

# Agent-based null models for examining experimental social interaction networks

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# My research

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- Distributional regression, variable selection, random effects models, neural networks, survival analysis
- Psychology experiments, network science, opinion dynamics, agent-based modelling
- <https://kevinburke.ie/>

# Agent based null models ...

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## Agent-based null models for examining experimental social interaction networks

[Susan C. Fennell](#), [James P. Gleeson](#), [Michael Quayle](#), [Kevin Durrheim](#) & [Kevin Burke](#) 

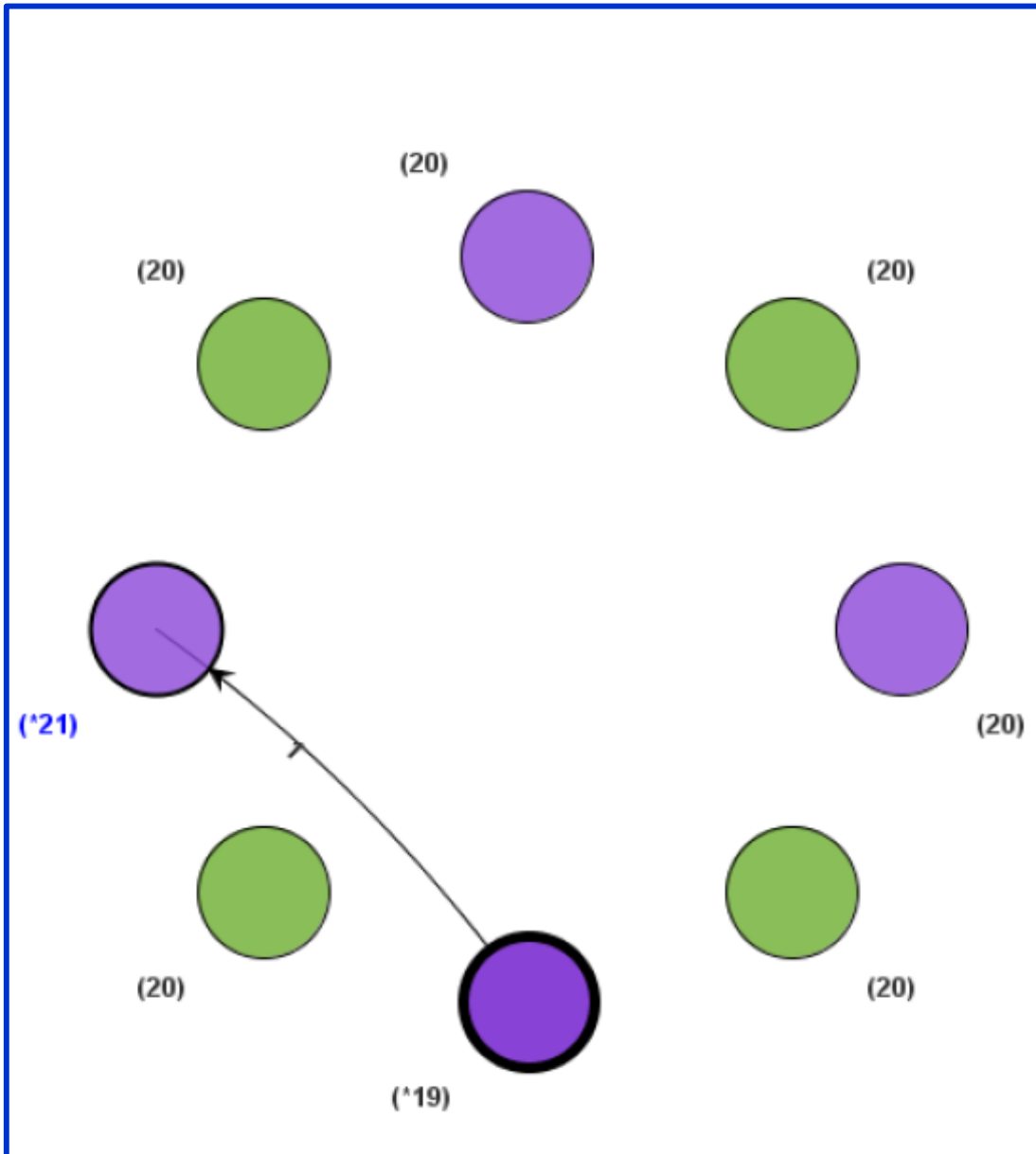


# Experimental setup

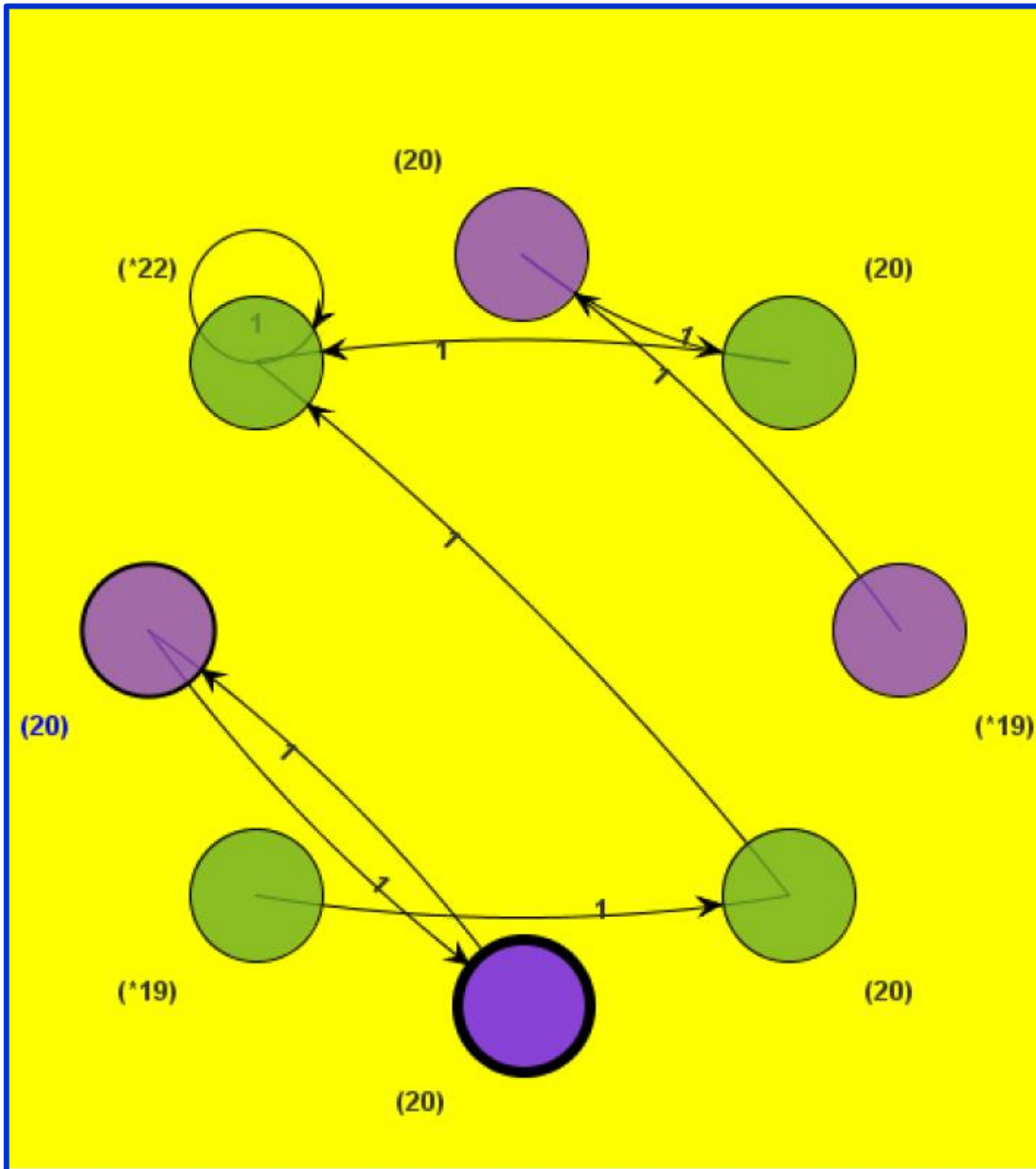
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- ▶ Participants (“players”) are assigned randomly to one of two groups
- ▶ They interact with each other over 40 rounds in a “token exchange” game
- ▶ They see the results of each round
- ▶ VIAPPL (Virtual Interaction Application)

# VIAPPL: Giving a token



# VIAPPL: End of round



## Social Norms

- **Reciprocation**  
Exchanges between pairs of players
- **Ingroup favouritism**  
Exchanges between players in the same group

# Linear regression model

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- ▶  $Y_{ij}$  = tokens player  $i$  receives from player  $j$
- ▶  $G_{ij}$  = players  $i$  and  $j$  are in different groups
- ▶  $Y_{ij} = \alpha + \rho Y_{ji} + \gamma G_{ij} \quad (i \neq j)$
- ▶ "Tokens received from a player"

$$\begin{aligned} &= \alpha \quad + \quad \rho \text{ "Tokens given to that player"} \\ &\quad + \quad \gamma \text{ "Do the groups differ?"} \end{aligned}$$

# Experimental results

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- 4 games each spanning 40 rounds, 14 players per game, 20 tokens each

Term	$\hat{\theta}$	Game1	Game2	Game3	Game4
$Y_{ji}$	$\hat{\rho}$	0.31	0.29	0.87	0.37
$G_{ij}$	$\hat{\gamma}$	-1.95	-1.96	-0.42	-1.99

- $\hat{\rho} > 0 \Rightarrow$  reciprocity
- $\hat{\gamma} < 0 \Rightarrow$  ingroup favouritism
- Games 1, 2, 4 remarkably similar



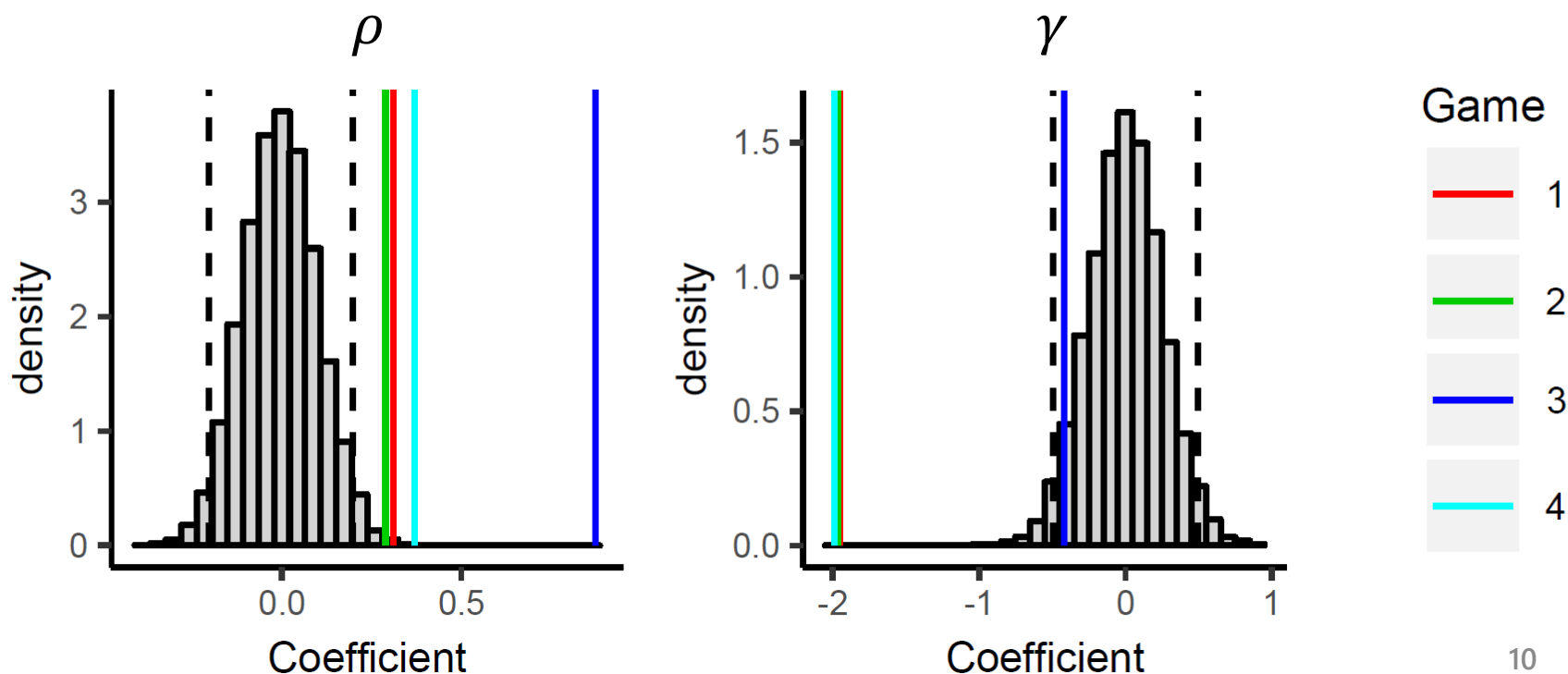
# Statistical significance?

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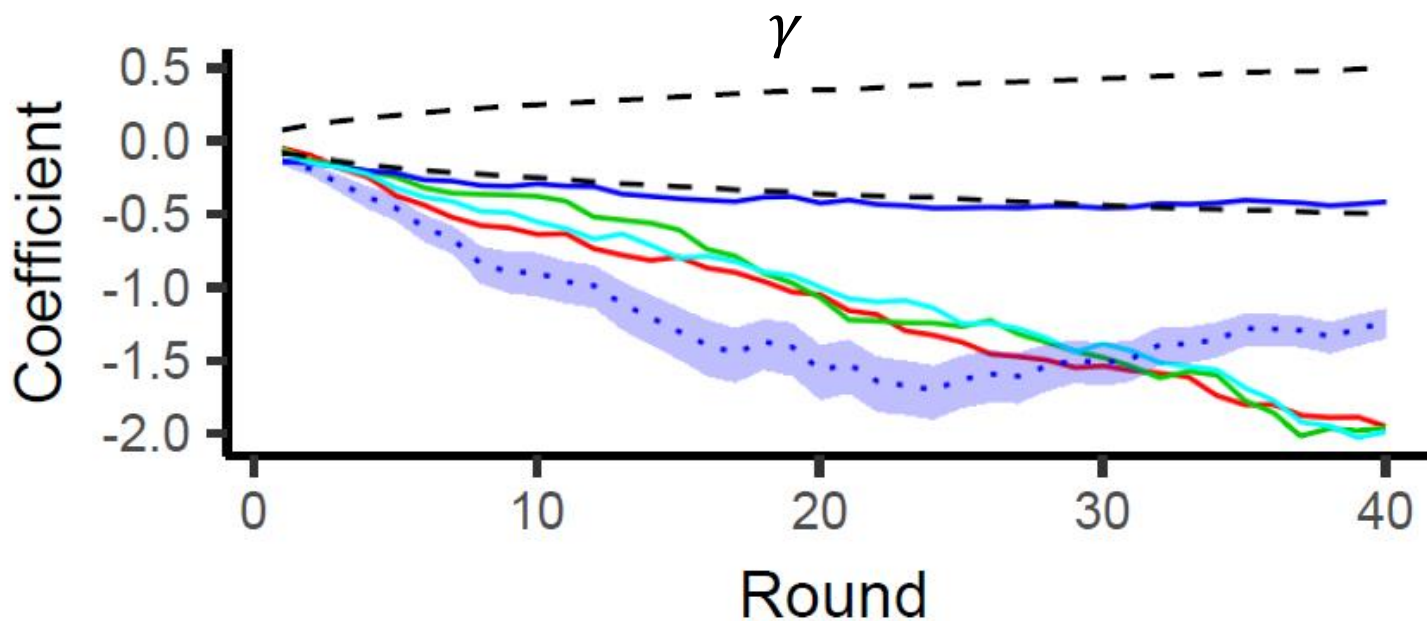
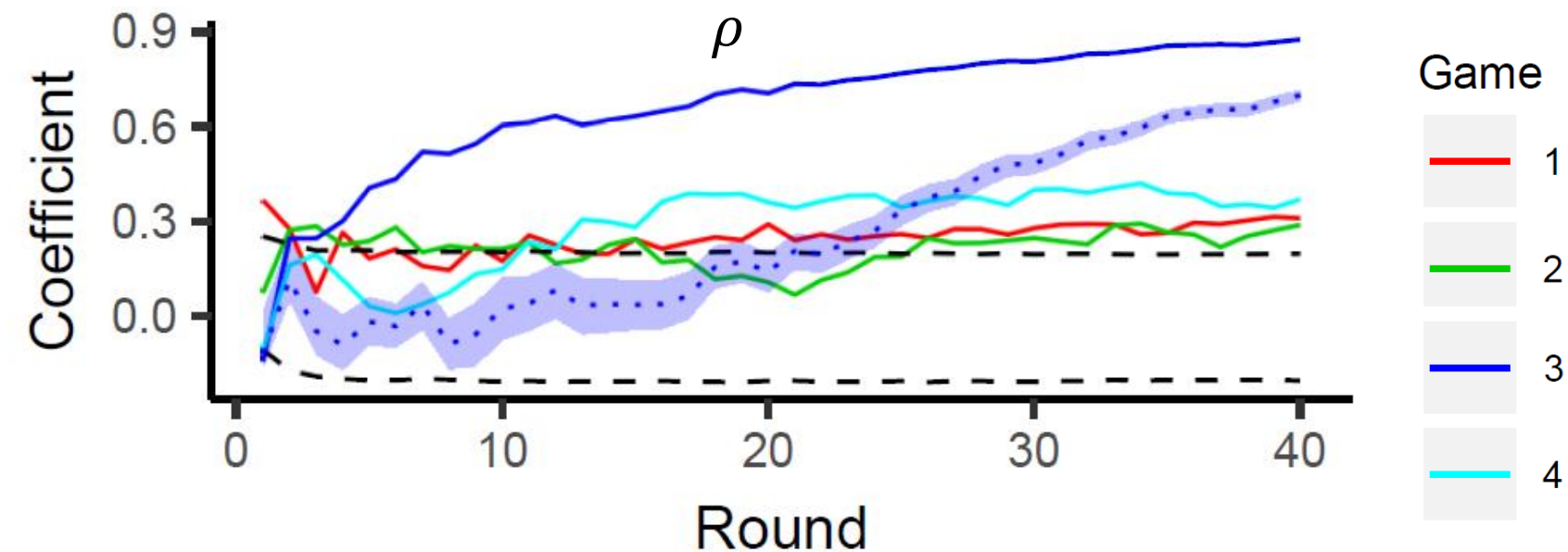
- **Response/covariate:**  $Y_{ij} = \alpha + \rho Y_{ji} + \gamma G_{ij}$
- **Constraints:** each player starts with 20 tokens, exchanges 1 per round, and does this over 40 rounds
- **Dependence:** high connectivity between small number of players in a game, and temporal effects

# Agent-based null model

- Generate synthetic  $Y$  from agent-based model with same rule set as real game
- Fit linear regression ( $\rho^*, \gamma^*$ )
- Repeat: null distribution (random giving)

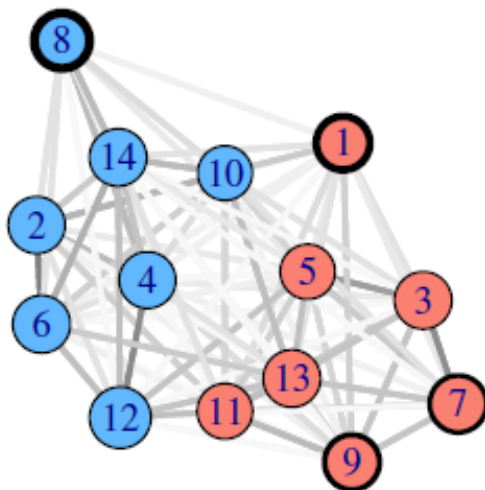


# Coefficients in each round

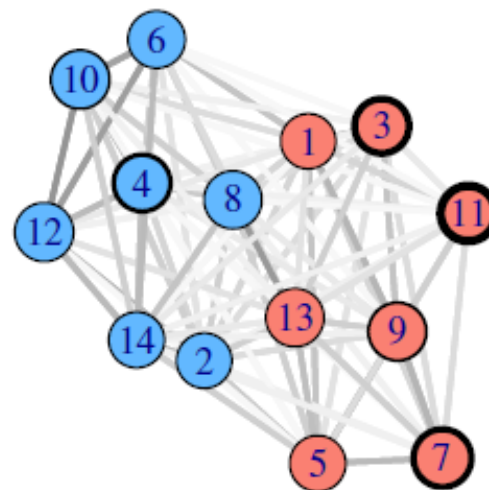


# Network visualisation

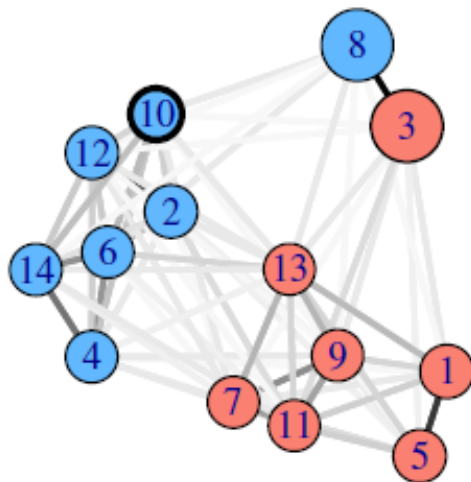
Game 1



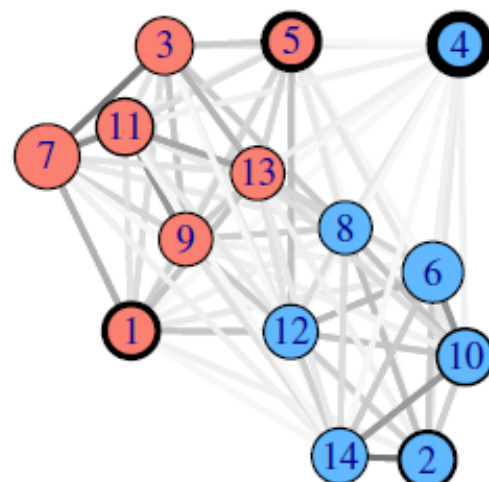
Game 2



Game 3

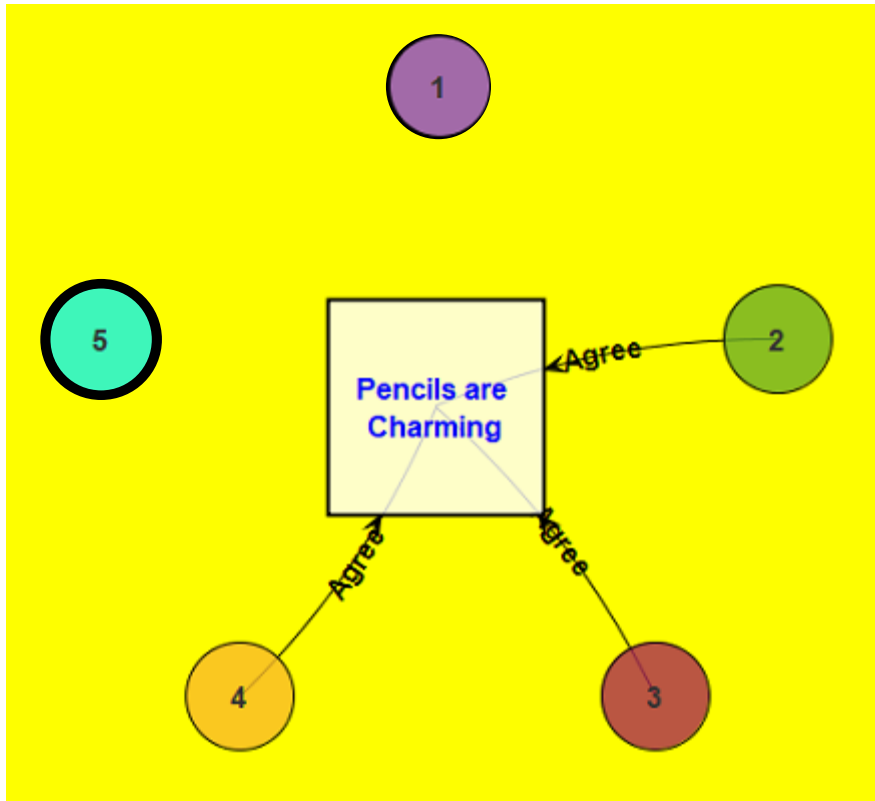


Game 4



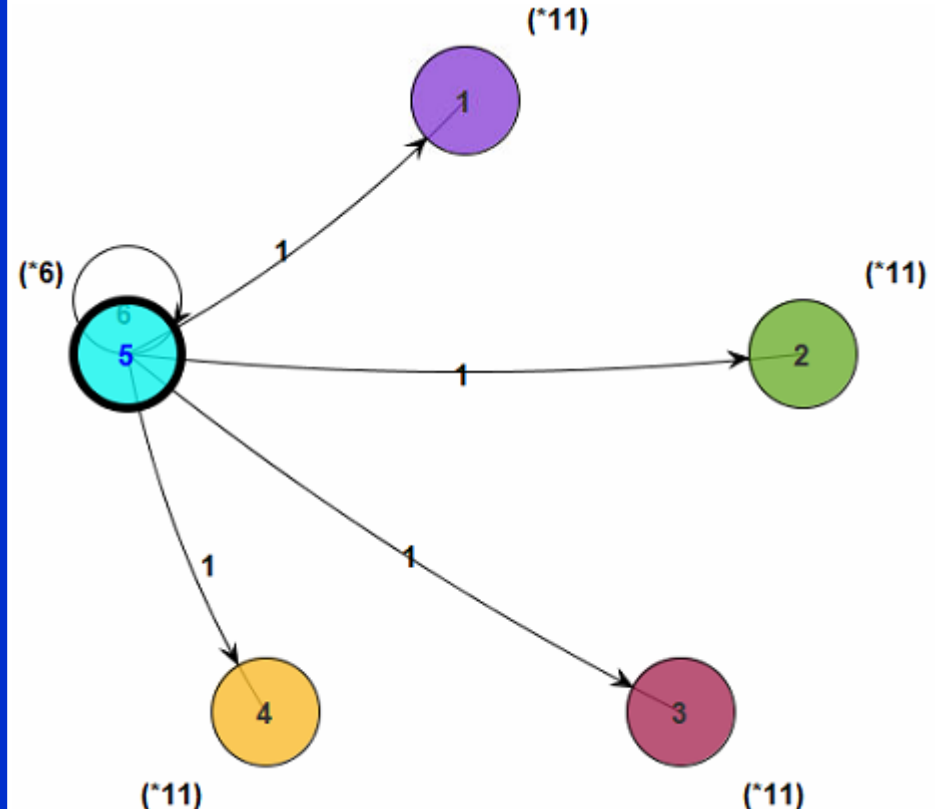
# Another VIAPPL experiment

First, see who you agree with on 4 topics

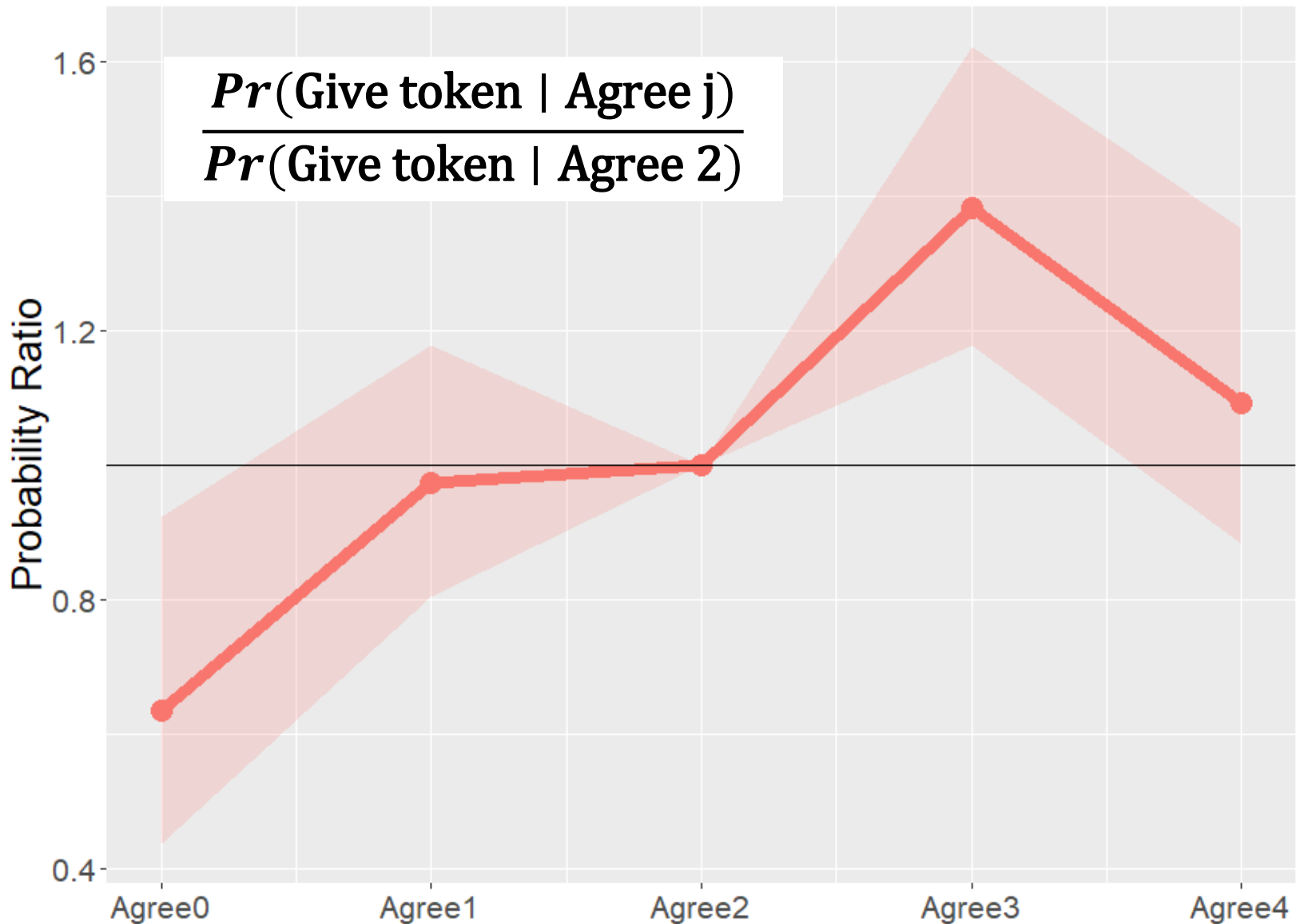


"Pencils are charming"  
"The circle is a noble shape"  
"Concrete blocks are problematic"  
"Paper is trustworthy"

Then, give tokens in one round



# Another VIAPPL experiment: results



# Summary

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## ■ Applied results

- Players favour their group (and “similar” players)
- Players reciprocate with each other

## ■ Modelling approach

- Linear regression + agent-based null models
- Network visualisation
- Future
  - Directly fit agent-based model
  - Multinomial regression
  - Network models (Siena, ERGM)

## ■ Reference

- Fennell, Gleeson, Quayle, Durrheim & **Burke** (2023). Agent-based null models for examining experimental social interaction networks. *Scientific Reports*.
- Also see: [kevinburke.ie](http://kevinburke.ie) and [arxiv.org/a/burke\\_k\\_1](https://arxiv.org/a/burke_k_1)