THE SP THEORY OF INTELLIGENCE

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SUMMARY

- Information compression as a unifying theme in human intelligence, computing, and mathematics.
- Theory realised in the SP computer model.
- Multiple alignment as key concept.
- Simplification and integration of several aspects of perception, learning, and thinking.
- Potential benefits and applications.
- Proposed development of high-parallel SP machine.

OVERVIEW

- Motivation and background.
- Key ideas.
- Benefits and applications.
- Development of a high-parallel SP machine.

FRAGMENTATION IN COMPUTER SCIENCE

Computer science, including artificial intelligence, has become fragmented into a myriad of concepts and many specialisms.

A ‘Copernican’ revolution is needed!

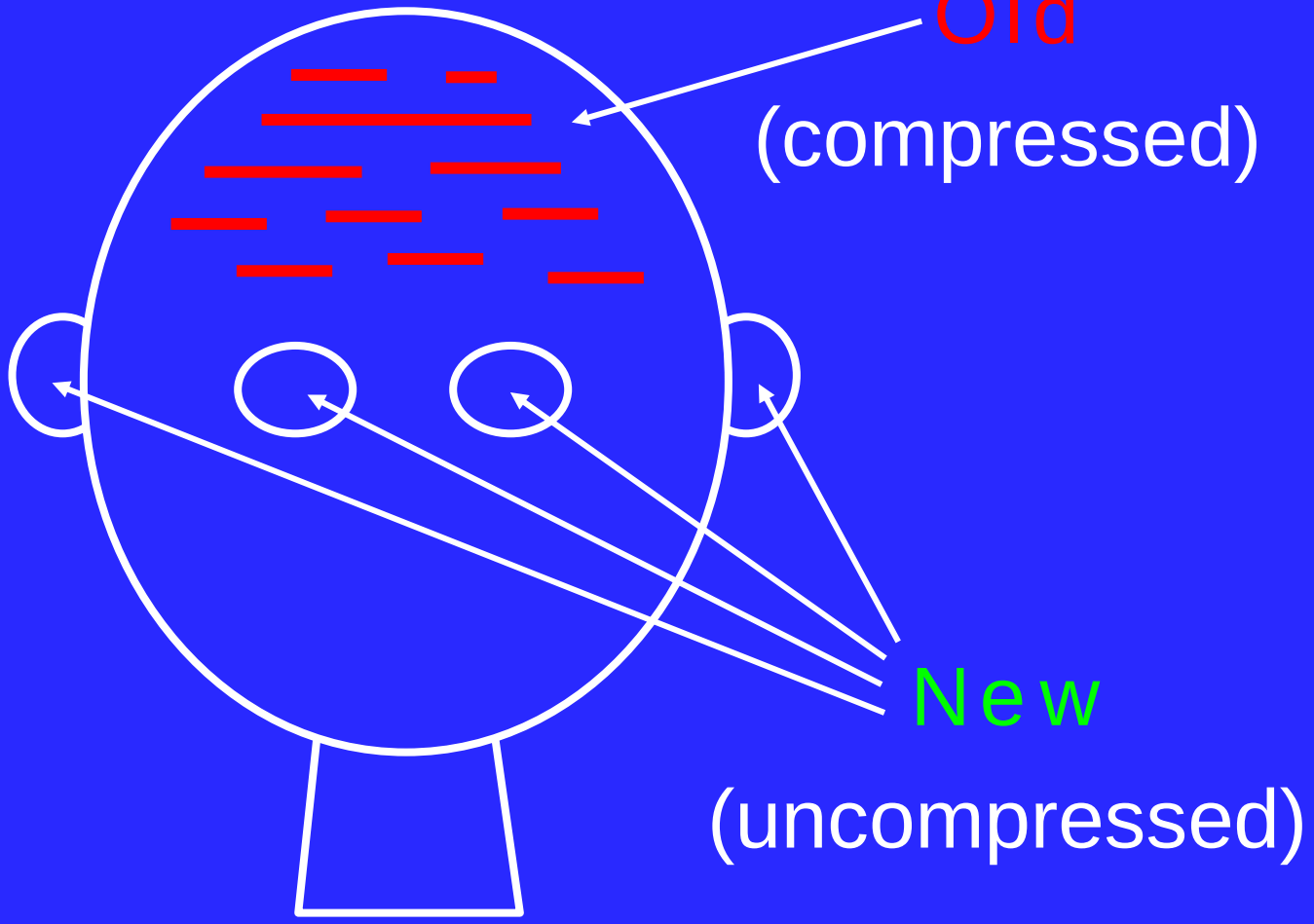
THE TURING MACHINE AS A UNIFYING THEORY?

- Turing model brilliantly successful but does not solve the problem of fragmentation in artificial intelligence and mainstream computing.
- Alan Turing saw that computers might become intelligent (Turing, 1950), but the Turing model, in itself, does not tell us how!
- The SP theory aims to plug the gap.

BACKGROUND

- Information compression in brains and nervous systems (Fred Attneave, Horace Barlow, and others).
- Models of language learning: compression of information via the matching and unification of patterns.
- Principles of minimum-length encoding (Solomonoff and others).
- Several observations point to the importance of information compression in computing, mathematics, and logic.

OVERALL ORGANISATION OF THE SP SYSTEM



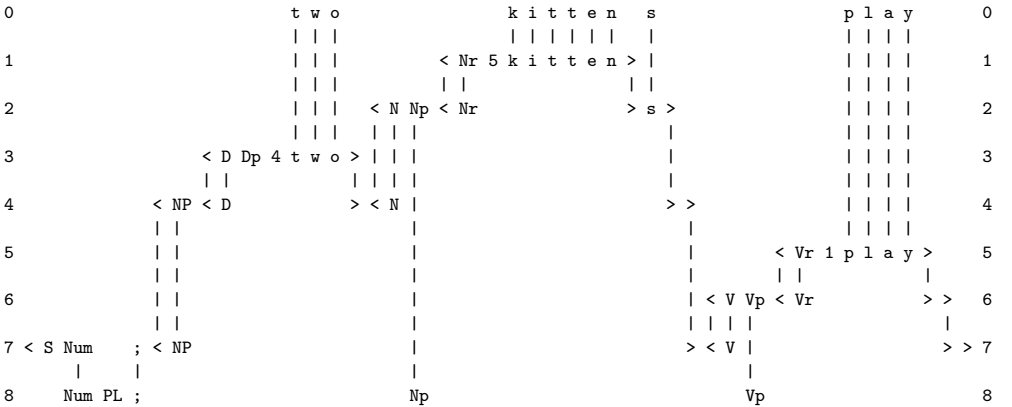
ELEMENTS OF THE SP THEORY

- All knowledge expressed as patterns.
- All processing is done by compression of information.
- Probabilities may be calculated.
- 'Multiple alignment' is a powerful central idea.
- The SP theory realised in the **SP70** computer model.
- Patterns may be realised in a modified version of Hebb's cell assembly concept.

MULTIPLE ALIGNMENT: A CONCEPT BORROWED FROM BIOINFORMATICS

MULTIPLE ALIGNMENT IN THE SP THEORY

- The system aims to find multiple alignments that enable a New pattern to be encoded economically in terms of one or more Old patterns.
- Multiple alignment provides the key to:
  - Versatility in representing different kinds of knowledge.
  - Versatility in different kinds of processing in AI and mainstream computing.
- Some of that versatility can be seen in the three slides that follow. These examples are output from the SP computer model.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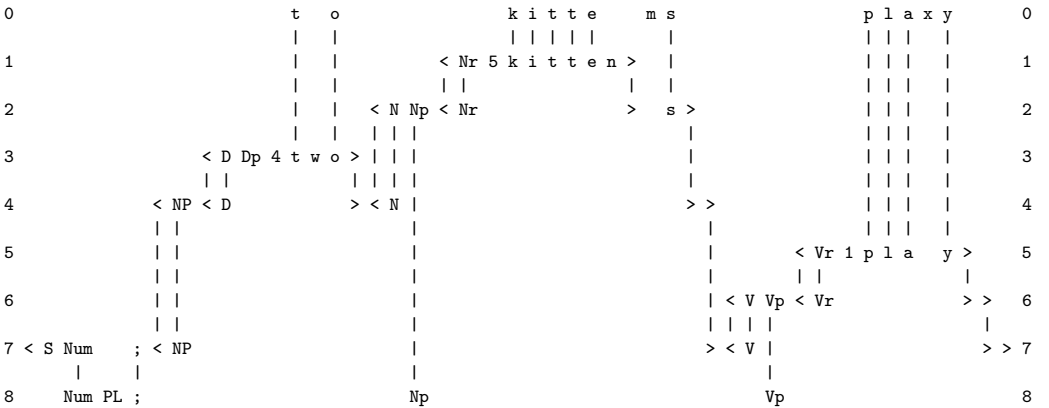
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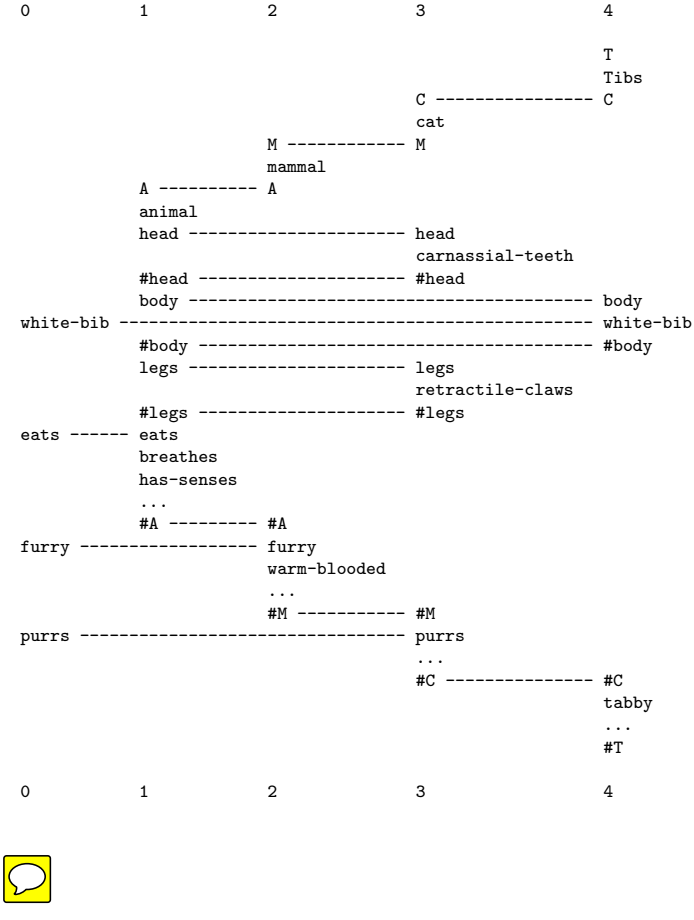
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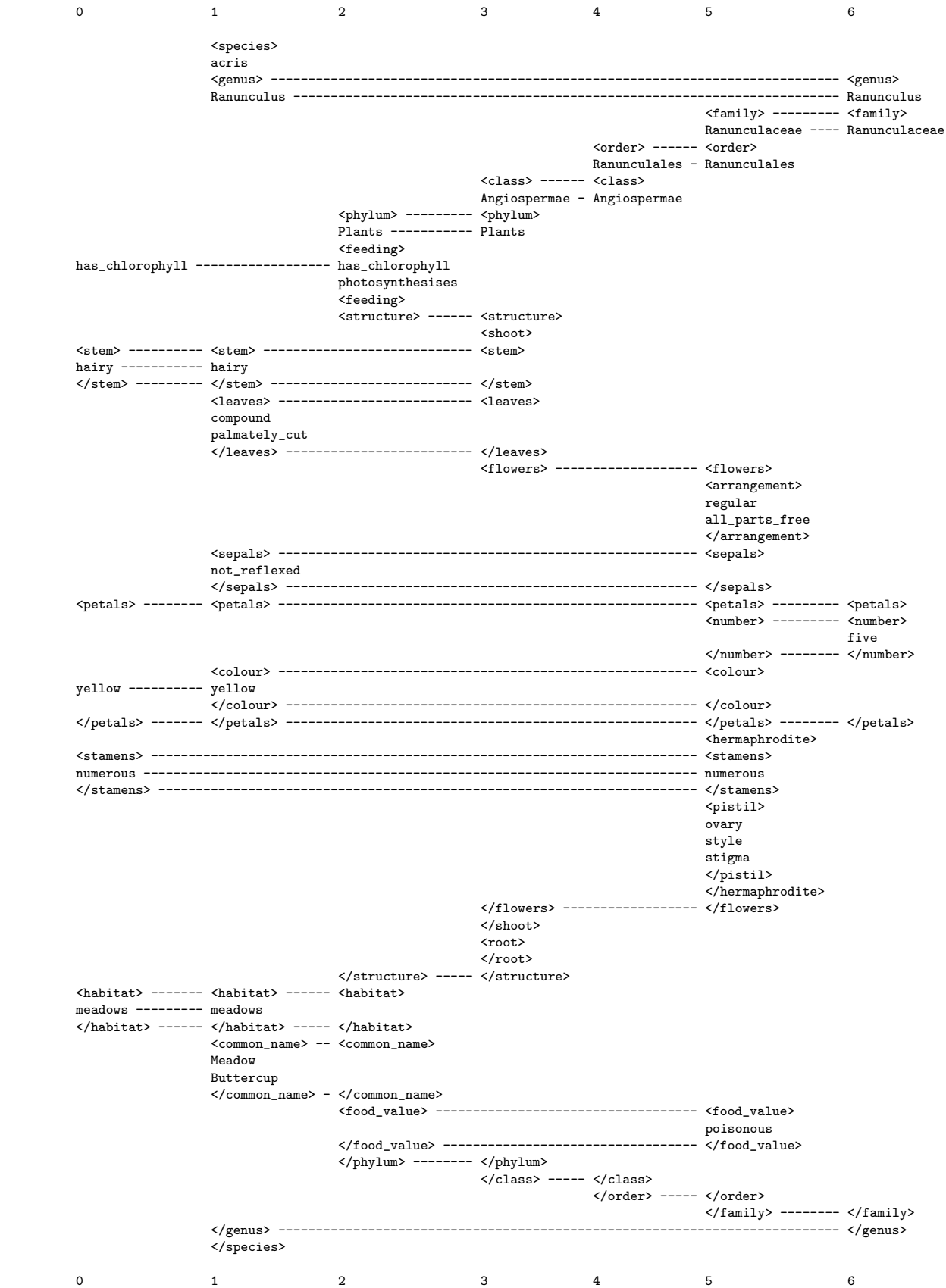
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BENEFITS OF THE SP THEORY

- Conceptual simplicity combined with descriptive and explanatory power across several aspects of intelligence.
- Simplification of computing systems, including software.
- Deeper insights and better solutions in several areas of application.
- Seamless integration of structures and functions within and between different areas of application.

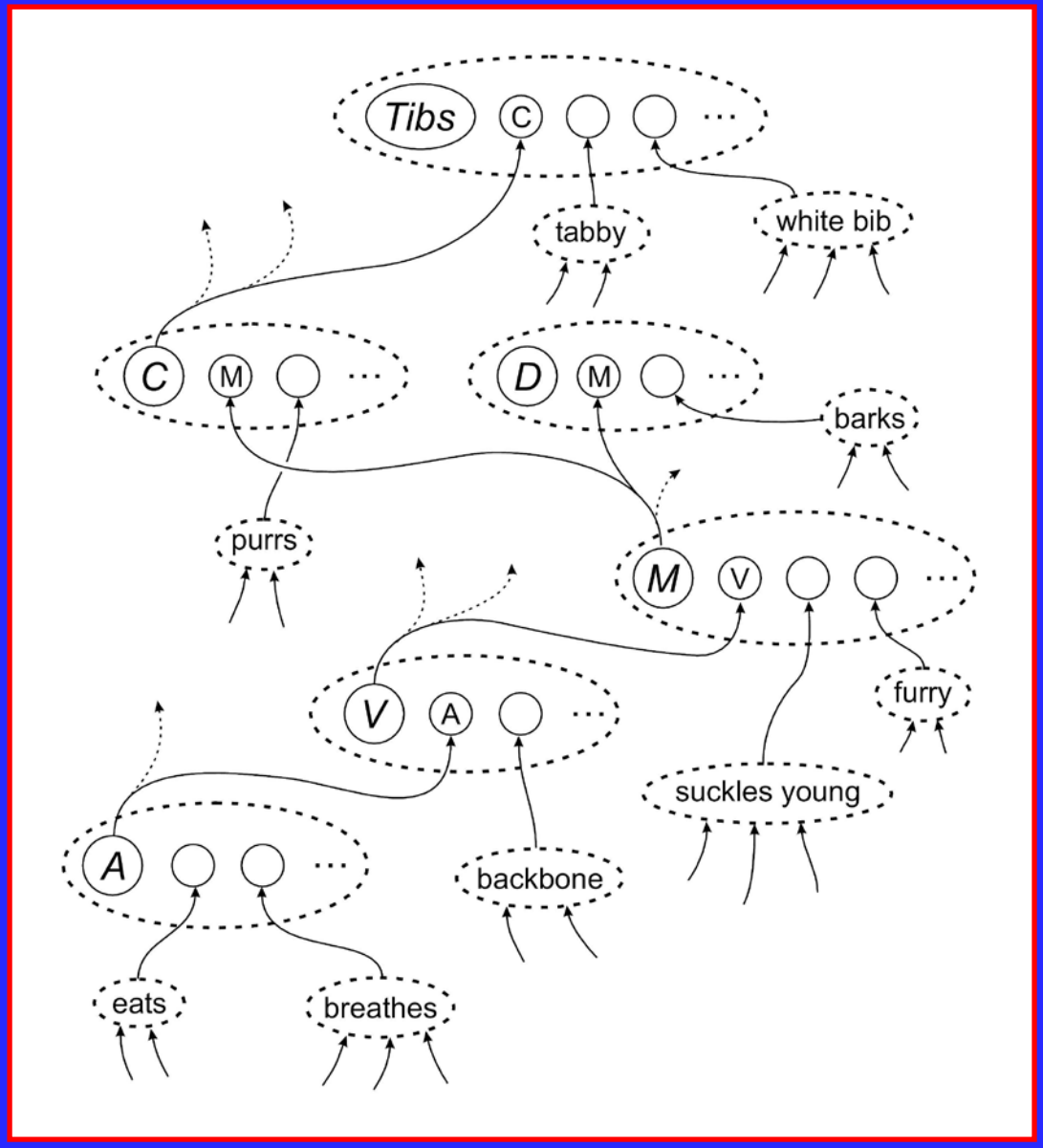
DESCRIPTIVE AND EXPLANATORY POWER

- A new concept of ‘computing’.
- Representation of knowledge.
- Natural language processing.
- Pattern recognition.
- Information storage and retrieval.
- Several kinds of reasoning.
- Unsupervised learning.
- Planning and problem solving.
- Information compression.
- Human perception and cognition.

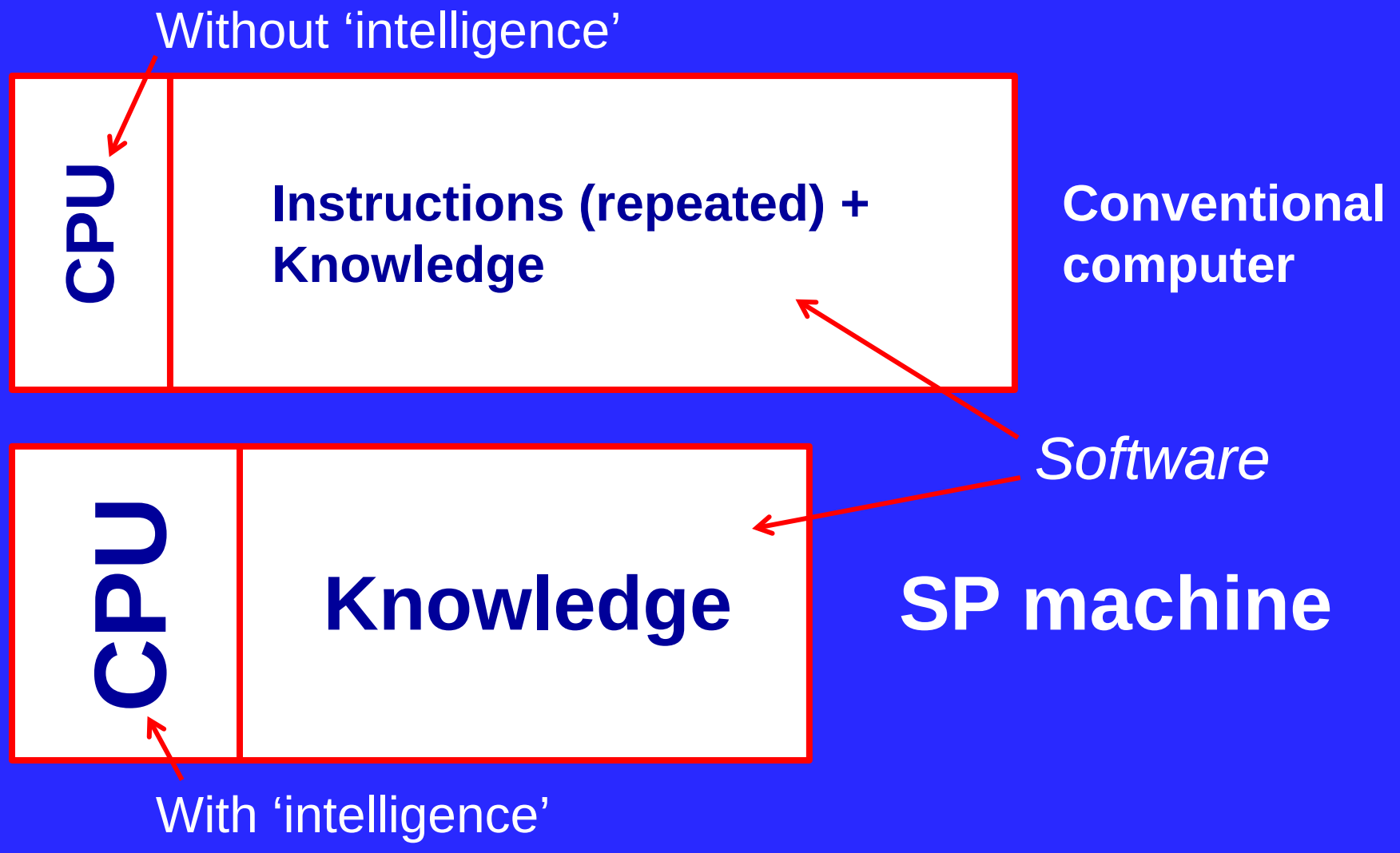
SP patterns may be realised in an adapted version of Hebb's cell assembly concept.

Key:

- 'C' = cat,
- 'D' = dog,
- 'M' = mammal,
- 'V' = vertebrate,
- 'A' = animal



SIMPLIFICATION OF COMPUTING SYSTEMS



DEEPER INSIGHTS AND BETTER SOLUTIONS IN SEVERAL AREAS OF APPLICATION

- Natural language processing.
- Autonomous robots.
- Pattern recognition and computer vision.
- Several kinds of reasoning.
- Big data.
- The semantic web.
- Economical transmission of data.
- Data fusion.
- Bioinformatics.
- And more.

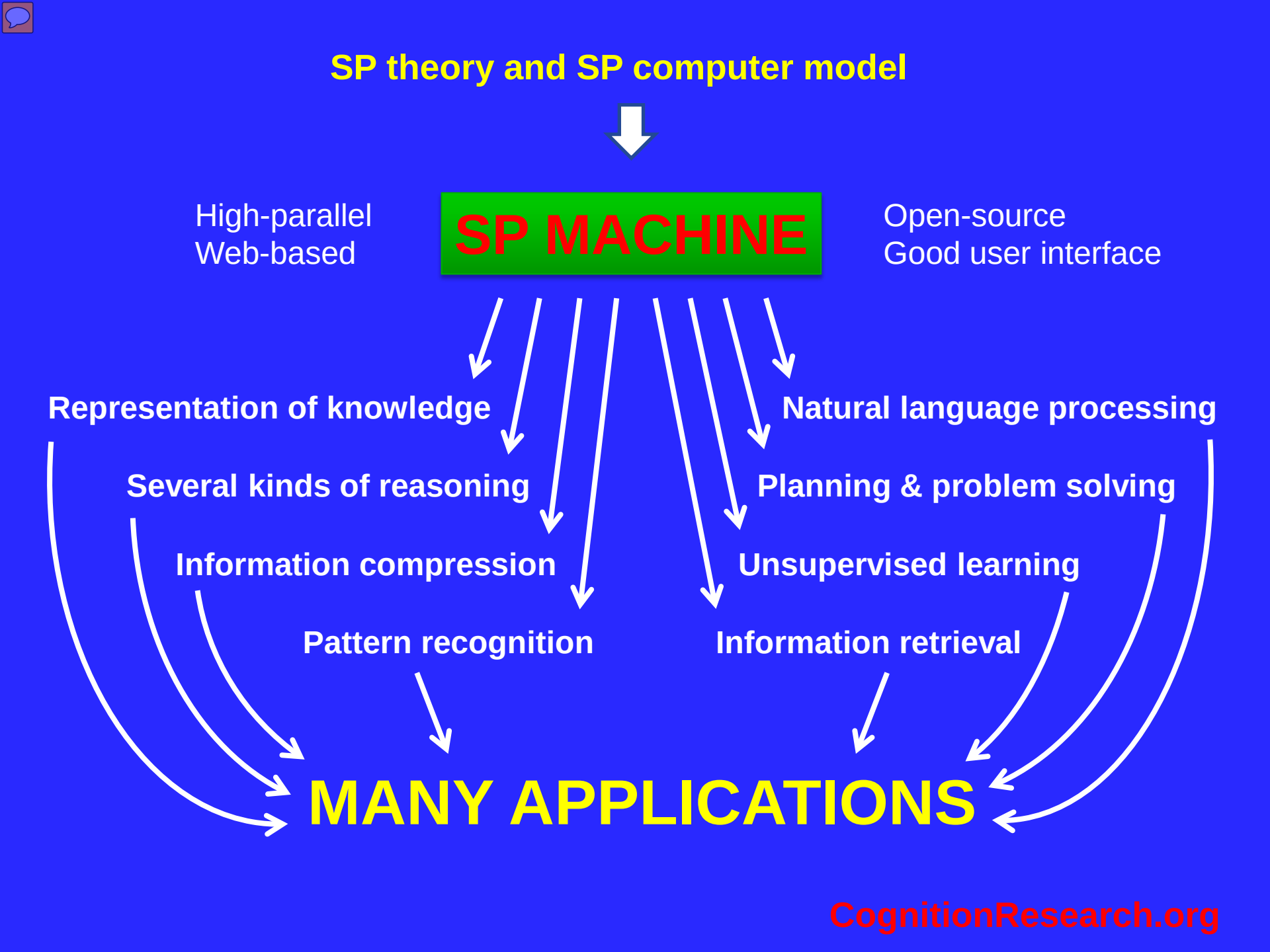
INTEGRATION

Probably the most important benefit is:

Seamless integration of structures and functions within and between different areas of application.

PROPOSAL: THE DEVELOPMENT OF A HIGH-PARALLEL, WEB-BASED, SP MACHINE

- Based on the SP computer model.
- Built as a software virtual machine, with high-parallel search mechanisms.
- Existing high-performance computer as foundation for the SP machine.
- An open-source model, available, via the web, to the research community everywhere.
- A vehicle for experimentation and research.


SP theory and SP computer model
High-parallel
Web-based
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
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FURTHER INFORMATION

- Book: *Unifying Computing and Cognition*, CognitionResearch.org.
- www.cognitionresearch.org .
- Information compression as a unifying theme in brains, computing, and mathematics: bit.ly/13uGwoU .
- More examples: bit.ly/XxS0Uh .
- *Contact:* jgw@cognitionresearch.org, +44 (0) 1248 712962, +44 (0) 7746 290775.