MultiON: Benchmarking Semantic Map Memory using Multi-Object Navigation

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

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

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

Map memory variants
• NoMap (RNN)
• ProjNeuralMap
• ObjRecogMap
• OracleEgoMap
• OracleMap

Map memory variants
• Fully learned (no oracle information)
• 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

Quantitative results

Model | 1-ObjectNav | 2-ObjectNav | 3-ObjectNav
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NoMap (RNN) | 62 | 39 | 24
FRMQN (prev work) | 62 | 42 | 29
SMT (prev work) | 63 | 44 | 22
OracleMap | 94 | 79 | 62
OracleEgoMap | 83 | 71 | 54
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

Value
Action
Probabilities

• 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

Input: RGBD observations and sequence of target objects
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Learned
Oracle
NoMap

Matterport3D environments
Target objects

MultiON allows direct control of task complexity

MultiON

Navigable area
Goal category

FRMQN (prev work)
SMT (prev work)
OracleMap
OracleEgoMap
EgoMap
ProjNeuralMap
ObjRecogMap

Conclusions
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