MultiON: Benchmarking Semantic Map Memory using Multi-Object Navigation

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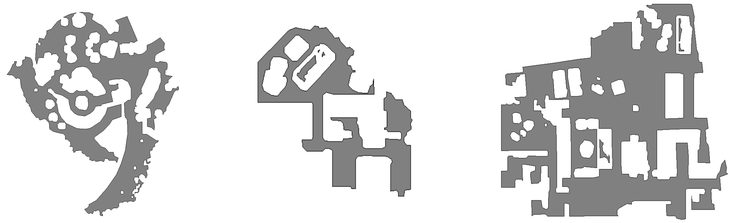
http://shivanshpatel35.github.io/multi-ON/

Benchmarking map memory for long horizon tasks



Occupancy map visualizations

- Long-horizon navigation tasks in embodied AI remain challenging
- Spatial map memory used by much prior work
- However, no systematic study of map memory impact on long horizon tasks

Contributions:

1. Introduce **MultiON**: a multi-object navigation benchmark task
2. Quantify the utility of map memory and effect of different design choices

MultiON

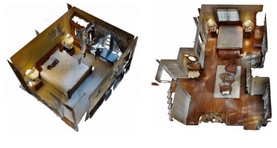
Navigate to an ordered sequence of target objects placed within the environment

Input: RGBD observations and sequence of target objects

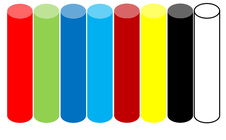
Output: actions

Assumptions: perfect localization, sensors, actuation

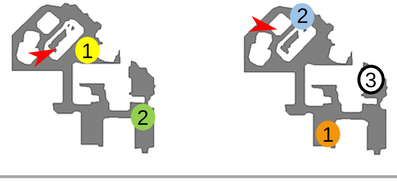
Matterport3D environments



Target objects



MultiON allows direct control of task complexity



Map memory variants

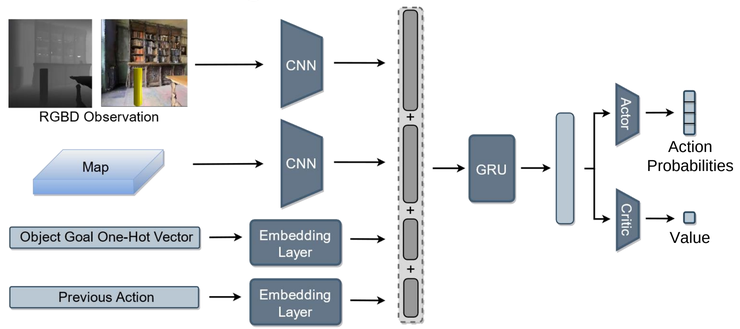
- NoMap (RNN)
- ProjNeuralMap
- ObjRecogMap

} Fully learned (no oracle information)

- OracleEgoMap
- OracleMap

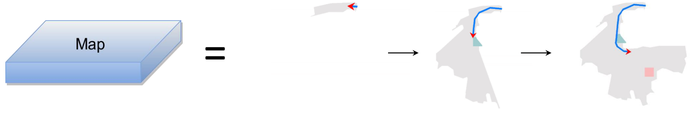
} Not fully learned (use oracle maps)

Agent architecture

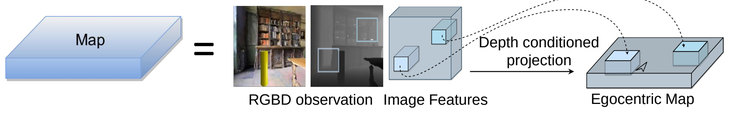


OracleMap: full oracle maps

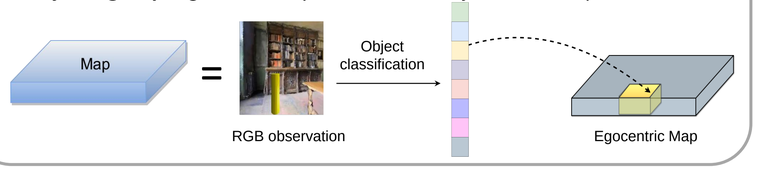
OracleEgoMap: egocentrically revealed oracle maps



ProjNeuralMap: egocentrically constructed neural feature maps



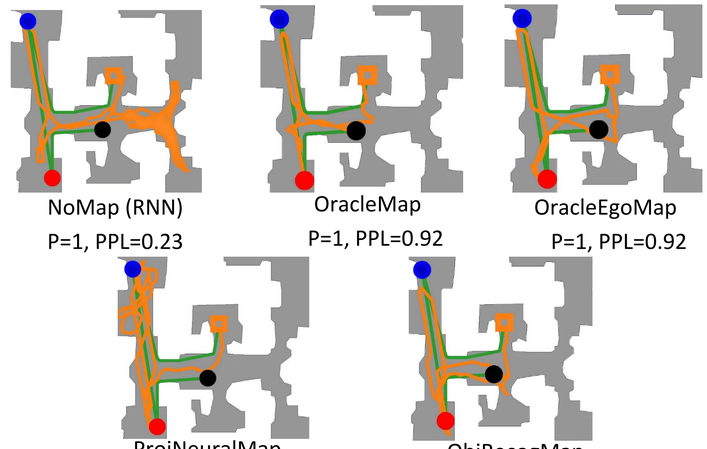
ObjRecogMap: egocentrically constructed object class maps



Evaluation metrics

- **Progress:** fraction of goals found
- **PPL:** progress weighted by normalized inverse path length
- **Success:** binary indicator of episode success
- **SPL:** success weighted by normalized inverse path length

Qualitative results



Quantitative results

	Model	1-ObjectNav	2-ObjectNav	3-ObjectNav
NoMap	NoMap(RNN)	62	39	24
	FRMQN (prev work)	62	42	29
	SMT (prev work)	63	44	22
Oracle	OracleMap	94	79	62
	OracleEgoMap	83	71	54
Learned	EgoMap	69	59	44
	ProjNeuralMap	70	57	**46**
	ObjRecogMap	**79**	**62**	40

Progress of agents on 1-ON, 2-ON and 3-ON test set

Conclusions

- Spatial maps are useful for long horizon navigation tasks
- Goal information more useful than occupancy information
- Sizeable gap between oracle and learned agents is incentive for future work