Econoscape: Towards a Generative Model of Innovation Ecosystems

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Agent-based computational economics (ACE) has increased in popularity over the past few years as a tool to both understand and explain complex economic phenomenon. Econoscape is an ACE model being developed at the University of Central Florida. It differs from many existing ACE models by removing the distinction between firms and households and placing a core emphasis on innovation and technological adoption. In Econoscape, every economic agent is both a consumer and a producer. As a result of this design, production and trade become the core economic behaviors of every economic agent. In addition, we explicitly represent technological know-how as a set of resource transformation rules that are subject to evolutionary forces. This representation allows population dynamics to alter the technological landscape of the economy and provides a straightforward method of exploring innovation and knowledge driven economic growth.

Each agent in our model, called an adaptive resource transformer (ART), lives within an economic ecosystem where individuals are connected by social networks and the actions of an agent can have unintended consequences beyond its nearest neighbors. The primary purpose of Econoscape is to serve as a computational economics laboratory that can be used to verify and explore existing economic ideas and theories on knowledge and innovation driven growth, and help to inspire and create new ideas and theories. Econoscape is also intended to serve as a tool for exploring the impact of economic policy by allowing modelers to view the potential consequences of their decisions in silico, before they are enacted in the real world. The current model is written in Java, using the MASON toolkit. It is being employed to explore the benefits of entrepreneurial support organizations, such as university incubators, and examine the structure and influence of economic networks.

The modeling approach taken by Econoscape draws from the traditional literature on generative models. Economic behaviors and macro-economic phenomenon are emergent properties of simple interactions that occur at the micro level. In the case of Econoscape, the micro level is composed of many adaptive resource transformers that interact with one another. Adaptive resource transformers are simple computational agents that have, at their core, a set of transformation rules that specify what an agent is able to consume and produce, and a set of resources used by these rules. These transformation rules define the types of agents in the population. Each adaptive resource transformer associates a supply and demand price with each resource it has, and is driven to acquire any and all resources as specified by the inputs of its transformation rules. Resource acquisition is accomplished through trade with neighboring transformers. As an adaptive resource transformer trades with its neighbors, it adjusts the prices that it associates with each resource. When an adaptive resource transformer is unable to acquire any further resources because it has nothing to trade, it dies. This death effect is countered by a birth process that introduces new adaptive resource transformers into the system.

Adaptive resource transformers offer a new approach to abstracting economic agents. They can be programmed to act as purely rationally utility maximizing agents, or enhanced to make use of intelligent or irrational behavior. Because innovation and technological adoption are central to adaptive resource transformers, this abstraction also offers the potential to better understand innovation-driven economic growth and development. Finally, because the core concepts of our model are kept simple and general, adaptive resource transformers can be used to model more general economic systems; such as energy exchange at the cellular level or task allocation within multi-agent systems.