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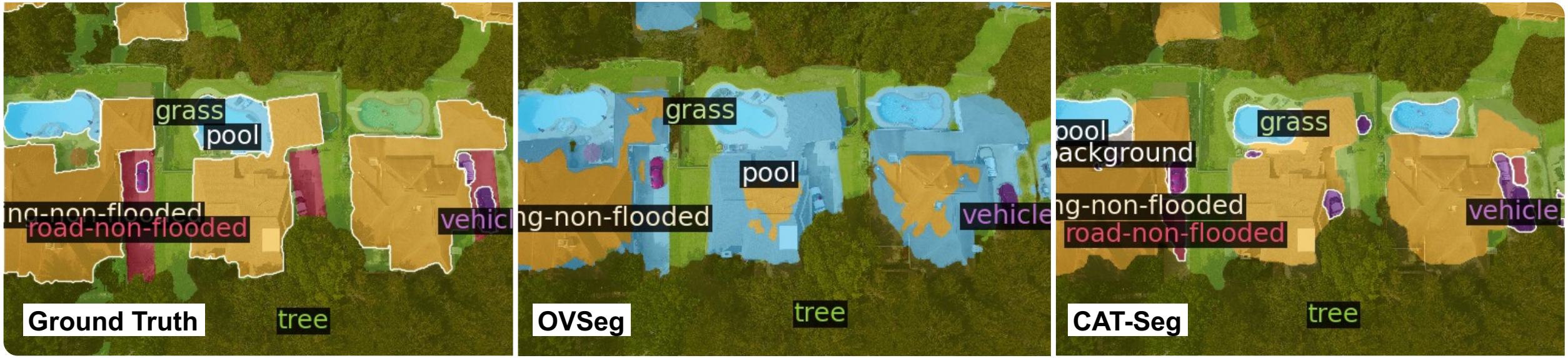
What a MESS: Multi-Domain Evaluation of Zero-Shot Semantic Segmentation

Benedikt Blumenstiel, Johannes Jakubik, Hilde Kühne, Michael Vössing



Zero-shot semantic segmentation models can process varying class names during inference.

Variable classes: *road, building, sky, …*

Zero-shot model

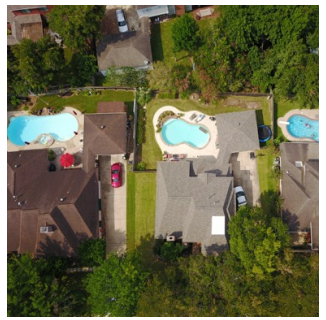
Dataset examples from BDD100K and FloodNet.

Zero-shot semantic segmentation models can process varying class names during inference.

Variable classes: *road, building, sky, …*

Zero-shot model

Variable classes: *grass, tree, pool, …*



Zero-shot model

Dataset examples from BDD100K and FloodNet.

Previous zero-shot evaluation focused on in-domain while MESS evaluates the generalizability across domains.

person, dog, car, chair, …

person, dog, … building, wall

Dataset examples from COCO-Stuff, ADE20K, Pascal Context, CHASE DB1, WorldFloods, UAVid, and SUIM.

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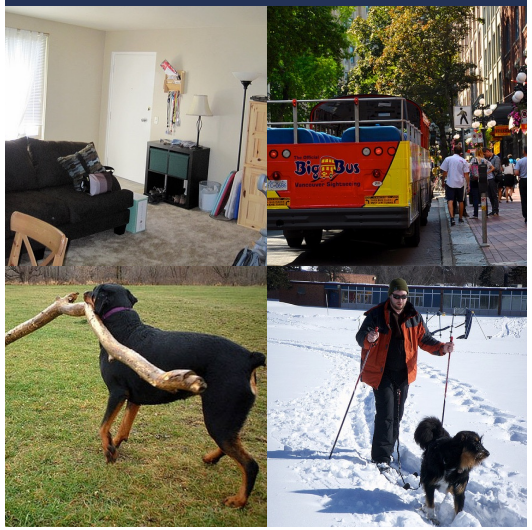
Training – COCO

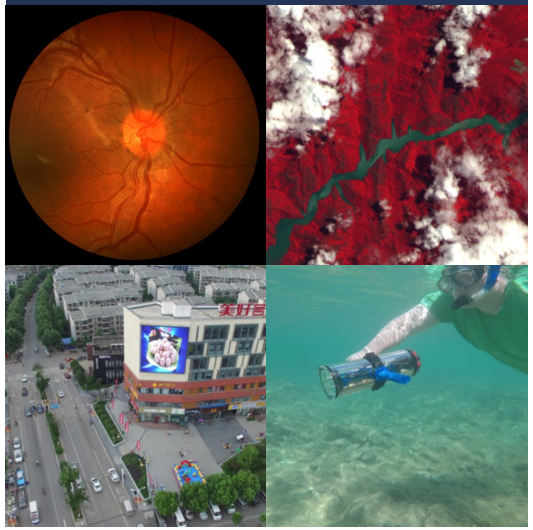


person, dog, car, chair, …

Testing – ADE/PC

person, dog, … building, wall

Real-world



blood vessels, flood, …

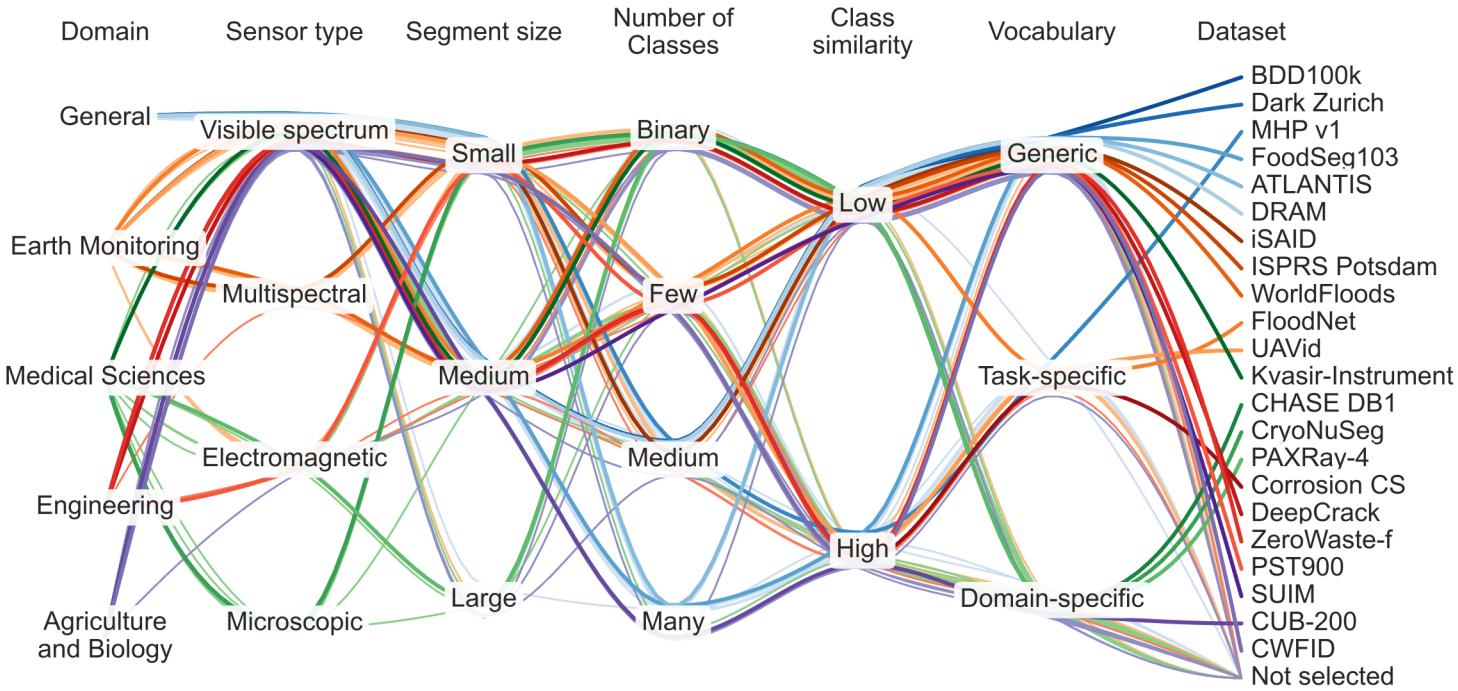
Dataset examples from COCO-Stuff, ADE20K, Pascal Context, CHASE DB1, WorldFloods, UAVid, and SUIM.

The MESS benchmark includes 22 datasets and covers a variety of visual and language characteristics.

>500
reviewed datasets

120
classified datasets

Visual and language characteristics of segmentation tasks



Taxonomy development based on from Nickerson, R. C. et al. (2013). A method for taxonomy development and its application in information systems. *European Journal of Information Systems.*

The domain-averaged mIoU results show differences in the generalizability between models and domains.

Model	General	Earth Monitoring	Medical Sciences	Engineering	Agri. and Biology	Mean
Random (LB)	*1.17*	*7.11*	*29.51*	*11.71*	*6.14*	*10.27*
Best supervised (UB)	*48.62*	*79.12*	*89.49*	*67.66*	*81.94*	*70.99*
ZSSeg-B	19.98	17.98	41.82	14.0	22.32	22.73
ZegFormer-B	13.57	17.25	17.47	17.92	25.78	17.57
X-Decoder-T	22.01	18.92	23.28	15.31	18.17	19.8
SAN-B	29.35	30.64	29.85	23.58	15.07	26.74
OpenSeeD-T	22.49	25.11	**44.44**	16.5	10.35	24.33
CAT-Seg-B	**34.96**	**34.57**	41.65	26.26	**29.32**	**33.74**
Grounded-SAM-B	29.51	25.97	37.38	**29.51**	17.66	28.52
OVSeg-L	29.54	29.04	31.9	14.16	28.64	26.94
SAN-L	36.18	38.83	30.27	16.95	20.41	30.06
CAT-Seg-L	**39.93**	**39.85**	**48.49**	26.04	34.06	**38.14**
Grounded-SAM-L	30.32	26.44	38.69	**29.25**	17.73	29.05
CAT-Seg-H	37.98	37.74	34.65	29.04	**37.76**	35.66
Grounded-SAM-H	30.27	26.44	38.45	28.16	17.67	28.78

Bold = best model; underlined = second-best model; Random = randomly expected mIoU with uniformly distributed predictions; Best supervised = SOTA separately selected for each dataset.
All results are available at https://blumenstiel.github.io/mess-benchmark/leaderboard/.

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- CAT-Seg performs best, followed by SAN.
- Limited generalizibility of two-stage or not CLIP based models.
- The performance varies between domains and datasets.

Bold = best model; underlined = second-best model; Random = randomly expected mIoU with uniformly distributed predictions; Best supervised = SOTA separately selected for each dataset.
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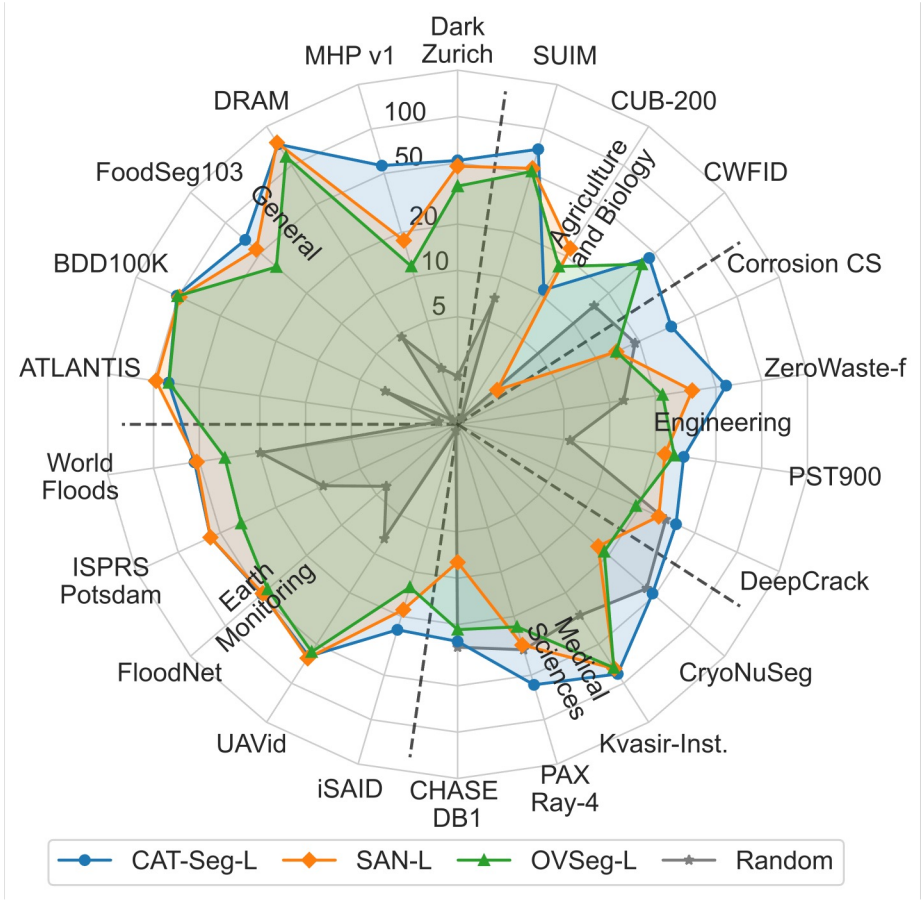
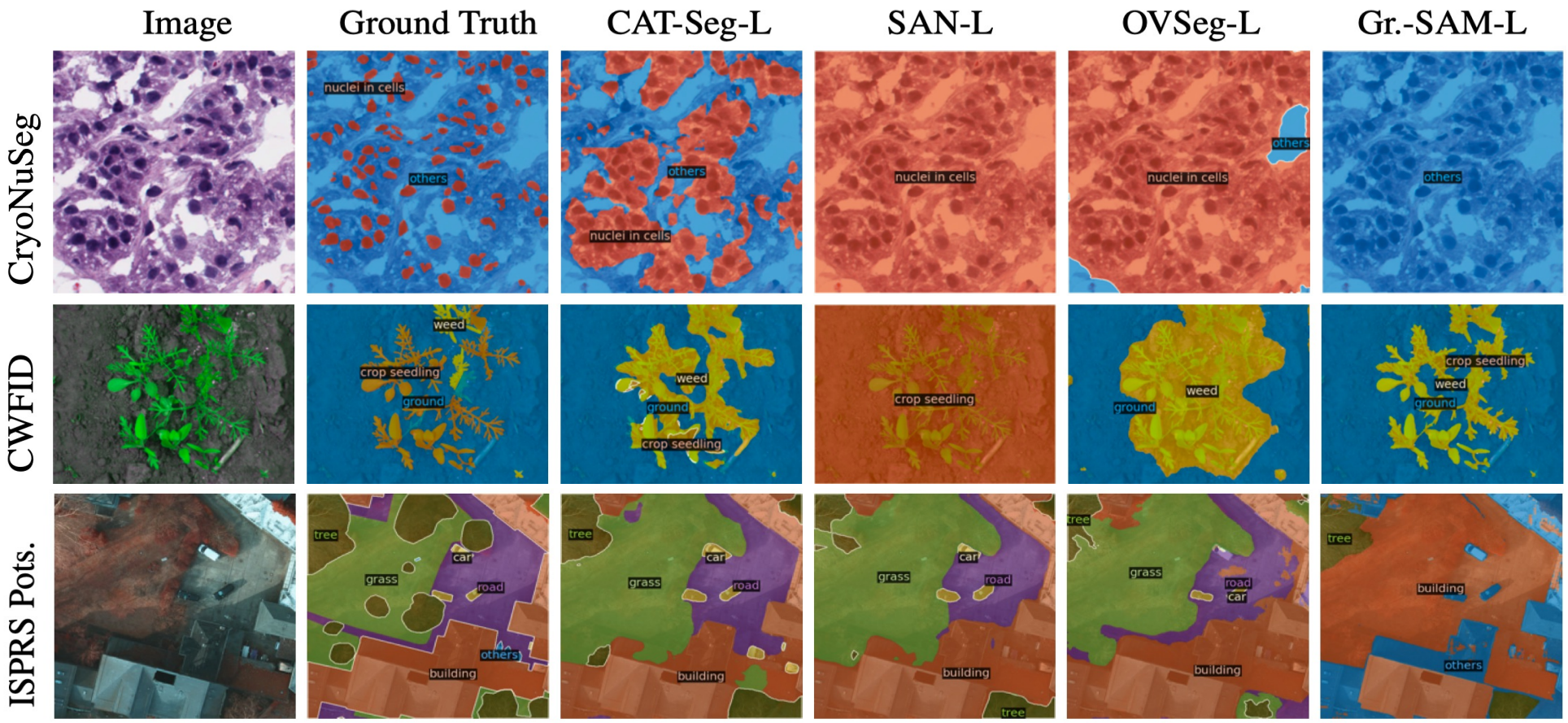
The visual and language characteristics from the datasets can influence the results of zero-shot models.

- Zero-shot transfer models **match supervised models** on everyday classes and images (DRAM, BDD100K).
- **Common classes** are correctly predicted in other domains (e.g., FloodNet, Kvasir-Instrument, SUIM).
- **Medical and engineering** datasets are very challenging for zero-shot transfer.
- The applicability is influenced by **visual and language characteristics** of the domain tasks.



Relative performance to the supervised results, visualized on a log scale (100 = supervised).

Small segments and similar class names are challenging but common classes can be detected in domain tasks.



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https://blumenstiel.github.io/mess-benchmark/