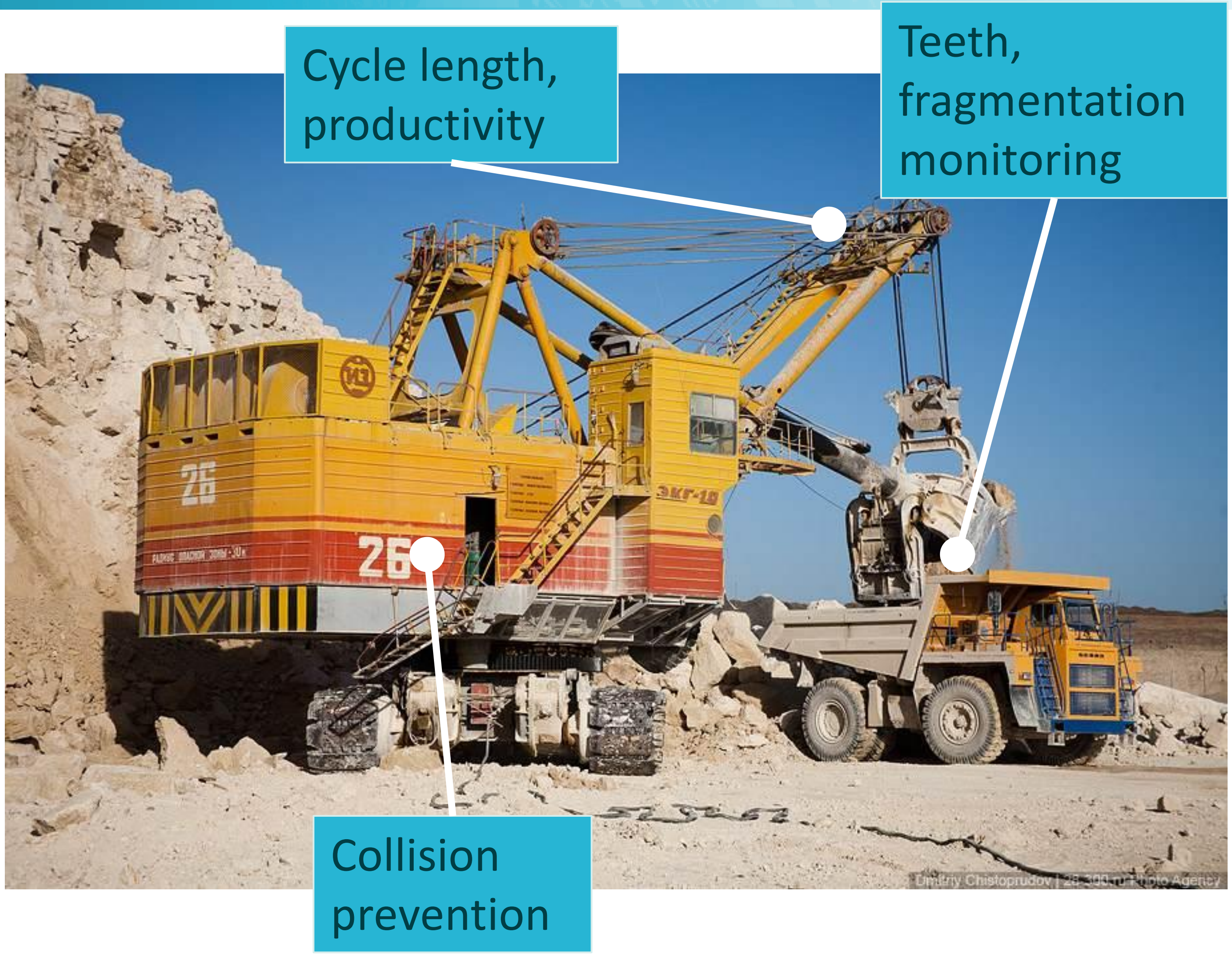
An example of oil well drilling safety analytics

- **10+ safety violations detecting with near real-time alerts**
- SLA 24/7 with low downtime
- 15 cameras, 40 people, nothing around for miles, 2 days to get there
- Only satellite connection, and it ain’t Starlink
- Low bitrate (< 1 video stream, lots of packet loss)

An example of mining shovels monitoring

- **Monitoring teeth wear and loss, fragmentation in the bucket, cycle length**
- Wi-Fi mesh network working at random times with random speed
- Hardware access possible at semi-random time once per 1-2 month
- Surges, vibration, coal dust


Cycle length, productivity

Teeth, fragmentation monitoring

Collision prevention

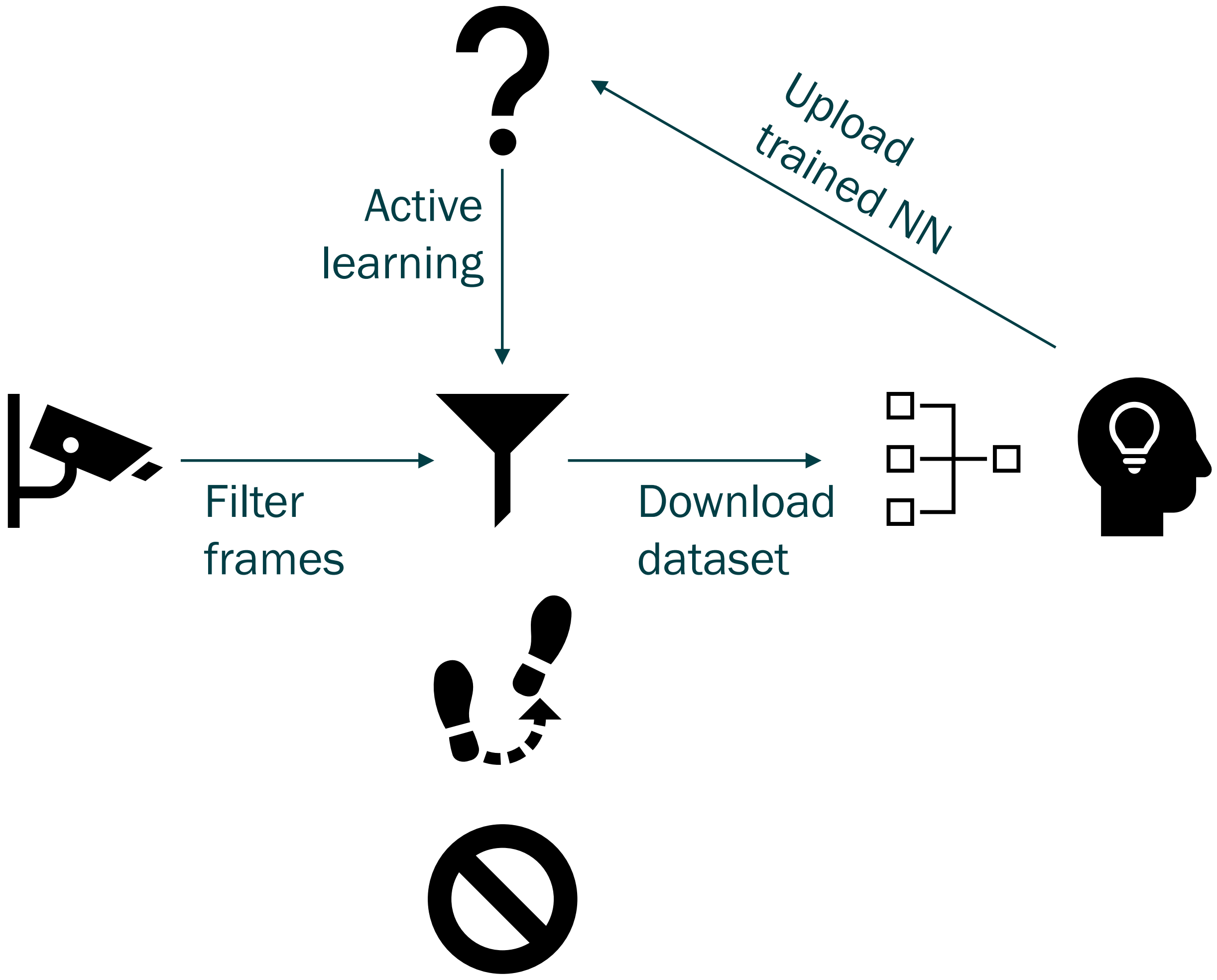
Challenges

1. Getting the data from the edge device
2. Uploading software, including NN themselves
3. Some events are too rare to train
4. No room for error: hard to update, high cost of error

1. Getting the data from the edge device

Getting the data from the edge device

- Filter for blocked view, no movement, fog
- Active learning



Active learning explained

Uncertainty sampling

The simplest and most common method for uncertainty sampling is to take the difference between 100% confidence and the most confidently predicted label for each item.

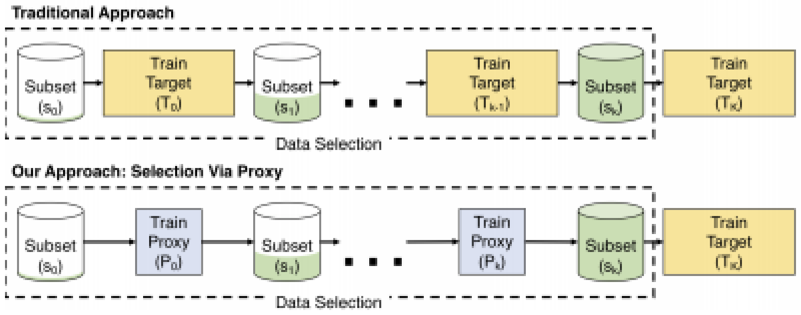
$$\phi_{LC}(x) = P_\theta(y^* \mid x)$$

Distort to confuse

Minimizing the sensitivity to perturbations with the idea of inducing “consistency”, i.e., imposing similarity in predictions when the input is perturbed in a way that would not change its perceptual content.

$$\mathcal{L}_u(x, M) = D(P(\hat{Y} = \ell | x, M), P(\hat{Y} = \ell | \tilde{x}, M)),$$

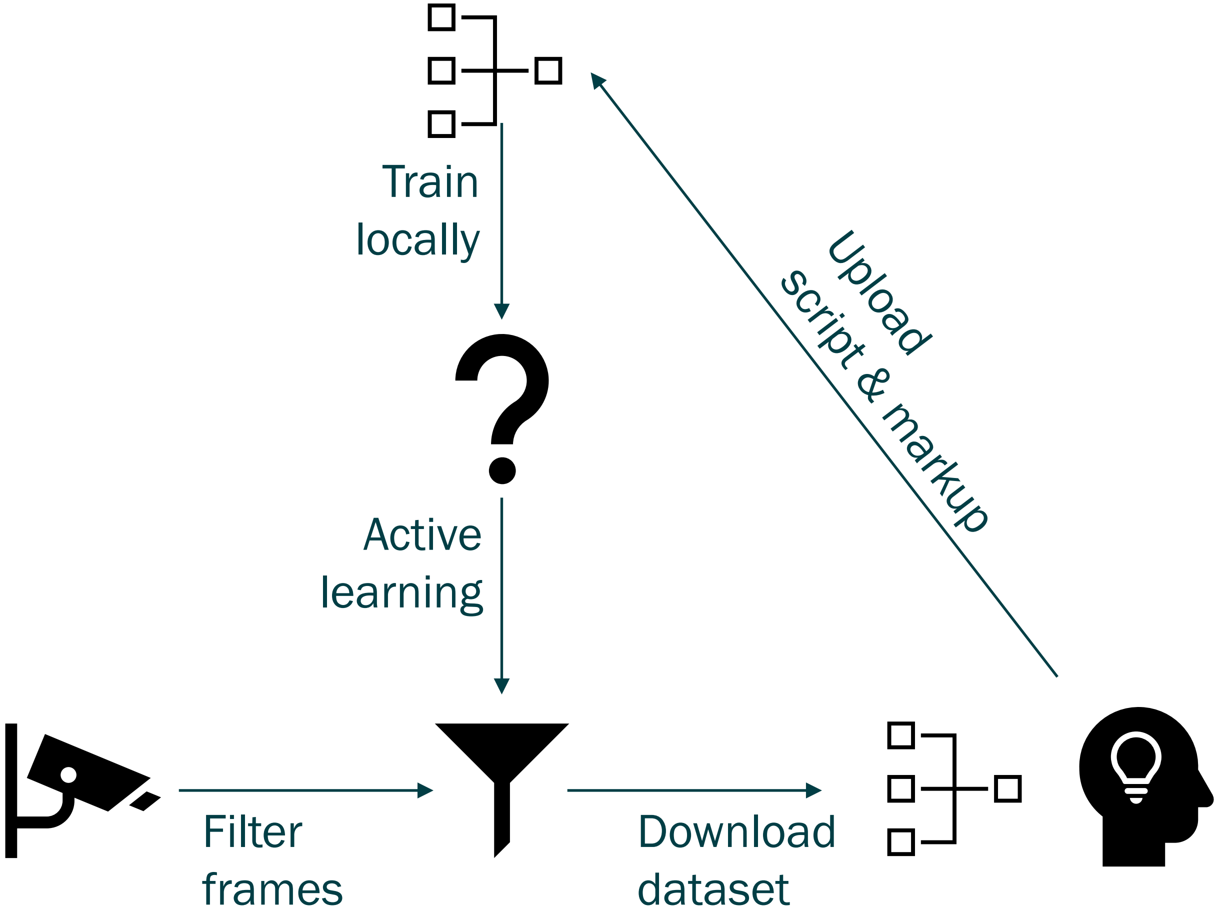
Proxy ranking



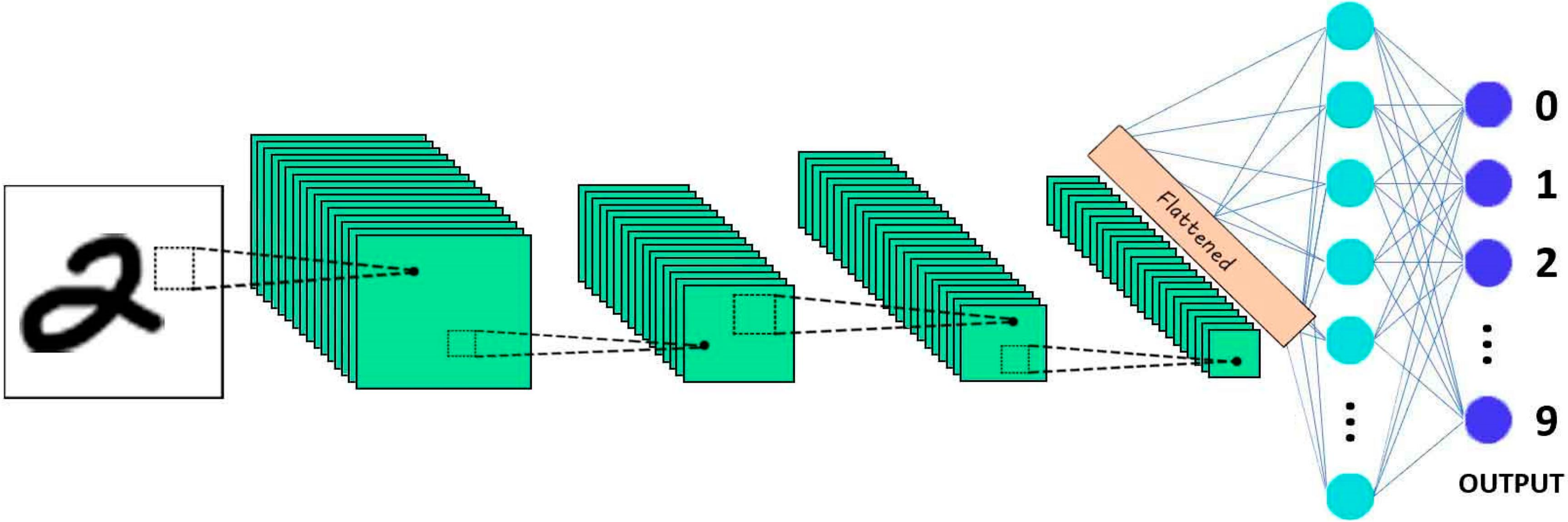
2. Uploading software, including NN themselves

Uploading software, including NN themselves

- **Training on the edge devices themselves, upload only script and markup (batch size could be smaller due to memory limitation)**
- **Upload NN diff (only changed bits)**



Why uploading NN diff is working



1. Further back – less changes

2. Maybe training only FC

3. Some events are too rare to train

Some events are too rare to train

- **Using administrative resource to stage the events**
- **Using mannequin**
- **Generate more data:**
  - ‘Style transfer’ say from Minecraft
  - 3D-modelling
  - GANs

Ways to generate data

'Style transfer' say from Minecraft

3D-modelling

GANs

4. No room for error: hard to update, high cost of error

No room for error: hard to update, high cost of error

- **Monitoring:**
  - Direct light, blockage, shifting
  - Event distribution
- **Full simulation of hardware and software**
- **Reserve infrastructure**
- **Auto-restart, auto-rollback**

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Wrap Up

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Main takeaways

1. Expect development costs 50% higher
2. Expect to spend the delta on DevOps
3. Figure out the network and data transfers limits

Resources

Resource Category 1

Papers mentioned

https://yadi.sk/d/QtogGW0j64Ea4w

FUNIT project page

https://nvlabs.github.io/FUNIT/

Thank you