Deadline: 09.Mar.2022 at 24:00
Submission type: report PDF format
Where: Moodle - Exercise 1

Exercise 1

# Real World Semantic Segmentation

The objective of this exercise is to identify the potentials and limitations of state-of-the-art visual semantic segmentation frameworks. Note that the conclusions you draw from this exercise are not necessarily limited to visual data and semantic segmentation, and most probably some generalize to many more sensor modalities and robotic tasks.

## Description

As we have observed in the introduction lecture, semantic segmentation is achieving an astonishing level of accuracy on common "clean" driving situations (see Fig.1)

Figure 1. Image of a street and its semantic segmentation obtained by [1].

In this exercise you are asked to test state-of-the-art systems for semantic segmentation and the confidence of their outputs. You will give a qualitative assessment on their performance, the reasons for their successes and failures and possible improvements to be made.

In order to simplify the developments for other researchers and, in this case, the exercise, a former colleague of yours has made available an easy-to-use re-implementation of the semantic segmentation network proposed in [1], and several confidence measures, as it was needed for your own colleague's research project [2]. The script[1] is hosted in the Colab environment[2]. For more efficient runs you can also try the open source code.

[1] Please change the source for the files from:

```
!wget --no-check-certificate
'https://dissimilarity.s3.eu-central-1.amazonaws.com/demo_files.tar'
```

To

```
!wget --no-check-certificate
'http://robotics.ethz.ch/~asl-datasets/Dissimilarity/demo_files.tar'
```

[2] https://colab.research.google.com/notebooks/intro.ipynb

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Your tasks:

1. **(2.0) Your good baseline**
   Take your smartphone and go to the streets. Pick a regular scene and take a picture (hopefully with a tripod) of it (e.g. Fig. 1 or Fig. 2). The important part of this selection is that in your experience a state-of-the-art semantic segmentation network should work reasonably well.
   a. Run the semantic segmentation and report the original image, the semantic segmentation output, and some confidence/uncertainty of the output (clearly specify the method for computing the confidence/uncertainty).
   b. Please analyze the performance of the semantic segmentation network and of the uncertainty/confidence estimation method. (min 100 words, max 250 words).


Figure 2. Examples of regular city scenarios.

2. **(2.0) Make it fail!**
   In this part you will take another picture in the same place, and as similar as possible point of view, as before (the one you took in part **1**). The difference is that you will introduce a real world adversarial attack (be creative) to make the semantic segmentation fail.
   a. Run the semantic segmentation and report the original image, the semantic segmentation output, and the confidence/uncertainty of the output (same method as above).
   b. Please analyze the performance (and failures) of the semantic segmentation network and of the uncertainty/confidence estimation method. (min 100 words, max 250 words).

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Figure 3. The automotive industry uses camouflages to hide shape designs from their competitors and the public.

3. **(2.0) Camouflages**
   Please look on the internet for another image using camouflages to deceive vision sensors (e.g. see Fig. 3).
   a. Run the semantic segmentation and report the original image, the semantic segmentation output, and the confidence/uncertainty of the output (same method as above).
   b. Please analyze the performance (and failures) of the semantic segmentation network and of the uncertainty/confidence estimation method. (min 100 words, max 250 words).

**Extra point (Optional):**

**(0.5 point) Alternative public open source semantic segmentation network**
You take the extra step of looking for an alternative code/script to perform the semantic segmentation that has been released in the last 2 years (>=2020). A short description (max. 100 words) of the system is required. The same network has to be used for the 3 cases above.

**Hint:** One option to upload your own image into Colab is:

```
from google.colab import files
files.upload()
```

[1] Yi Zhu, Karan Sapra, Fitsum A Reda, Kevin J Shih, Shawn Newsam, Andrew Tao, and Bryan Catanzaro. Improving semantic segmentation via video propagation and label relaxation. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pages 8856–8865, 2019.
[2] Di Biase, Giancarlo, Hermann Blum, Roland Siegwart, and Cesar Cadena. Pixel-wise anomaly detection in complex driving scenes. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 16918–16927. 2021.