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Cédric Buron, Sylvain Ductor, Zahia Guessoum

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MocANA, an automated negotiation agent based on Monte Carlo Tree Search

Cédric L. R. BURON

Zahia GUESSOUM

Sylvain DUCTOR

THALES



INTRODUCTION

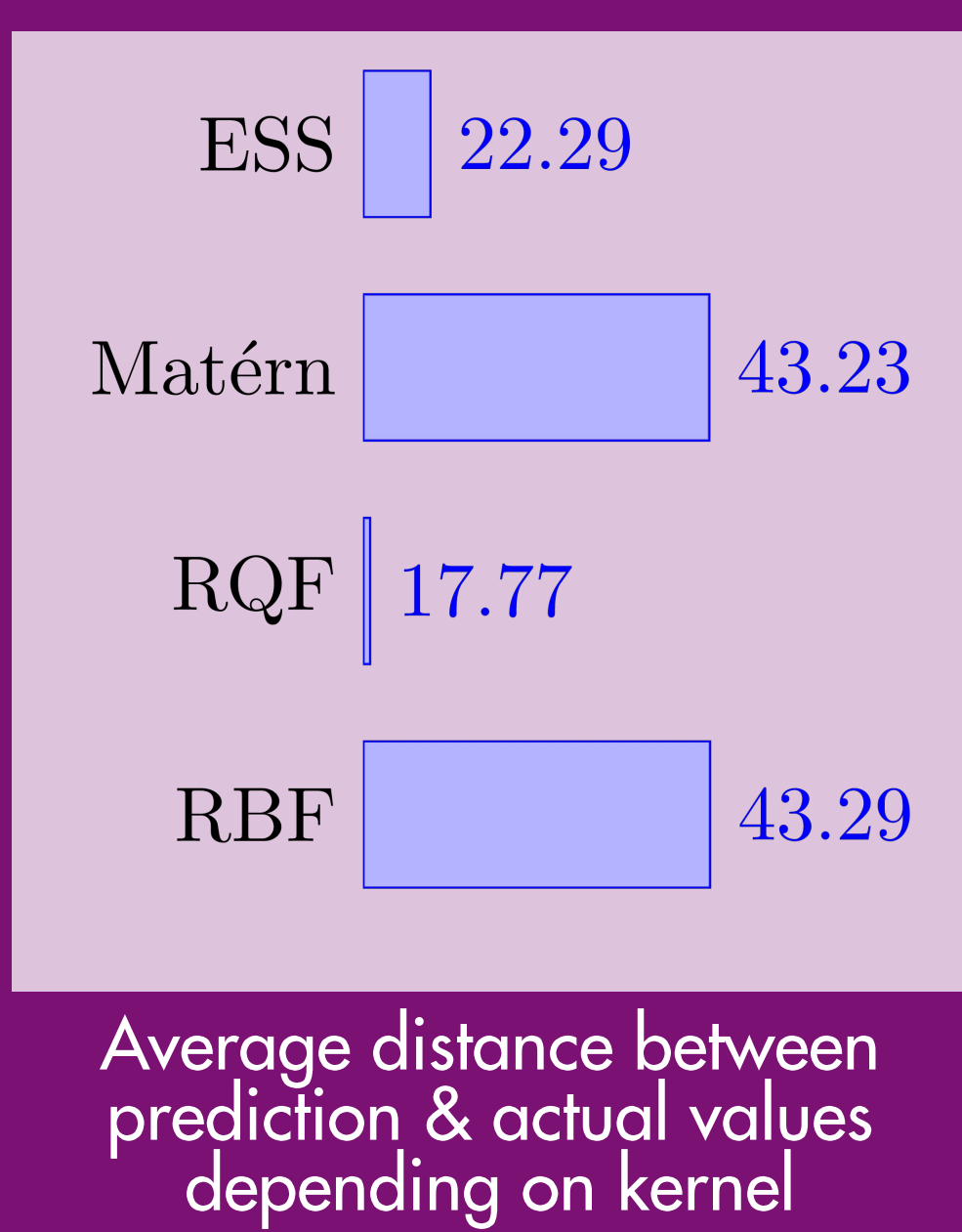
Context

- Automated negotiation;
- Complex negotiation domains;
- Example application: factoring
- Buy/Sell invoices;
- Proposal: debtor (categorical), discount rate (continuous), total amount (numerical);
- Varying time pressure, cannot rely on deadline;
- Nonlinear preferences;

Contribution: an agent able to negotiate:

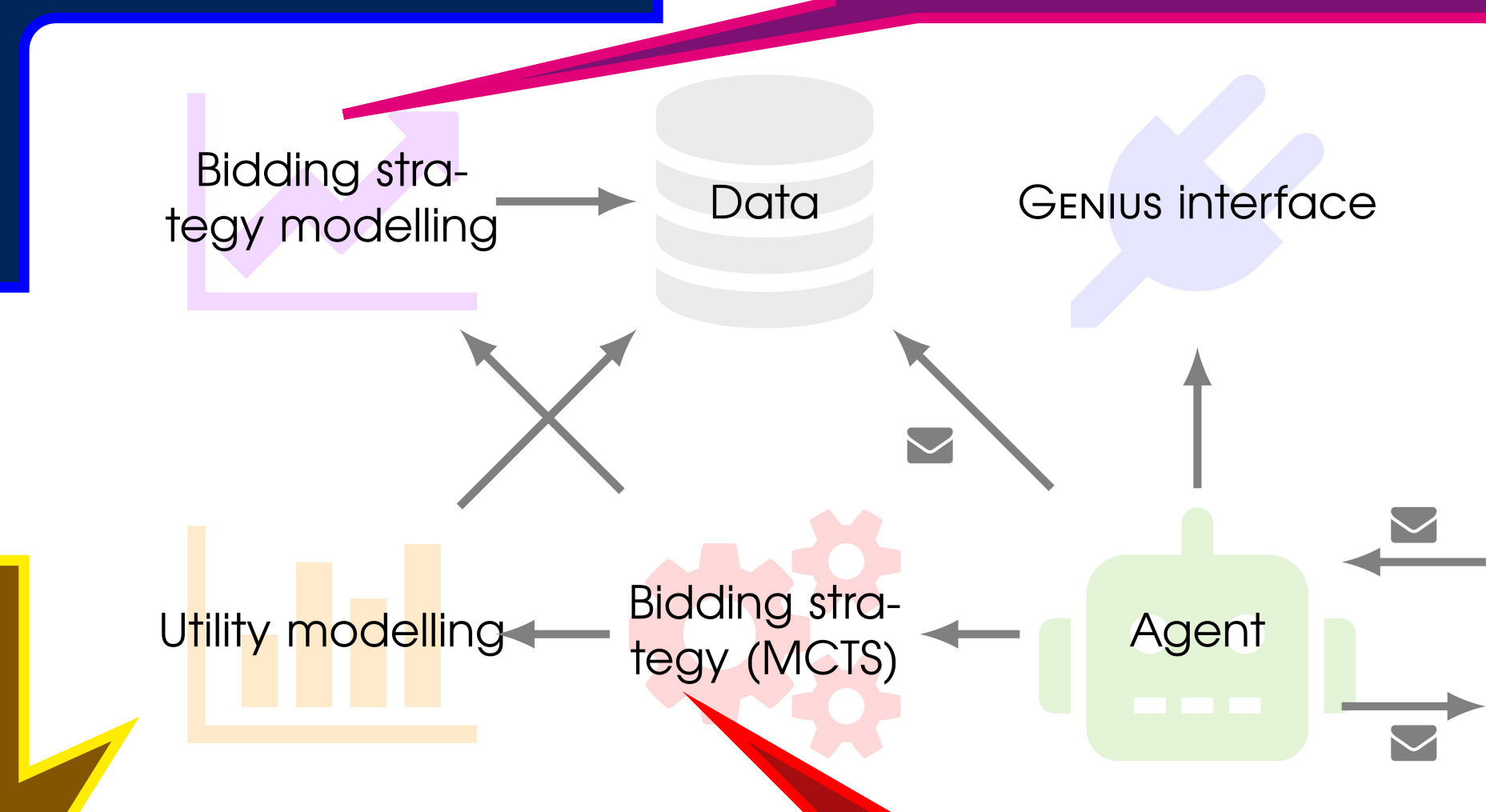
- with nonlinear preferences,
 - without relying on a deadline,
 - on both categorical, numerical and continuous issues;
- Representation of negotiation as a game; using AI for games techniques.

BIDDING STRATEGY MODELLING



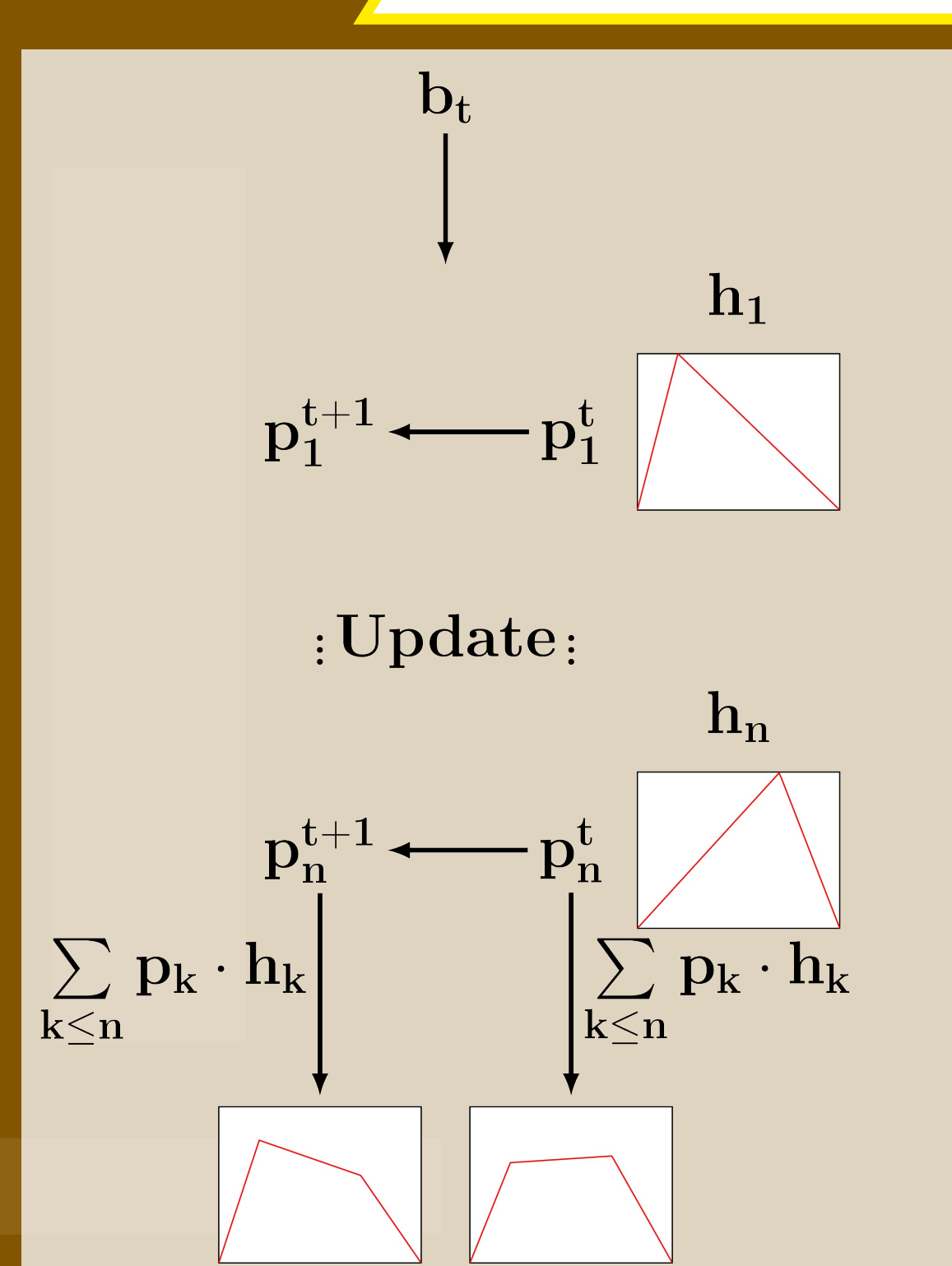
Average distance between prediction & actual values depending on kernel

- Gaussian Process regression;
- Based on a kernel:
 - Radial Basis Function,
 - Rational Quadratic Function,
 - Matérn,
 - Exponential Sine Square;
- tested on 50 random negotiation sessions
- Initially used on numerical issues, can be extended to categorical;
- Generates bid distribution using history;



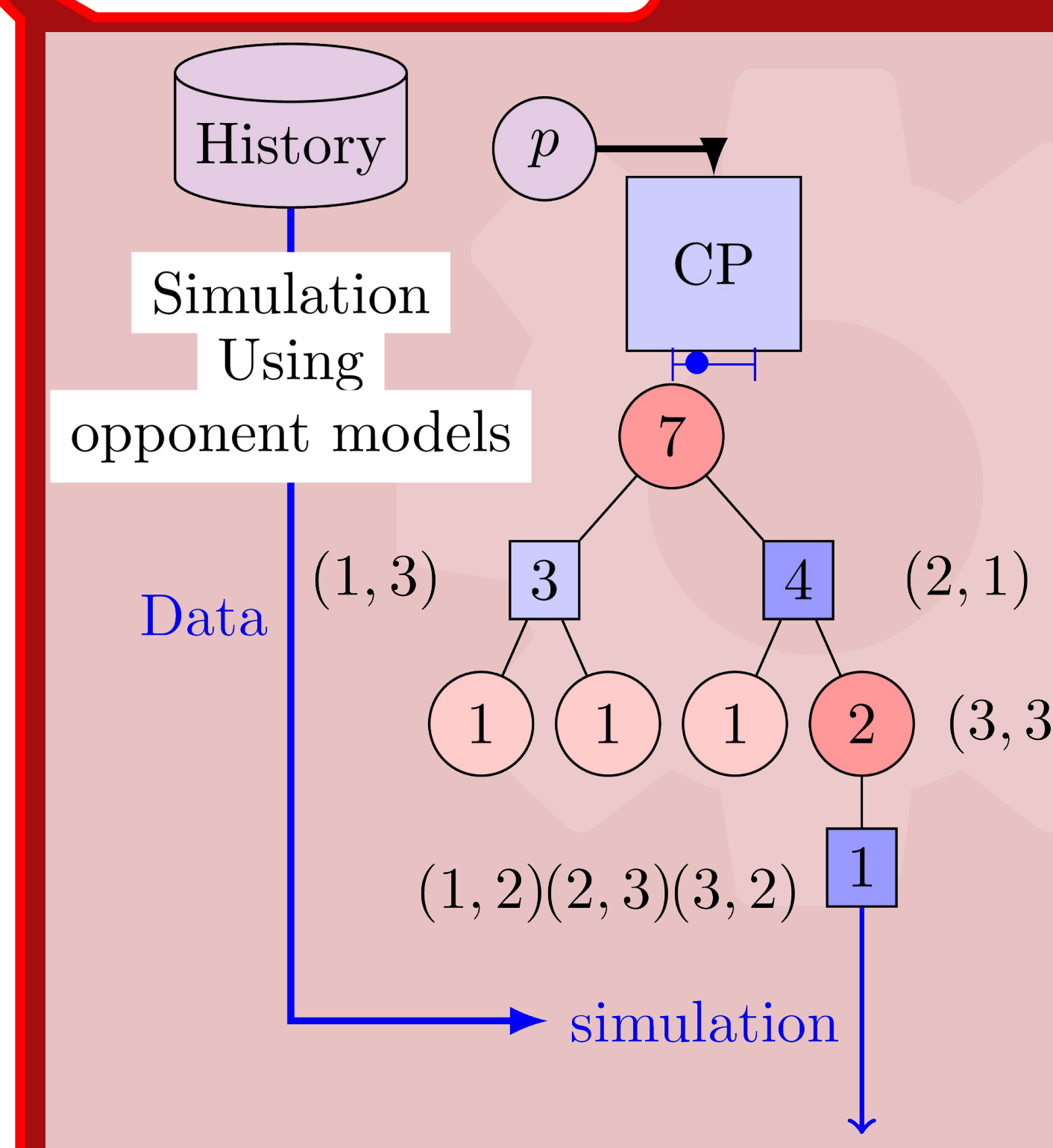
UTILITY MODELLING

- Bayesian learning;
- Presupposition: concession rate from the opponent;
- Hypotheses:
 - Triangular functions
 - Order/Weight on the issues
- Computation: Hypotheses probabilities (based on opponent previous proposals);
- Resulting function: sum of the hypothesis, weighted by probabilities;
- For numerical, extended to categorical.



BIDDING STRATEGY

- Based on Monte Carlo Tree Search;
- Uses Progressive widening for selection & expansion;
- Uses modelling for the simulation;
- Backpropagates the utility of both agents through utility modeling;
- Prunes the proposals with utility lower than the best proposal from the opponent;
- Parallelizes simulations to make more.



EXPERIMENTAL PROTOCOL

- Use of a **genius interface** (reference framework);
- Negotiation domain: ANAC:
 - Large domain (10 issues, 10 values/issue)
 - Numerical issues
- 3 min/round (suitable for the application context);
- Only 3 opponents in this context: Random Walker, Tit-for-Tat and Nice Tit-for-Tat;
- Neverending sessions for MoCaNA vs. Nice Tit-for-Tat: indirect comparison (through RandomWalker);
- 20 negotiation sessions per setting with each profile;
- Representation of both average score and standard deviation.

OPPONENTS

RandomWalker

- Makes random proposals,
- Accepts a proposal if better than the generated one.

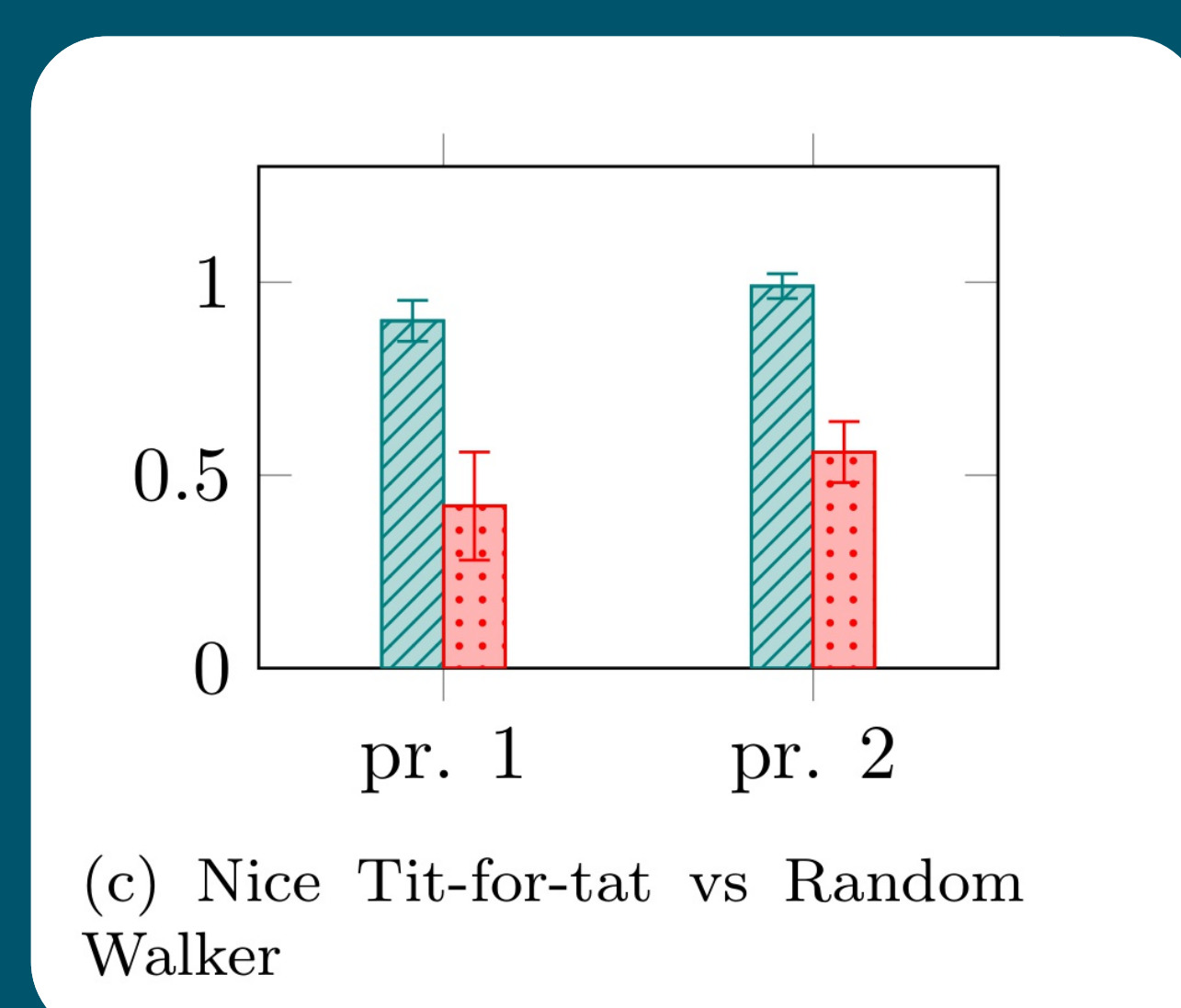
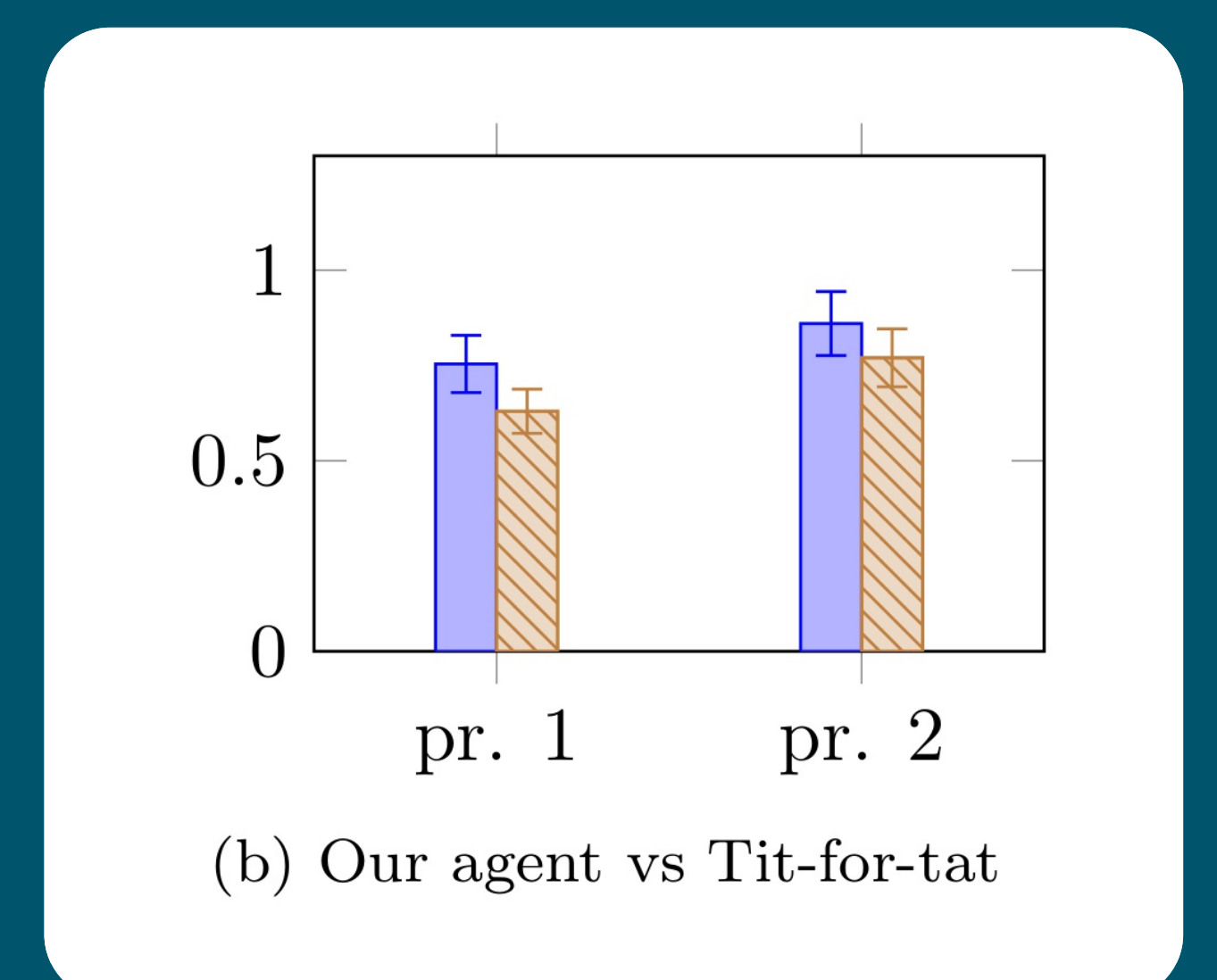
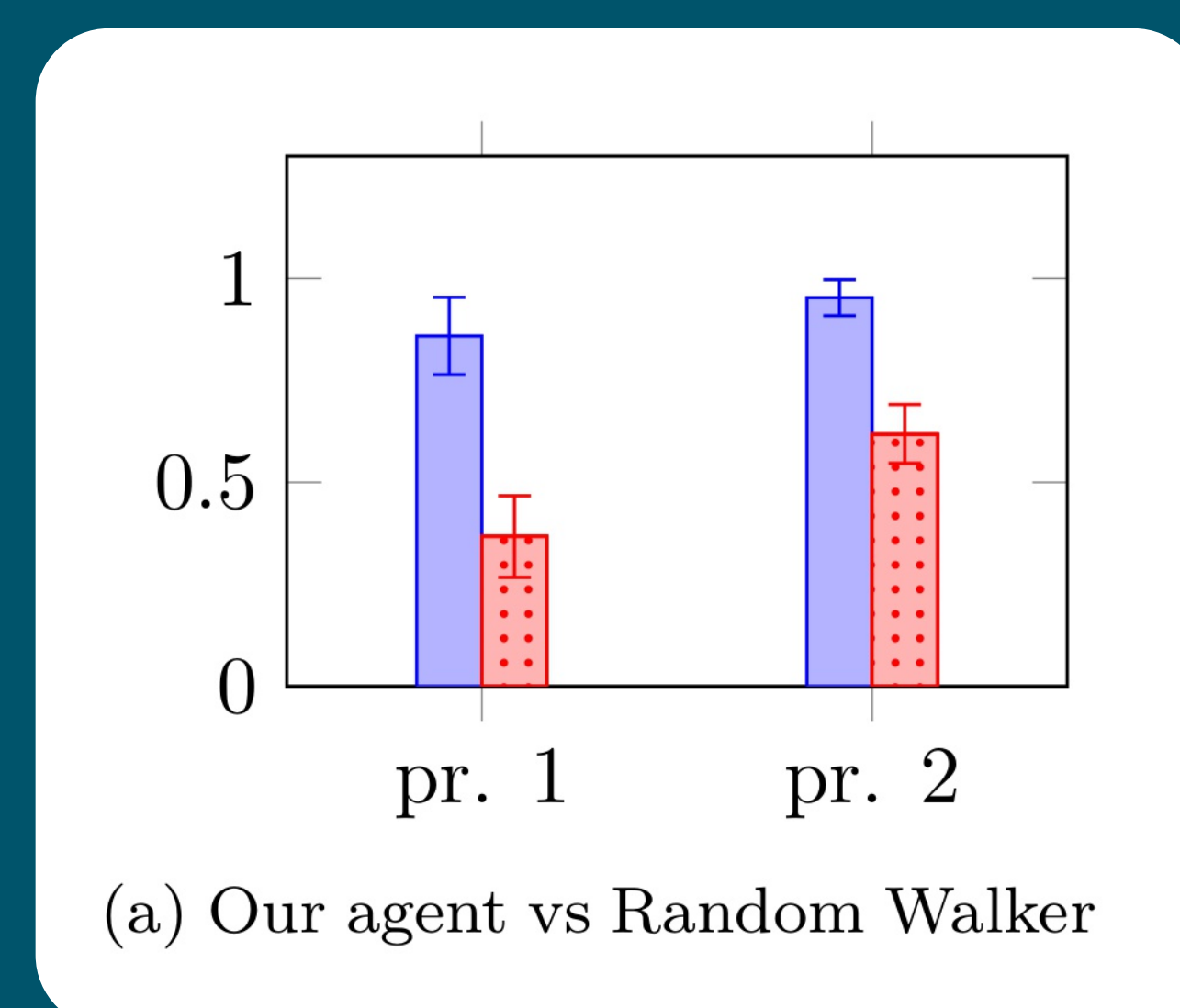
Tit-For-Tat

- Returns moves (concession = concession of the opponent),
- Accepts a proposal if better than the generated one.

Nice Tit-for-Tat

- Identical to Tit-for-Tat but:
- Computation made on a Nash Point, computed through utility modelling (bayesian learning).

RESULTS



Conclusion

- At least as good as any agent in this context;
- Possibility to improve (RAVE/AMAF);
- Many things to test (other opponent modeling, other AI for games as CFR minimization...)
- Possibility to expand to multilateral negotiation.

Legend: Our agent (blue), Random Walker (red), Tit-for-tat (orange), Nice Tit-for-tat (green)