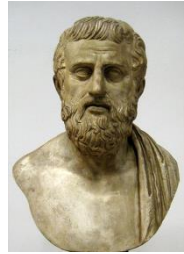


0101110100101010
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Quantifying the balance between local dynamics and global interaction structure

Using the concept of 'information processing'



22.09.2014

Rick Quax

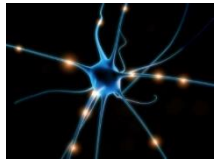
Research question

Quantify how much of a given system's macroscopic behavior is determined by:

Local dynamics

versus

Global structure of interactions



5%?

95%?

60%?

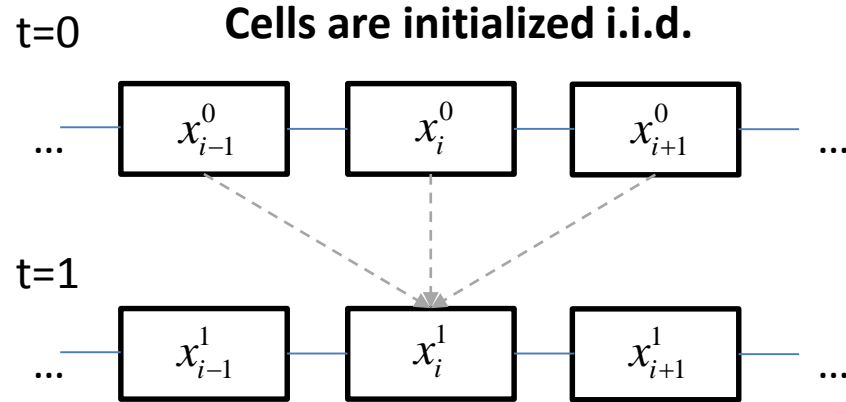
40%?

Thought in the back of my mind:

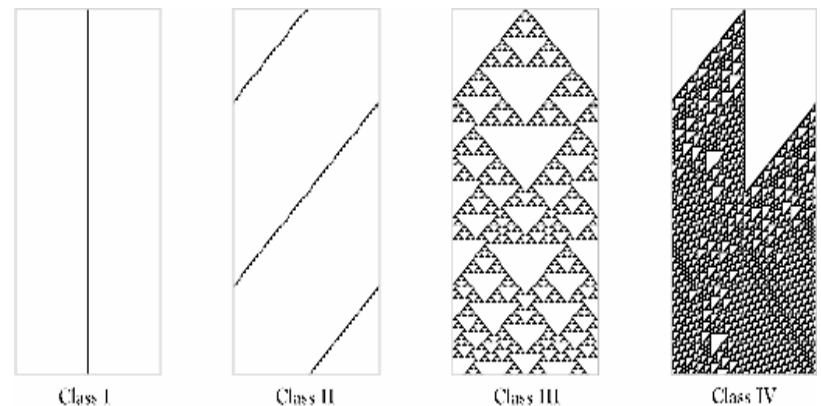
What do interactions do?

Essentially they induce

correlated inputs to nodes

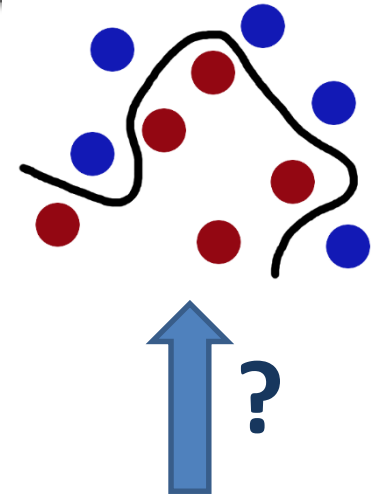


Simple model leads to four different macroscopic behaviors:



Information processing in 1st step

Measure name	Symbol	Formula
Memory	M	$I(x_i^0 : x_i^1)$
Transfer Right	TR	$I(x_{i+1}^0 : x_i^1)$
Transfer Left	TL	$I(x_{i-1}^0 : x_i^1)$
Transfer	T	TR + TL
Integrated Information	II	$I(x_{i-1}^0, x_i^0, x_{i+1}^0 : x_i^1) - M - T$
...partial II... etc.

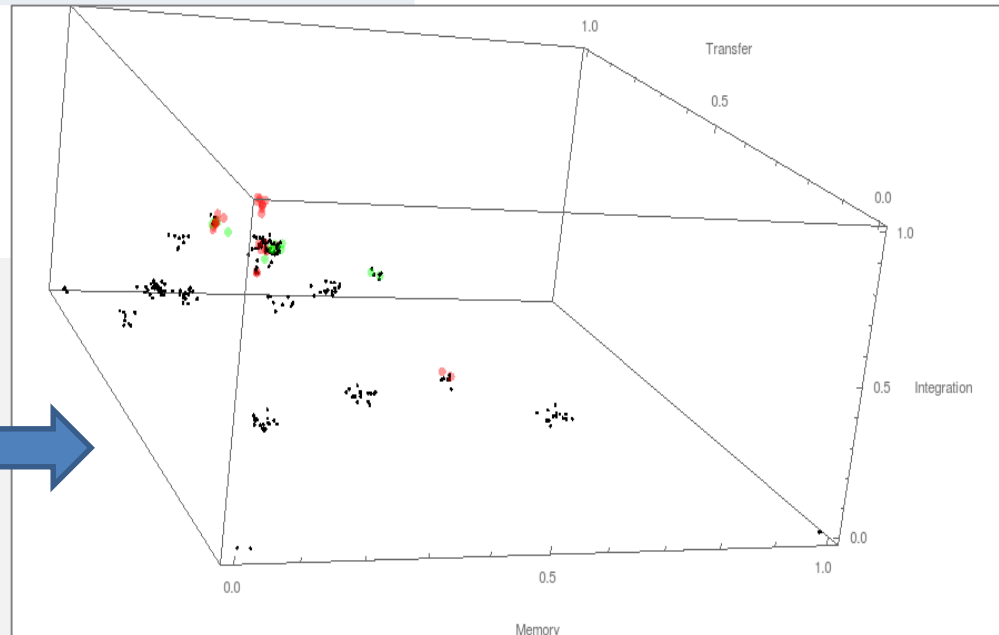


256 rules → 256 points

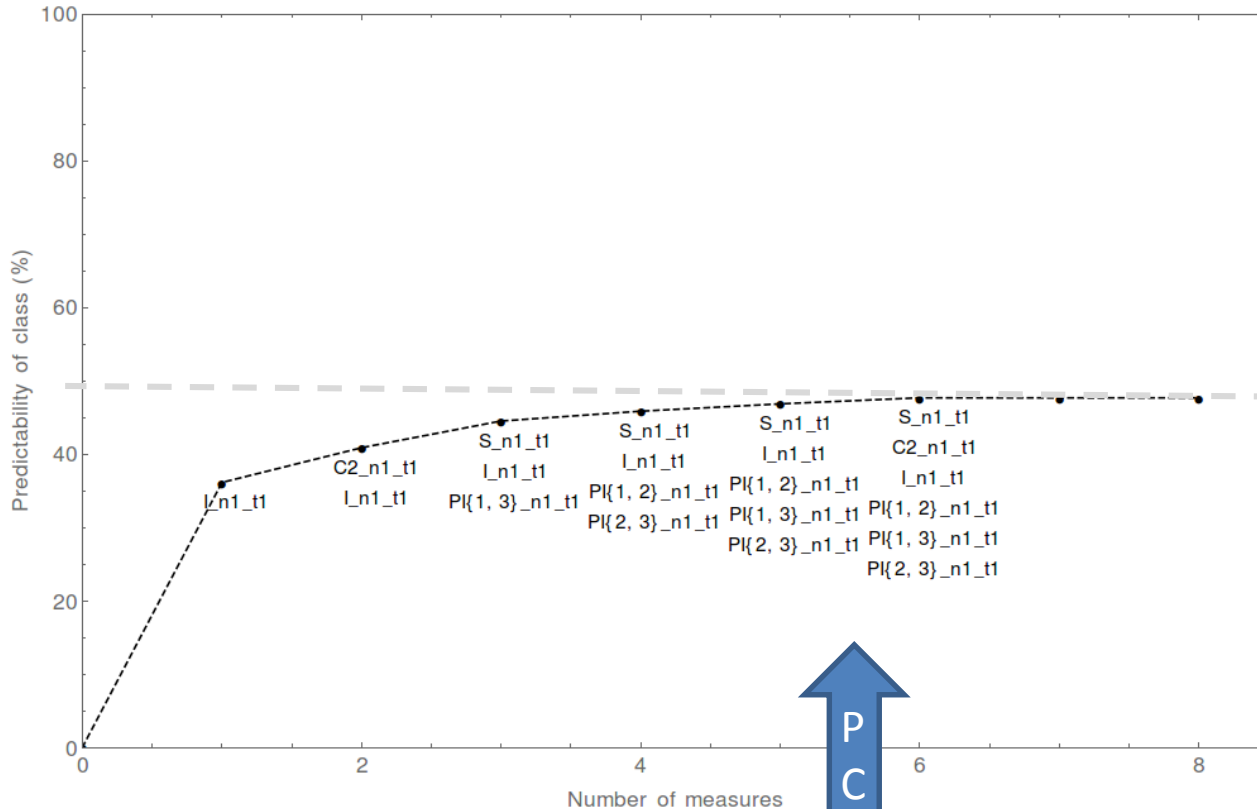
Compute 8 measures for each ECA rule

Information processing measures:

$$\begin{array}{l}
 \text{Rule 0} \\
 \text{Rule 1} \\
 \vdots \\
 \text{Rule 255}
 \end{array}
 \left(
 \begin{array}{cccccc}
 M_0 & TL_0 & TR_0 & T_0 & II_0 & \dots \\
 M_1 & TL_1 & TR_1 & T_1 & II_1 & \dots \\
 M_2 & TL_2 & TR_2 & T_2 & II_2 & \dots \\
 \vdots & \vdots & \vdots & \vdots & \vdots & \ddots
 \end{array}
 \right)$$



PCA of information processing after one step (t=1)



52% of a rule's classification is determined by processing *correlated inputs*

48% of a rule's classification is determined by processing *uncorrelated inputs*

	Information processing measures:		Result vector:
Rule 0	$\begin{pmatrix} M_0 & TL_0 & TR_0 & T_0 & II_0 & \dots \end{pmatrix}$	PCA	$\begin{pmatrix} \text{class}[0] \\ \text{class}[1] \\ \text{class}[2] \\ \vdots \end{pmatrix}$
Rule 1	$\begin{pmatrix} M_1 & TL_1 & TR_1 & T_1 & II_1 & \dots \end{pmatrix}$		
Rule 2	$\begin{pmatrix} M_2 & TL_2 & TR_2 & T_2 & II_2 & \dots \end{pmatrix}$		
...	$\begin{pmatrix} \vdots & \vdots & \vdots & \vdots & \vdots & \ddots \end{pmatrix}$		
Rule 255	$\begin{pmatrix} \vdots & \vdots & \vdots & \vdots & \vdots & \ddots \end{pmatrix}$		

