Chaotic Time Series Prediction, for the Game Rock–Scissors–Paper

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Question

"*Since chaos "models" irrationality, can a super–rational agent exploits irrationality in order to perform better than a Nash strategy?*" This project is going to build such a super–rational agent. The agent employs embedding, and a strategy based on Local Lyapunov Exponent to beat an irrational agent.

Framework

- Two "irrational" players of Scissors–Paper–Rock
- They want to win
- They do not play $Nash$
- There is chaos

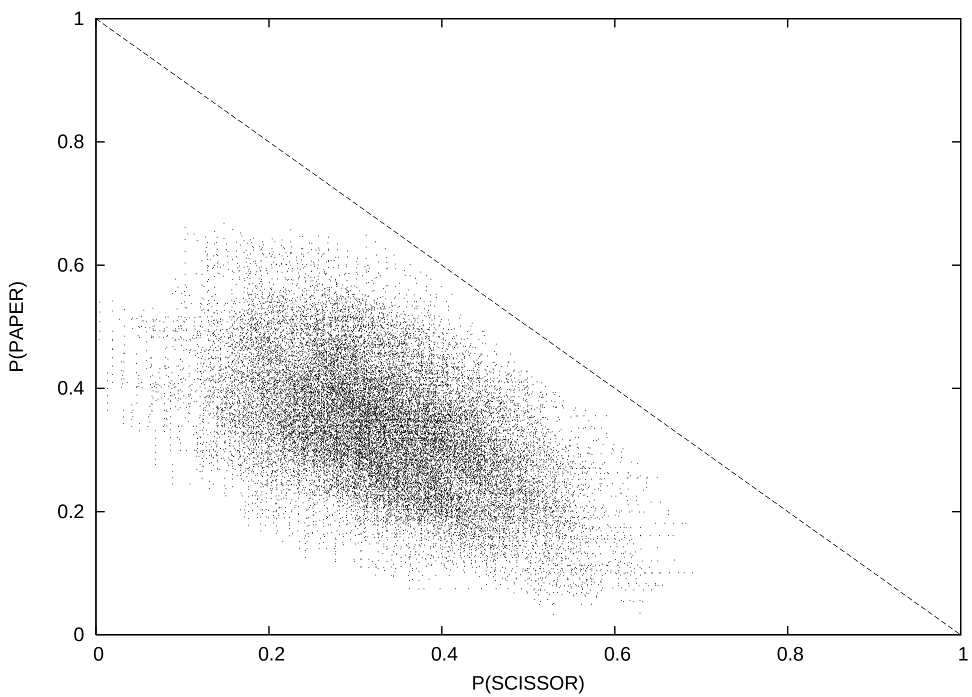
Goals of the super–agent

- An external observer:
  - wants to predict their behavior
  - does not affect the learning of the others
  - uses Local Lyapunov Exponent, Entropy and observations
  - plays a benchmark strategy intermittently

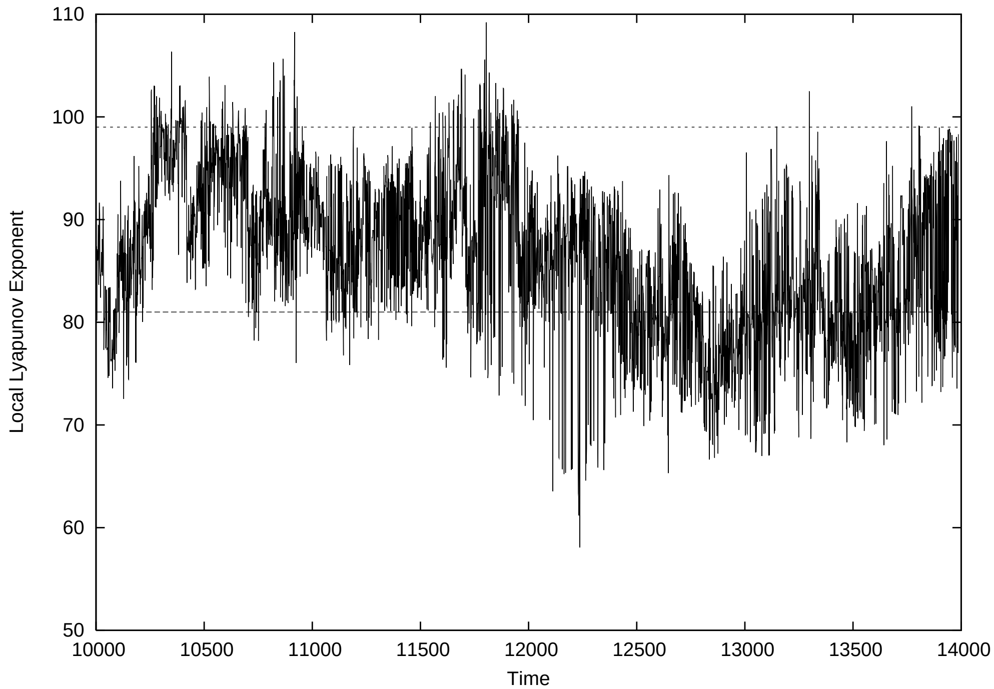
Techniques employed

- Local Lyapunov Exponent (LLE)
- Entropy
- Embedding
- Adaptive Thresholds
- Double Embedding Cascade

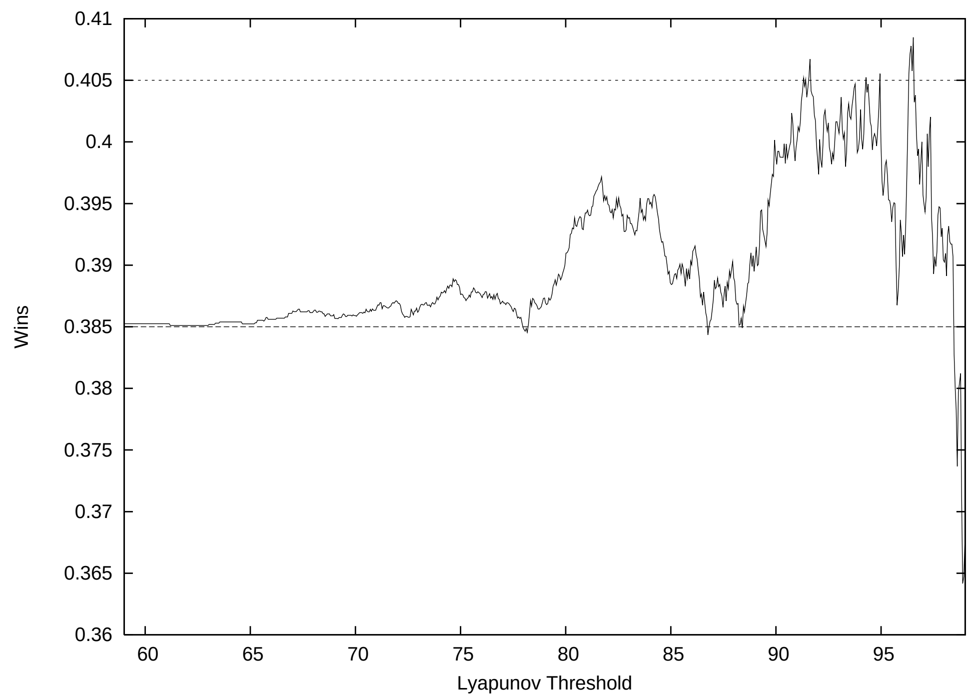
Trajectory in the Probability Space



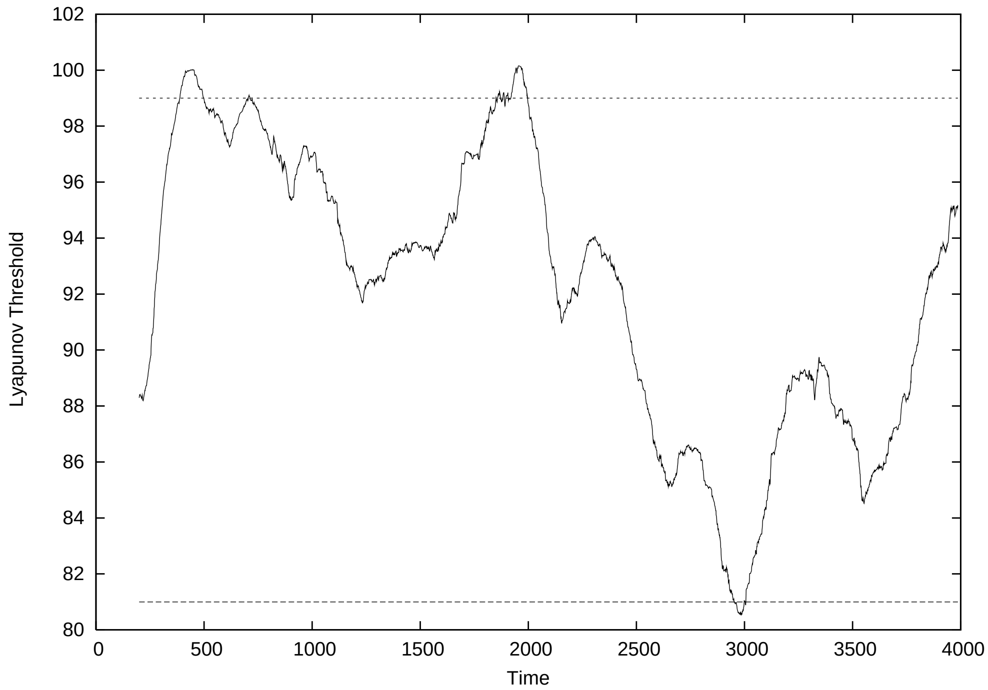
LLE graph


110
100
90
80
70
60
50
Local Lyapunov Exponent
10000
10500
11000
11500
12000
12500
13000
13500
14000
Time

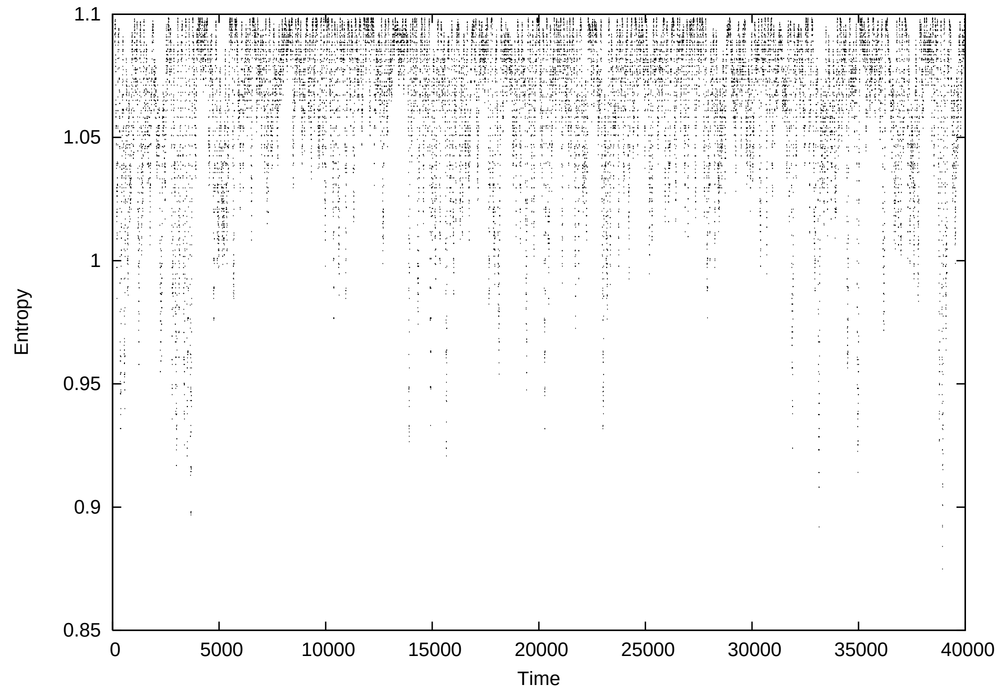
LLE filtering



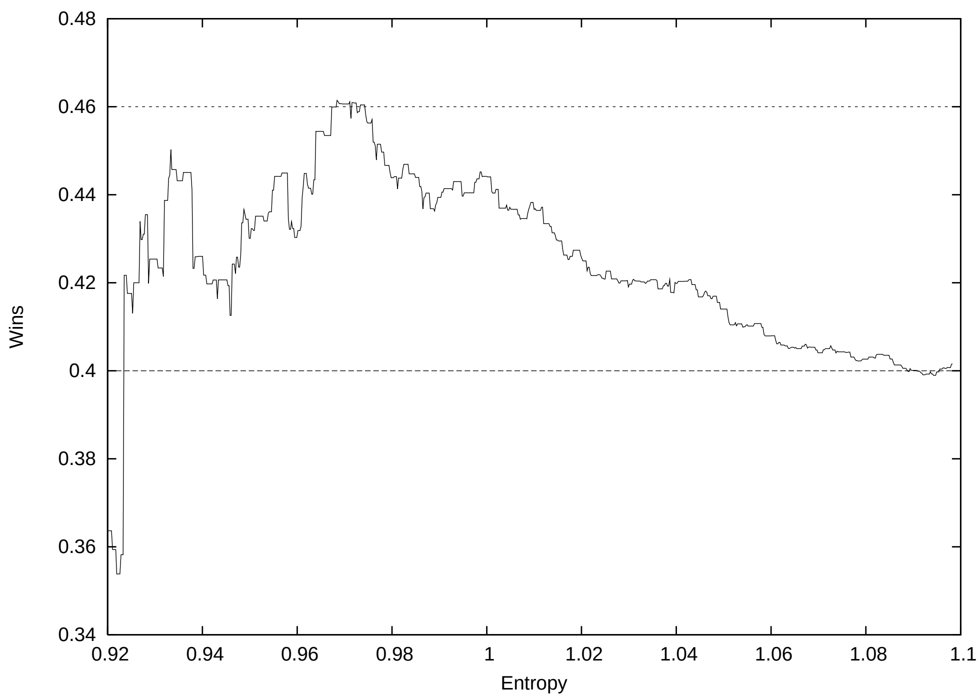
Adaptive LLE threshold



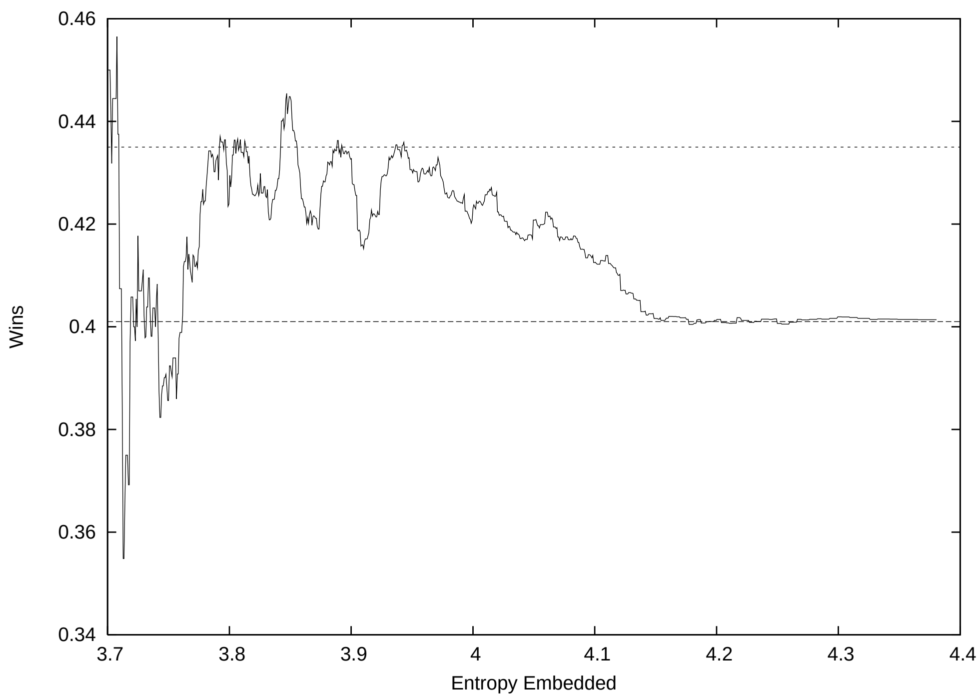
Entropy graph



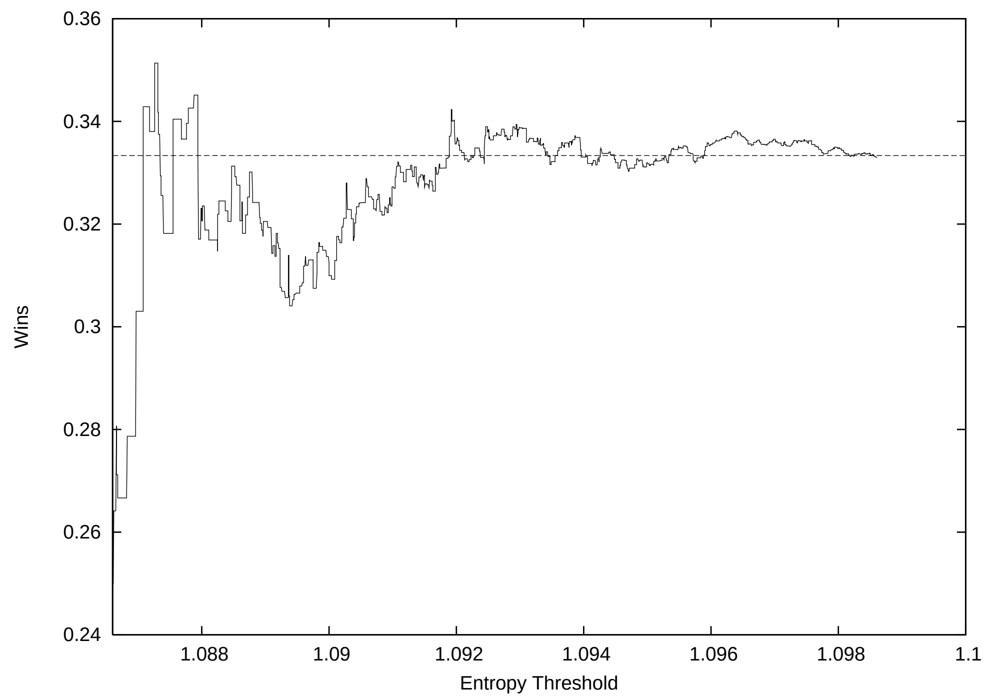
Entropy filtering



Entropy Embedded filtering



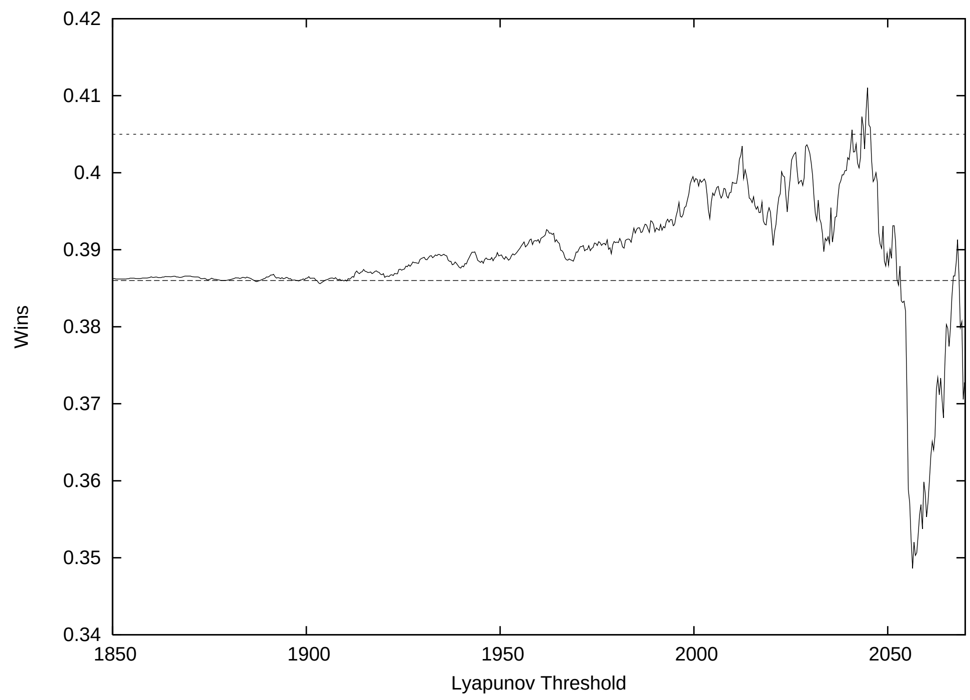
Entropy filtering of a Random Player



Double Embedding Cascade

Observation	$P, R, S, S, P, \ldots$
transf. in base 3	$2, 0, 1, 1, 0, \ldots$
transf. in Real Number	$0 \cdot 3^{-1} + 1 \cdot 3^{-2} + 1 \cdot 3^{-3} \ldots$
get a sequence	$0.15637, 0.71879, \ldots$
embed such a sequence in 3D	$(x, y, x)_1, (x, y, x)_2, \ldots$
compute a sequence of LLE	$LLE_1, LLE_2, LLE_3, \ldots$

Double Embedding Cascade filtering



Conclusions

- Chaotic behavior can be a weakness
- Intermittency improve the performance
- LLE does worst than Entropy
- Double Embedding Cascade is robust
- . . . ready for Wall Street?

Acknowledgments

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Questions . . .

. . . thank you.