

# Climbing Social Ladders in Networks

## DIMACS REU 2010

Jing Li

June 11th, 2010

Faculty Advisors: S. Muthukrishnan, Liviu Iftode

# Overview

## 1 Project Description

- Goals
- Motivation

## 2 Background

- Game Theory
- Social Networks

## 3 Ideas for Project

- Goals
- Initial Ideas
- Work Plan

# Goals

We want to model as a game the process of “making friends” in an online social network. Players strategically decide which friend to make next.

# Motivation

## Reality

In online social networks like LinkedIn, each member has a network of “Connections” consisting of their immediate connections as well as secondary connections (friends of friends). Members can initiate requests for connections to be formed, but if a connection request is refused, future requests become a bit more complicated.

## Model

Suppose that each player has a value, given in part by the values of his friends. Being refused incurs a cost.

Players aim to maximize their utility, which means they want to increase their social ranking/value and minimize the occurrences of being refused.

# Game Theory

**Game theory** is the study of multi-agent decision problems. The basic assumptions are that individuals act rationally to maximize some form of utility or payoff, but uncertainty, irrationality, and different time horizons can also be incorporated into models.

# Social Networks

- individuals = nodes
- relationships = edges
- directional/non-directional edges possible
- degree of a node = number of edges incident upon the node
- real social networks typically have low diameter and a thick tail in the degree distribution

# Formation Models of Networks

Usually as a non-cooperative game (games in the usual sense of game theory).

- Aumann and Myerson (1988) - extensive form game.
- Myerson (1981) - simultaneous move game.
- Currarini and Morelli (2000) - network formation and bargaining for individual player values at the same time.
- other more complicated models with dynamics and evolution

## Goals (again)

We want to model as a game the process of “making friends” in an online social network. Players strategically decide which friend to make next.



# Computing Player Values

Each individual  $i$  gets a value that is given in part by the value of his friends (like PageRank).

- Person  $i$  gets a value from his charisma,  $v_i \sim f(v_i)$ , where  $f$  is some distribution on  $[\underline{v}, \bar{v}]$ .
- Each person also gets value from the number of friends/links he has,  $l_i$ . Let the value from friends be a function  $h$  of the number friends.
- Each person's value  $A_i = v_i + h(l_i)$ .
- We'll need to refine the specifics, and  $h$  should intuitively be monotone increasing.

# Accepting Friends

- People do not want to agree to all friend requests (could lead to too much exposure of information, or to association with “undesirable” people).
- Each player  $j$  accepts a friend request from player  $i$  if  $A_i$  ( $i$ 's value) is greater than  $j$ 's threshold for accepting friends.
- A player's threshold can change with time.

# Game Play

- Assume perfect information for now.
- Player  $i$ 's utility comes from his value  $A_i$ , less costs of being refused.
- To become friends with player  $k$ , can friend player  $j$  first so that he exceeds  $k$ 's acceptance threshold.

# Work Plan

- Formalize initial ideas for model
- Solve for Nash equilibria or other solution concepts
- Confirm the theory with data from an actual social networking site.