Structured, differentiable models of 3D scenes via Generative Scene Graphs

- Ben Zinberg, Marco Cusumano-Towner, Vikash K. Mansinghka
- MIT Probabilistic Computing Project

Generative scene graphs in Gen

1. Extensible object library with simple shapes & YCB ground-truth meshes
2. PyBullet renderer for debugging and synthetic data generation
3. Inference-friendly parameterizations of 6DOF poses and contacts
4. Intersection & occlusion testing via bounding box approximations
5. Gradient-based inference for fine-tuning poses
6. Monte Carlo inference for structure learning & large-scale pose search

Involutive MCMC in Gen: Structure Moves on Scene Graphs

- Cusumano-Towner, Lew, and Mansinghka (2018; PLDI 2019; arXiv 2020)

Current research – applications

1. Robust 3D scene graph state estimation from noisy neural detections via sequential Monte Carlo inference given a dynamic open-universe prior
2. Grounded language understanding via CCG parsing into GSGs
3. Intuitive physics via probabilistic programming (IP3) modeling object permanence, motion continuity, shape constancy, and collisions
4. Generating synthetic data with controlled clutter & occlusion to test systematic generalization of neural approaches to computer vision

Current research – scene graph PPL infrastructure

1. Undirected scene graph edges for over-determined contacts
2. Optimized automatic differentiation by exploiting scene graph structure
3. Visualization of distributions over scene graphs for modeling & inference
4. Variational GSG approximations to concisely summarize 3D scene posteriors