Fragmented Basins of Attraction of Recursive Processing Elements in Associative Neural Networks and its Impact on Pattern Recovery Performance

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My apologies for not being able to be at Vancouver

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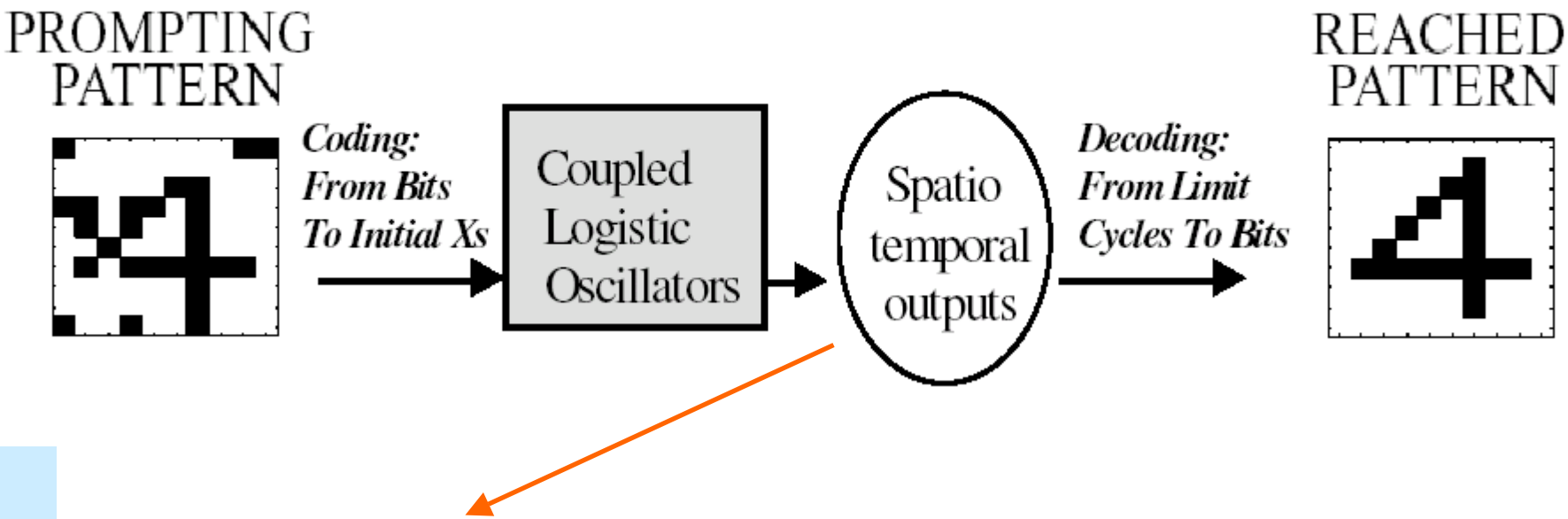
Context: Associative Networks Based on Coupled Recursions / Coupled Oscillators

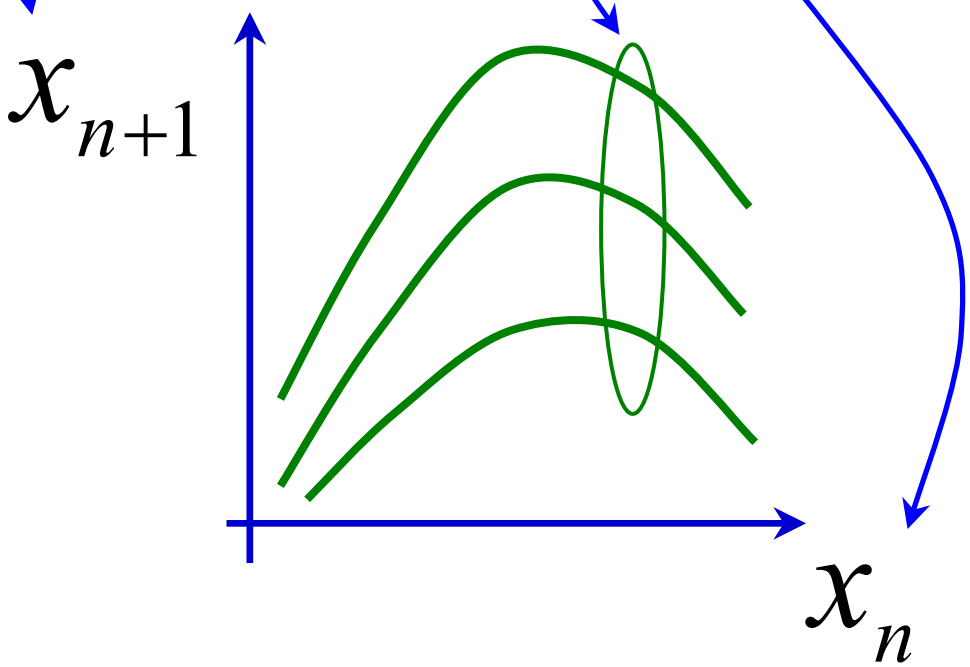


Spatiotemporal Attractors Define the Recovered Information

Each Node of the Network is an *RPE – Recursive Processing Element*

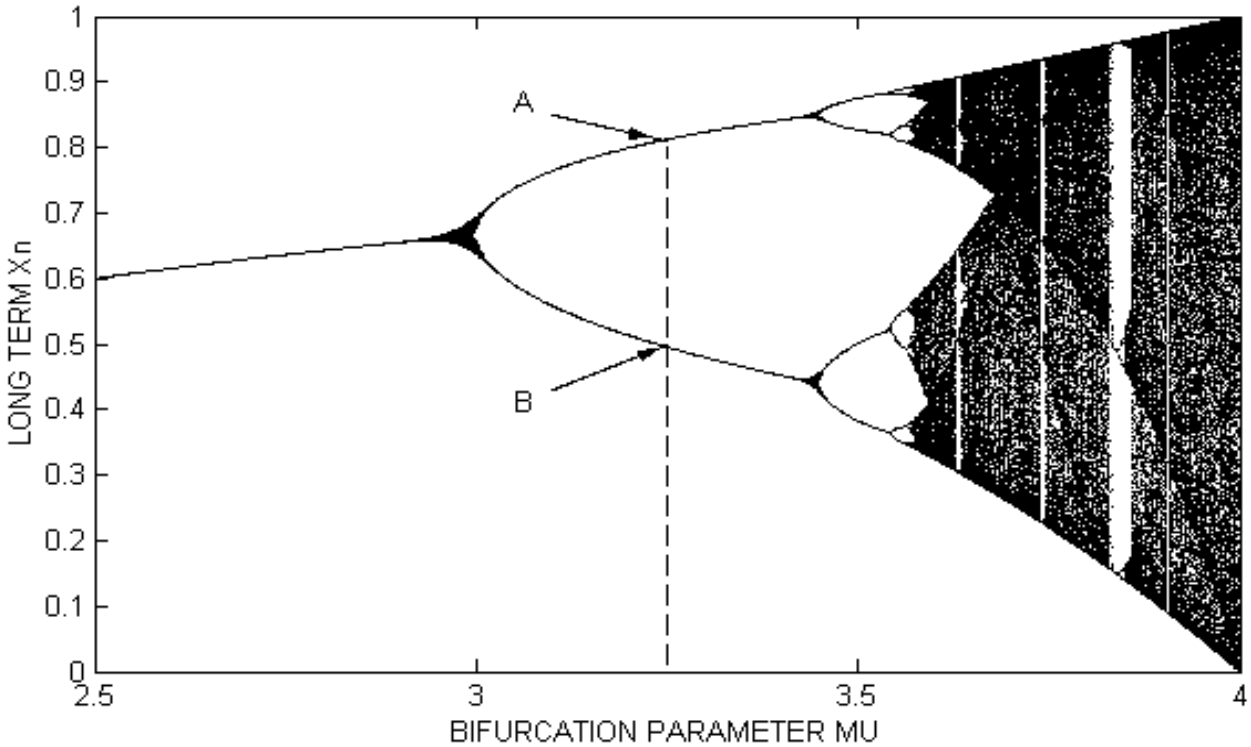
... each RPE is defined by a family of recursive maps:

$$x_{n+1} = R_p(x_n)$$



The logistic map is an example of a Recursive Processing Element (RPE) Bifurcating Node

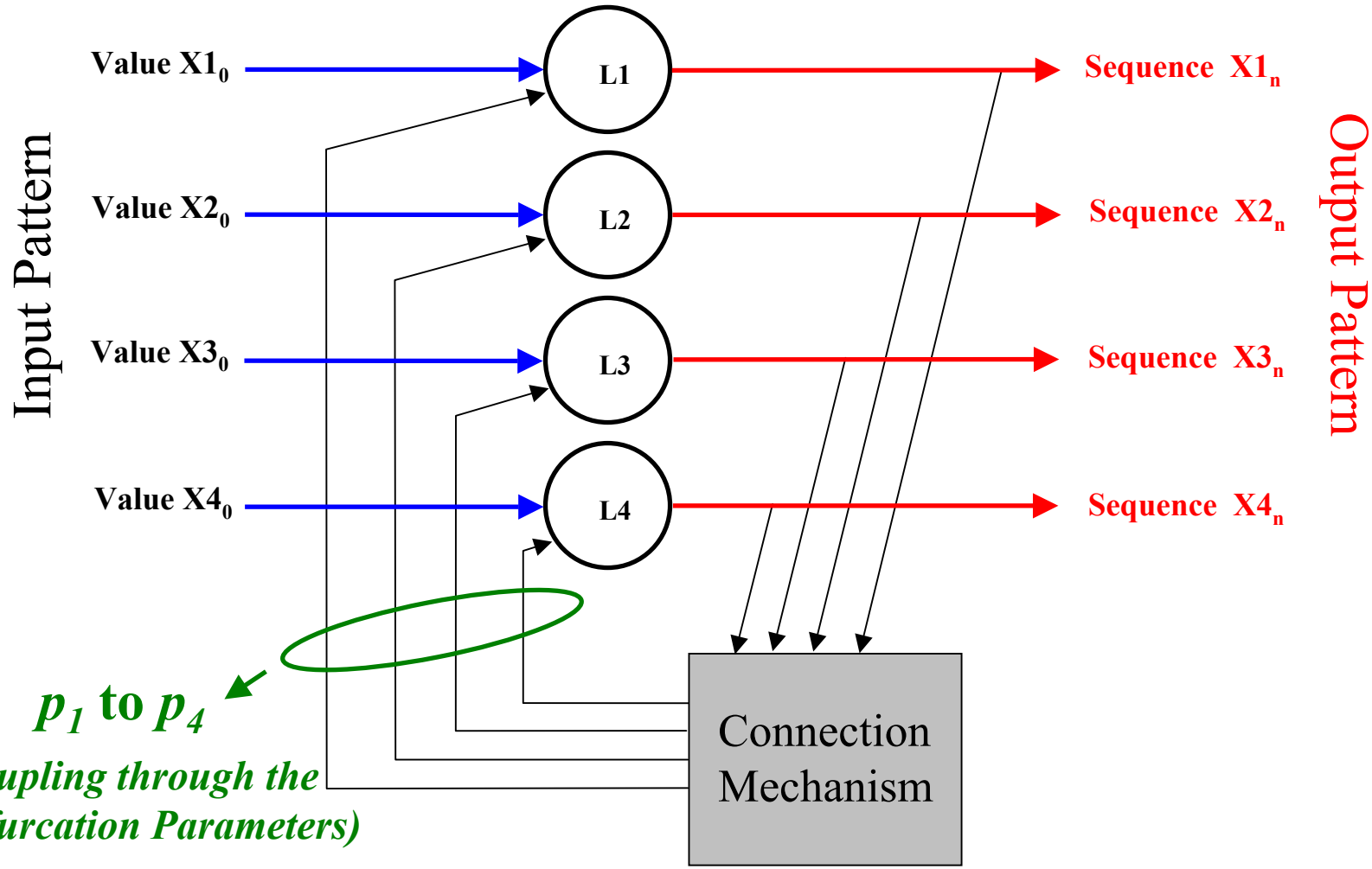
Logistic Recursion: $x_{n+1} = p x_n (1 - x_n)$



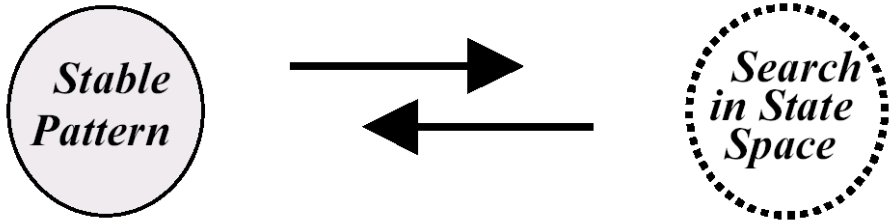
Main Features of RPEs Architectures, as Described in Previous Works (*see for example Neural Networks V.18, pp. 532-540, which is the IJCNN 2005 Special Issue*)

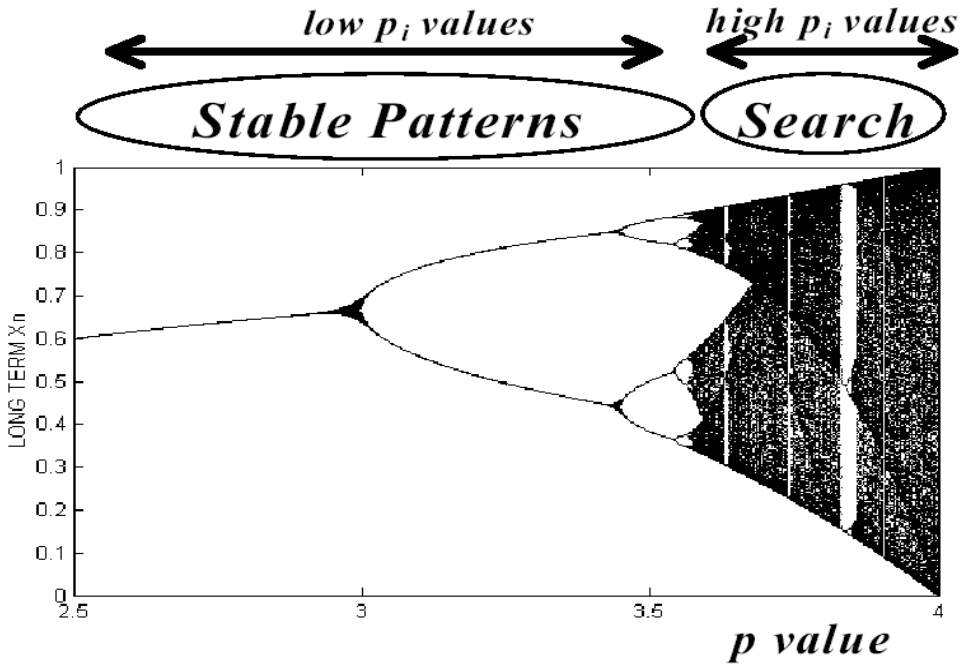
- **The attractors which emerge at the output are spatiotemporal patterns, not static attractors**
  (production of multidimensional & spatiotemporal patterns)
- **Modularity, auto and heteroassociation, and heterogeneous multi-assemblies architectures**
  (modeling / implementation of complex structures / functions)
- **Time-dependent inputs**
  (sensing of changing environment)
- **Arbitrary recursive nodes easily explored**
  (modeling different dynamical phenomena)
- **Many periodic attractors are there**
  (period – 2, … period – 4, period – 8 and etc …)

In this work we deal with associative structures based on Coupled Oscillators / Coupled RPEs



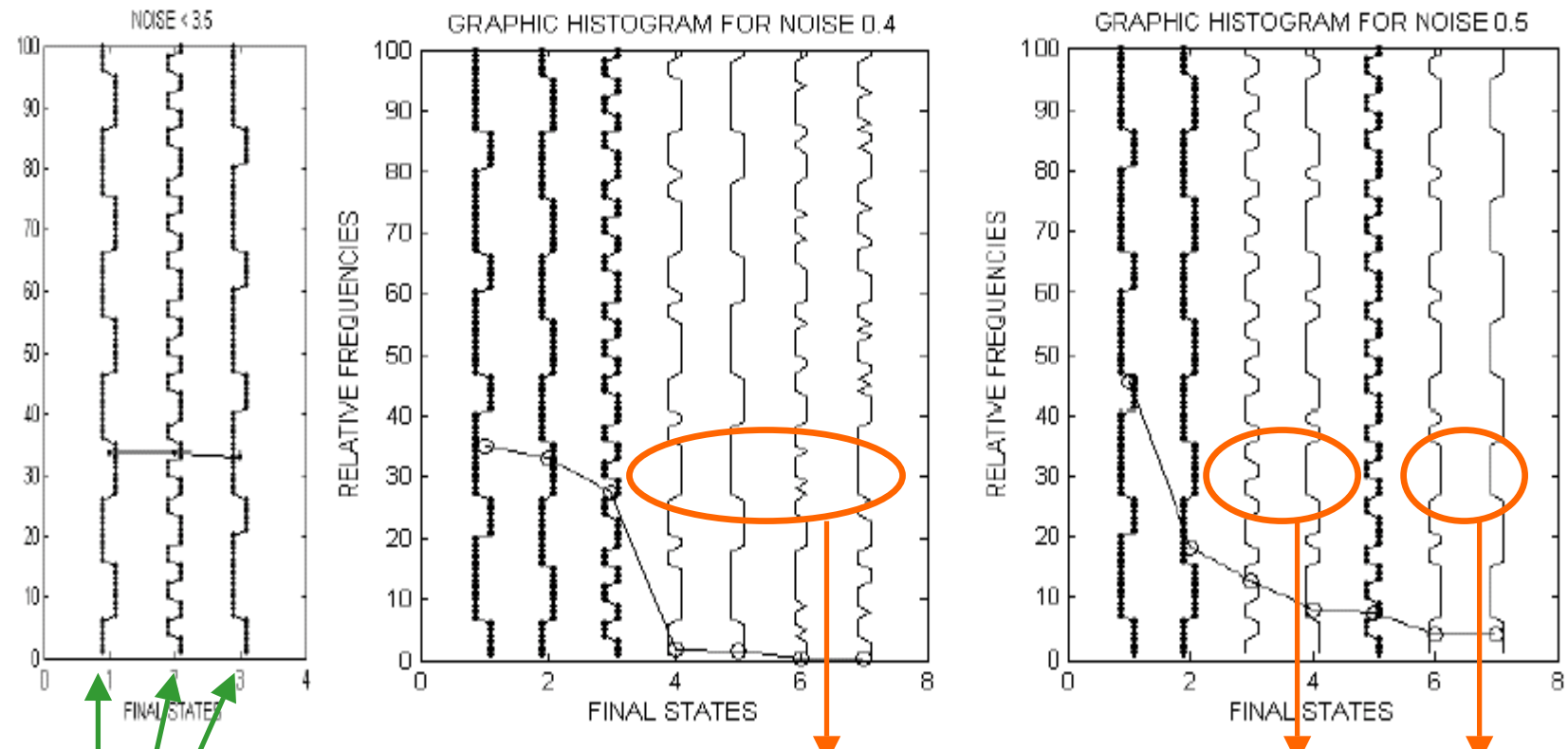
Ordered spatiotemporal patterns alternate with chaotic searches in the state space



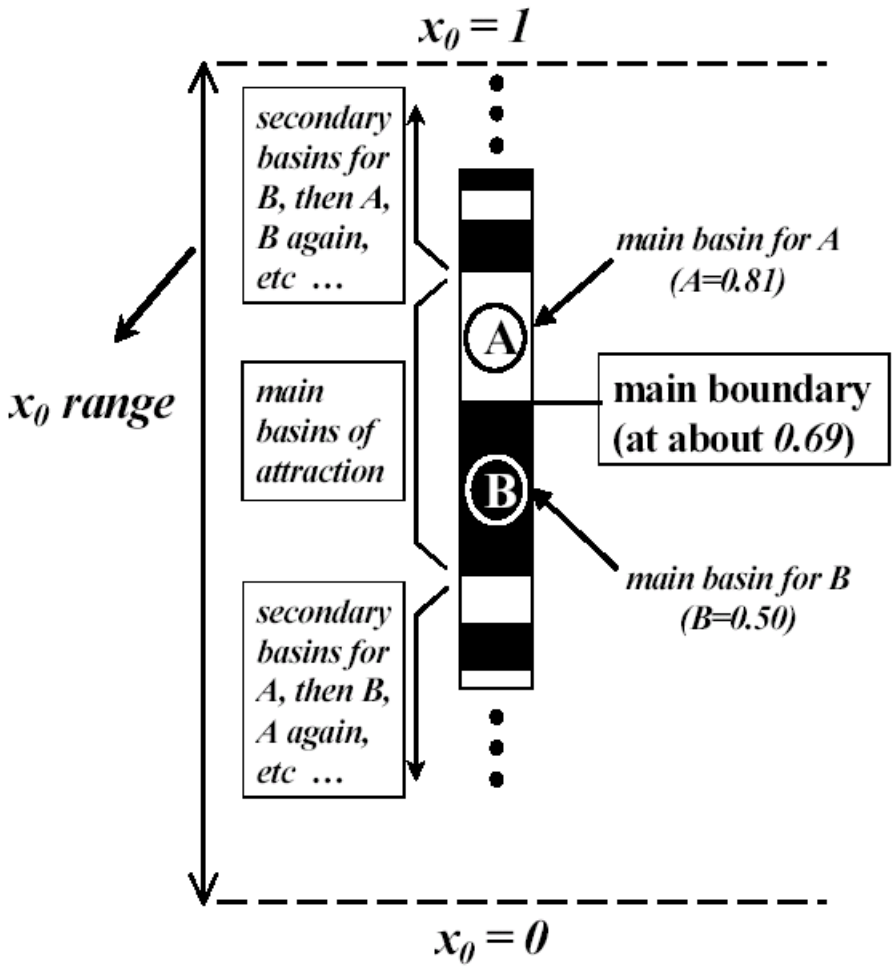


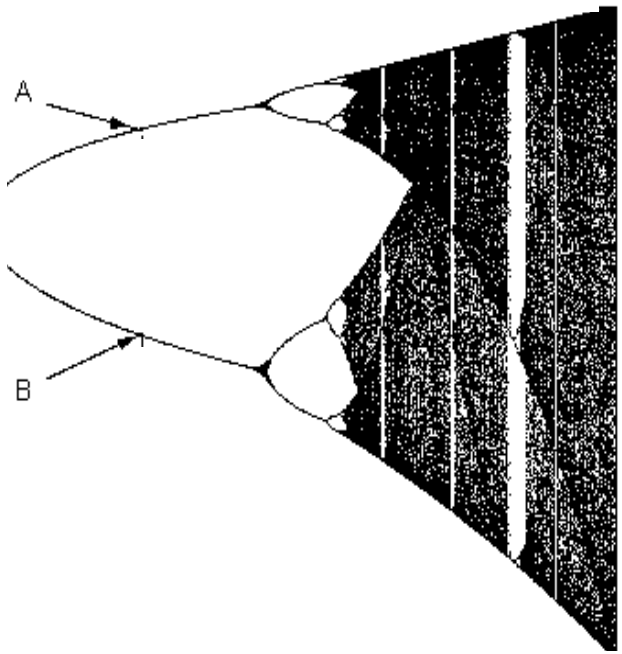
As prompting noise is increased, spurious patterns gain strong presence in the attractors histogram

low noise → *medium noise* → *high noise*

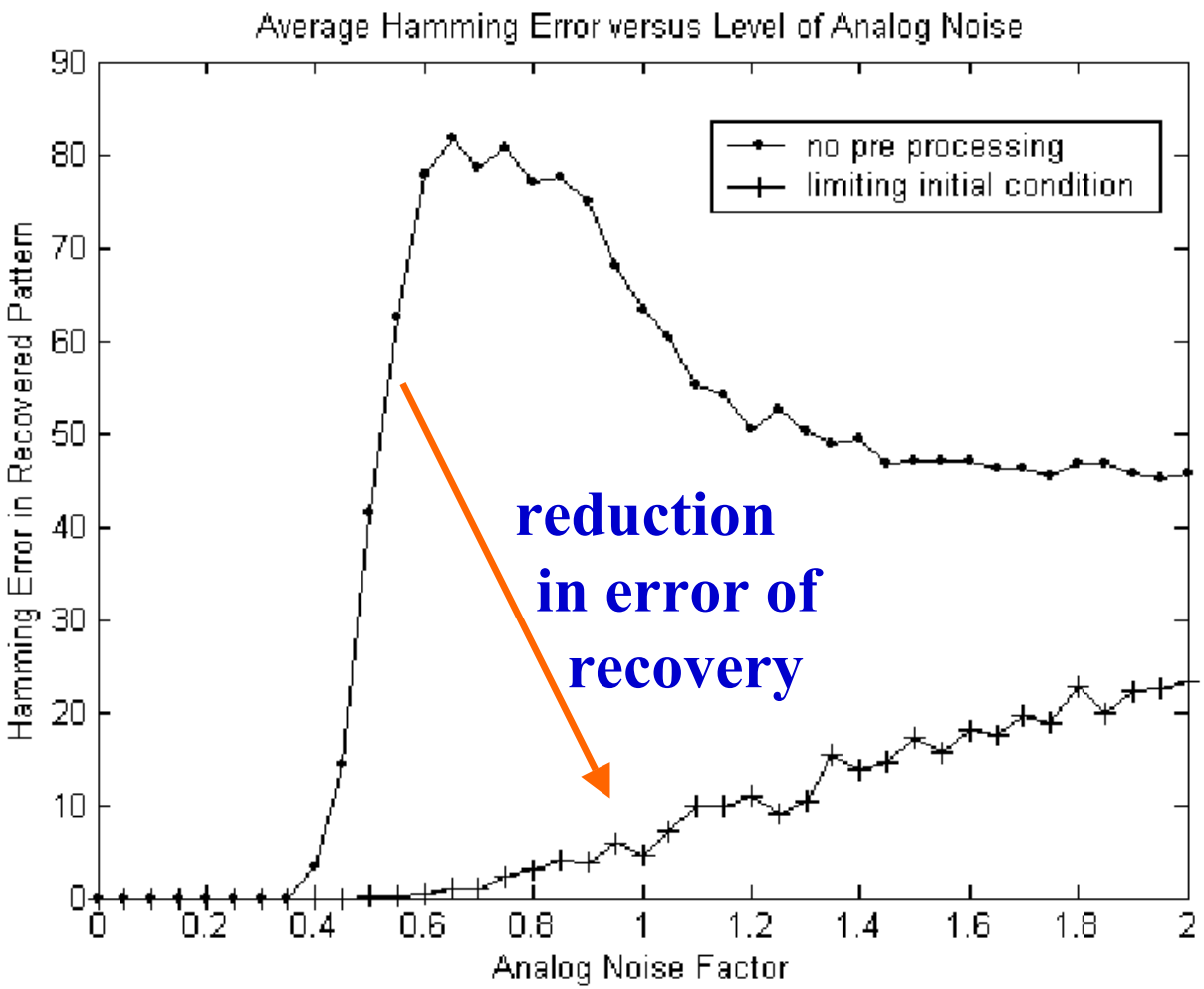


This work shows that the fragmented nature of the basins of attraction has an important role in such a degradation of the pattern recovery





… error in pattern recovery can be drastically reduced by avoiding the fragmented portion of the basins



A few comments based on these results

- Bifurcation and cascading to chaos offer diverse dynamical behavior, which is a good ingredient for information processing and richness of state space
- On the other hand, fragmentation of the basins of attraction comes together with such a richness, what increases imprecision in pattern recovery for input patterns with high levels of noise
- This suggests that range conditioning in input information paths can have a key role in enhancing performance of associative networks based on nodes with high dynamical diversity

More details on this work, available from my site

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