Argumentation-based Information Exchange in Prediction Markets

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ArgMAS-2008

Outline

- Intro: Social Choice & MAS
- MAS Prediction Market
- Information Exchange in Social Networks
  - Problem-centered Argumentation
  - Confidence on Predictions
  - Information Exchange Protocol
- Experimental Evaluation
- Conclusions & Future Work

Social Choice

Statistical Group Judgments

Deliberating Groups

Prediction/Information Markets

[Cass R Sunstein (2006) *Infotopia*]

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Prediction/Information Markets

Many Minds Problem

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Statistical Group Judgments

Voting/Condorcet Jury Theorem

Deliberating Groups

Ensemble ML

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Argumentation Changes Preferences

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AMAL

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Argumentation Changes Preferences

Prediction/Information Markets

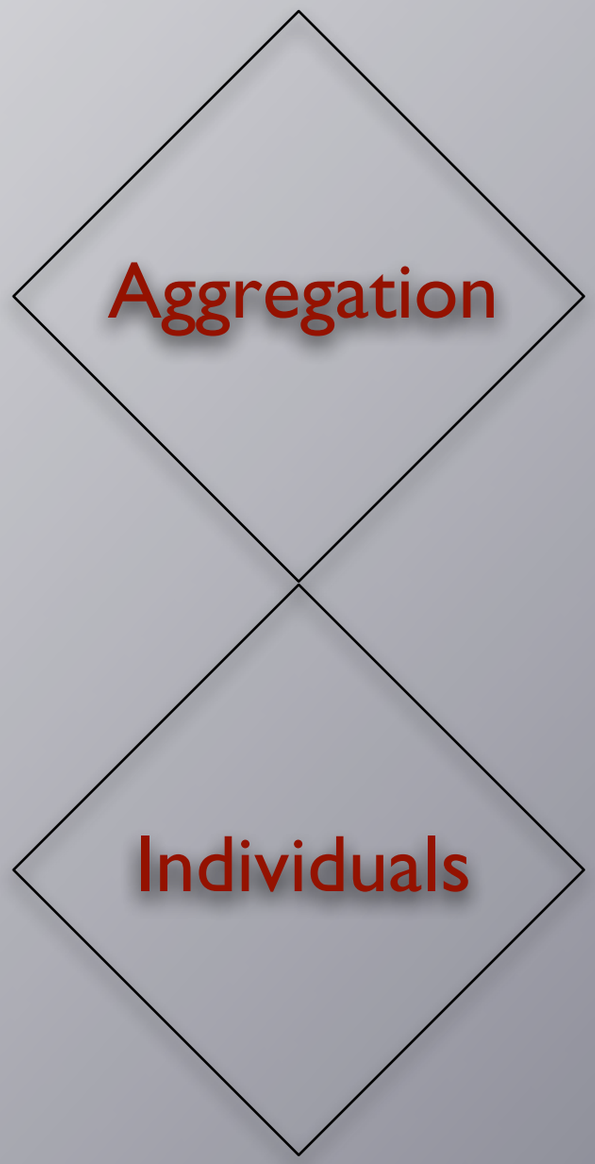
Aggregation/Price signals confidence

Ensemble ML

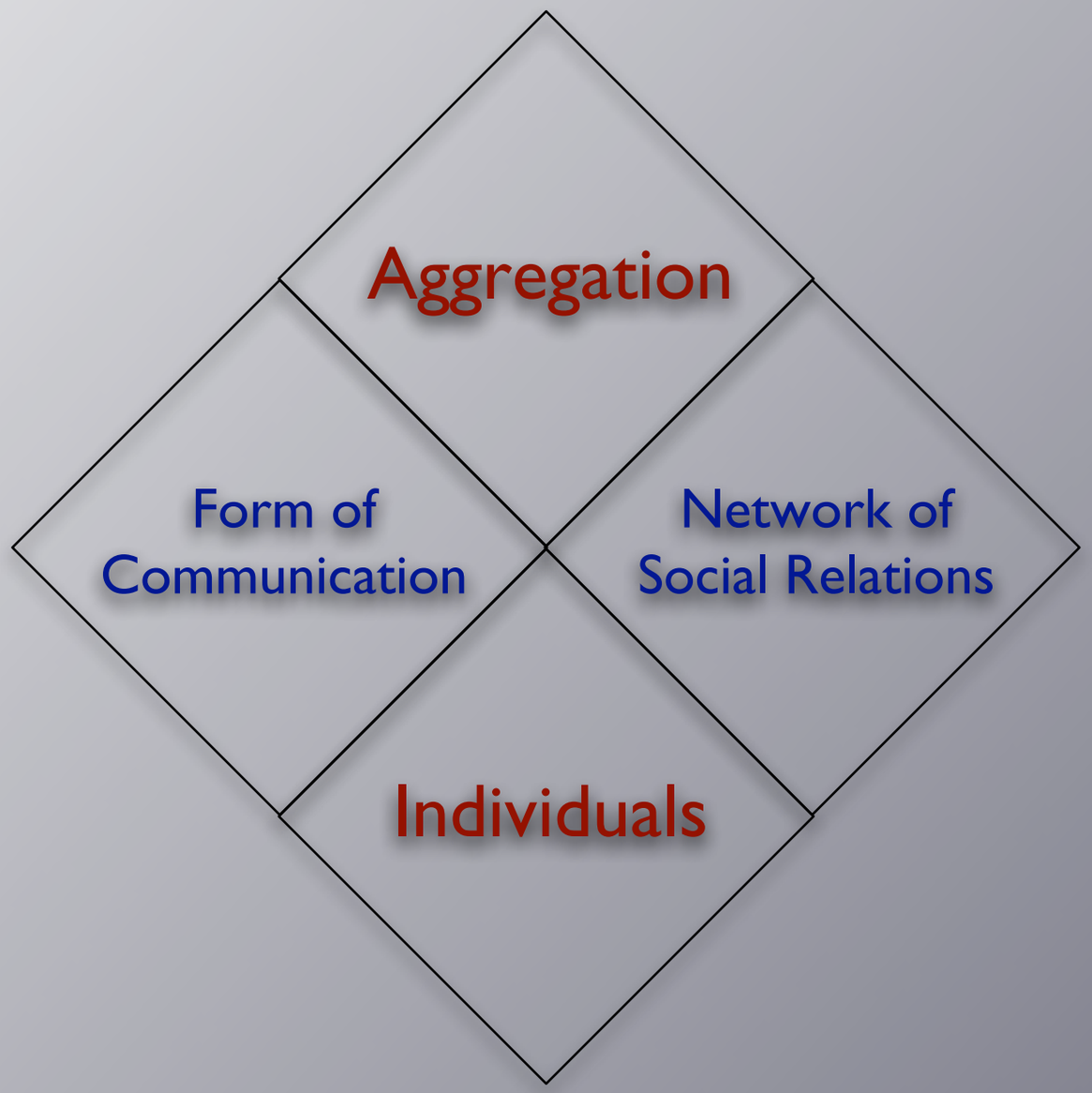
AMAL

Social Choice + Social Net

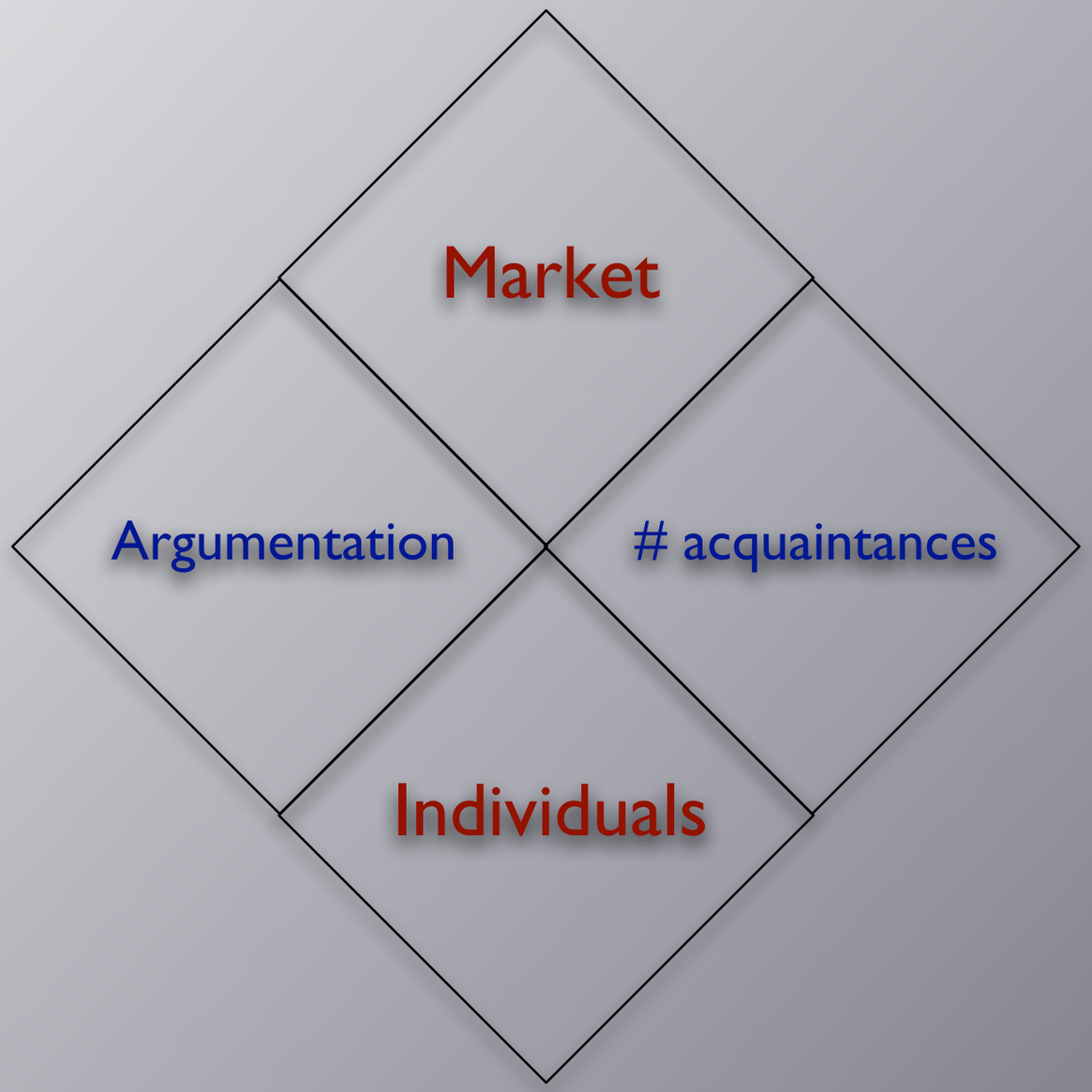
Social Choice + Social Net



Social Choice + Social Net



MAS Prediction Market



Social Networks

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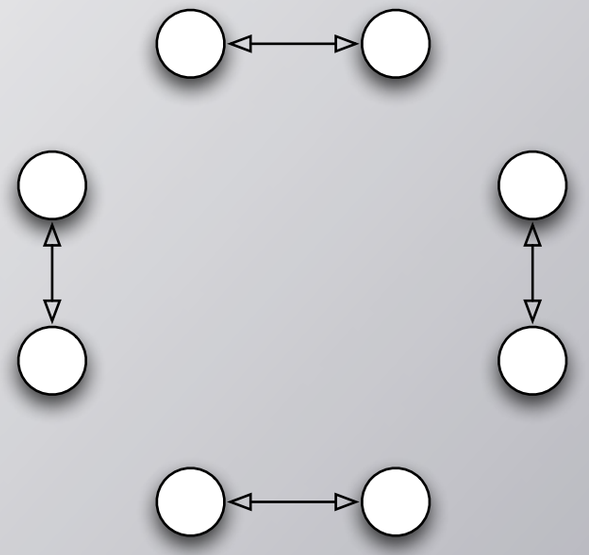
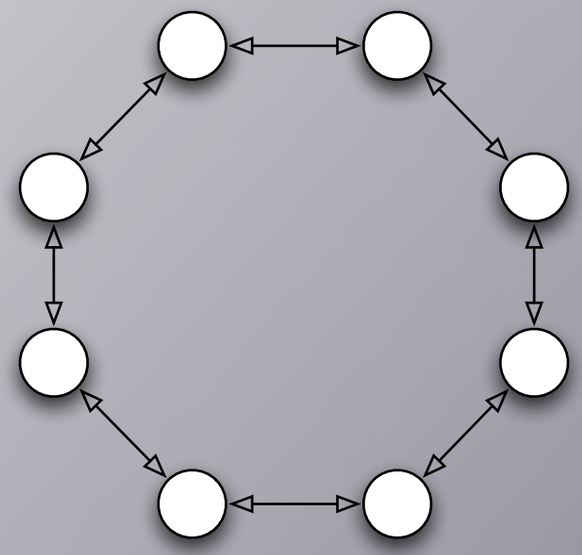
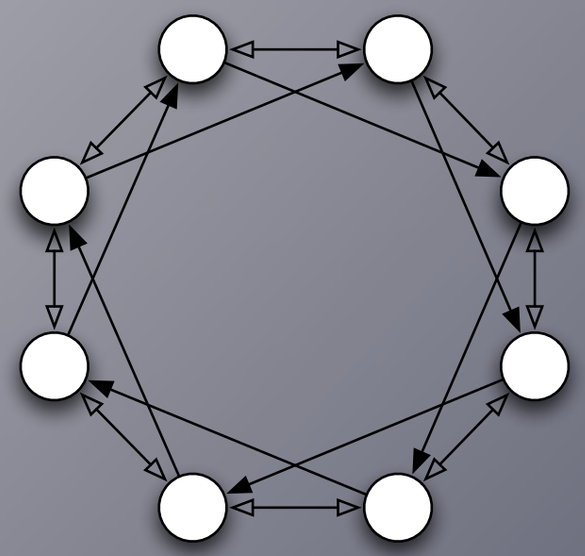


#acquaintances = 1



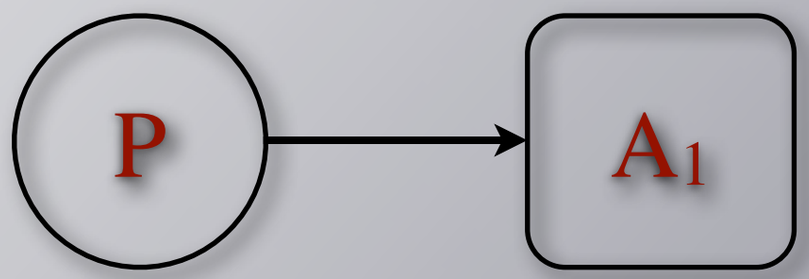
#acquaintances = 2



#acquaintances = 3

Argumentation

Problem-centered Information Exchange



Argumentation

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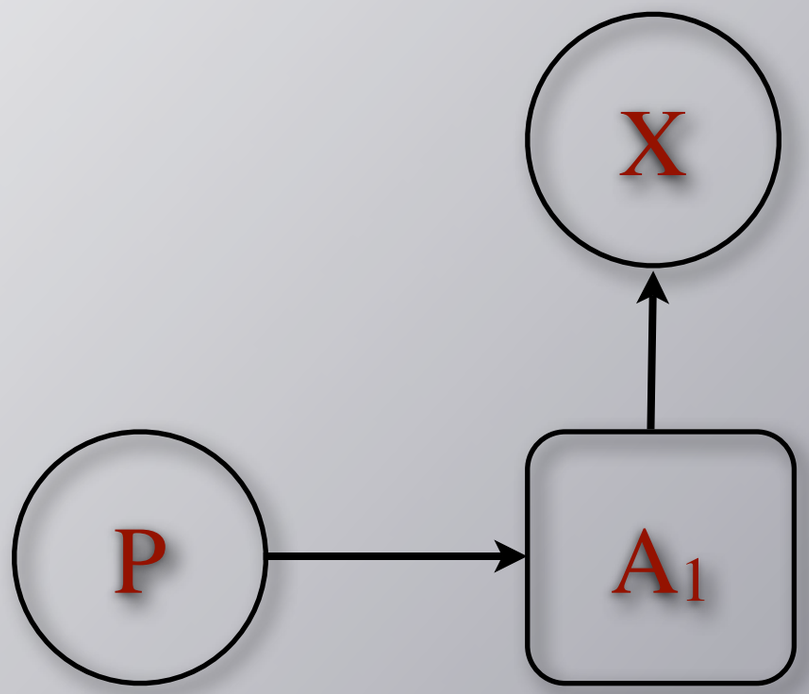

Argumentation

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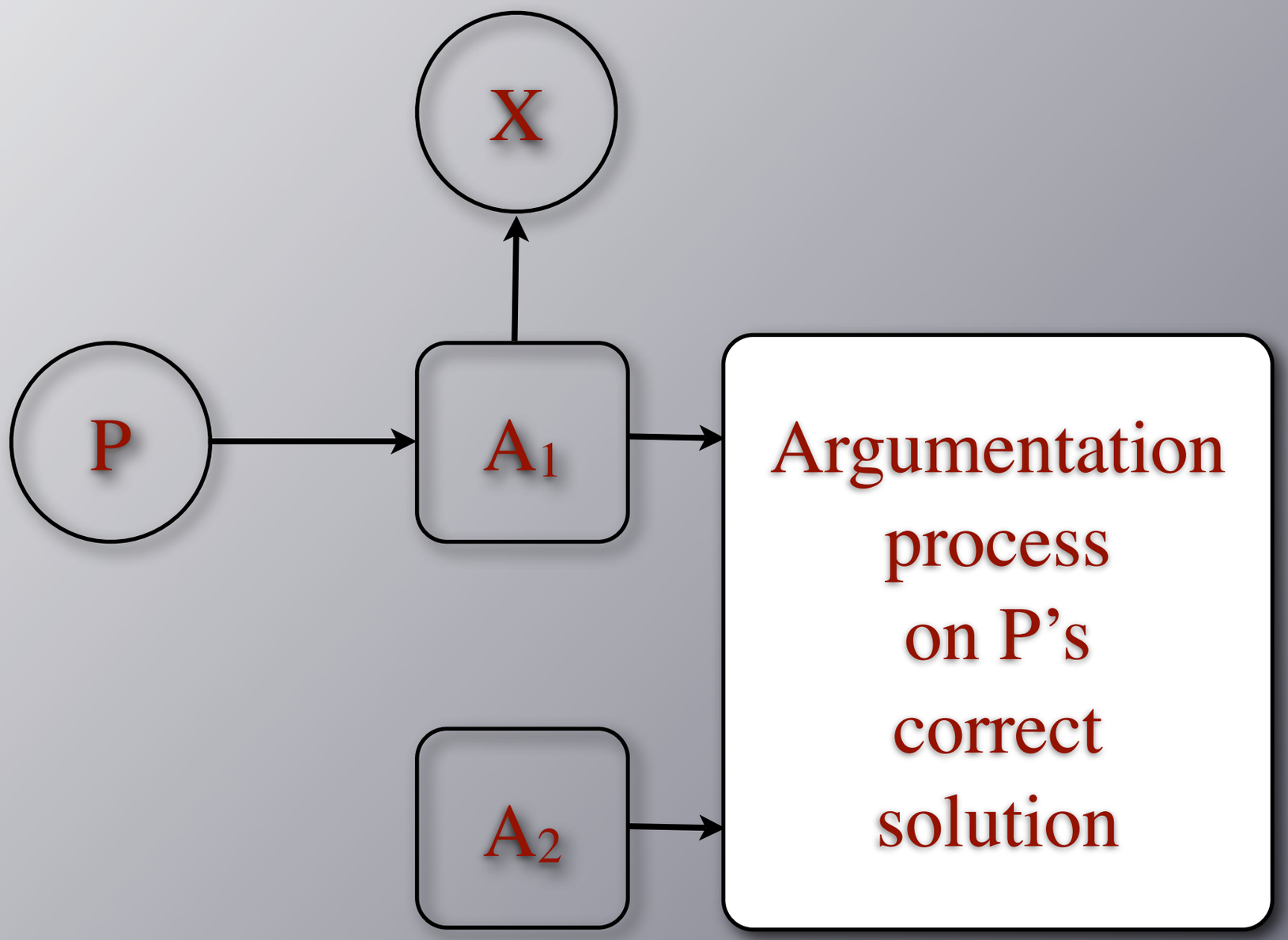
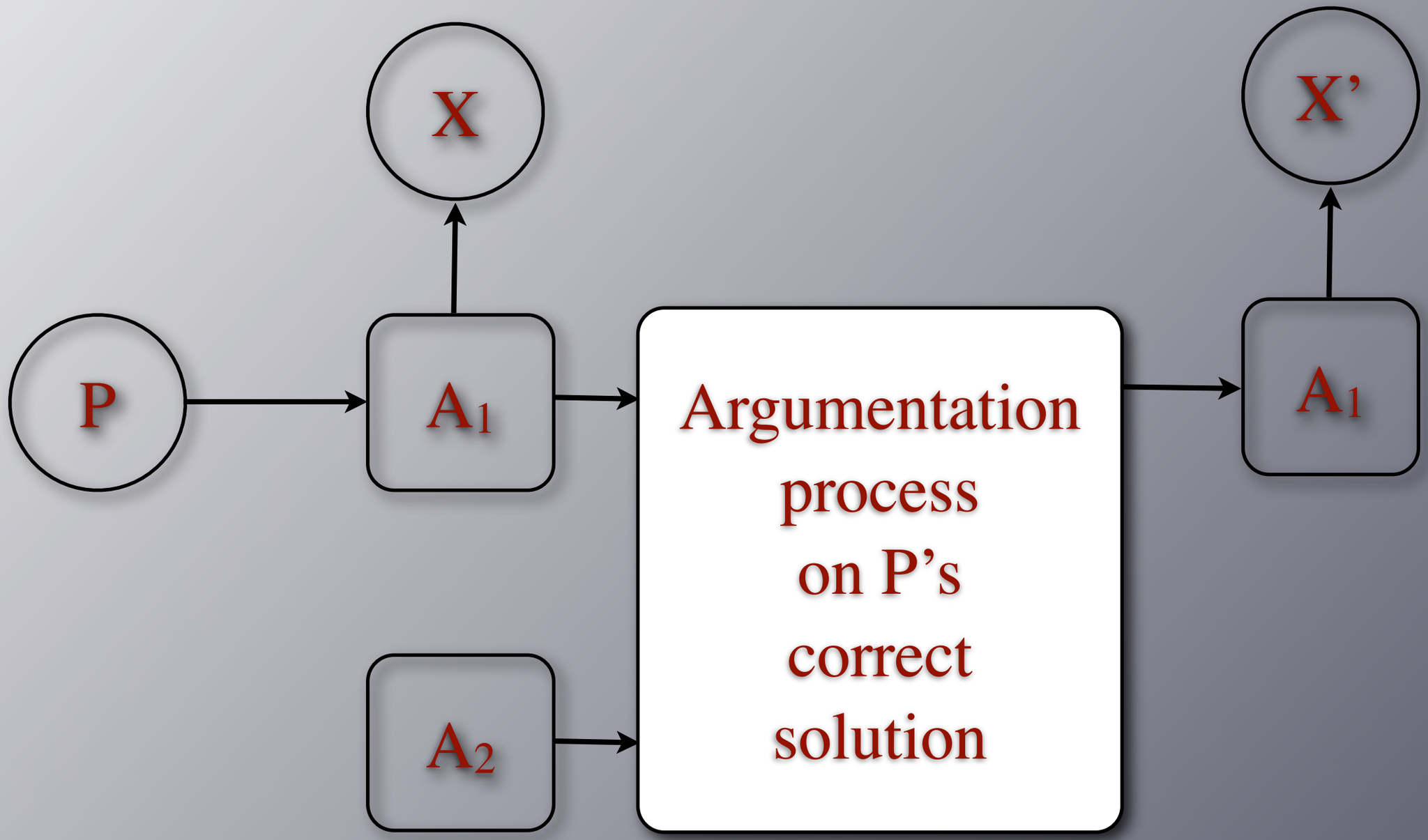


Argumentation

Problem-centered Information Exchange



Arguments

$$\alpha_1 = \langle A, P, S, D \rangle$$

- A — *according to A*
- P — *for problem P*
- S — *S is a solution*
- D — *Description why*

Argument is a justified prediction

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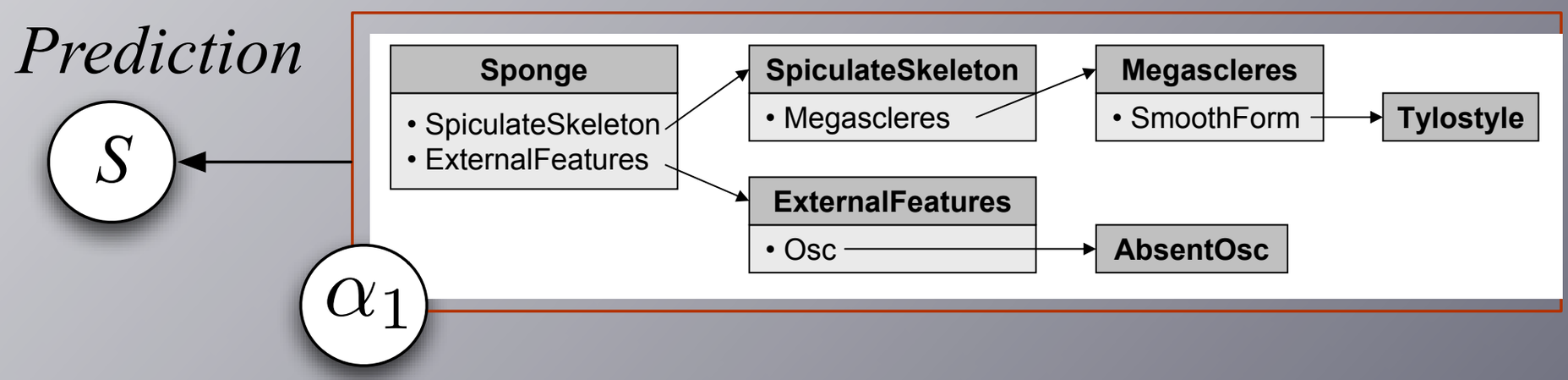
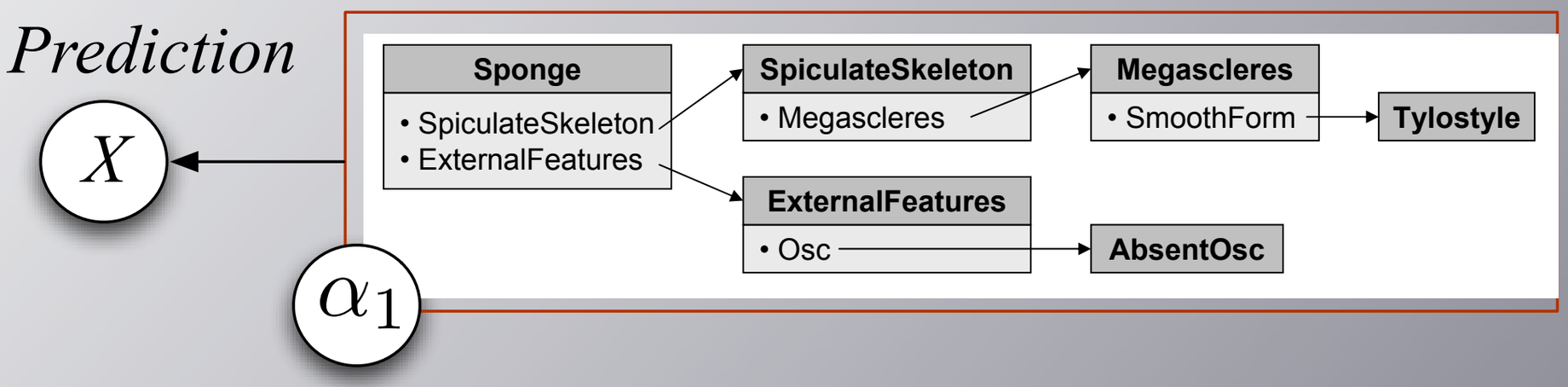


Counter-Argument



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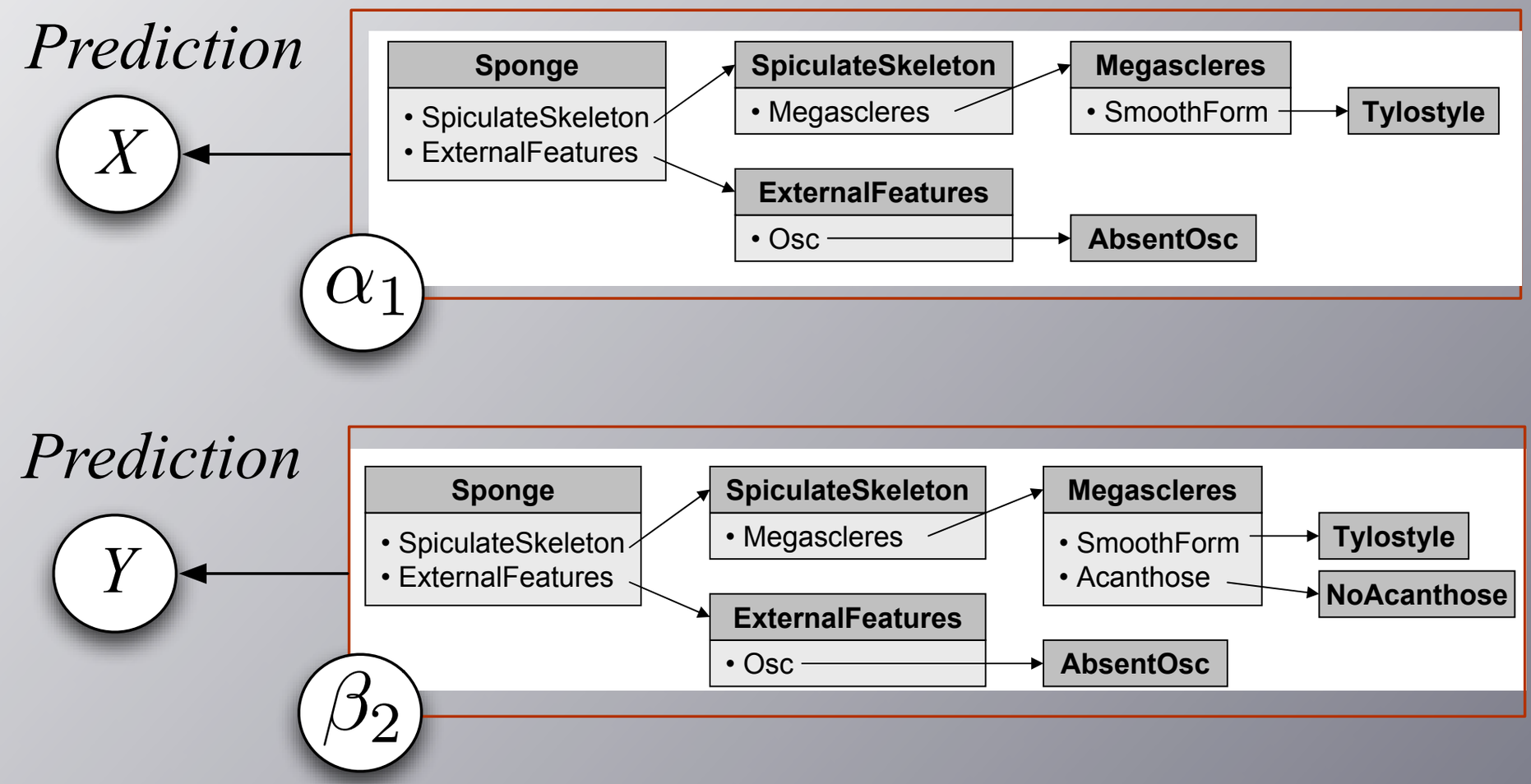
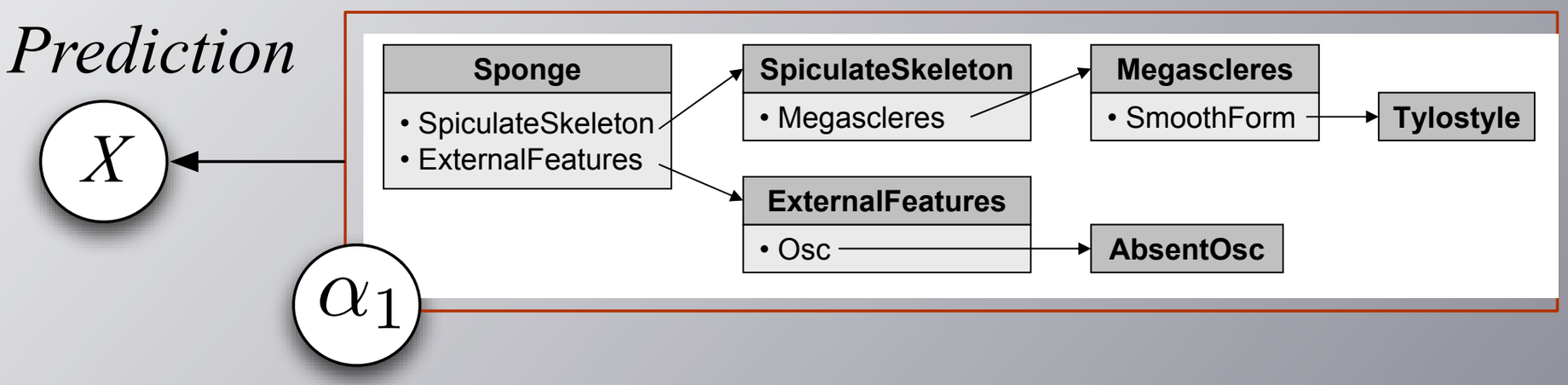


$$\alpha_1 = \langle A_i, P, X, D \rangle$$

$$\alpha_2 = \langle A_j, P, Y, D' \rangle$$

$$X \neq Y \wedge D \sqsubseteq D'$$

Counter-Example



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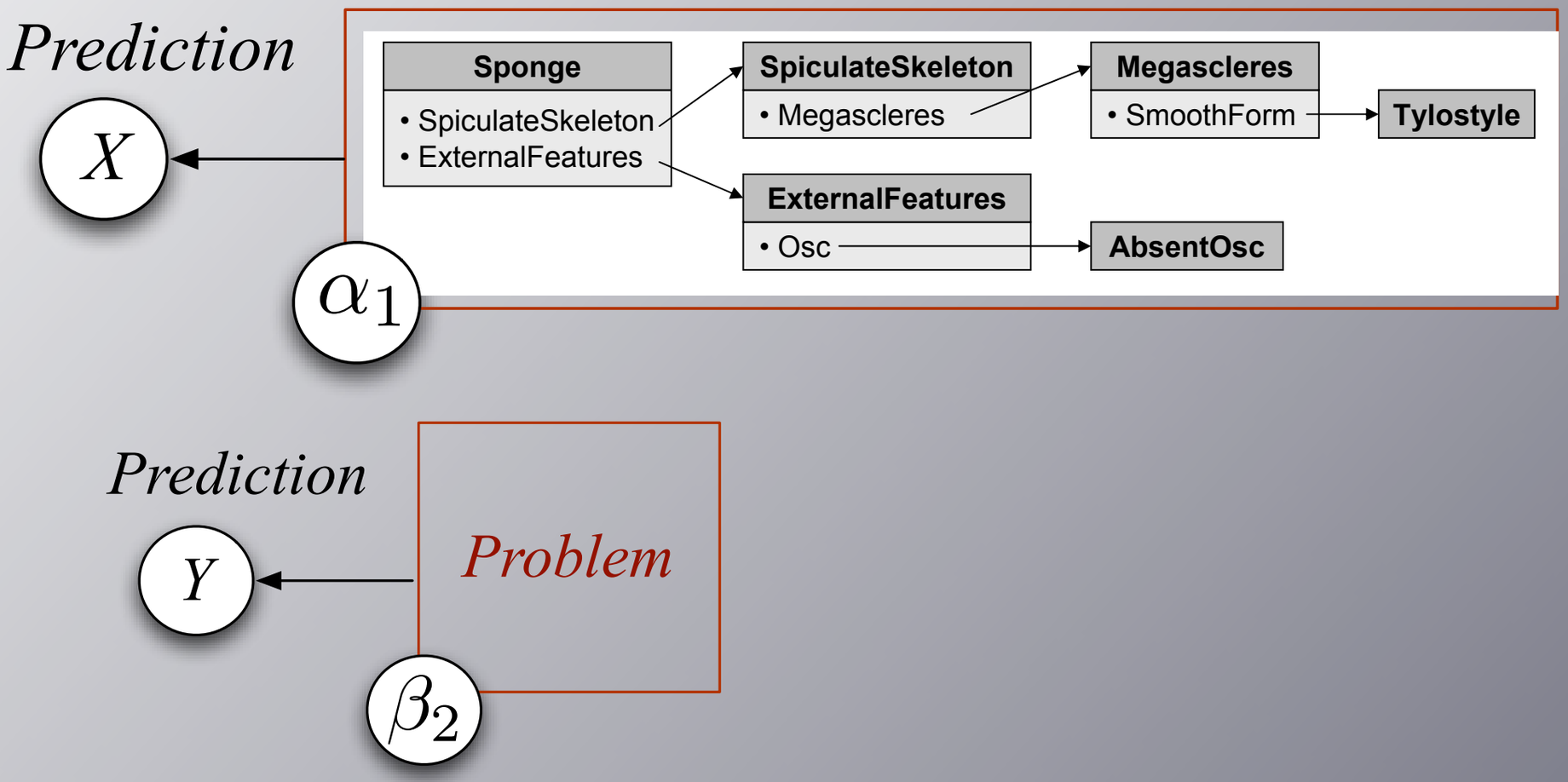
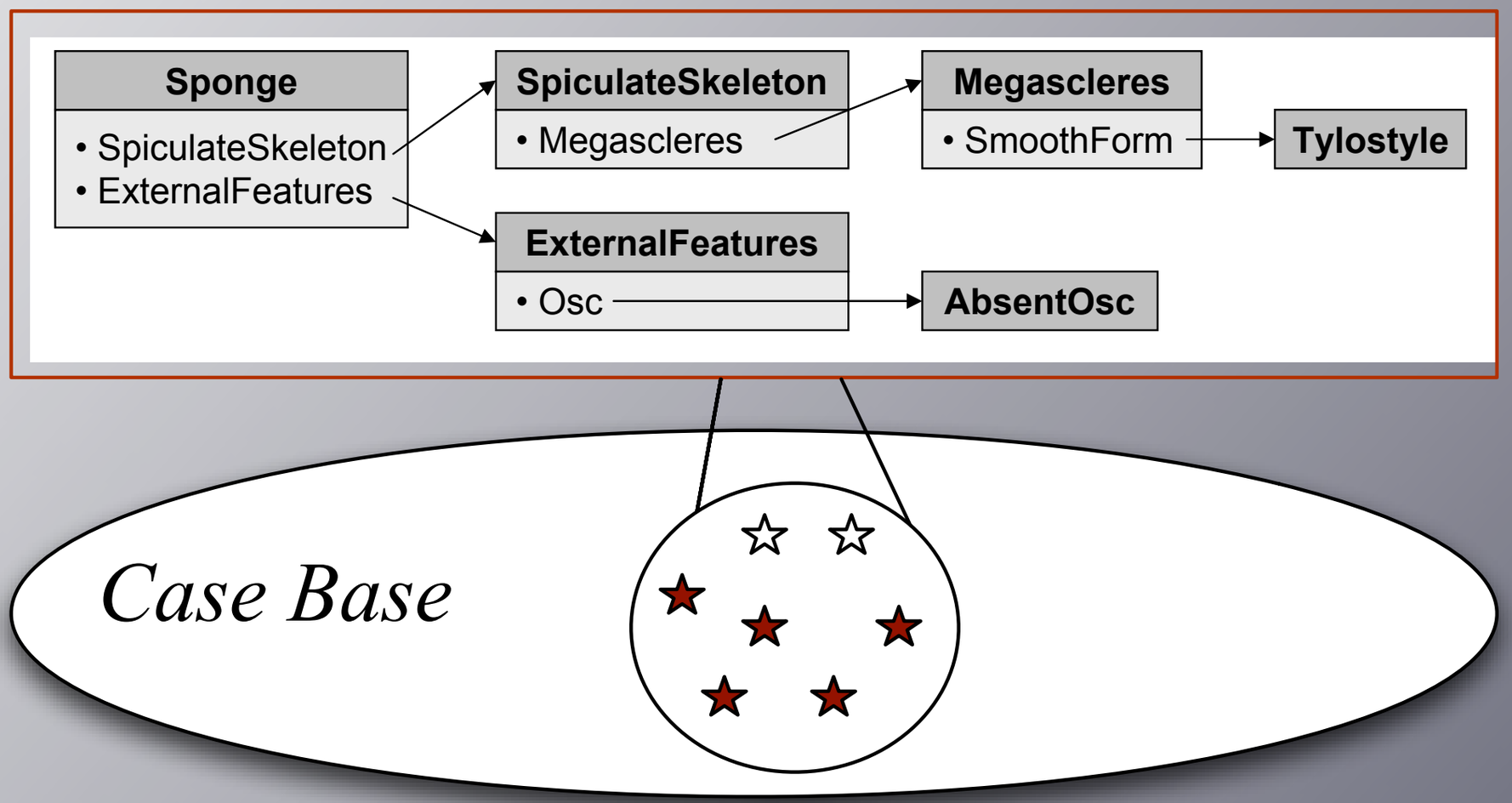


$$\alpha_1 = \langle A_i, P, X, D \rangle$$

$$\alpha_2 = \langle A_j, P, Y \rangle$$

$$X \neq Y \wedge D \sqsubseteq Problem$$

Generation


Sponge
• SpiculateSkeleton
• ExternalFeatures
SpiculateSkeleton
• Megascleres
Megascleres
• SmoothForm
Tylostyle
ExternalFeatures
• Osc
AbsentOsc
Case Base

Confidence

$$\mathsf{C}_{A_i}(\alpha) = \frac{Y_\alpha^{A_i} + 1}{Y_\alpha^{A_i} + N_\alpha^{A_i} + 2}$$

$$Y_\alpha^{A_i} = |\{c \in C_i |\ \alpha.D \sqsubseteq c.P \wedge \alpha.S = c.S\}|$$

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IF
My Confidence in a Counter-Argument
is higher than my confidence in my Argument
THEN
concede I was wrong and accept new solution

Confidence = Price

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Bet on predicting a solution S
an amount proportional to
my confidence on S

Info. Exchange Protocol

A_i presents its argument to the 1st acquaintance agent on problem P

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IF
a counterexample is received
THEN
learn from it and derive my new argument
(may be the same or a new one)

Info. Exchange Protocol

A_i presents its last argument to the 2nd acquaintance agent on problem P

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Info. Exchange Protocol

A_i bets on its last argument after all acquaintance agents on problem P

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The amount of the bet is proportional to the confidence A_i has on its last argument

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Argumentation with acquaintance is expected to increase the individual confidence on the final argument

Experiments

Broker agent receives bets on problem P

IF choice with higher bet is the correct solution
THEN agents that bet the correct solution will receive a reward
ELSE no reward

Individual reward is proportional to each bet w.r.t the total amount of bets + 10% bonus

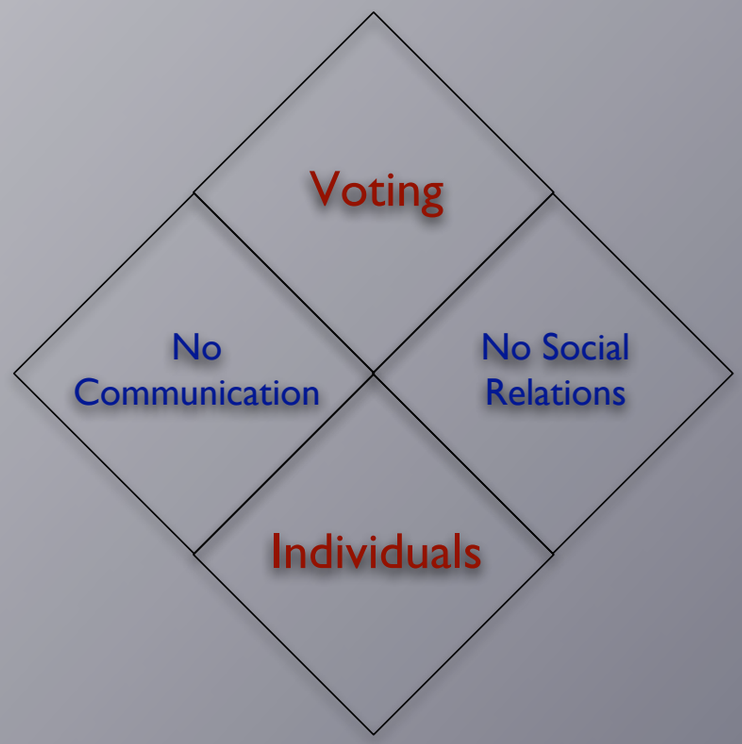
1) they have incentive to reveal true information
2) they benefit from joint accuracy

Market parameters

- Prediction Market vs. Majority Voting
- Effects of information exchange
  - on the market precision
  - on individual precision
  - on rewards
  - on confidence

Market vs. Majority Voting

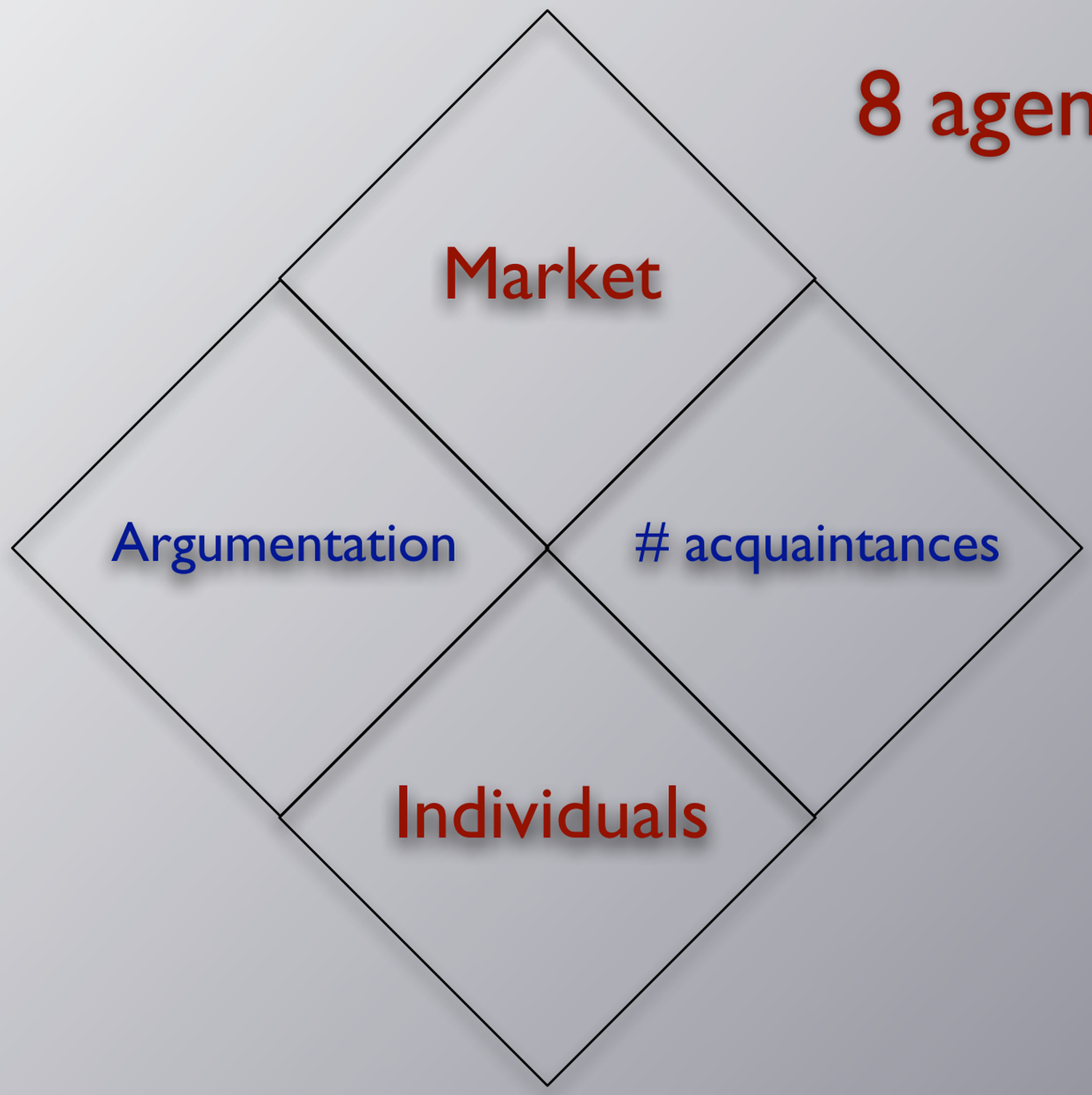
8 agents, no argumentation



89.71 Accuracy 88.93

Thus the individual confidence estimation is good enough to determine a good bet signal

P-Market + Social Net



8 agents, (max. 7 acquaintances)

Agent argues with 1, 2, 3, 4 and 5 acquaintances
(14%, 29% 43% 57% and 71% of population)

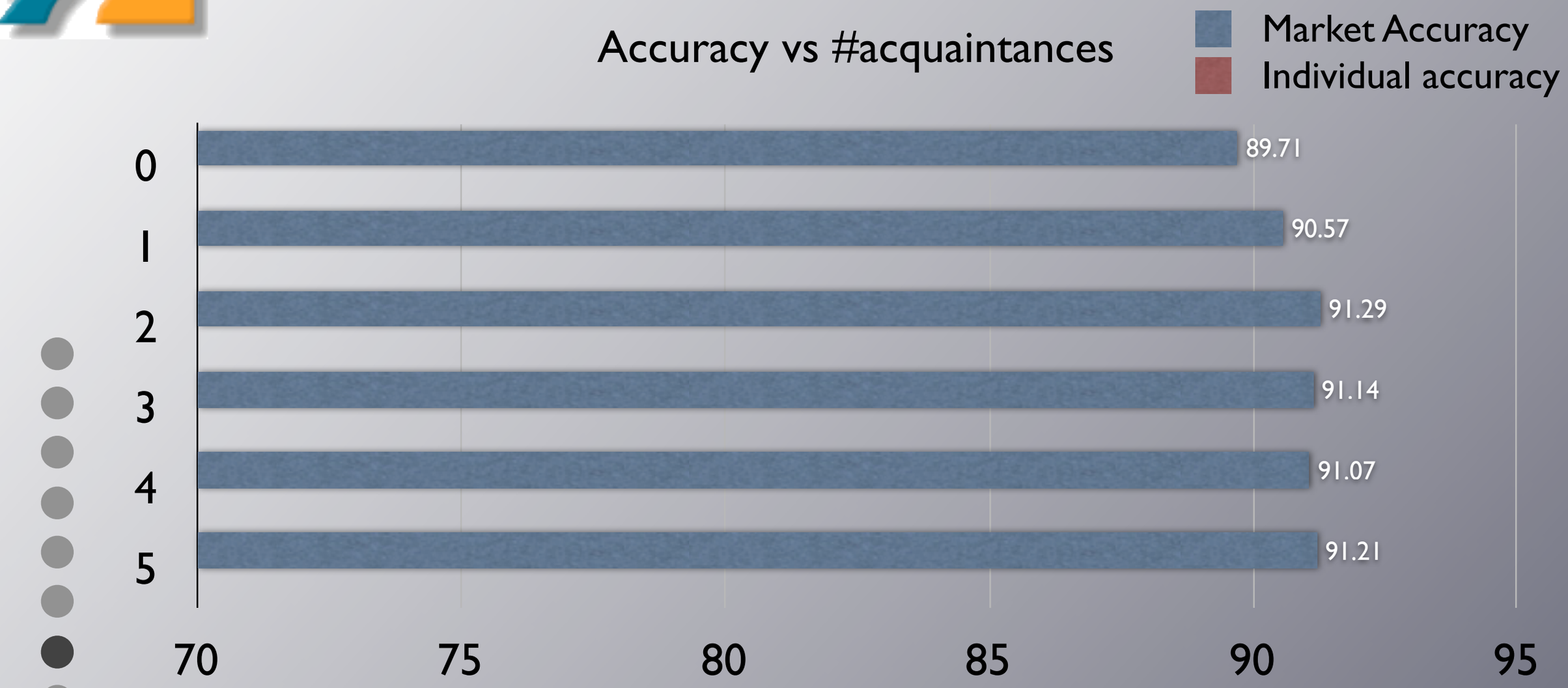
1	14%
2	29%
3	43%
4	57%
5	71%

Prediction + Social Net

Market Accuracy
Individual accuracy

Information exchange positive for individuals and market:
A) individual accuracy increases with #acquaintances
B) Market accuracy increases then flattens

Prediction + Social Net



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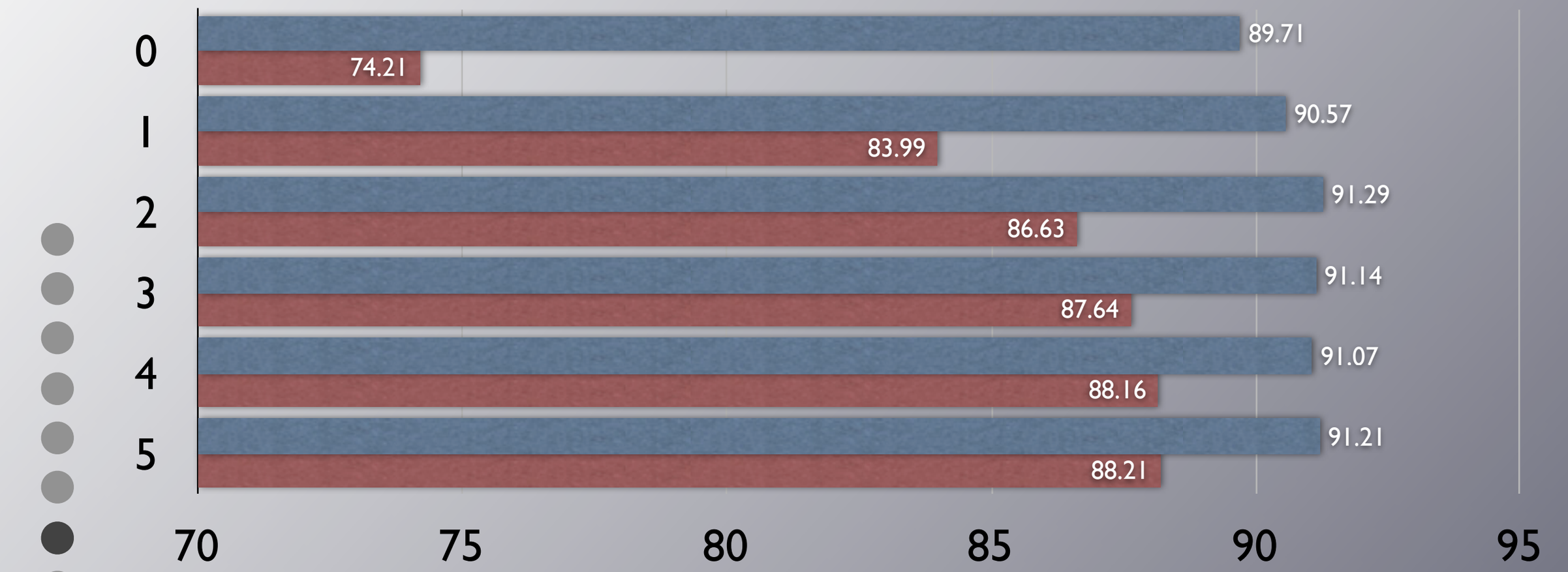

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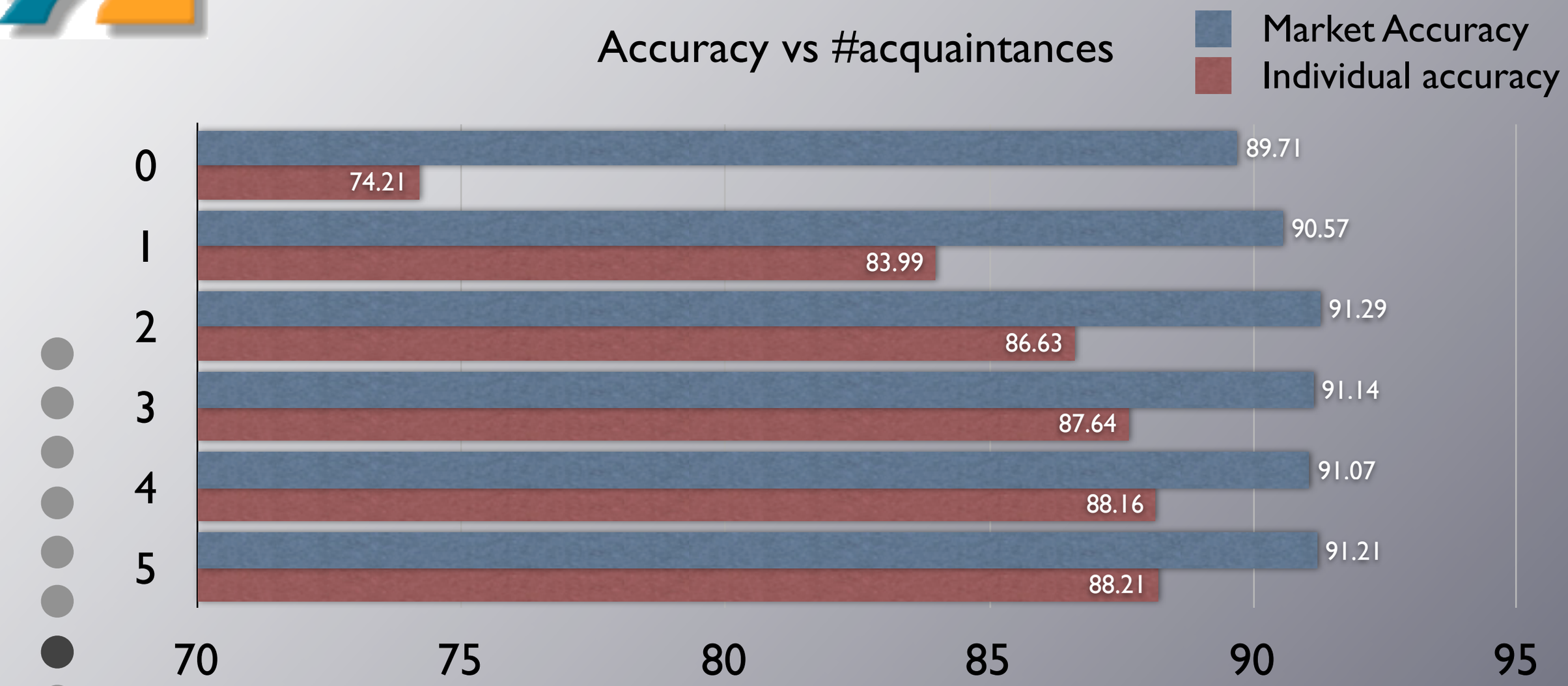

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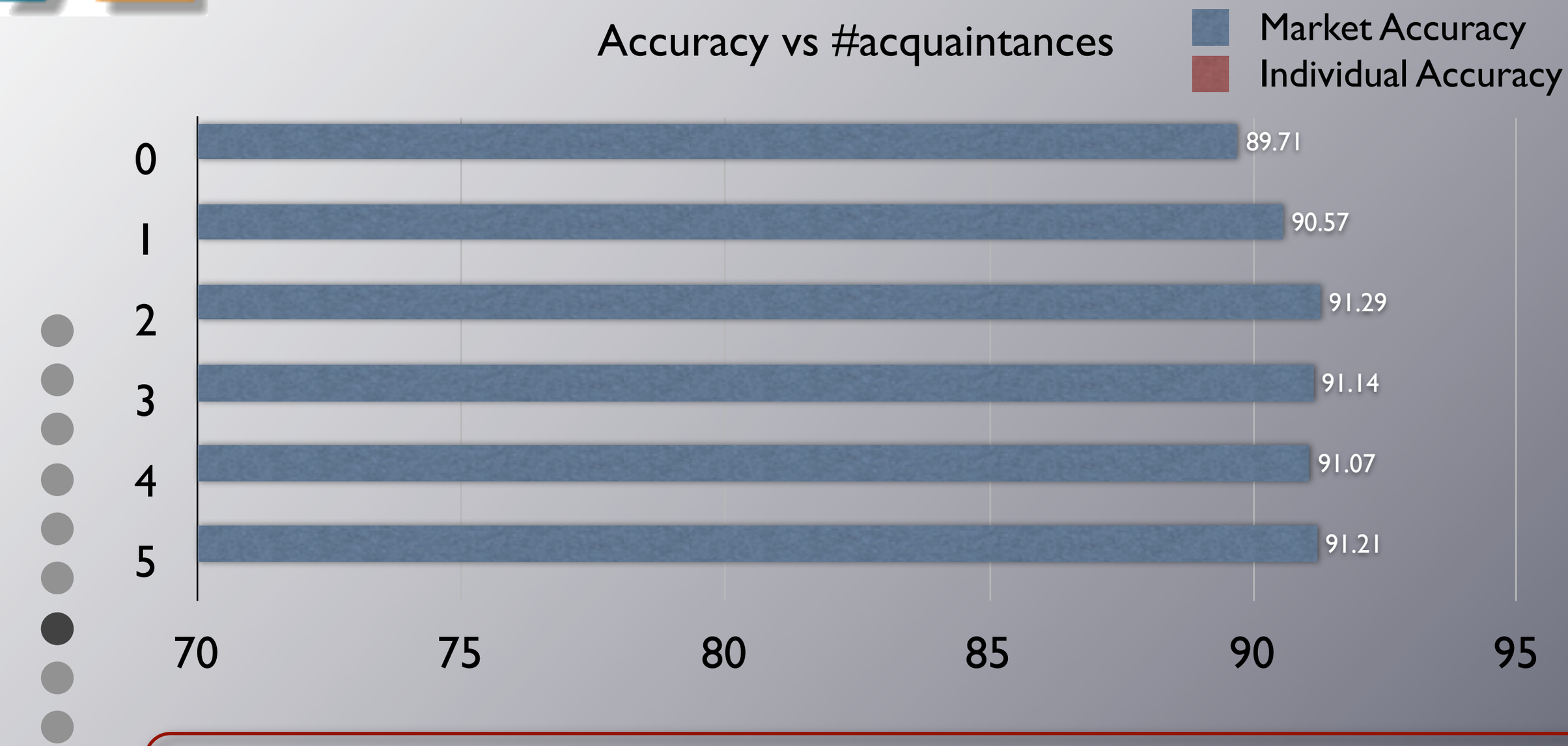
ENSEMBLE EFFECT

Prediction + Social Net

Argumentation is successful in acquiring individually valuable information: increase in individual accuracy and confidence explained by agents changing their minds during information exchange

Prediction + Social Net



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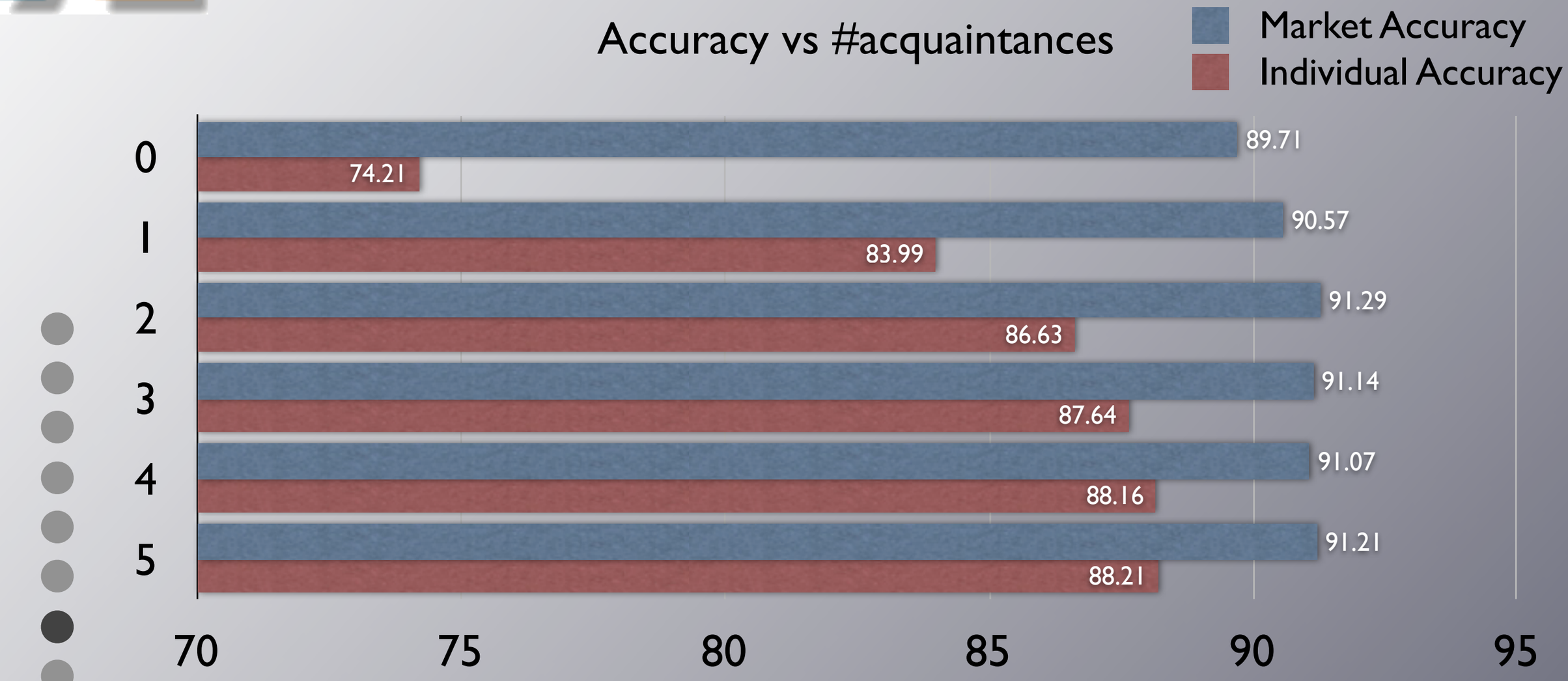
Prediction + Social Net

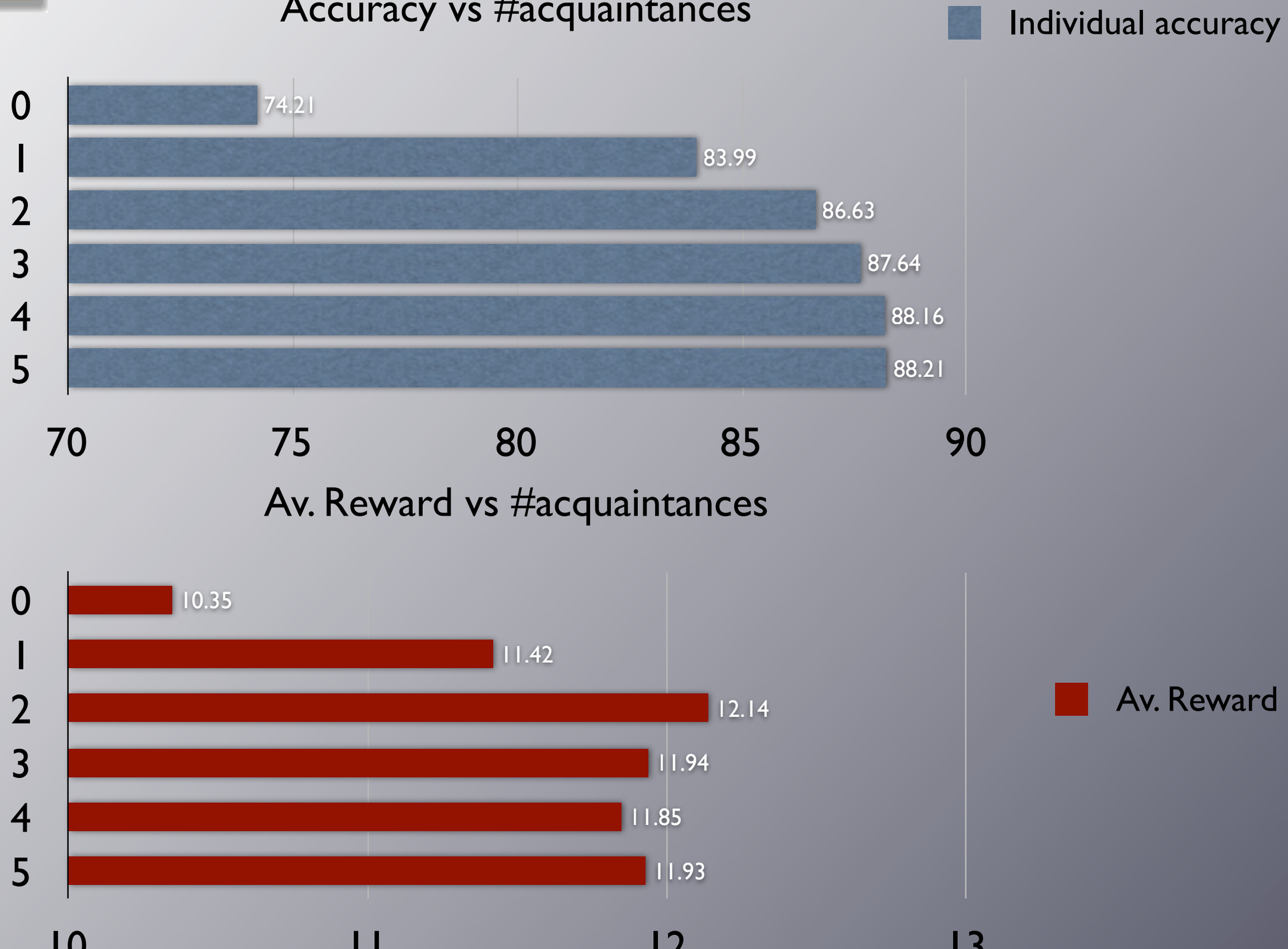


Argumentation is successful in acquiring individually valuable information: increase in individual accuracy and confidence explained by agents changing their minds during information exchange

Prediction + Social Net

- Individual accuracy
- Av. Reward

Prediction + Social Net



Conclusions

- Price as signal
  - Price=Confidence is useful
- Introducing deliberation in p-markets
  - Modeling people consulting trusted friends when making a decision
  - Effect of external/informal structure on method
- Deliberation increases individual accuracy and confidence
  - error correlation increases if social net too dense and joint accuracy suffers

Conclusions

- Group judgment aggregation is ubiquitous
  - methods like voting, deliberation, p-market
- Impact of structures outside methods
  - Information exchange through argumentation
  - via specific social networks
- SAME EFFECT (a.k.a. the “ensemble effect”)
  - of information exchange through deliberation in external networks in prediction markets as in voting/deliberating committees

Future Work

- Group judgment on multiple issues
  - deliberation about multiple issues
- Bias in individual data/experience
  - We assumed here good individual samples
  - See whether deliberation compensates for bias
- **Predicting**/aggregating information is different from **group decision**
  - social choice studies conflate both
  - formally always aggregating preferences