# A Downstream Task Informed Domain Adaptation GAN for Semantic Segmentation

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## Abstract and Contribution

We focus on understanding complex visual street scenes with the help of pixelwise classification (semantic segmentation). As labeled data is often rare, we consider computer simulations of urban scenes, where we can generate arbitrary many labeled samples with no or little cost and train a network on the fully controllable domain.
Neural networks may perform poorly when used in domains with a different underlying data distribution. This phenomenon is called domain gap. To solve semantic segmentation in other domains like the real world were labels are hard to obtain, we aim to mitigate the gap via style transfer and guidance of the generator towards the down stream task.
Our main contributions in this work are:

- Feasibility analysis of exploiting a fully controllable domain
- A semi-supervised method to guide the generator to a downstream task without retraining the downstream task network
- A more unbiased domain gap analysis by using a from scratch trained semantic segmentation network.

## Concept of Generative Adversarial Networks


## References

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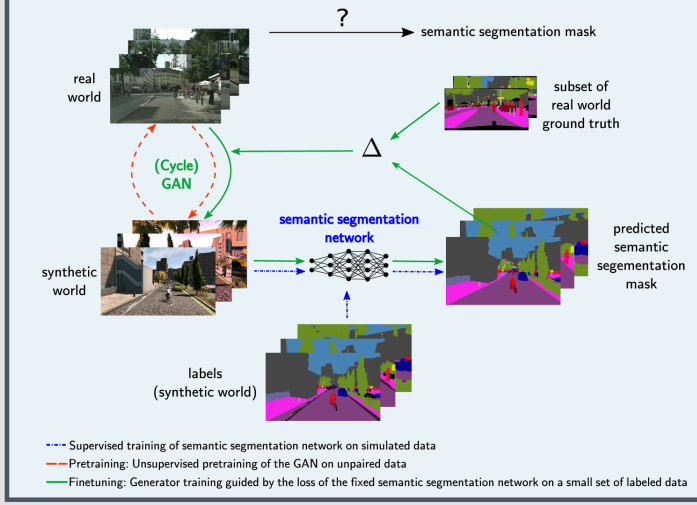
## Concept of Task Informed GAN (ours)




## Extended Generator Loss $\mathcal{L}_{G_\mathcal{S}}$

$$\mathcal{L}_{G_\mathcal{S}}(I) = (1-\alpha)\underbrace{\left\|D_s\left(G_\mathcal{S}(I)\right)-1\right\|^2}_{\substack{\text{original LSGAN}\\ \text{generator loss [2]}}} + \alpha\underbrace{\left(\gamma\, CE\left(f(G_\mathcal{S}(I)), l_r\right)\right)}_{\text{Cross entropy loss}},$$

with generator $G_\mathcal{S}$ from the real domain $\mathcal{R}$ to the synthetic domain $\mathcal{S}$, discriminator $D_\mathcal{S}$, semantic segmentation network $f$, real world image $I$ with label $l_r$ and $G_\mathcal{S}(I)$ its GAN transformed version.

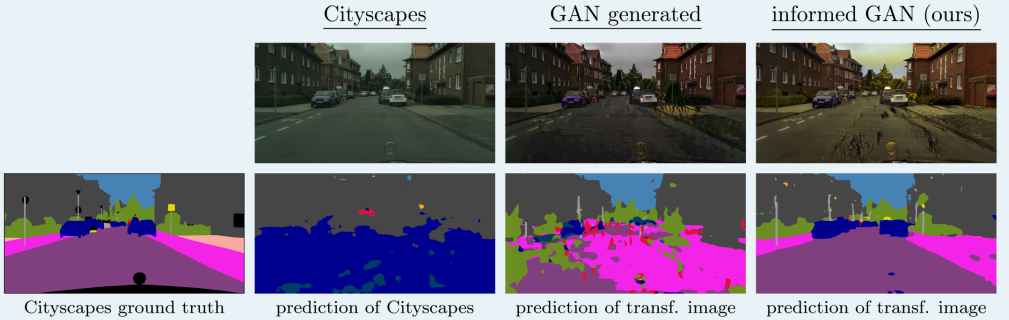
## Domain Gap

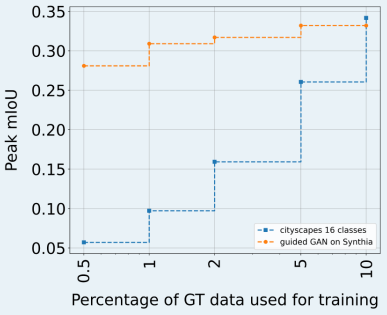
Our setup: DeepLabV3 [3] with ResNet101 as backbone trained from scratch on only synthetic data (Synthia [4]).

| input | pretrained | mIoU |
|---|---|---|
| Synthia [4] valset | no | 0.648 |
| Cityscapes [5] valset | no | 0.099 |
| Cityscapes [5] valset | yes | 0.386 [6] |

→ indication that backbones pre-trained on real world classification tasks are biased towards the real domain.

## GAN and Segmentation Results (based on Synthia)

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