An IKEA furniture assembly environment to train robots on complex manipulation tasks
13 December 2019, by Ingrid Fadelli

In order to complete complex everyday tasks such as using equipment, cooking or building furniture, robots should be able to plan their actions and manipulate objects in their surroundings. So far, however, teaching robots to complete complicated tasks, such as those that require planning over a considerable period of time, has proved to be rather challenging, also due to a lack of reliable simulated environments to test them in.

With this in mind, researchers at the University of Southern Carolina have recently developed the IKEA furniture assembly environment, a simulation platform where researchers can test artificial intelligence (AI) agents on complex manipulation tasks. In the environment they developed, presented in a paper prepublished on arXiv, agents can be evaluated on a variety of manipulation tasks that involve building and manipulating different items of furniture.

"The environment is designed to advance reinforcement learning from simple toy tasks to complex tasks requiring both long-term planning and sophisticated low-level control," the researchers wrote in their paper.

Assembling furniture can be a challenging task even for humans, as it typically requires both long-term planning and sophisticated manipulation skills. The environment developed by the researchers, which is fairly easy to use, has several interesting functions. As it generates a vast amount of synthetic labeled data, it can be used to train computer vision models on a wide range of tasks, including object pose estimation, scene understanding, and many more, without requiring human-annotated data.

In addition, the environment could serve as a benchmark for machine learning methods designed for furniture assembly or other long-horizon manipulation tasks, improving their control and planning capabilities. Interestingly, the visual and interactive data produced by the platform can also be used to acquire domain-specific knowledge for other applications, such as intuitive physics models.

The IKEA furniture assembly environment supports over 80 models of furniture and can be customized with background images, lighting and textures. It could ultimately be seen as a testbed for machine
learning techniques designed to give robots 
advanced object manipulation skills.

So far, the environment can be used to train or test 
three robots of different shapes and sizes, called 
Cursor, Sawyer and Baxter. In the next update, 
however, the researchers also plan to add support 
for Fetch, UR, Jaco and other popular robots.

In the future, this customizable environment could 
open up new possibilities for training and evaluating 
numerous machine learning techniques for robotics 
applications. In the meantime, the researchers plan 
to update the platform and improve some of its 
functions.

For instance, they would like to add support for 3-D 
motion devices, allowing users to operate robots 
remotely and create demonstration videos using a 
VR controller or 3-D mouse. These demonstration 
videos could then be used to train machine learning 
models, using a strategy known as imitation 
learning.

In future versions of the platform, users could also 
be allowed to guide robots via spoken instructions, 
and might even be able to train multiple agents 
simultaneously. Moreover, robots could eventually 
be trained on how to use specific tools, such as 
screwdrivers and hammers.

More information: IKEA furniture assembly 
environment for long-horizon complex manipulation 
arxiv.org/abs/1911.07246

clvrai.github.io/furniture/

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