Park Smart: AI at the edge to solve the parking problem

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Motivation and Solution
The quest for parking affects up to 50% of urban traffic!

- **CONGESTION**: 60 - 62 Min/day
- **AVERAGE SPEED**: 22 km/h
- **SOCIAL COST**: 2.6 Billions €
Why?

The number of vehicles in use is growing\(^1\)

Why?

The utilisation of parking spaces is inefficient!
Why?
Looking for parking is stressful!
Looking for parking is stressful!
Park Smart: AI at the edge to solve the parking problem
Depending on the configuration, the AISee can manage several cameras and perform fast inference and fine tuning.
AI at the Edge
We tackle the problem of declaring a parking stall as free or occupied as a binary classification problem.
Problem Formulation

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Given a sample frame, an operator manually annotates the stalls, which are subsequently cropped.
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The resulting patches are then classified using a fine-tuned Deep Convolutional Neural Network.
We fine-tuned three different architectures using the PKLot dataset.

<table>
<thead>
<tr>
<th>CNN Model</th>
<th>DS1</th>
<th>DS2</th>
<th>DS3</th>
<th>Avg Accuracy</th>
<th>Footprint</th>
</tr>
</thead>
<tbody>
<tr>
<td>AlexNet</td>
<td>98.80%</td>
<td>99.20%</td>
<td>93.82%</td>
<td>97.27%</td>
<td>217M</td>
</tr>
<tr>
<td>GoogLenet</td>
<td>99.72%</td>
<td>99.58%</td>
<td>99.26%</td>
<td>99.52%</td>
<td>40M</td>
</tr>
<tr>
<td>VGG16</td>
<td>99.13%</td>
<td>98.70%</td>
<td>94.91%</td>
<td>97.58%</td>
<td>528M</td>
</tr>
</tbody>
</table>

*lowest – highest*
Our Living Lab

Park Smart: AI at the edge to solve the parking problem
Dataset

Camera #1

Camera #2

Camera #3

Camera #4
Dataset

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Experimental settings

- Architectures:
  - AlexNet;
  - GoogLenet;
  - VGG16.

- Evaluation measures:
  - Accuracy: weighted over classes;
  - Timing: model loading.

- Boards:
  - Jetson TX1 vanilla;
  - Jetson TX2 vanilla.
Accuracy

![Accuracy Chart]

- **AlexNet**
- **GoogLeNet**
- **VGG16**

**Cameras**
- 1
- 2
- 3
- 4
- All

**Accuracy Levels**
- 0.8
- 0.85
- 0.9
- 0.95
- 1

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Comparison TX1 vs TX2

Average model loading time (seconds):

- **AlexNet**:
  - TX1: 4.5 seconds
  - TX2: 3.5 seconds

- **GoogLeNet**:
  - TX1: 3.0 seconds
  - TX2: 3.0 seconds

- **VGG16**:
  - TX1: 5.0 seconds
  - TX2: 4.5 seconds

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Demo!
Conclusions

+ simple approach;
+ fine-tuning can be performed on the box;
- need of manual cropping and labeling.
Future works

> include car detection;
> optimize software architecture;
> learn more general models;
> region proposal for semi-automatic cropping.
Life is what happens to others
Remember...

Life is what happens to others while you’re looking for parking!

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Thanks for your attention!
Questions?

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