Chapter 11

Evolutionary Stability: Cooperation Mutation And Equilibrium

We discuss evolution and game theory, and introduce the concept of evolutionary stability. We ask what kinds of strategies are evolutionarily stable, and how this idea from biology relates to concepts from economics like domination and Nash equilibrium. The informal argument relating these ideas toward at the end of his lecture contains a notation error [U(Ŝ,S') should be U(S',Ŝ)]. A more formal argument is provided in the supplemental notes.

Evolution And Game Theory

1. Influence of game theory on biology. Animal behavior. Strategies are related to genes and payoffs are related to genetic fitness.
2. Influence of biology on social sciences.

Simplified Model

- Within species competition.
- Symmetric 2 player games
- Large population random matching Average payoffs.
- Relatively successful strategies will grow.
- No gene redistribution. Asexual reproduction.

Lessons

1. Nature can suck.
2. If a strategy is strictly dominated, then it is not evolutionary stable.
3. If a strategy S is not Nash, (s, s) is not Nash equilibrium then S is not evolutionary stable. If S is evolutionary stable then (s, s) is Nash equilibrium.
4. If (s, s) is a strict Nash equilibrium then S is evolutionary stable.

Formal Definition: In a symmetric two player game, the pure strategy s'' is evolutionary stable (in pure strategies) if there exists an e' > 0.
(1 - e)*(u(s'', s'')) + (e)*(u(s'', s')) > (1 - e)*(u(s', s'')) + e*(u(s', s')) for all possible deviations s' and for all mutation sizes e < e'.

Definition: A strategy s'' is evolutionary stable (in pure strategies) if

A. (s'', s'') is a symmetric Nash equilibrium. i.e. u(s'', s'') >= u(s', s'') for all s' AND
B. If u(s'', s'') = u(s', s'') then u(s'', s') > u(s', s').

Fix a s'' and suppose a (s'', s'') Nash equilibrium u(s'', s'') >= u(s', s'') for all s' .

A. u(s'', s'') > u(s'', s') for all s'. The mutant dies out because she or he meets s'' often.
B. u(s'', s'') = u(s', s'') but u(s'', s') > u(s', s'). The mutant does okay against s'' but does badly against s'.