The science of complexity

Common to the study of complexity is the notion that complex adaptive systems operate with multiple elements, each adapting or reacting to the patterns the system itself creates. Complex adaptive systems are in a constant process of evolving over time. An essential element of a complex adaptive system is a feed-back loop. How exactly do agents in a complex adaptive system interact? How do they go about collectively creating, and then changing, a model for predicting the future?

For those of us who are not scientists, finding a way to visualize the process is helpful. Brian Arthur gives us an answer, with an example he has dubbed **"the El Farol Problem"**

Definition:

El Farol Bar problem

From Wikipedia, the free encyclopedia

El Farol located on Canyon Road, Santa Fe, New Mexico

The **El Farol bar problem** is a problem in game theory. The problem is as follows: There is a particular, finite population of people. Every Thursday night, all of these people want to go to the El Farol Bar. However, the El Farol is quite small, and it's no fun to go there if it's too crowded. So much so, in fact, that the preferences of the population can be described as follows:

- If **less than 60%** of the population go to the bar, they'll all have a better time than if they stayed at home.
- If **more than 60%** of the population go to the bar, they'll all have a *worse* time than if they stayed at home.

Unfortunately, it is necessary for everyone to decide *at the same time* whether they will go to the bar or not. They cannot wait and see how many others go on a particular Thursday before deciding to go themselves on that Thursday.

One aspect of the problem is that, no matter what method each person uses to decide if they will go to the bar or not, if *everyone* uses the same pure strategy it is guaranteed to fail. If everyone uses the same deterministic method, then if that method suggests that the bar will not be crowded, everyone will go, and thus it *will* be crowded; likewise, if that method suggests that the bar will be crowded, nobody will go, and thus it will *not* be crowded. Often the solution to such problems in game theory is to permit each player to use a mixed strategy, where a choice is made with a particular probability. In the case of the single-stage El Farol Bar problem, there exists a unique symmetric Nash equilibrium mixed strategy where all players choose to go to the bar with a certain probability that is a function of the number of players, the threshold for crowdedness, and the relative utility of going to a crowded or an uncrowded bar compared to staying home. There are also multiple Nash equilibria where one or more players use a pure strategy, but these equilibria are not symmetric.[1] Several variants are considered in *Game Theory Evolving* by Herbert Gintis.[2]

In some variants of the problem, the people are allowed to communicate with each other before deciding to go to the bar. However, they are not required to tell the truth.

Based on a bar in Santa Fe, New Mexico, the problem was created in 1994 by W. Brian Arthur. The problem (without the name of El Farol Bar) was formulated and solved dynamically six years earlier by B. A. Huberman and T. Hogg.[3]

We can quickly see how the El farol process echoes the Darwinian idea of survival through natural selection, and how logically this extends to economies and markets.

In the markets, each agent's predictive models compete for survival against the models of all other agents, and the feedback that is generated causes some models to be chaned and others to disappear.

It is a world, says Arthur, that is **complex, adaptive, and evolutionary.**

This is the reason we have to stay agile, dynamic, flexible and hence, adaptive.