

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

Franco Salvetti

Dept. of Computer Science
University of Colorado at Boulder

May 21, 2004

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

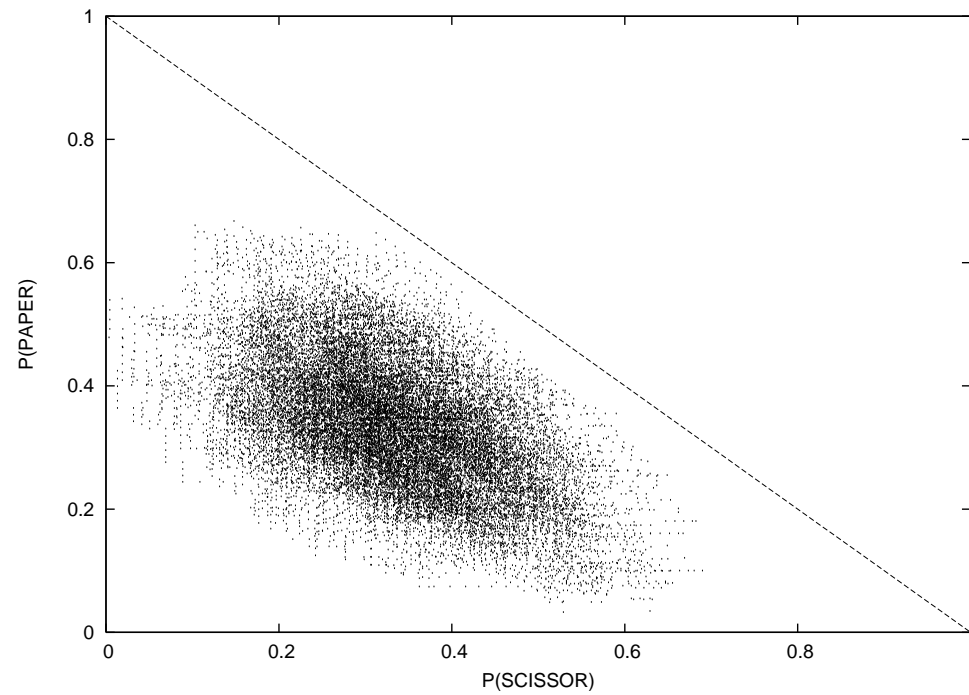
Goals of the super-agent

- 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

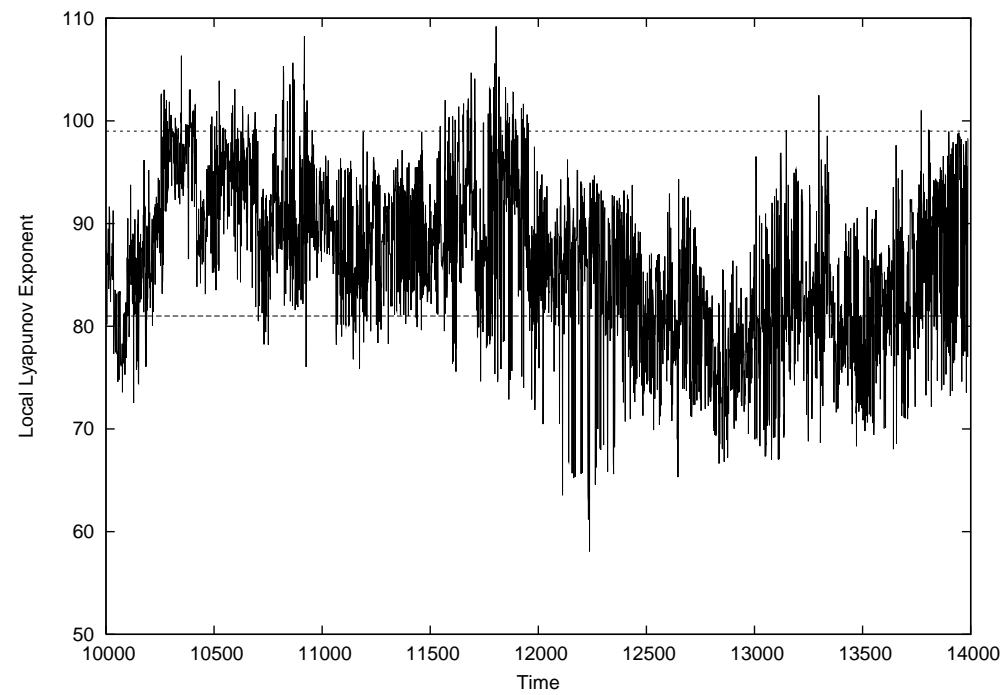
Techniques employed

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

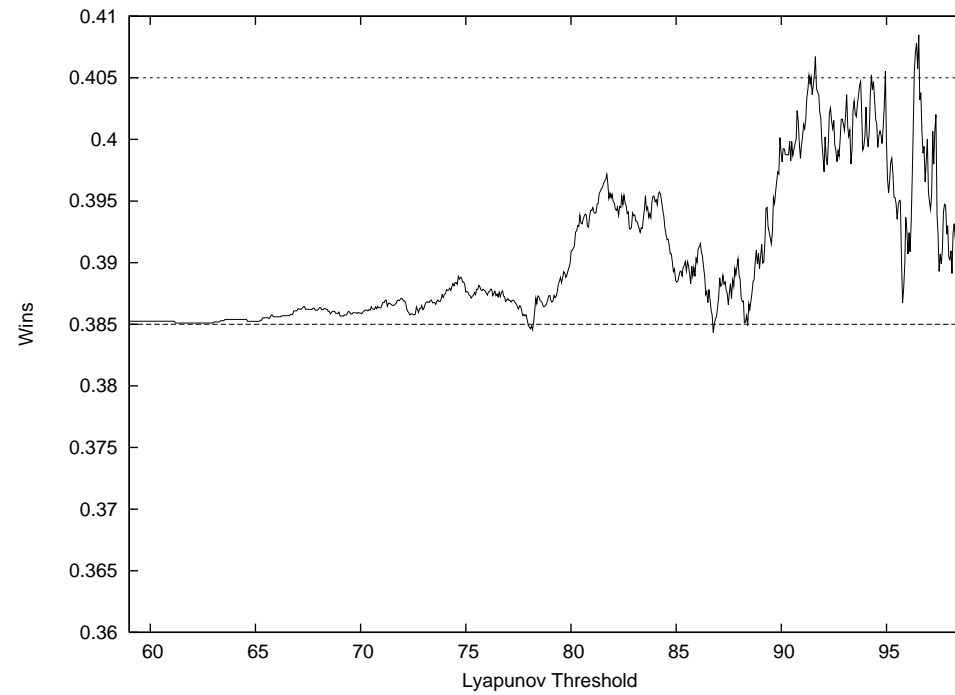
Trajectory in the Probability Space



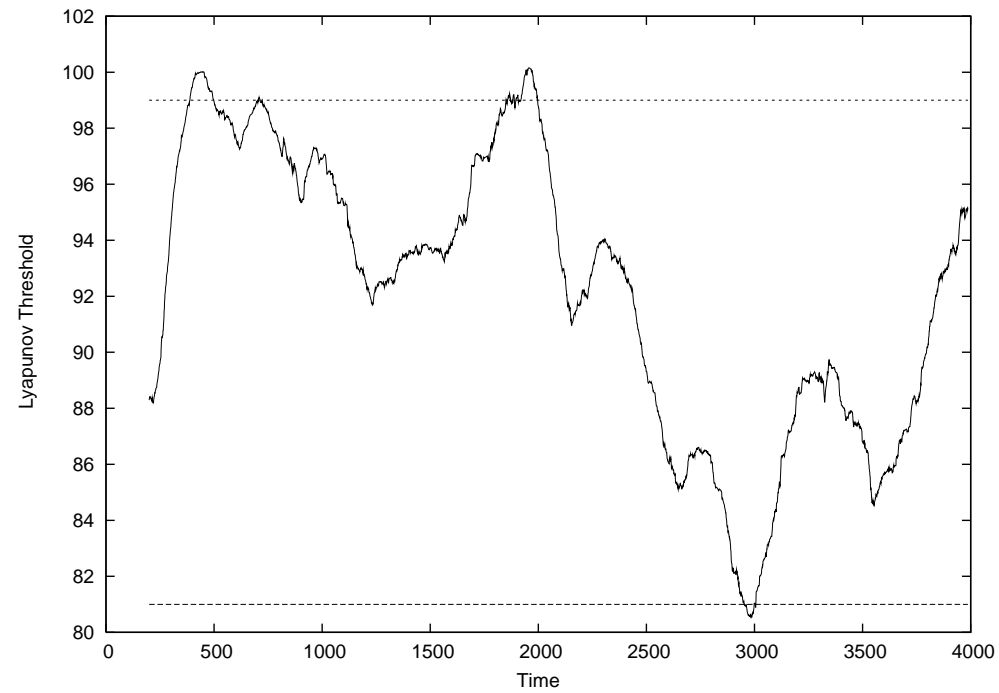
LLE graph



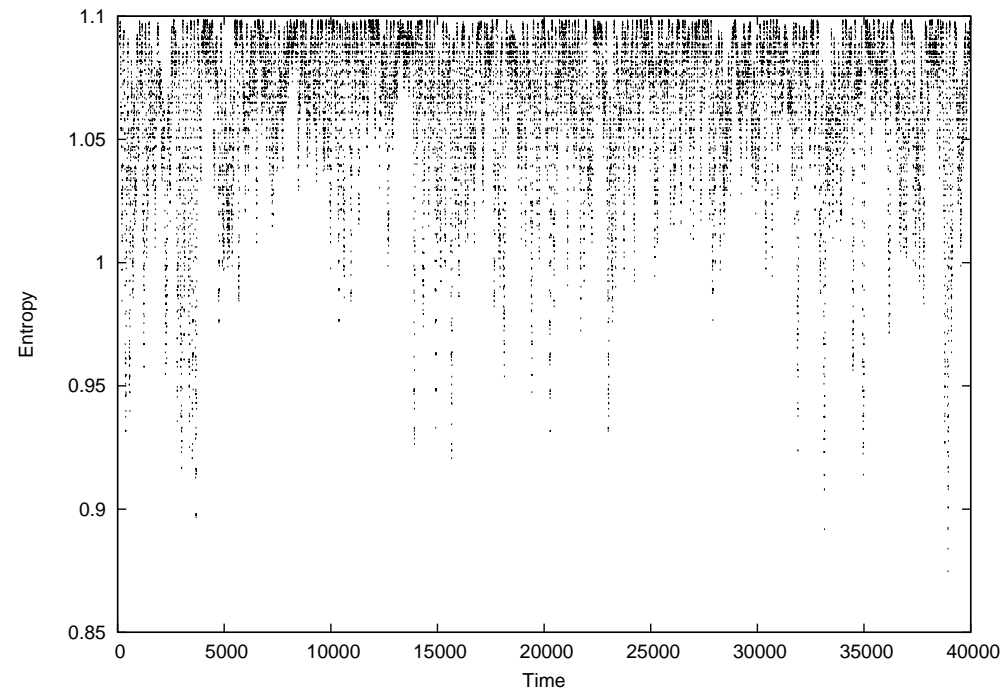
LLE filtering



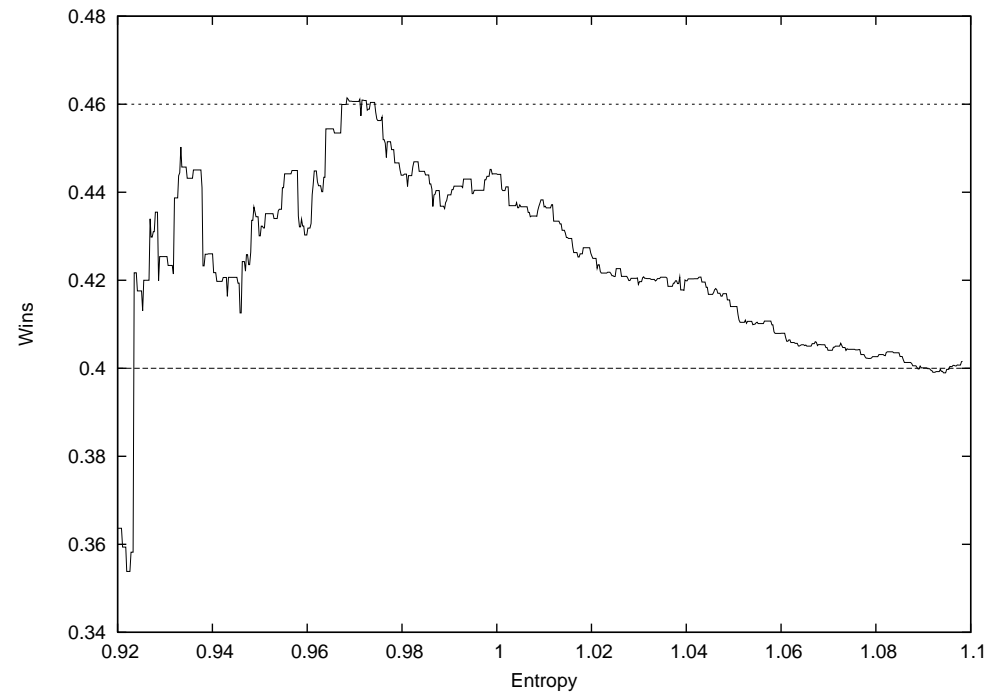
Adaptive LLE threshold



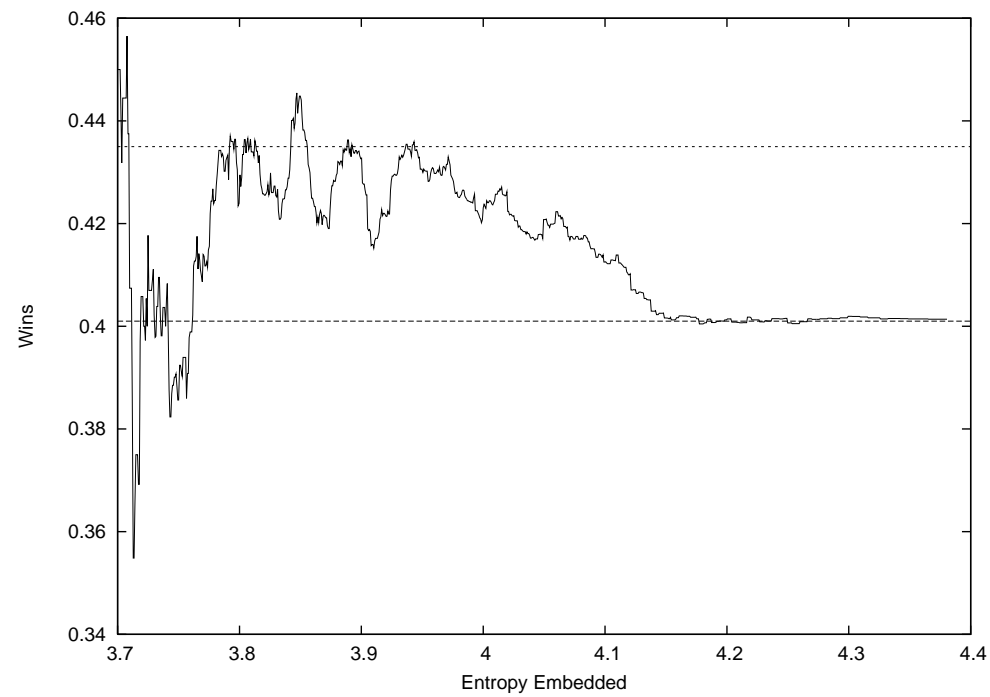
Entropy graph



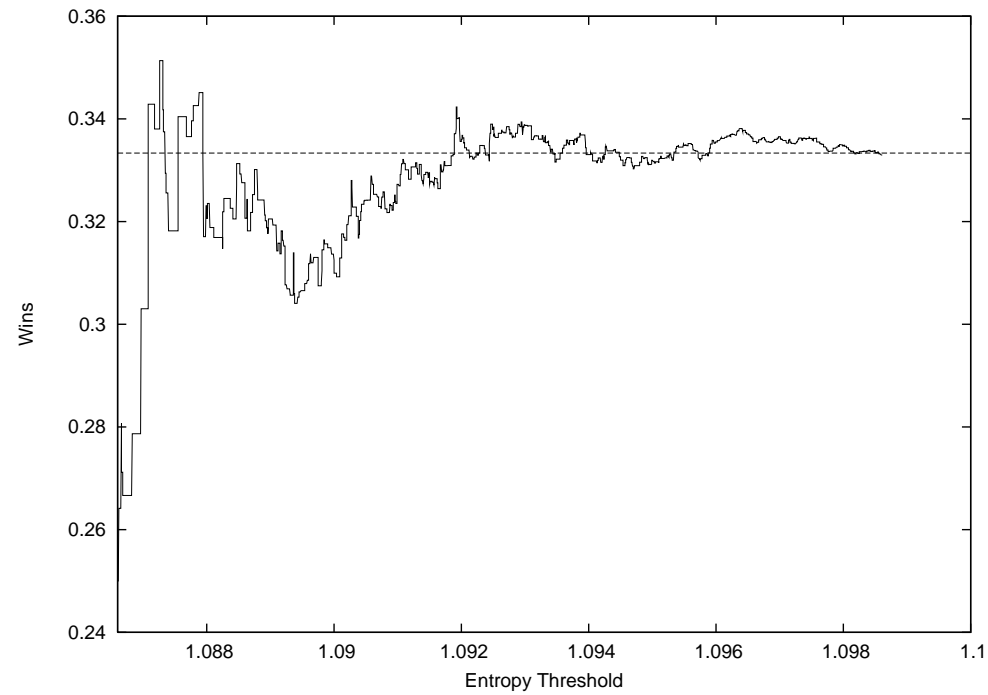
Entropy filtering



Entropy Embedded filtering



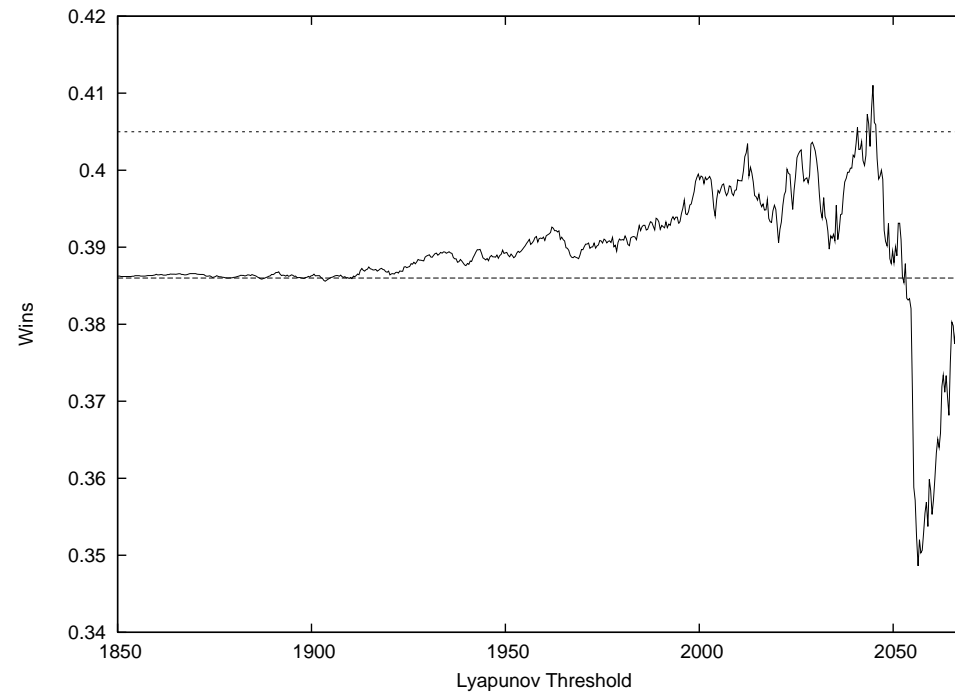
Entropy filtering of a Random Player



Double Embedding Cascade

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

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

The author wish to thank Liz Bradley, Simone Nicolo, Rock–Scissors–Paper, Paolo Patelli, Yuzuru Sato, Akiyama Eizo, Dominik Scheder and Brian Van Matre for their important support during the development of this project.

Questions . . .

. . . thank you.