



# INFORMATION COMPRESSION, MULTIPLE ALIGNMENT, AND INTELLIGENCE

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# OVERVIEW

- This talk is an introduction to the **SP theory of intelligence** and its realisation in the **SP computer model**.
- The SP theory, the SP computer model, and a book and papers, are the product of about 20 years of research.
- A key idea in the theory is the powerful concept of **SP-multiple-alignment** (more later).
- With Dr Vasile Palade of Coventry University, an aim now is to develop a high-parallel **SP machine** (next).

# A HIGH-PARALLEL SP MACHINE FOR APPLICATIONS AND FOR RESEARCH

SP theory and SP computer model



High parallel  
In the cloud

## SP MACHINE

Open source  
Good user interface

Representation of knowledge

Natural language processing

Several kinds of reasoning

Planning & problem solving

Information compression

Unsupervised learning

Pattern recognition

Information retrieval

## MANY APPLICATIONS



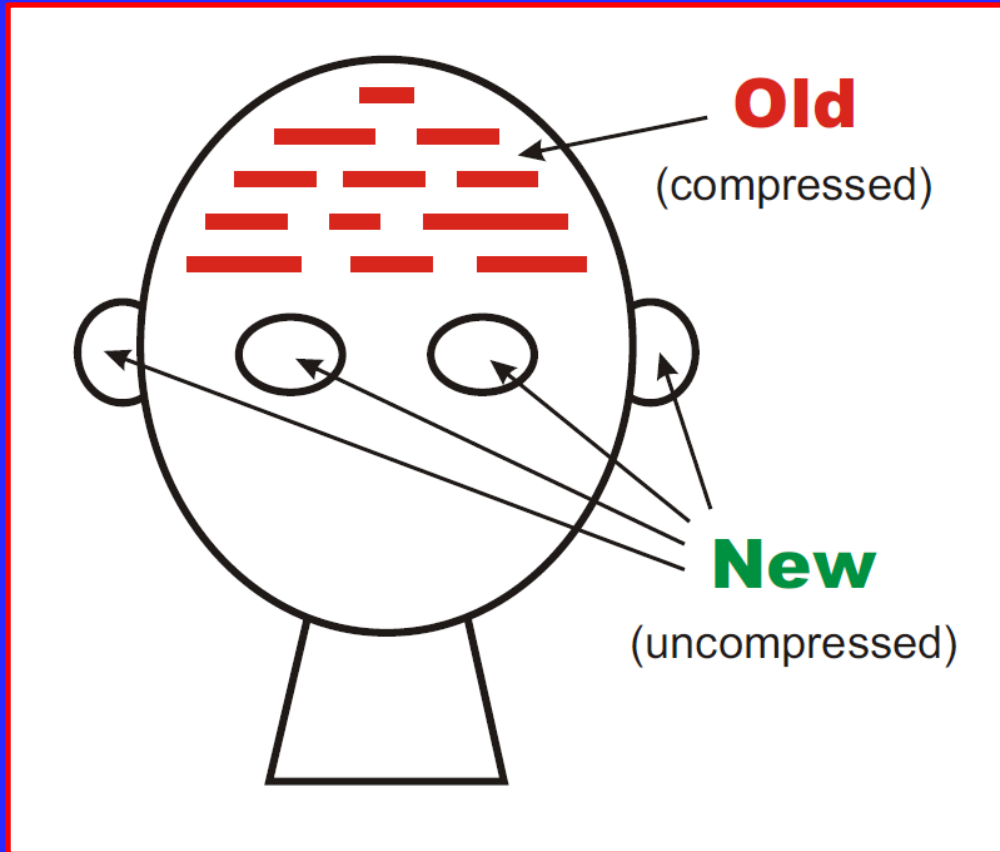
# SIMPLIFICATION, INTEGRATION, AND INFORMATION COMPRESSION

- Simplification and integration. The SP theory of intelligence is a unique attempt to simplify and integrate observations and concepts across artificial intelligence, mainstream computing, mathematics, and human learning, perception and cognition.
- Information compression is a unifying theme—there is abundant evidence for the importance of information compression in human learning, perception, and cognition.

# WHAT ABOUT “DEEP LEARNING”?

- There are at least 14 significant problems with deep learning.
- The SP system provides good solutions to all 14 problems.
- The SP system has a much wider **explanatory range** than deep learning.
- The SP system provides a much firmer foundation for the development of **general, human-level artificial intelligence**.

# OUTLINE OF THE SP SYSTEM



The SP theory is conceived as a **brain-like system** that receives **New** information and compresses some or all of it to create **Old** information .

# A MULTIPLE ALIGNMENT FROM BIOINFORMATICS

```

      G G A      G      C A G G G A G G A      T G      G      G G A
      | | |      |      | | | | | | | | |      | |      |      | | |
      G G | G      G C C C A G G G A G G A      | G G C G      G G A
      | | |      | | | | | | | | | | |      | |      |      | | |
A | G A C T G C C C A G G G | G G | G C T G      G A | G A
      | | |      | | | | | | | | | | |      | |      |      | | |
      G G A A      | A G G G A G G A      | A G      G      G G A
      | | |      | | | | | | | | |      | |      |      | | |
      G G C A      C A G G G A G G      C      G      G      G G A
  
```

- “Stretching” of sequences in a computer brings matching letters into line.
- Heuristic methods are needed because the search is complex.

# AN SP-MULTIPLE-ALIGNMENT

0			t	h	e				a	p	p	e	s		a	r	e		s	w	e	e	t	0	
1									N	Nr	6	a	p	p	e	#N								1	
2									N	Np	N	Nr			#N	s	#N							2	
3			D	17	t	h	e	#D																3	
4			NP	0a	D		#D	N						#N	#NP									4	
5															V	Vp	11	a	r	e	#V			5	
6	S	Num	;	NP										#NP	V				#V	A				#A	#S
7																									
8	Num	PL	;				Np							Vp											8

- The powerful concept of **SP-multiple-alignment** is borrowed and adapted from bioinformatics.
- It promises human-like **versatility** and **adaptability** in intelligence.

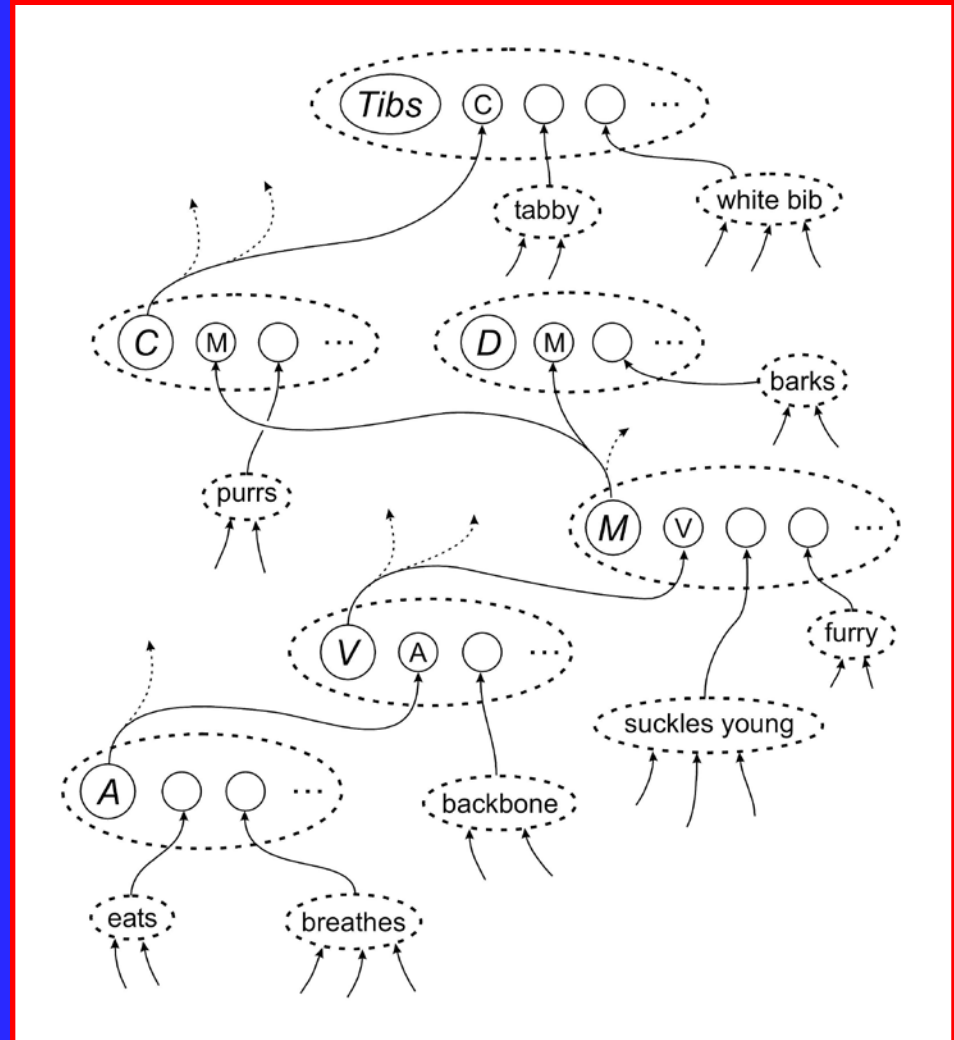


# VERSATILITY AND ADAPTABILITY IN THE SP SYSTEM

- Unsupervised learning.
- Representation and processing of diverse forms of knowledge.
- Natural language processing.
- Pattern recognition.
- Information storage and retrieval.
- Several kinds of reasoning.
- Planning and problem solving.
- Information compression.
- Modelling human perception and cognition.
- Modelling neural structures and processes.

# SP-NEURAL

- SP patterns may be expressed in an adapted version of Donald Hebb's concept of a **cell assembly**.
- This is quite different from “artificial neural networks” that are popular in computer science.
- Learning in the SP system is quite different from “Hebbian” learning.



# POTENTIAL BENEFITS AND APPLICATIONS

- Helping to solve nine problems with **big data** (paper in *IEEE Access*).
- **Autonomous robots** (paper in *IEEE Access*).
- **Computer vision** (paper in *SpringerPlus*).
- **Intelligent databases** (paper in *Data & Knowledge Engineering*).
- **Medical diagnosis** (paper in *Decision Support Systems*).
- Others (paper in *Information*):
  - Natural language processing.
  - Software engineering.
  - Bioinformatics.
  - And several more.



# FURTHER INFORMATION

- [www.cognitionresearch.org/sp.htm](http://www.cognitionresearch.org/sp.htm) .
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