

ArchCAD-400k: A Large-Scale CAD drawings Dataset and New Baseline for Panoptic Symbol Spotting

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GitHub

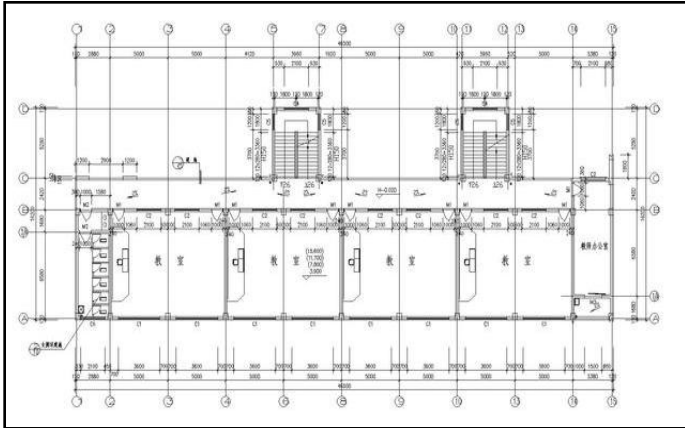


HuggingFace

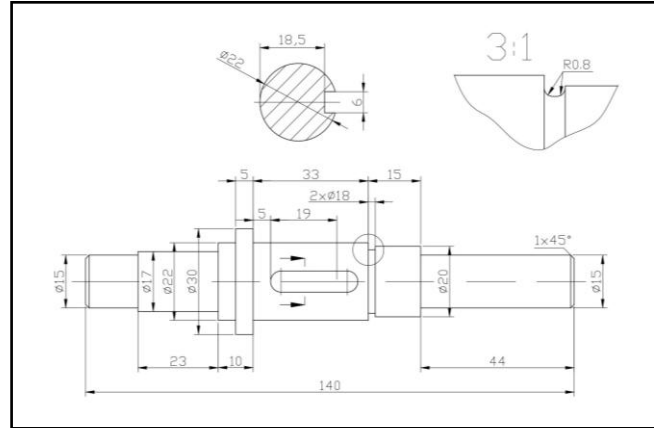
Background



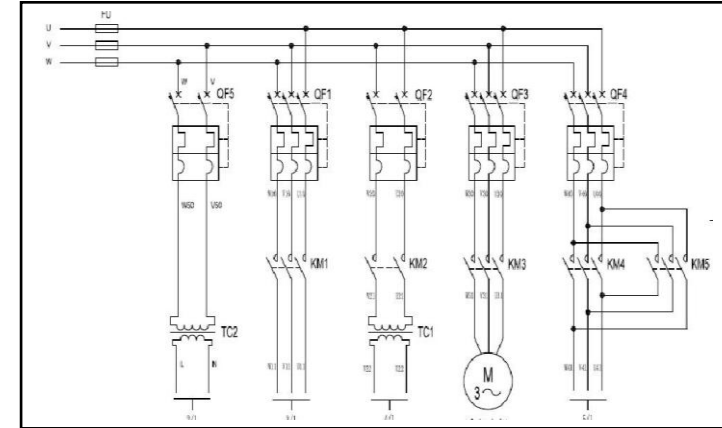
CAD Drawings — A Universal Language in Engineering fields



Architectural Drawings



Mechanical Drawings

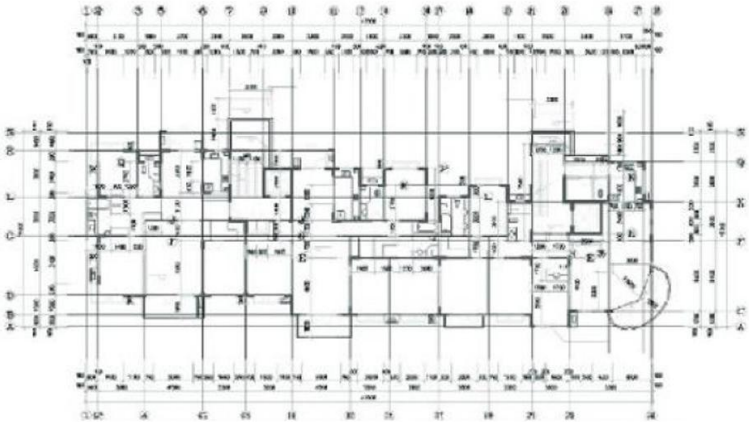


Electrical Drawings

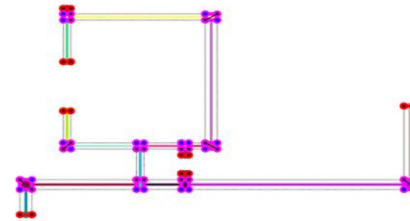
Background



From Primitives to Semantics

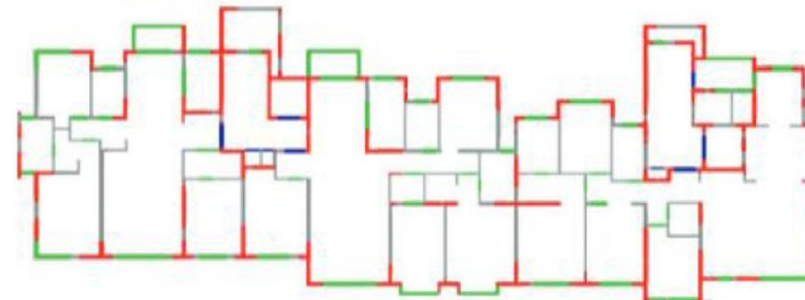


CAD Drawings



```
Line1: start(..,..), end(..,..)  
Line2: start(..,..), end(..,..)  
Line3: start(..,..), end(..,..)  
... ..
```

Basic Primitives

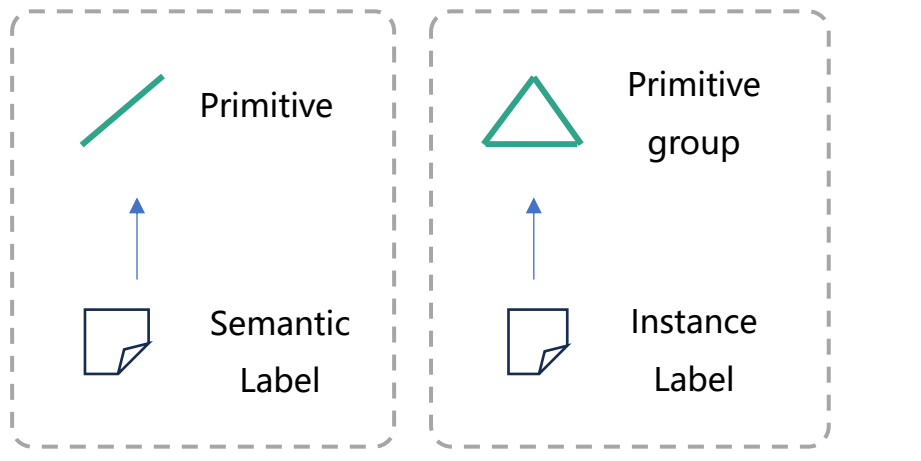


Design intentions

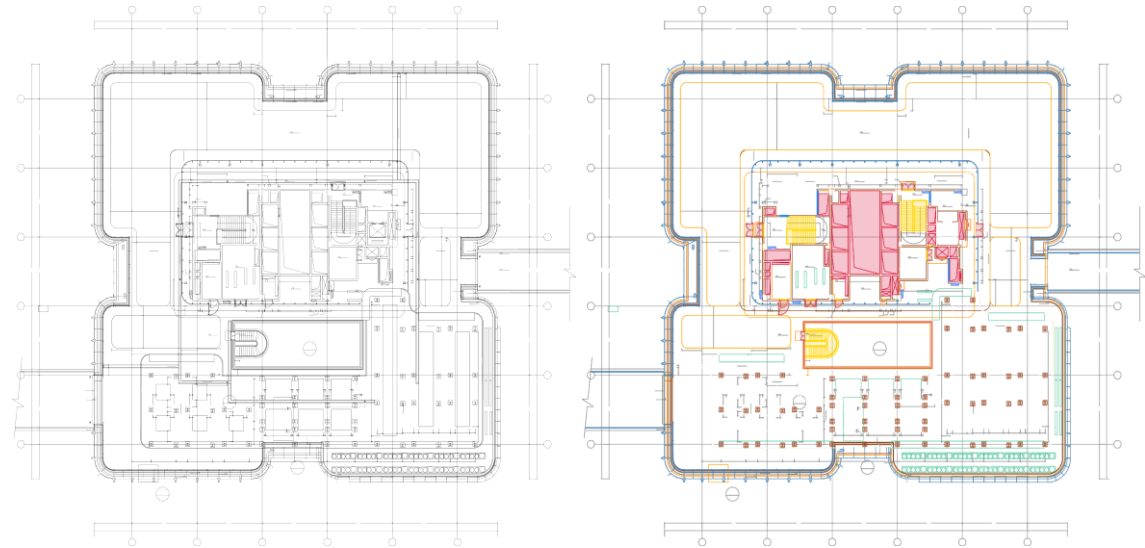
Background



Panoptic symbol spotting aims to interpret CAD drawings by assigning semantic and instance labels to graphical primitives.



Illustration



Visualization

Background



Value of Panoptic symbol spotting

- Various downstream tasks
- Structured engineering corpora



3D reconstruction



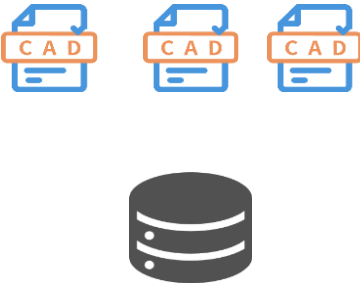
Automated review

表二：地下室附属面积及数据

功能区	房间名称	建筑面积 (m²)	数量	备注
公共区域	楼梯	376	1	√
	多用途厅	910	1	√
	展览厅	910	1	有新建展览厅和展览厅，展览厅面积宽度为6m
	陈列厅	400	1	√
	文物展示厅	88	1	长宽尺寸30m，宽宽尺寸4m
	儿童活动室	88	1	√
	图书馆	88	1	√
	办公室	76	1	√
	展厅	66	1	√
	管理室	66	1	√
业务区域	藏品室	166	1	√
	藏品中厅	90	1	√
	文物展示室	180	1	√
	陈列室	170	2	√
其他	走廊、楼梯、电梯等	125	1	√
总计		3300	1	√

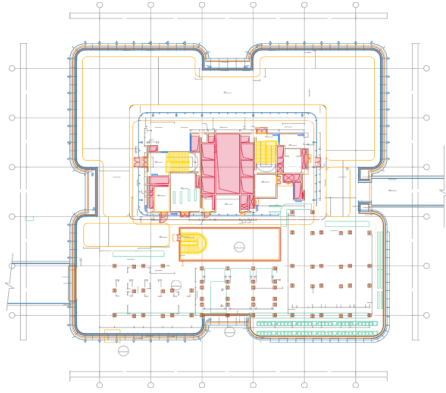
地下室总建筑面积3300m² (含附属面积125m²)

Cost estimation

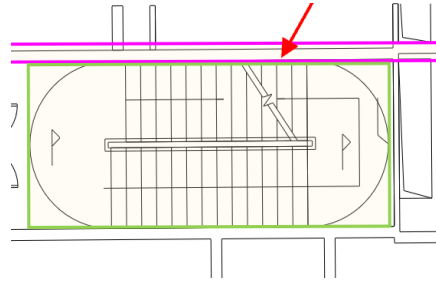


Engineering corpora

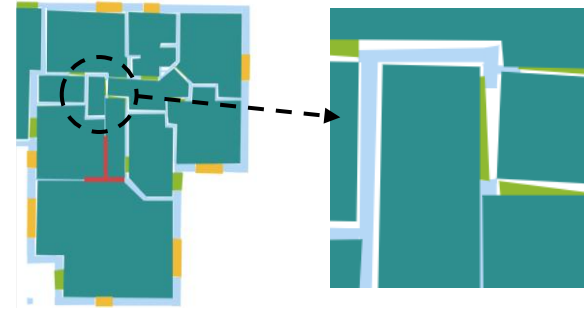
Data Scarcity comes from difficulty in labeling



Numerous Instances



**Difficult to distinguish
boundaries**



Inaccurate positioning

Layers and Blocks — Interior structures embedded in CAD drawings

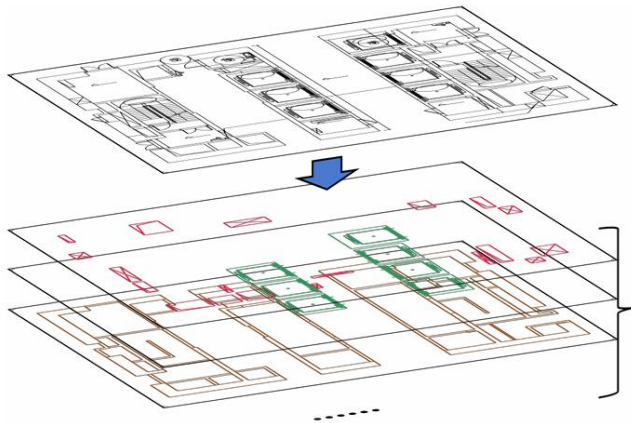


Illustration of Layers

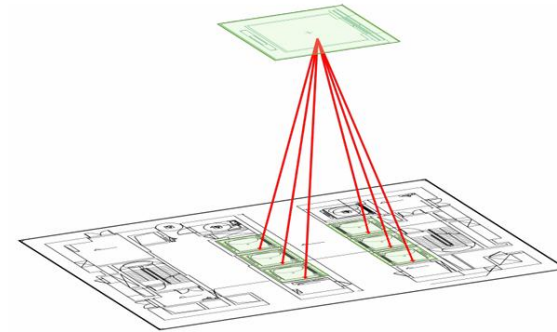
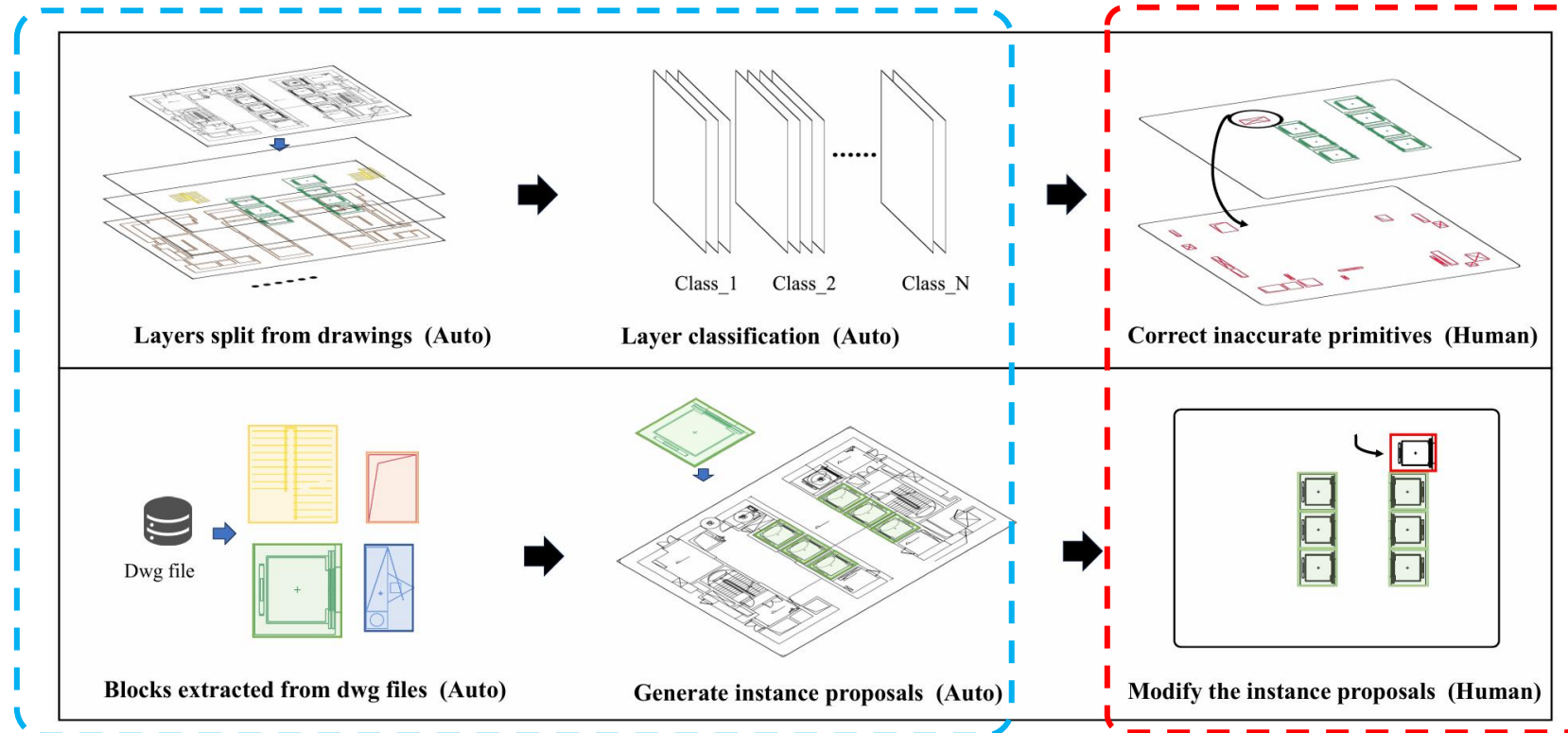


Illustration of Blocks

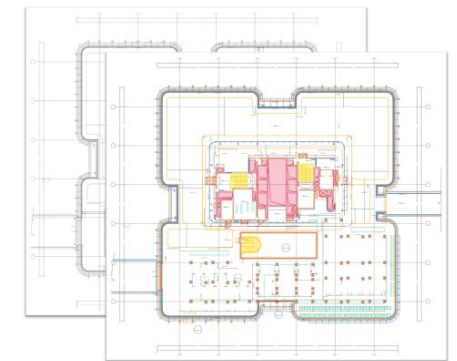
Human-machine collaborative annotation

Auto

Human



Example:
Finished in less than **8min** !

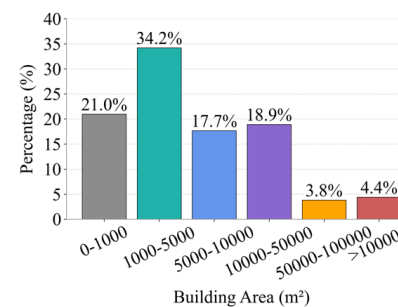
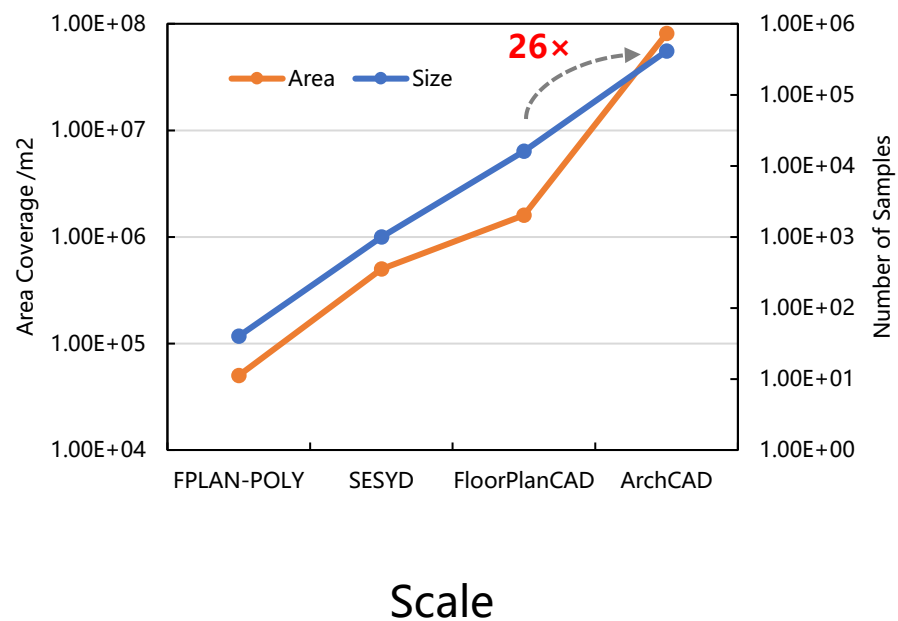


Exploring ArchCAD-400k

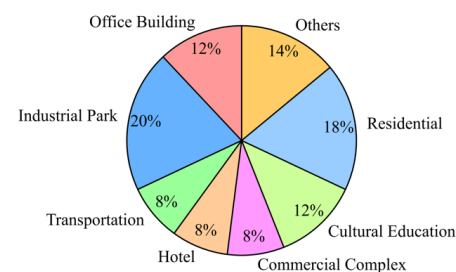


- Larger Scale;
- Data of rich diversity;

- Primitive level label;
- Extended semantic category coverage.

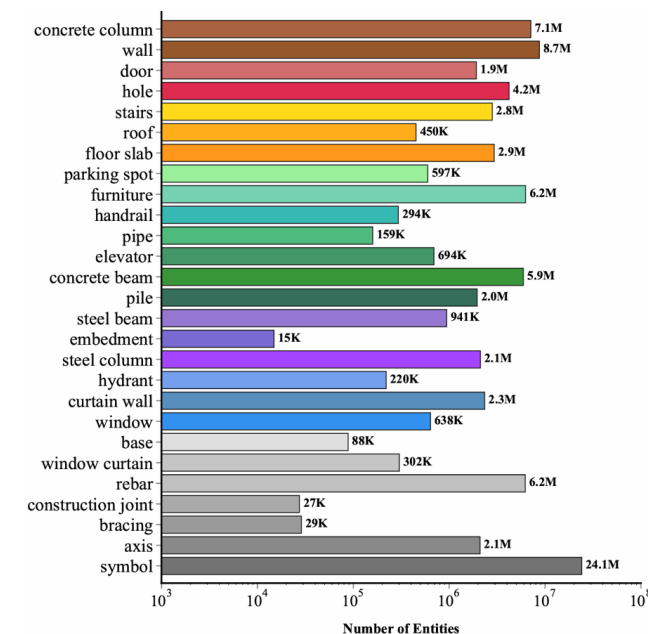


(a)



(b)

Diversity



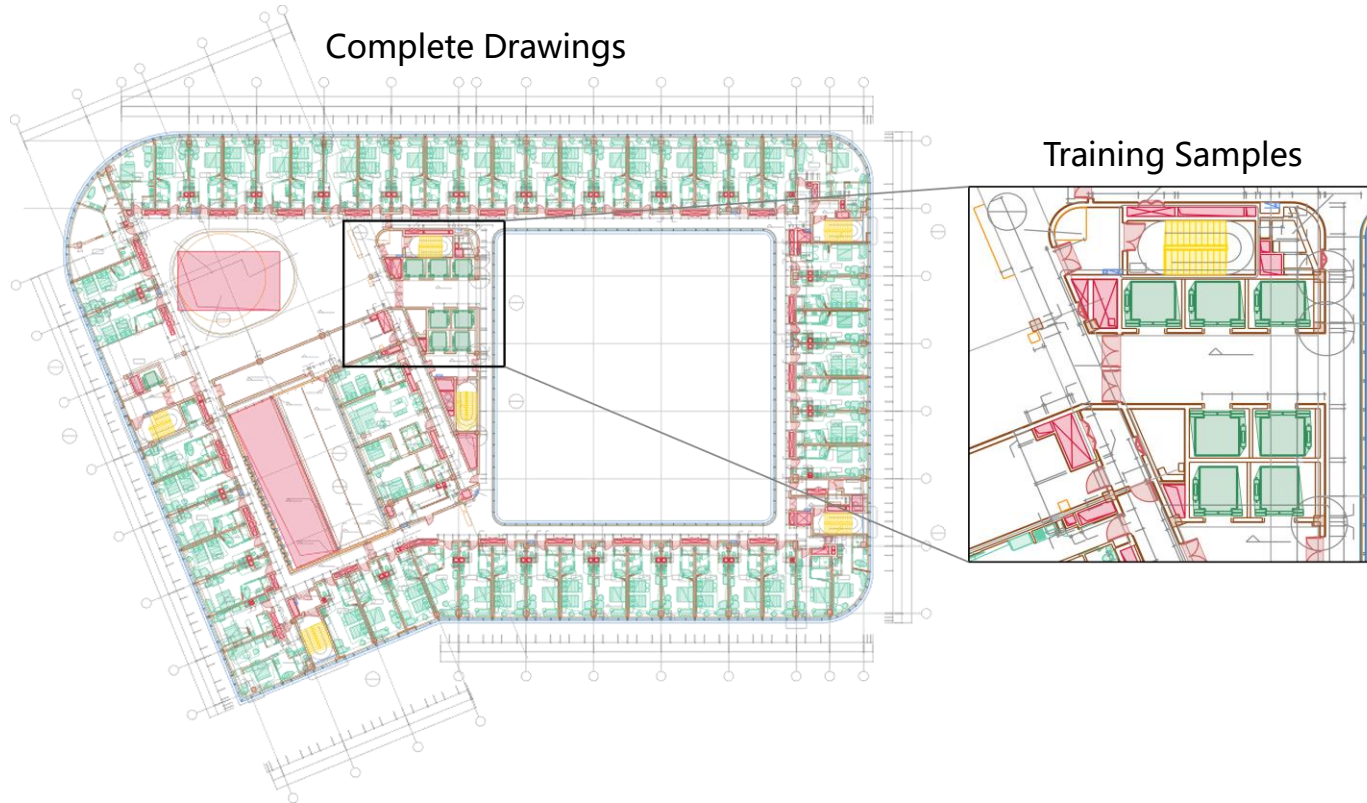
(c)

Category coverage

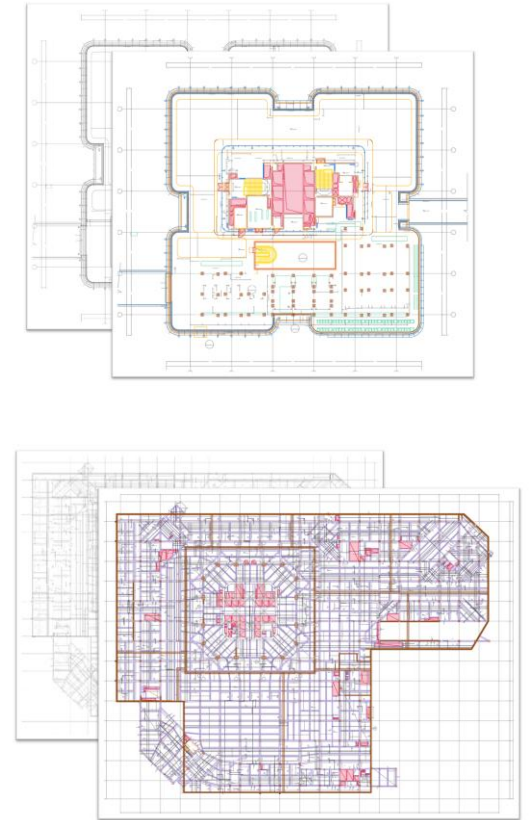
Exploring ArchCAD-400k



A Glimpse



Examples from the Dataset



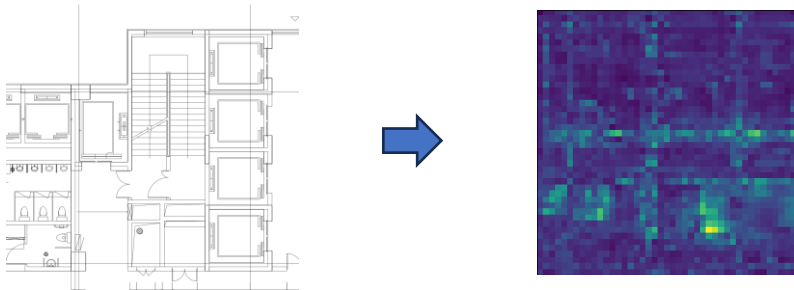
More Examples

Panoptic Symbol Spotting

→ **Key Problem: How to represent CAD primitives ?**

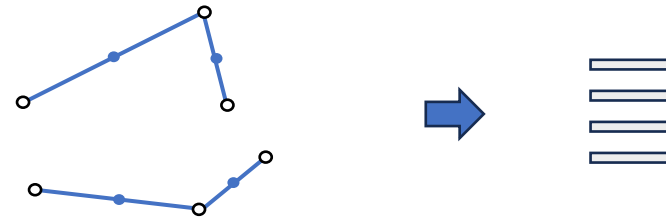
Image based representation

- Good at capturing geometric shapes and contextual information;



Primitive based representation

- Good at capturing the distance, size, and topological relationships of primitives;

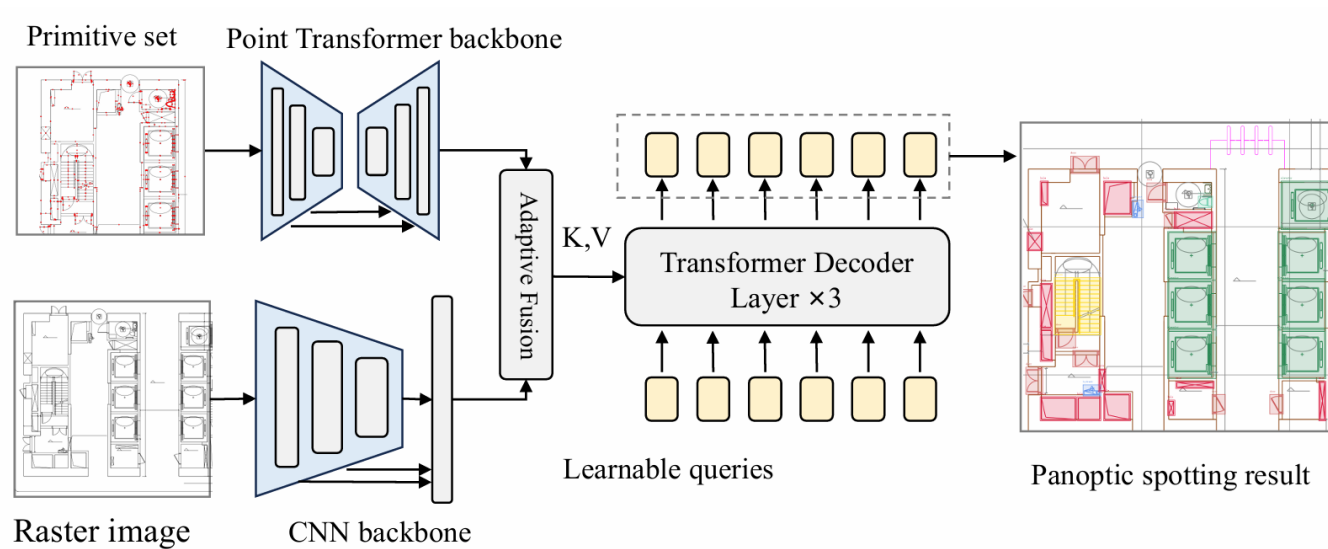


DPSS Framework

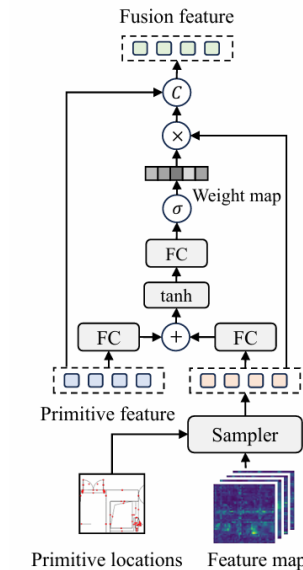


DPSS Components

- A **dual branch encoding** strategy for image and graphics;
- An **adaptive fusion module** for bimodal features from images and graphics;
- An **End to end transformer decoder** for panoptic symbol spotting.



(a) DPSS Framework



(b) Adaptive fusion

Experiments — Baseline results



On FloorPlanCAD

Method	Additional prior inputs	Total			Thing			Stuff		
		PQ	SQ	RQ	PQ	SQ	RQ	PQ	SQ	RQ
SymPointV2	w/	90.1	96.3	93.6	90.8	96.6	94.0	80.8	90.9	88.9
CADSpotting	w/	88.9	95.6	93.0	89.7	96.2	93.2	80.6	89.7	89.8
DPSS	w/	89.5	96.2	93.1	90.4	96.6	93.5	79.7	91.1	87.5
CADTransformer	w/o	68.9	88.3	73.3	78.5	94.0	83.5	58.6	81.9	71.5
GAT-CADNet	w/o	73.7	91.4	80.7	—	—	—	—	—	—
SymPoint	w/o	83.3	91.4	91.1	84.1	94.7	88.8	48.2	69.5	69.4
SymPointV2	w/o	83.2	91.3	91.1	85.8	92.5	92.7	49.3	70.3	70.1
DPSS	w/o	86.2	93.0	92.6	88.0	94.1	93.5	64.7	83.0	77.9

Method	Additional prior inputs	Semantic spotting		Instance spotting		
		F1	wF1	AP50	AP75	mAP
SymPointV2	w/	89.5	88.3	71.3	60.7	60.1
CADSpotting	w/	93.5	93.9	72.2	69.1	69.0
DPSS	w/	93.1	93.2	74.8	71.0	70.8
DeepLabv3+R101	w/o	68.8	71.4	—	—	—
DINO	w/o	—	—	64.9	54.9	47.5
CADTransformer	w/o	82.2	80.1	—	—	—
SymPoint	w/o	86.8	85.5	66.3	55.7	52.8
SymPointV2	w/o	87.0	86.3	66.4	57.7	57.5
DPSS	w/o	92.0	93.2	67.0	61.8	61.5

On ArchCAD-400K

Method	Total			Thing			Stuff		
	PQ	SQ	RQ	PQ	SQ	RQ	PQ	SQ	RQ
CADTransformer	60.0	89.7	66.9	52.5	83.6	62.7	70.1	96.7	72.5
SymPoint	47.6	86.1	55.3	51.4	91.9	55.9	39.9	73.9	54.0
SymPointV2	60.5	88.0	68.8	62.4	91.7	68.1	52.8	73.7	71.7
DPSS	70.6	90.2	78.2	65.6	92.4	70.9	77.6	87.8	88.4

Method	Semantic Spotting		Instance Spotting		
	F1	wF1	AP50	AP75	mAP
CADTransformer	84.1	83.4	—	—	—
SymPoint	76.8	62.0	36.1	30.9	30.8
SymPointV2	69.8	69.3	44.9	40.2	39.7
DPSS	87.8	84.1	45.6	41.1	40.7

Experiments



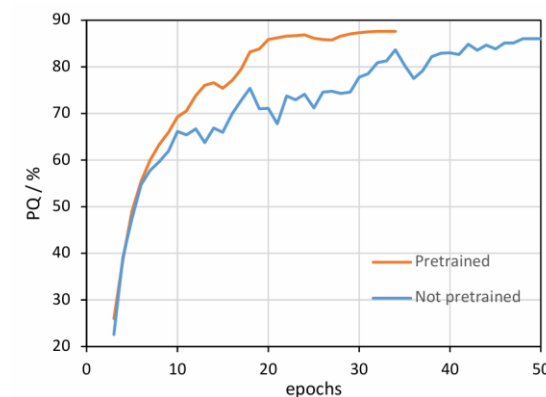
① Ablation studies

Effective encoding & fusion module

Primitive Encoder	Image Encoder	Adaptive Fusion	PQ	RQ	SQ
✓			81.7	90.1	90.6
	✓		80.9	89.4	90.6
✓	✓		83.0	90.1	92.1
✓	✓	✓	86.2	93.0	92.6

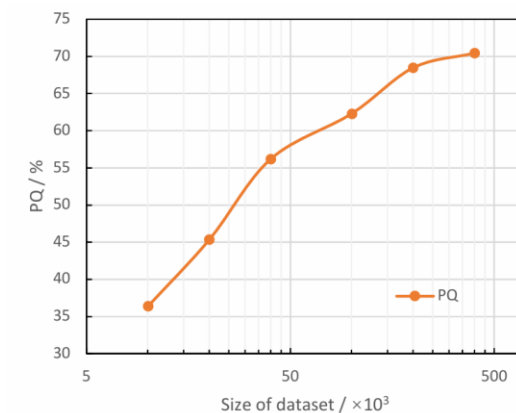
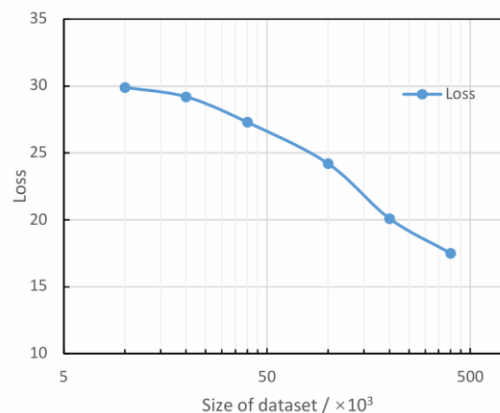
② Cross dataset experiments

Quality and transferability of ArchCAD-400K



③ Scaling experiments

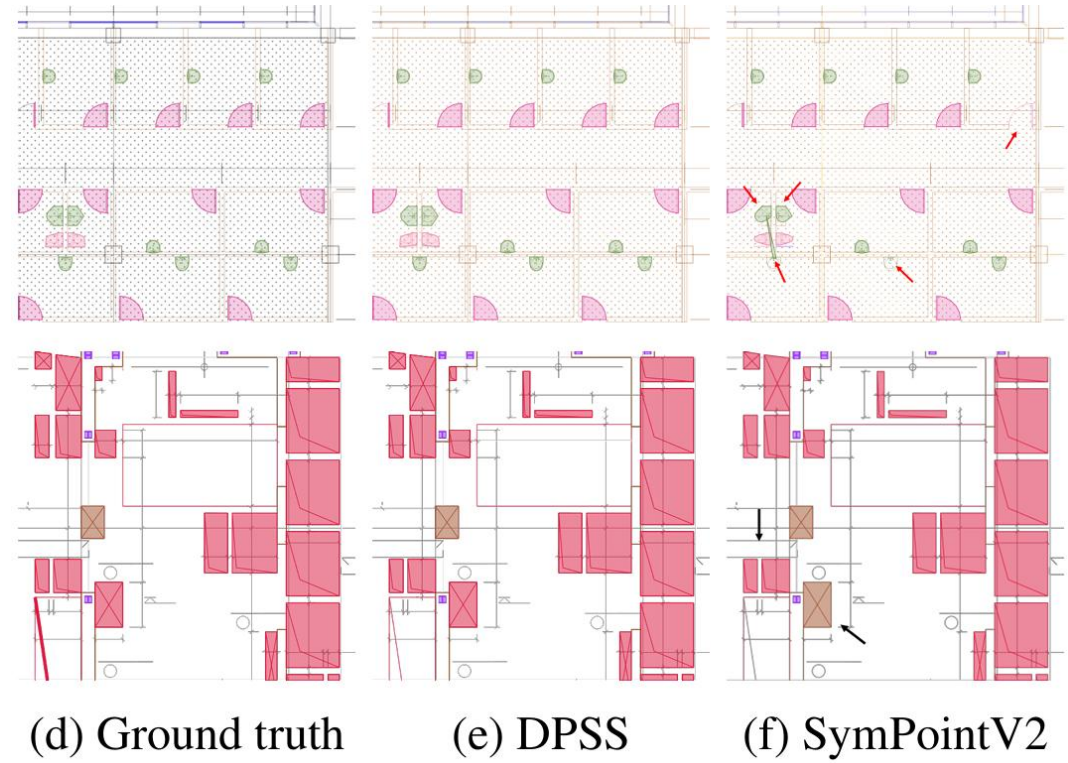
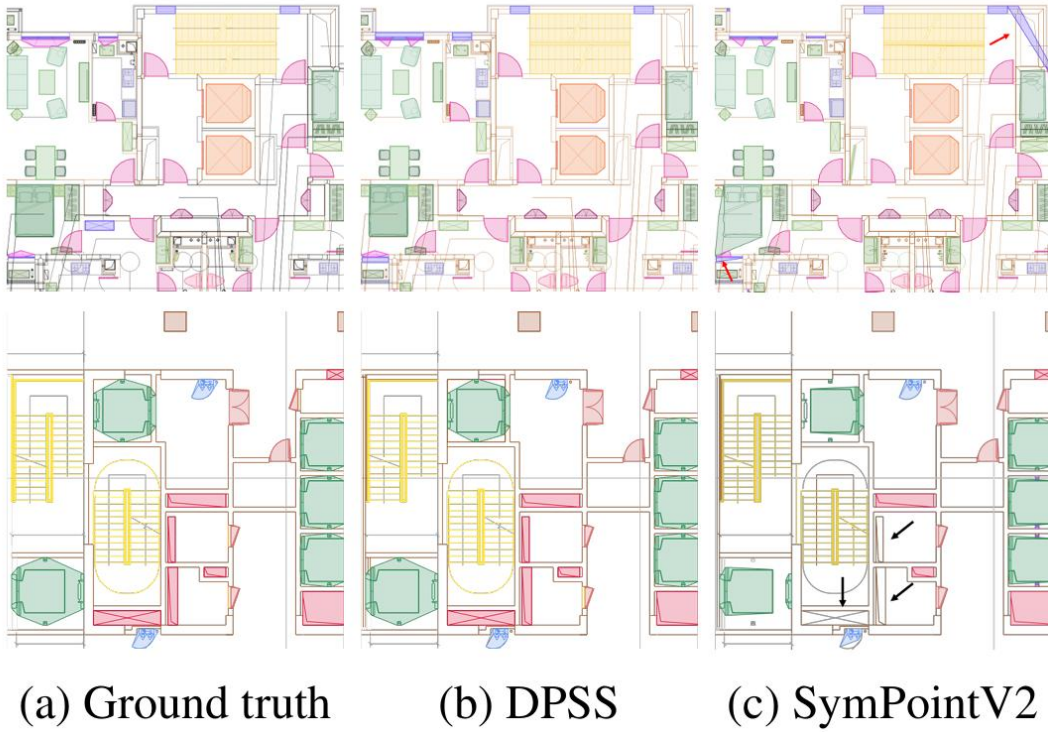
Robust and scalable performance of DPSS framework



Experiments



Visualizations



Thank you



GitHub



HuggingFace