

# Friendships, IQ, and Social Status: Comparing Equation-based p-models with Intelligent Agent Models

## Model 1

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Monday, May 30, 2005

## 1 Models and Rules

The basic p-friendship model:

$$\log\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_0 + \beta_s s_i + \beta_r r_j + \delta X_{ij} - |z_i - z_j|$$

### ★ p-Model 1:

$$\text{logit}(p_{ij}) = \beta_0 - |z_i - z_j|$$

- $\text{logit}(p_{ij})$  is the *degree* of friendship between agents  $i$  and  $j$ .
- $\beta_0$  is the baseline degree of friendship between any two agents.
- $i = 1, \dots, 20$ .  $j = 1, \dots, 20$ . The degree of friendship between an agent and itself,  $\text{logit}(p_{ii})$ , is undefined.
- $z_i$  is the position of agent  $i$  in two-dimensional Social Space.  $|z_i - z_j|$  is the distance between agents  $i$  and  $j$ .

### ★ Rules for Agent Model 1:

- Rule #1. All agents are the same (same Sex, same sociality).
- Rule #2. At time=1 agents are randomly assigned a unique location on the grid in 2-dimensional Social Space.
- Rule #3. At every time step each agent  $i$  proffers a friendship to all agents  $j \neq i$ , and these proffers are accepted with probability  $p_{ij}$ .
- Rule #4. At each time step agents move a “**move.fraction**” towards the average of their friends’ locations in Social Space.

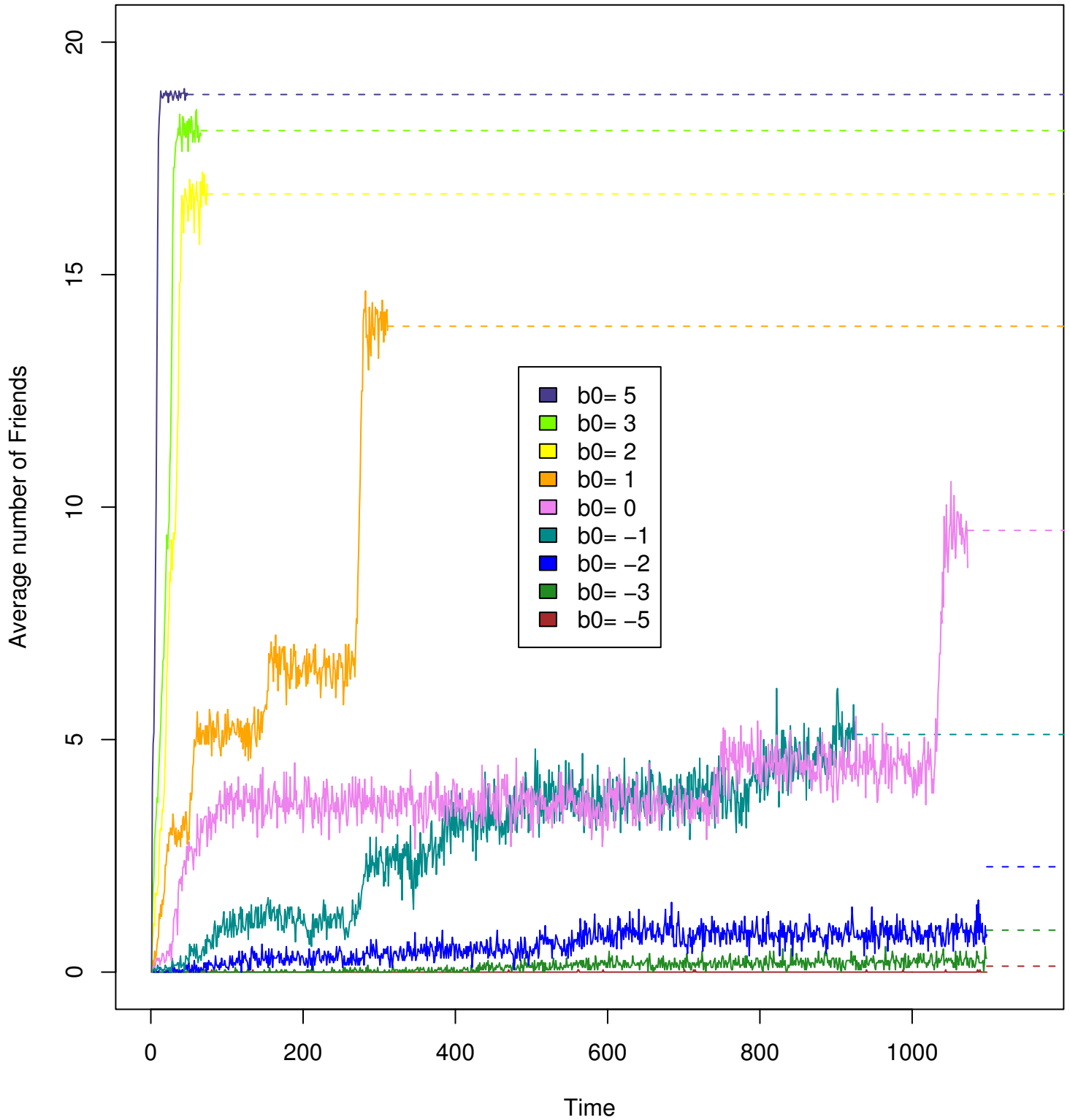
## Questions and Implications

- $\beta_0$ , **move.fraction**, and the size of Social Space are the only parameters in either model.
- What is the appropriate size of Social Space? (in relation to sociality)
- Three summary statistics are:
  - 1) Average number of Friends
  - 2) Number of completed Triads
  - 3) Number of very close Clusters

## 2 Results

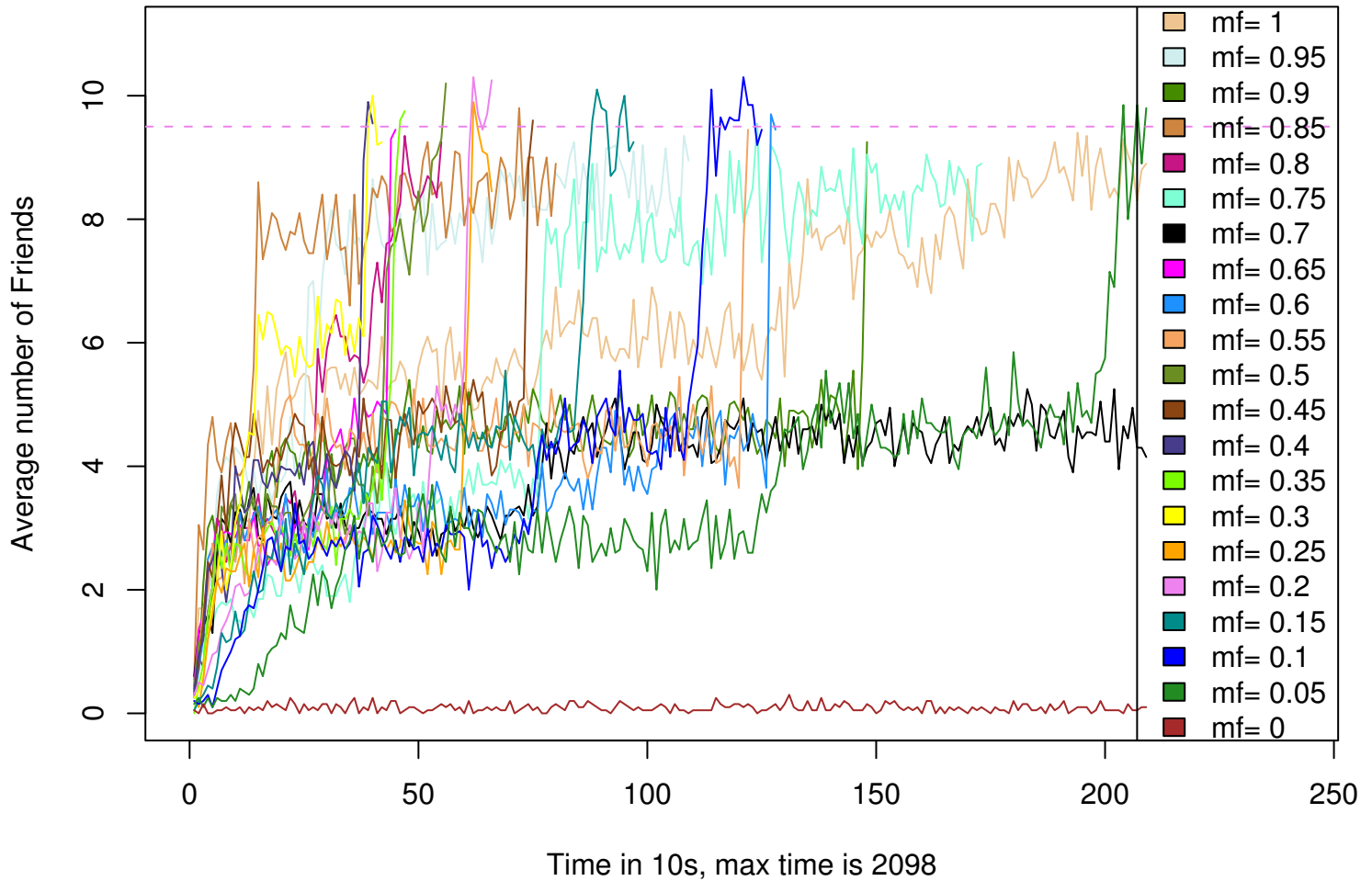
Since there are only 2 parameters in Model 1, I show the results for changing  $\beta_0$  and changing `move.fraction`. A larger  $\beta_0$  baseline implies the agents make more friends and converge to one perfect cluster faster. However, this relationship is not always monotonic since the agents behave with large degrees of randomness.

**Average number of Friends Model 1**

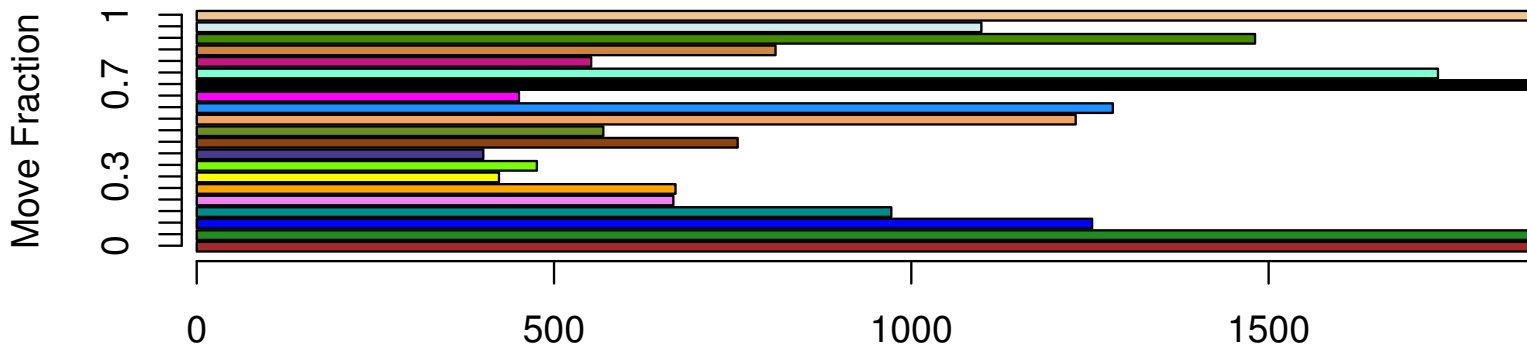


Increasing the **move.fraction** has an unpredictable effect in convergence time (perfect clustering). When `move.fraction=0` the agents will never converge. ( $\beta_0 = 0$  in all these models.) Many repetitions of the experiment will be needed in order to determine the relationship between **move.fraction**, Average number of Friends, and time until perfect clustering.

### Avg #Friends Model 1 with different Move Fractions



### Model 1 Run times before perfect clustering, $\beta_0 = 0$



### 3 Conclusions for Model 1

- As long as **move.fraction**  $> 0$ , all the agents will eventually move together to form one perfect cluster.
- Sometimes two clusters of friends far apart will emerge and perfect clustering will take a very long time.
- In general, the larger the baseline friendship degree  $\beta_0$  is, the higher the average number of friends, and the quicker it is until perfect clustering.
- However, even if  $\beta_0$  is large, if clusters form far apart, then they might stay apart for a very long time.
- The likelihood for friendships to emerge in the intelligent agent model is derived from the simple p-model:  $\text{logit}(p_{ij}) = \beta_0 - |z_i - z_j|$ . The difference between the equation-based model and the agent-based model is that the intelligent agent model is dynamic. The **move.fraction** causes agents to move towards their friends at each time step.
- Many repetitions of the experiments would be needed in order to determine the relationships between  $\beta_0$ , **move.fraction**, time to perfect clustering, and the other summary statistics.