EVOLUTIONARY STABILITY ON GRAPHS

Background Presentation
Cappy Pitts
Evolutionary Game Theory

- Evolutionary game theory
  - Applies game theory to model the way that populations change over time
  - This makes modeling animal’s survival strategies easier
- Evolutionarily stable strategy (ESS)
  - A mutant strategy will not be able to invade if every member of a population adopts and evolutionarily stable strategy
  - ESS’s become the equilibrium states and this is what is interesting to study
Well mixed population vs. Realistic population

Well mixed population
- In the past ESS have been adopted for a well mixed population that is infinite
- In other words every one is equally likely to interact

Realistic population
- Realistically, a member of a population is more likely to interact more with its neighbors than with someone who is very far away
- Also the population is not infinite
Spatial Evolutionary Game Theory

- Members of a population are distributed on a evenly spaced grid
- Each member of the population only interacts with its neighbors
- Strategies interact with neighboring regions and are updated if the neighboring strategies work better
- Spatial games behave much differently than those of well-mixed populations but are more realistic
Evolutionary Graph Theory

- In evolutionary graph theory populations are represented as graphs
- Spatial games can be represented as lattices
- Well mixed can be represented by evenly weighted complete graphs
Evolutionary Stability for Well-Mixed Population
Update Rules

- **Birth-Death (BD)**
  - An individual is chosen for reproduction proportional to its fitness and will replace one of its neighbors who is chosen randomly

- **Death-Birth (DB)**
  - An individual is randomly chosen to die and its neighbors fight for its place proportional to their fitness

- **Imitation (IM)**
  - An individual is randomly chosen to update his strategy and either sticks with it or changes to one of his neighbor’s strategies proportional to fitness
Questions?