The Mechanism of Thought

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Overview

- **Confabulation Theory Overview**
  - Cortical Representation of the Objects of the Mental World
  - Acquisition and Storage of Cognitive Knowledge
  - Confabulation
  - The Origin of Behavior
  - Confabulation Mathematics
- **Confabulation Neuroscience**
- **Simulating Confabulation on a Computer**
  - A Single Confabulation
  - Multiconfabulation
  - Speech Understanding
- **Practical Applications**
  - *Chancellor*™ Project

Chancellor is a trademark of Fair Isaac Corporation.

# Add a *Plausible Next Sentence* to Two Given News Story *Context Sentences*

Several other centenarians at Maria Manor had talked about trying to live until 2000, but only Wegner made it.

Her niece said that Wegner had always been a character – former glove model , buyer for Macy's, owner of Lydia's Smart Gifts downtown during the 1950s and '60s – and that she was determined to see 2000 .

first context sentence

second context sentence

confabulation architecture
(exposed to millions of news stories,
NO: algorithms, rules,
Bayesian networks, etc.)
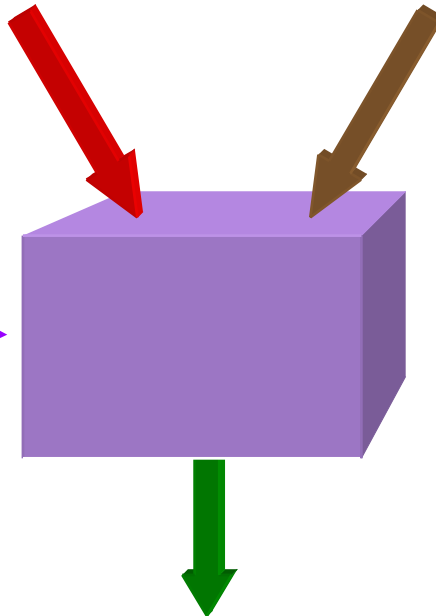
plausible next sentence

She was born in the Bronx Borough of New York City.

Plausible Next Sentence Experimental Results

Seeing us in a desperate situation, the Lahore airport authorities switched on the runway lights and allowed us to land with barely one to two minutes of fuel left in the aircraft, he said.
At Lahore, Pakistani authorities denied Saran's request to accept wounded passengers and women and children, but they refueled the plane.
Airport authorities said they were not consulted beforehand.

Michelle strengthened from a Category 2 to a Category 4 storm Saturday, with winds reaching 140 mph, but it was expected to weaken before it reached Florida.
The storm or its effects could strike the Keys and South Florida tonight or early Monday, said Krissy Williams, a meteorologist at the National Hurricane Center in Miami.
Forecasters warned residents to evacuate their homes as a precaution.

But the constant air and artillery attacks that precede the advance of Russian troops have left civilians trapped in southern mountain villages, afraid to venture under the bombs and shells raining on the roads, Chechen officials and civilians said.
Residents of the capital Grozny who had fled the city in hopes of escaping to Georgia, which borders Chechnya to the south, have been stuck in the villages of Itum-Kale, 50 miles south of Grozny, and Shatoi, 35 miles south of Grozny.
Russian forces pounded the strongholds in the breakaway republic.

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▶ **Confabulation Neuroscience**

▶ **Simulating Confabulation on a Computer**

    ▶ A Single Confabulation
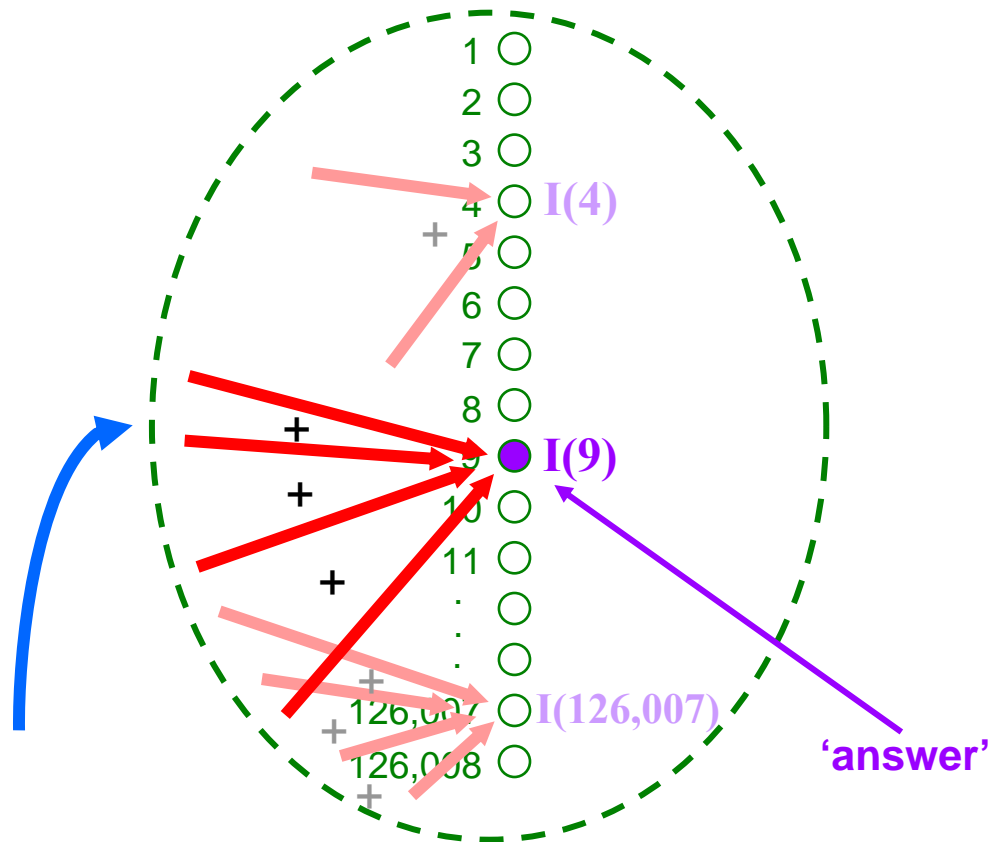
    ▶ Multiconfabulation

    ▶ Speech Understanding

▶ **Practical Applications**

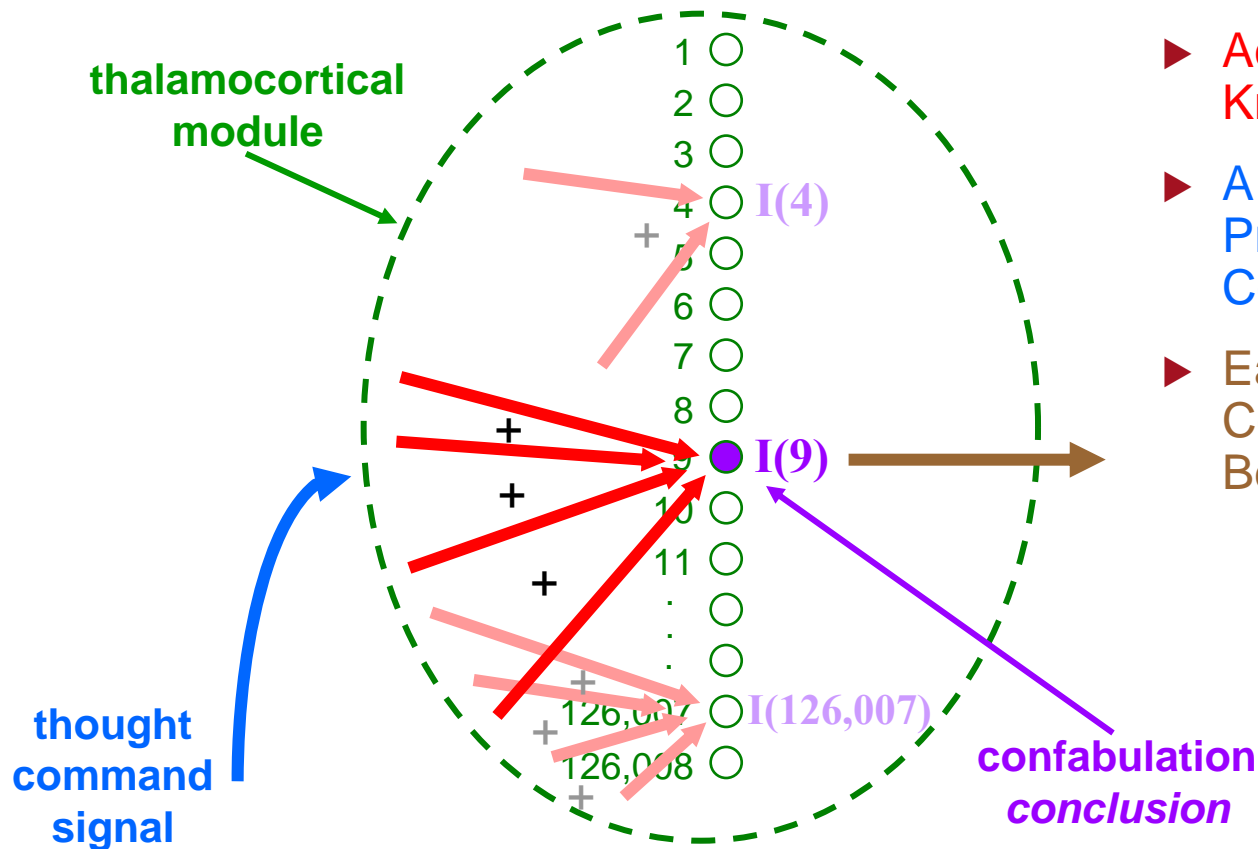   ▶ *Chancellor* Project

Confabulation Theory Summary

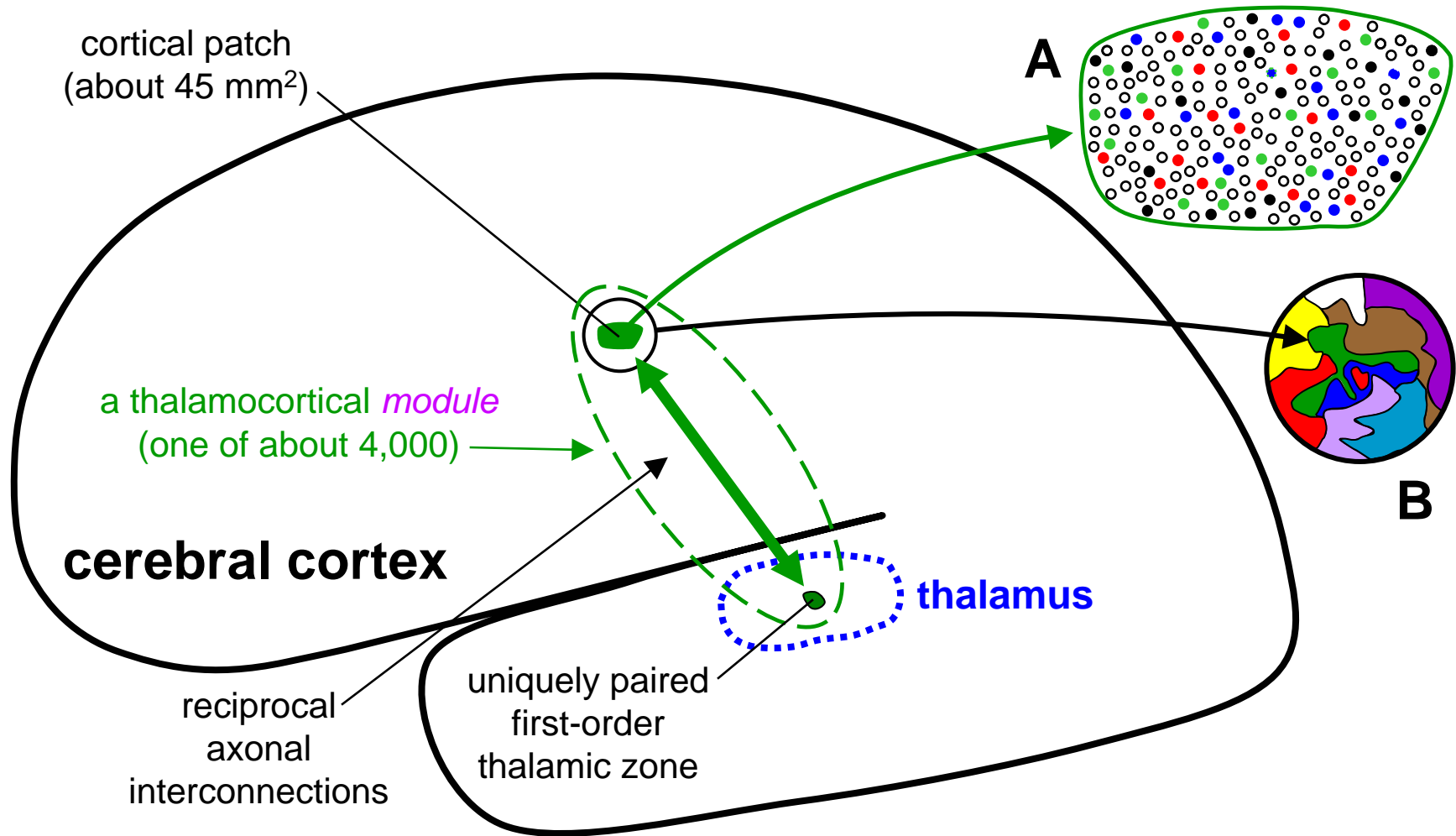# Confabulation Theory Summary

Confabulation Theory Summary

▶ Representation of the Objects of the Mental World

▶ Acquisition and Storage of Knowledge

▶ A Universal Information Processing Operation: Confabulation

▶ Each Confabulation Conclusion Triggers a Behavior

Each *Thalamocortical Module* is Responsible for Describing One *Attribute*, Which Objects in the Mental Universe May Possess

cortical patch
(about 45 mm²)

A

a thalamocortical *module*
(one of about 4,000)

cerebral cortex

B

thalamus

reciprocal
axonal
interconnections

uniquely paired
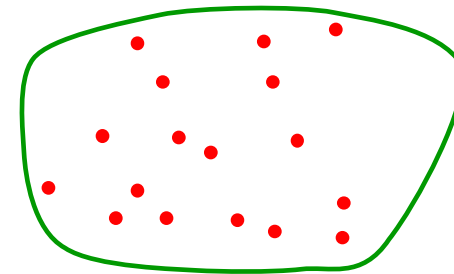first-order
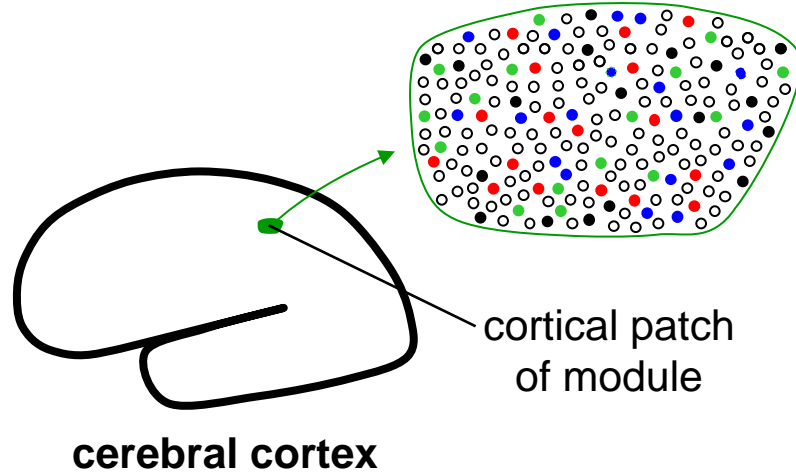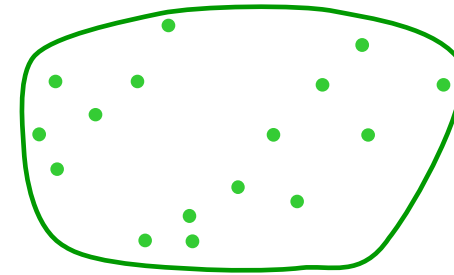thalamic zone

CONFABULATION THEORY KEY ELEMENT 1

Each Cortical Module is Responsible for Describing One *Attribute*, Which Objects in the Mental Universe May Possess

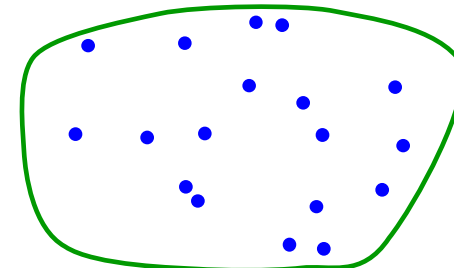cortical patch
of module

cerebral cortex

thalamocortical module

Symbol 1

Symbol 2

Symbol 126,008

CONFABULATION THEORY KEY ELEMENT 1

1 ◯
2 ◯
3 ◯
4 ◯
5 ◯
6 ◯
7 ◯
8 ◯
9 ◯
10 ◯
11 ◯
. ◯
. ◯
. ◯
126,007 ◯
126,008 ◯
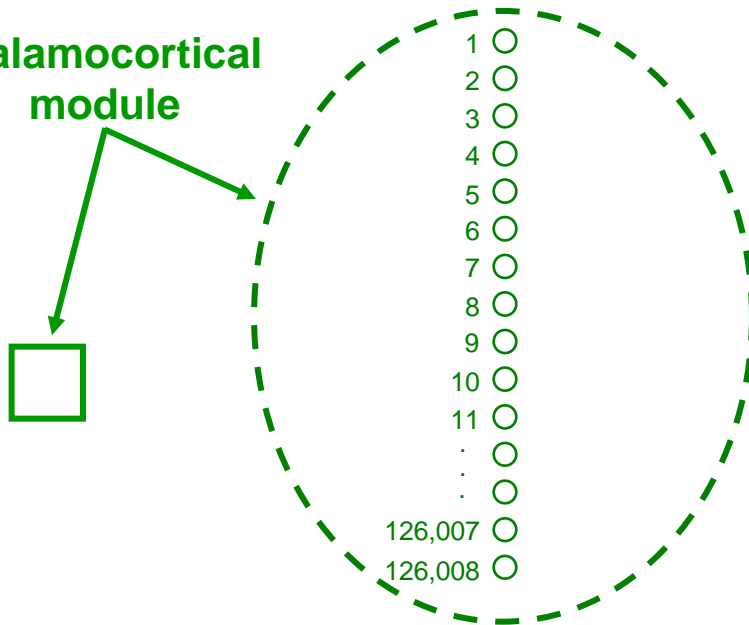
An Individual *Knowledge Link* Unidirectionally Connects a *Source Symbol* to a *Target Symbol*

symbol
(neuron collection)
representing color *red*

symbol
(neuron
collection)
representing word
apple

unidirectional
neuron collection-to-neuron
collection *knowledge link*

cortical module
representing <u>words</u>
describing mental
world objects

Cerebral Cortex
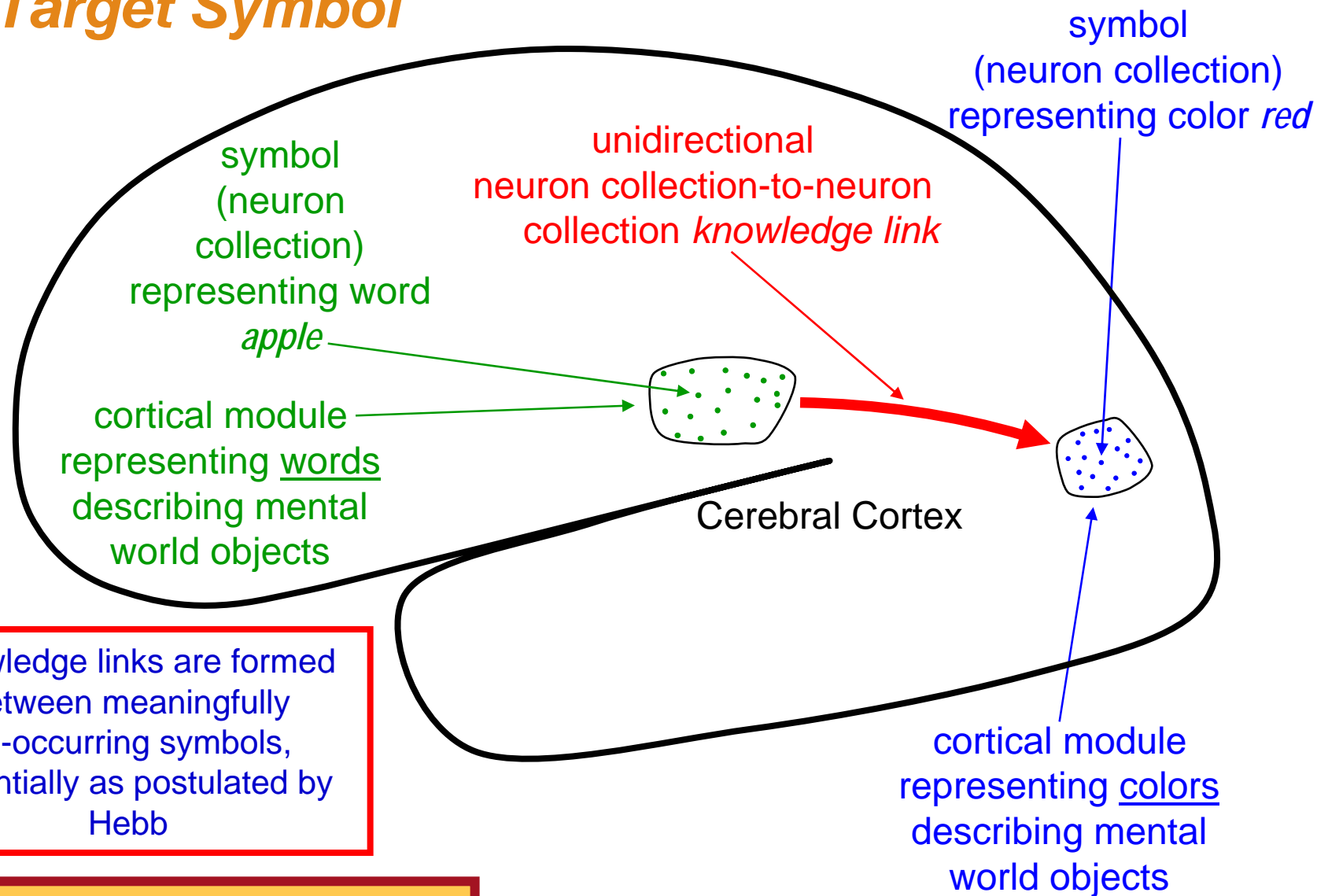
Knowledge links are formed
between meaningfully
co-occurring symbols,
essentially as postulated by
Hebb

cortical module
representing <u>colors</u>
describing mental
world objects

CONFABULATION THEORY KEY ELEMENT 2

symbol representing
apple **skin texture**

symbol
representing color *red*

symbol representing
word *apple*

symbol representing
apple chewing
motor behavior

Cerebral Cortex

The Average Human
Possesses
<u>**Billions**</u> of Items of Knowledge

symbol
representing *apple*
odor and taste

CONFABULATION THEORY KEY ELEMENT 2
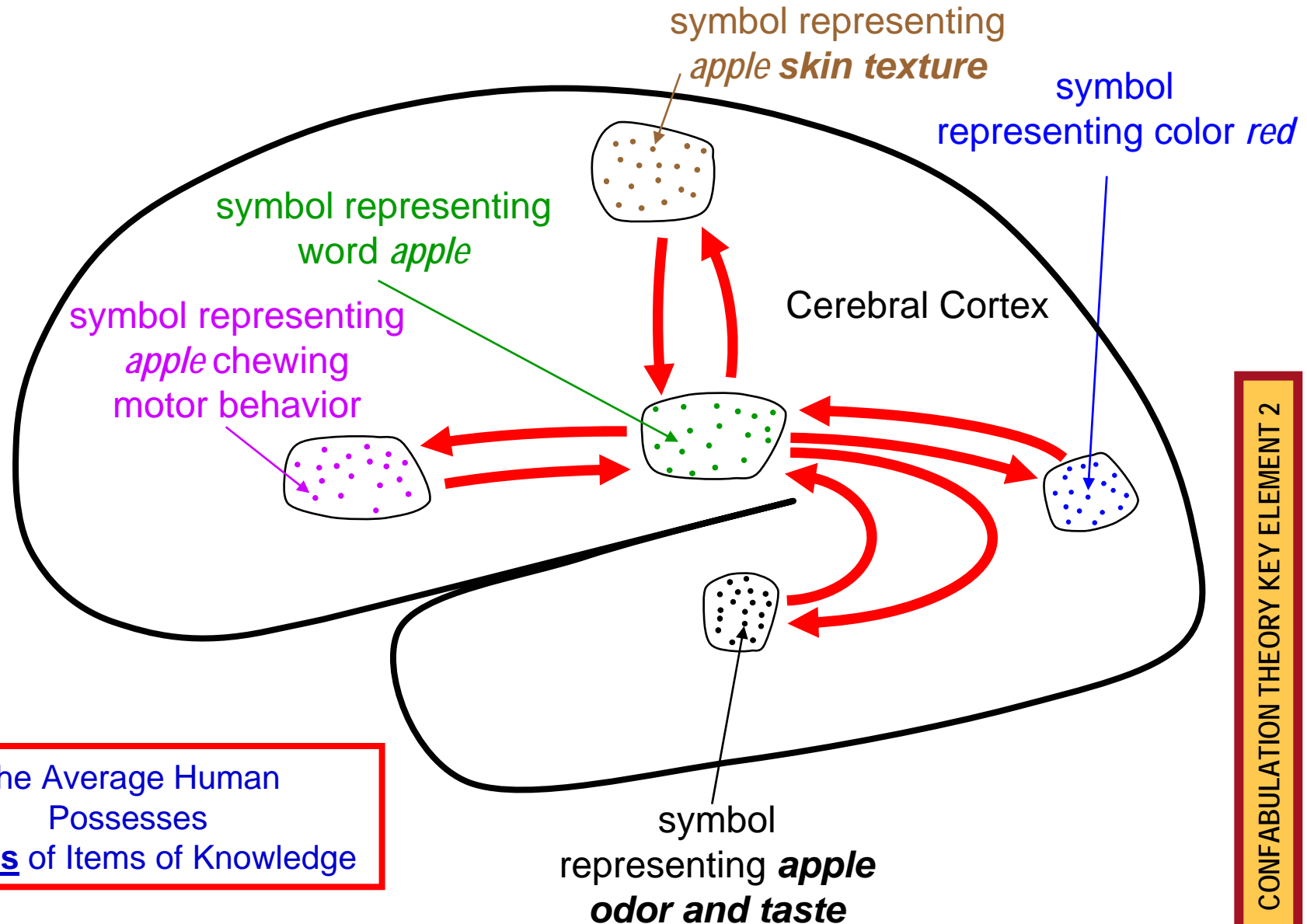
Two-Stage Abeles *Synfire Chain* Knowledge Link Implementation

transponder neurons

these synapses
are strengthened

target
module
symbol λ

Cerebral
Cortex

source
module
symbol ψ

CONFABULATION THEORY KEY ELEMENT 2
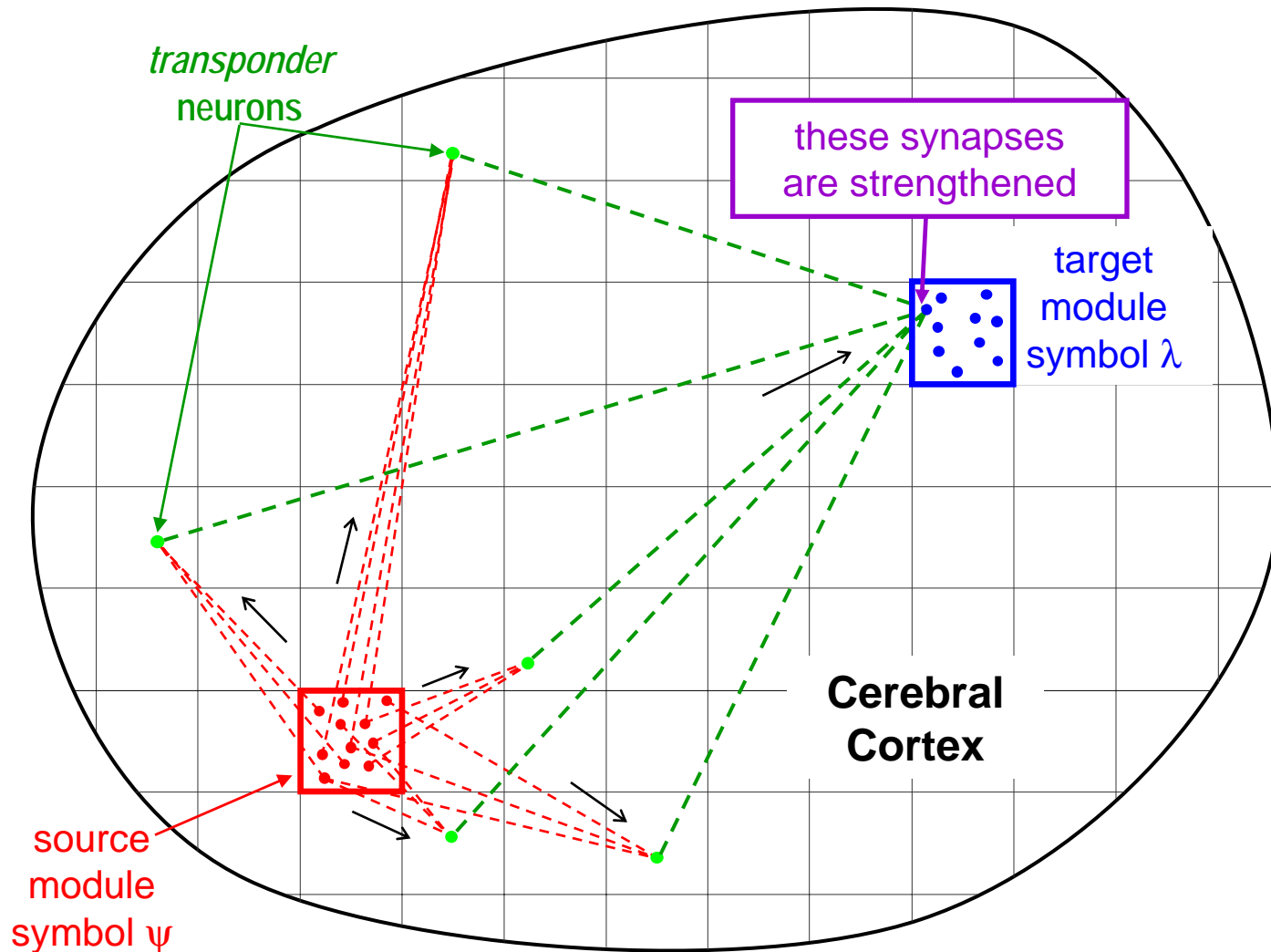
Confabulation is a Winners-Take-All Competition Between the Symbols of a Module
Based upon each Symbol's Summed *Input Excitation*
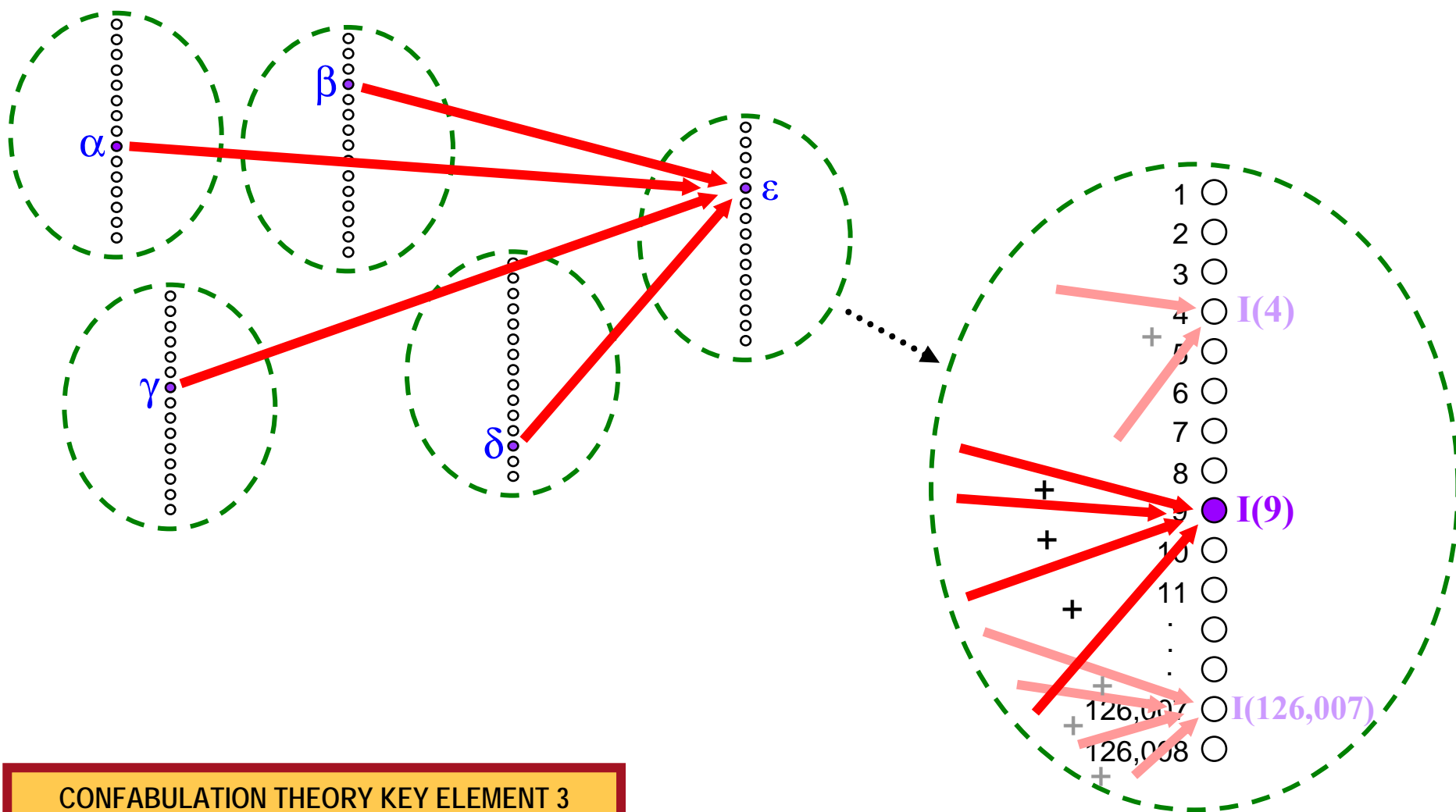
CONFABULATION THEORY KEY ELEMENT 3

Each Module Receives a *Thought Command* Input, Which Causes the Module to Implement *Confabulation*

externally supplied thought command signal

t_0

$t_0 + 40$ ms

$t_0 + 80$ ms

Confabulation is a fast, parallel, 'winners-take-all' competition between the module's symbols based upon their summed knowledge link input excitations

CONFABULATION THEORY KEY ELEMENT 3
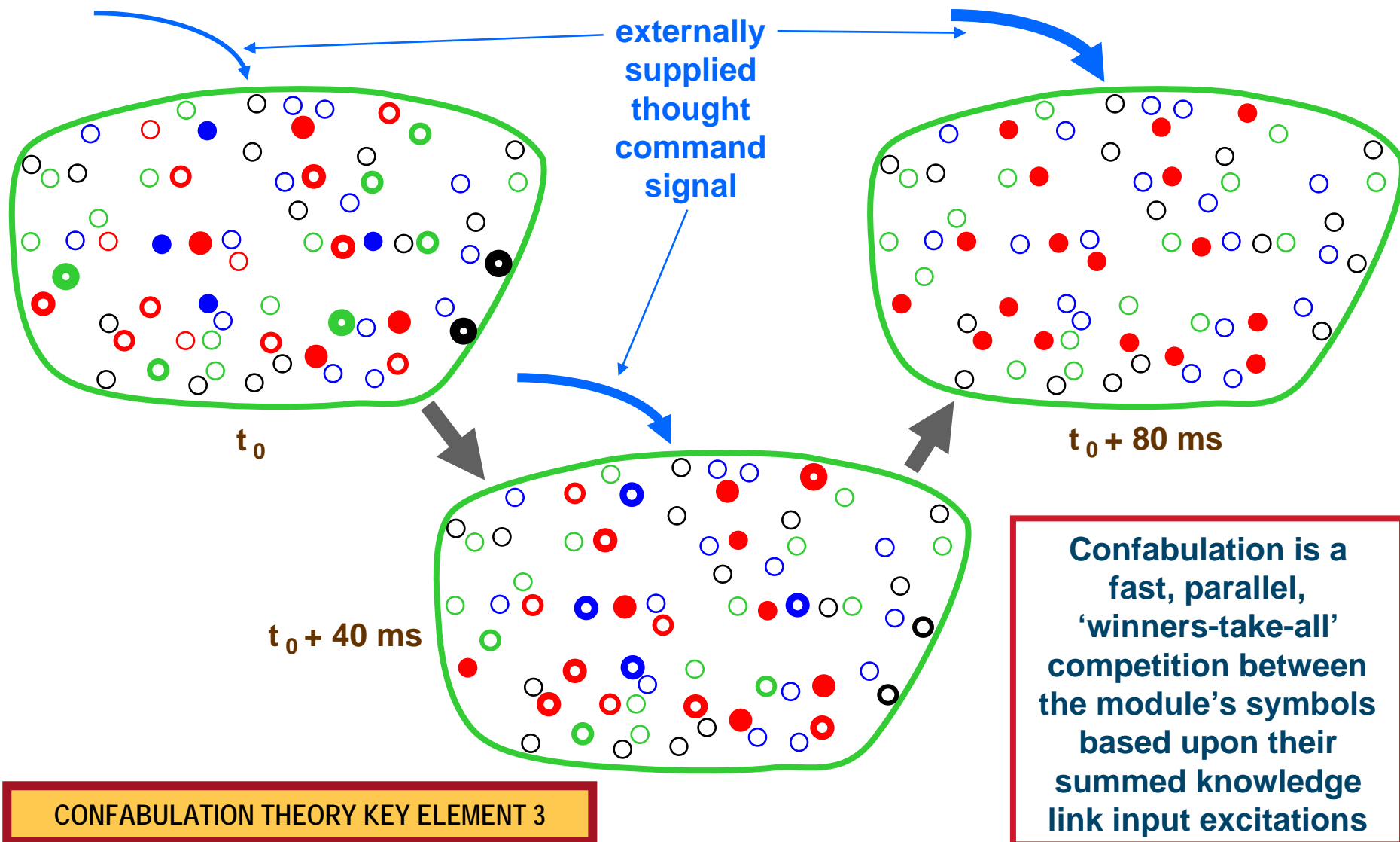
The *Conclusion-Action Principle*: The Origin of *Behavior*

Whenever a confabulation yields a conclusion, associated *action commands* are immediately issued. Action commands cause motor and/or thought processes (many per second).

thalamocortical module

skill knowledge

action command outputs (these proceed to subcortical motor and thought nuclei)

1
2
3
4
5
6
7
8
9
10
11
.
.
.
126,007
126,008

9

thought command signal

confabulation conclusion
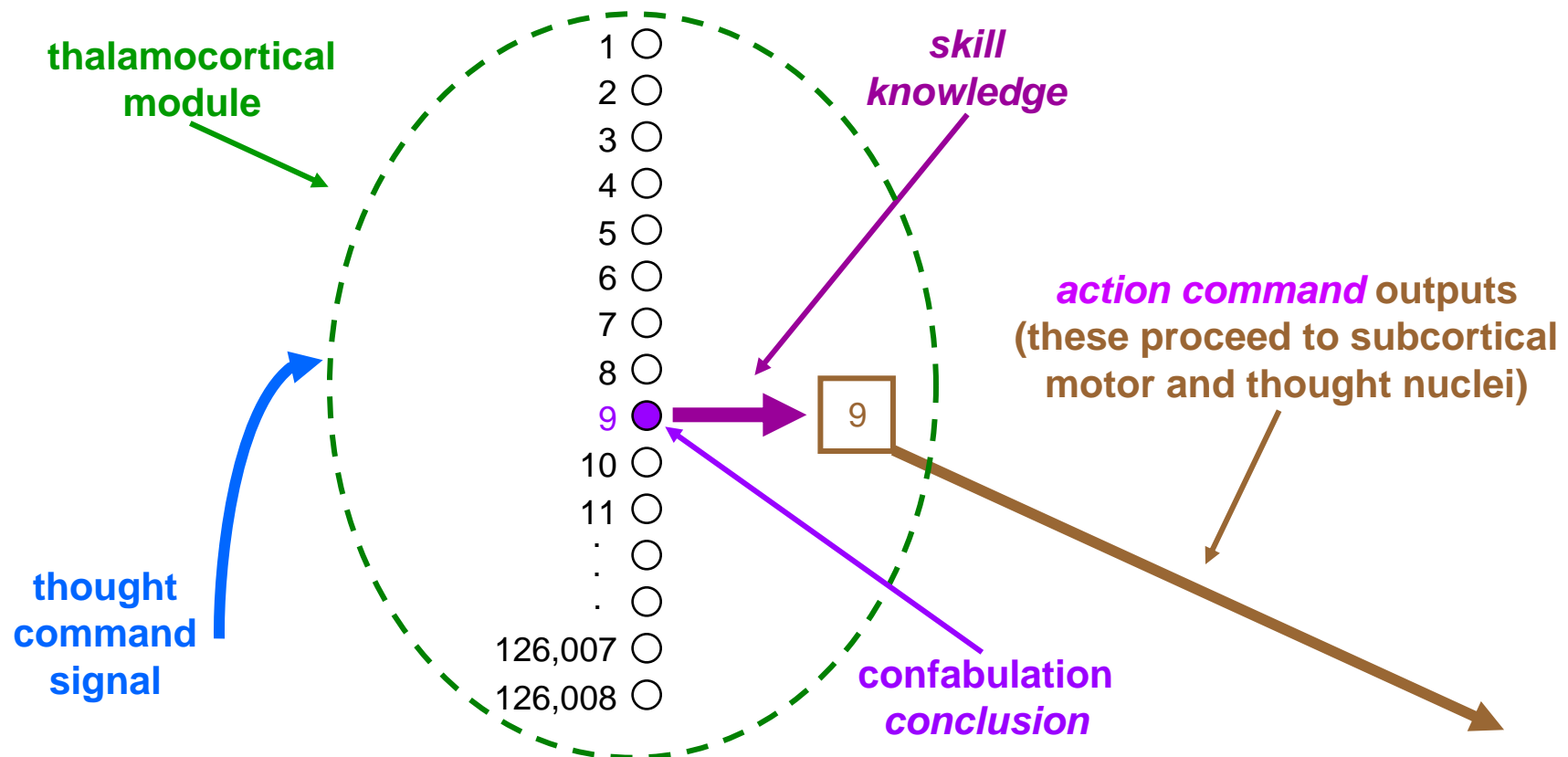
CONFABULATION THEORY KEY ELEMENT 4

The Mathematics of Confabulation

Given four *assumed fact* symbols α, β, γ, and δ (each being expressed on its own separate module), confabulation theory proposes [1] that *confabulation* finds that conclusion symbol ε having maximum *cogency* $p(\alpha\beta\gamma\delta|\varepsilon)$ (where juxtaposition indicates Boolean AND)

CONFABULATION THEORY MATHEMATICS
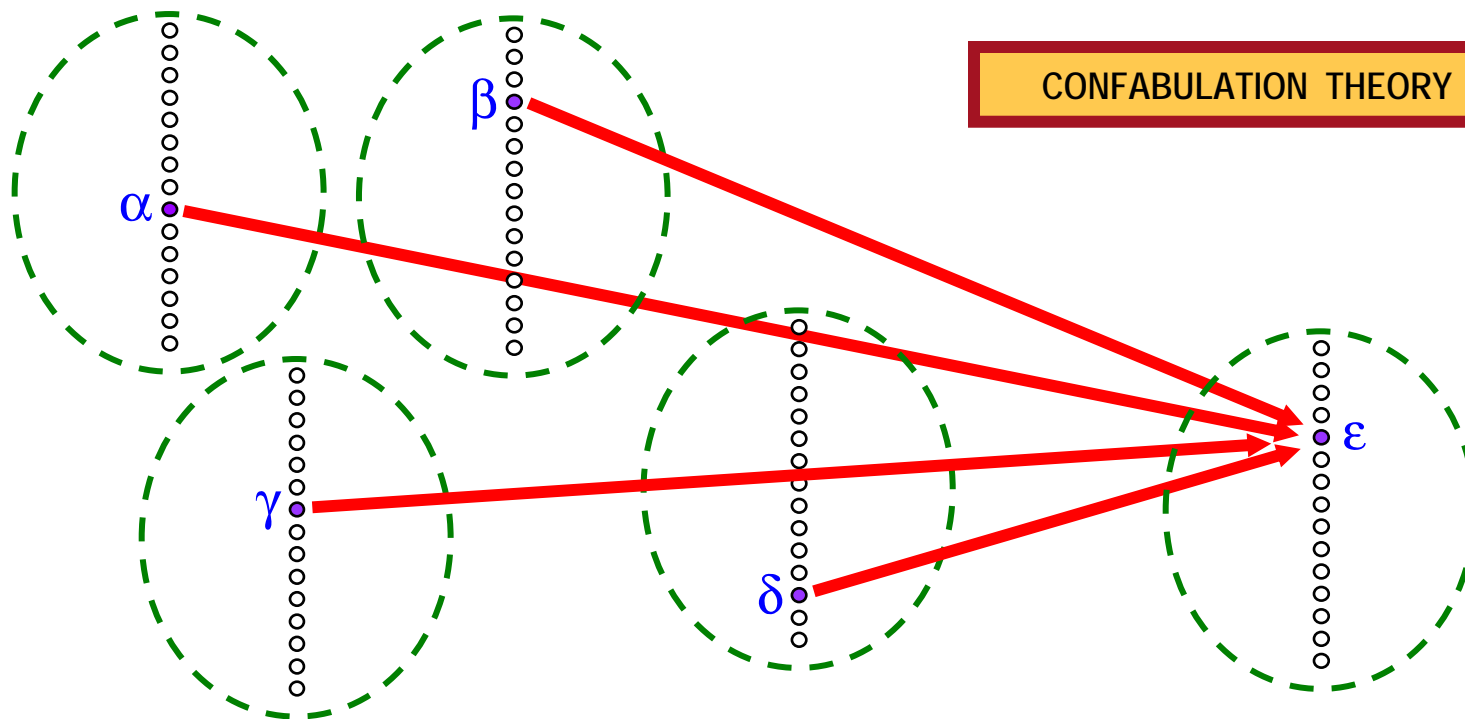
Confabulation produces that conclusion which, if assumed true, is most supportive of the probability of the assumed facts being true

In a 'Logical' Information Environment, Confabulation Produces Logical Conclusions

Theorem 1 [1]**:** In an Aristotelian logic information environment, if $\alpha\beta\gamma\delta \Rightarrow \varepsilon$ uniquely then ε uniquely maximizes cogency $p(\alpha\beta\gamma\delta|\varepsilon)$.

Thus, when doing mathematics or playing chess, confabulation will produce logical answers.

CONFABULATION THEORY MATHEMATICS

The Mathematics of Additive Knowledge Combination

Theorem 2 **The Fundamental Theorem of Cognition** [1]: Given non-exceptional assumed facts α, β, γ, and δ, and expectation element ε, then the following exact relationship holds between cogency $p(\alpha\beta\gamma\delta|\varepsilon)$ and the confabulation product $p(\alpha|\varepsilon) \cdot p(\beta|\varepsilon) \cdot p(\gamma|\varepsilon) \cdot p(\delta|\varepsilon)$:

$$[p(\alpha\beta\gamma\delta|\varepsilon)]^4 = [p(\alpha\beta\gamma\delta\varepsilon)/p(\alpha\varepsilon)]$$
$$\cdot [p(\alpha\beta\gamma\delta\varepsilon)/p(\beta\varepsilon)]$$
$$\cdot [p(\alpha\beta\gamma\delta\varepsilon)/p(\gamma\varepsilon)]$$
$$\cdot [p(\alpha\beta\gamma\delta\varepsilon)/p(\delta\varepsilon)]$$
$$\cdot [p(\alpha|\varepsilon) \cdot p(\beta|\varepsilon) \cdot p(\gamma|\varepsilon) \cdot p(\delta|\varepsilon)] \ . \ \blacksquare$$

$$\approx C \cdot [p(\alpha|\varepsilon) \cdot p(\beta|\varepsilon) \cdot p(\gamma|\varepsilon) \cdot p(\delta|\varepsilon)] \ .$$
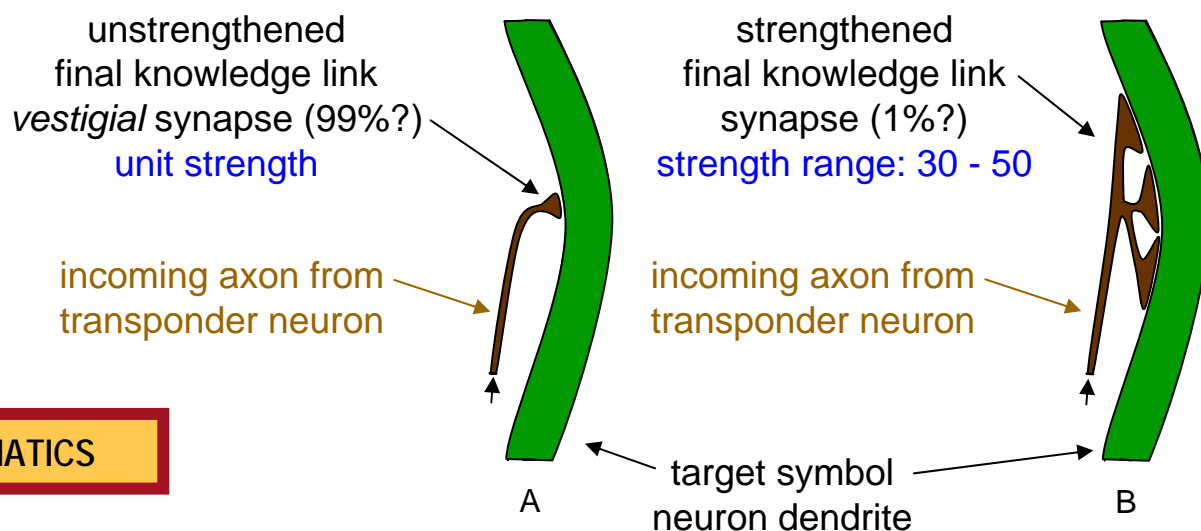
CONFABULATION THEORY MATHEMATICS

The Mathematics of Additive Knowledge Combination

Thus, to maximize cogency $p(\alpha\beta\gamma\delta|\lambda)$, we can instead find that target symbol λ which maximizes:

$$I(\lambda) \equiv [\log_a(p(\alpha|\lambda)/p_0) + b]$$
$$+ [\log_a(p(\beta|\lambda)/p_0) + b]$$
$$+ [\log_a(p(\gamma|\lambda)/p_0) + b]$$
$$+ [\log_a(p(\delta|\lambda)/p_0) + b] .$$

Note: if a = 1.5849 and b = 30, then the required "synapse strengths" are between 30 and 50 – a small dynamic range.

unstrengthened
final knowledge link
vestigial synapse (99%?)
unit strength

strengthened
final knowledge link
synapse (1%?)
strength range: 30 - 50

incoming axon from
transponder neuron

incoming axon from
transponder neuron

CONFABULATION THEORY MATHEMATICS

target symbol
neuron dendrite

A

B

Confabulation Characteristics

▶ Confabulation is a fast, neuronally implementable, decision-making operation for finding the 'best' (**maximum cogency**) conclusion to a universally-applicable type of probabilistic 'question.'

▶ Confabulation is postulated to be the underlying mechanism of all aspects of cognition (seeing, hearing, movement and thought process origination, planning, reasoning, language, etc., etc.).

▶ *Multiconfabulations* (multiple, temporally overlapping, mutually dynamically interacting, confabulations) are the norm in cognition.

CONFABULATION CHARACTERISTICS

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▶ **Confabulation Neuroscience**

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    ▶ Multiconfabulation

    ▶ Speech Understanding

▶ **Practical Applications**

    ▶ *Chancellor* Project

UCSD Confabulation Neuroscience Lab

▶ Research focus: How the neurons of human cerebral cortex / thalamus implement the functional elements of confabulation theory (symbols, knowledge links, confabulation, behavioral triggering).

▶ Methodology: Iterative development, evaluation, and improvement of biologically realistic computer models of functional neuronal structures. Strong interaction with La Jolla neuroscience community.

▶ Lab sponsor: **Office of Naval Research**

▶ Graduate Student Researchers: **Soren Solari** and **Erik Shipton**

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COMPUTER SIMULATED CONFABULATION
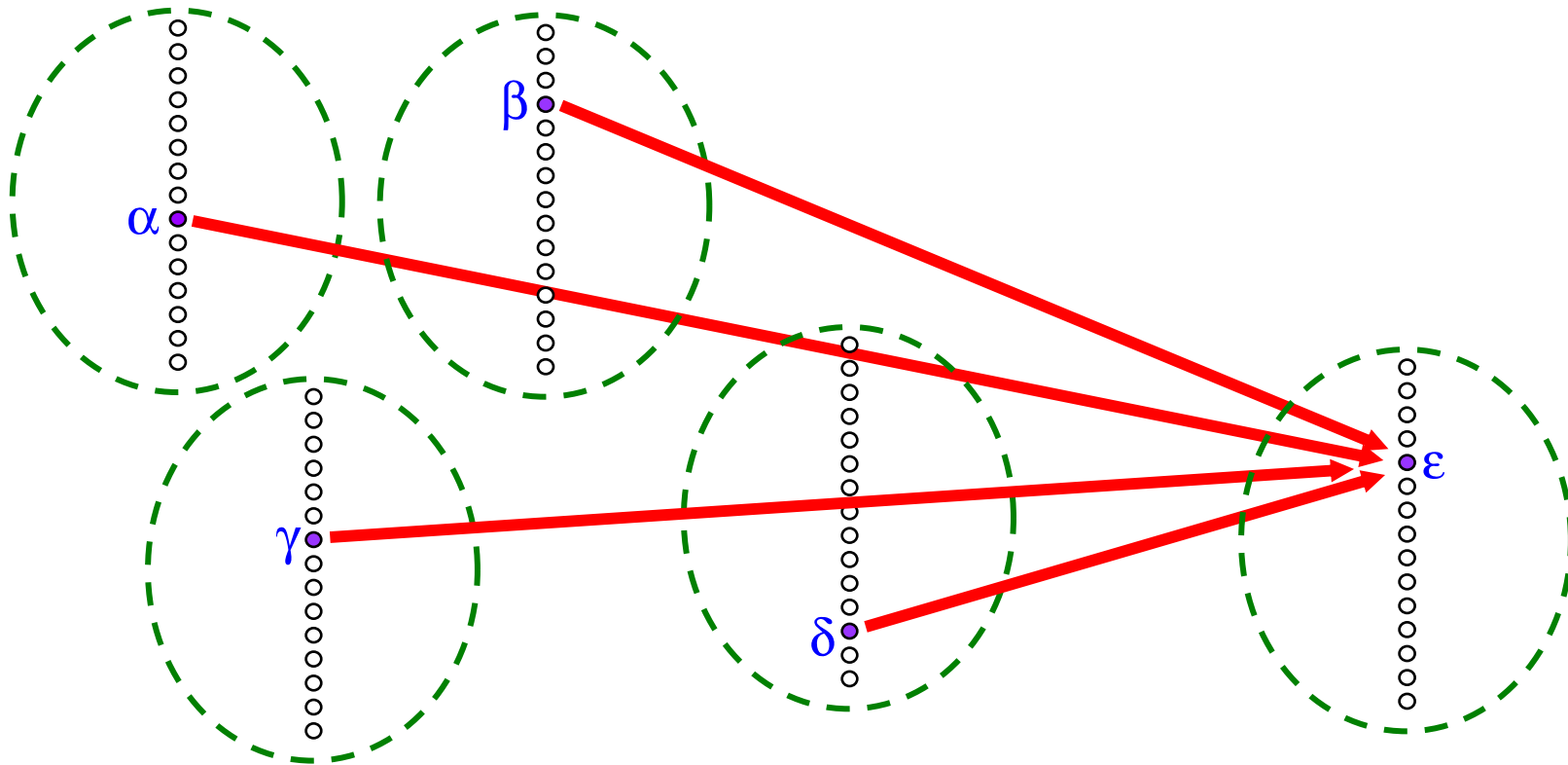
(unified, blockbuster, comprehensive, definitive, coordinated, protein)

for   lack   of   a   ___?___

5 modules, 4 knowledge bases, 5,251,335 knowledge links

knowledge link (one of millions)

ε
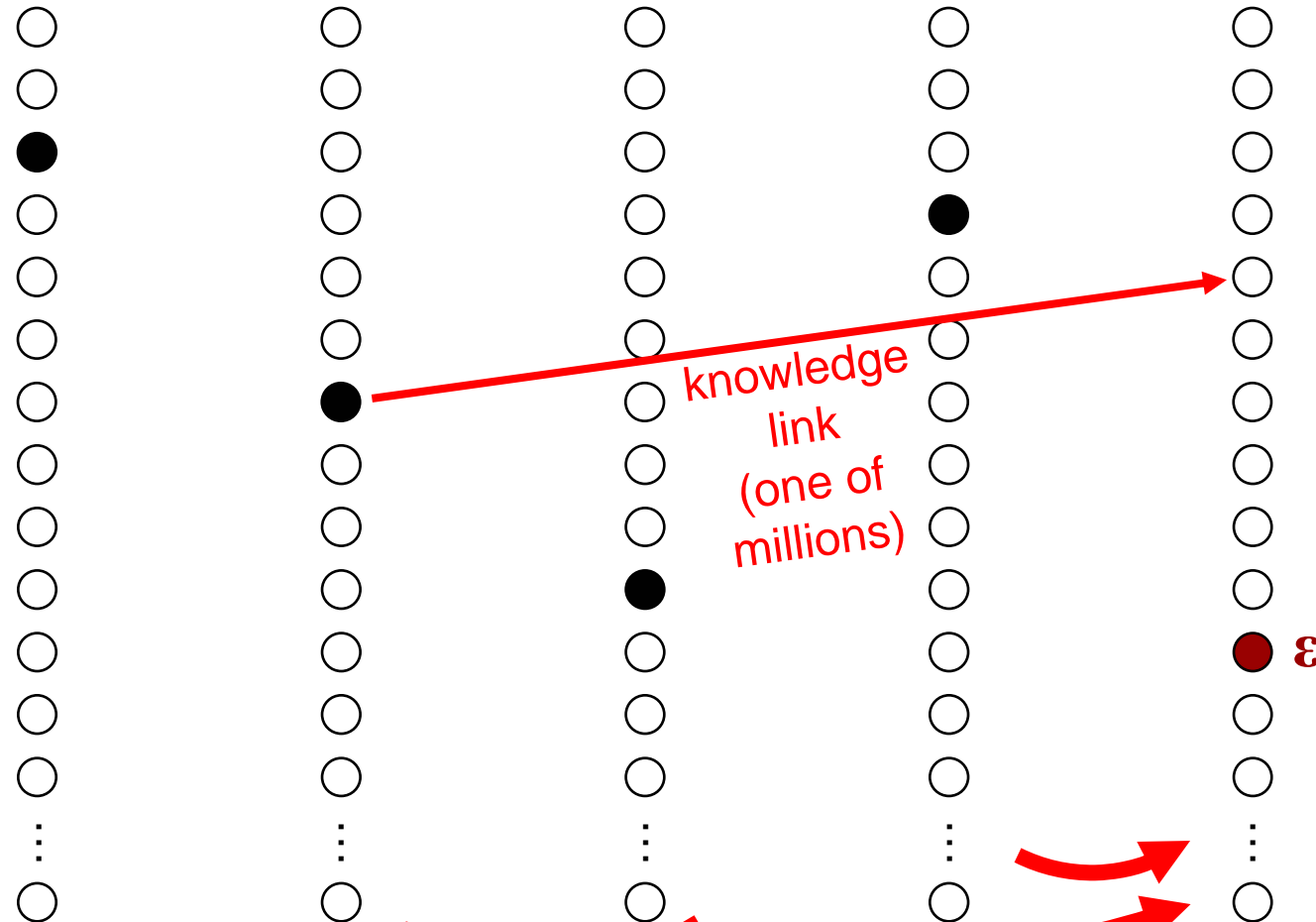
COMPUTER SIMULATED CONFABULATION

Assumed Facts →   α   β   γ   δ

Knowledge Bases
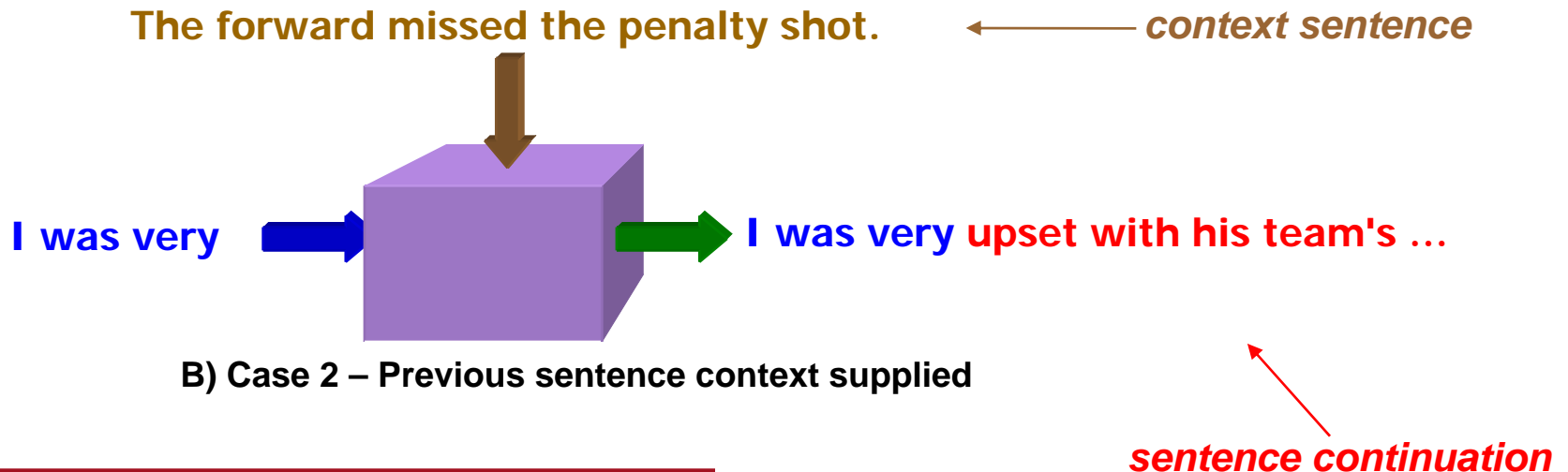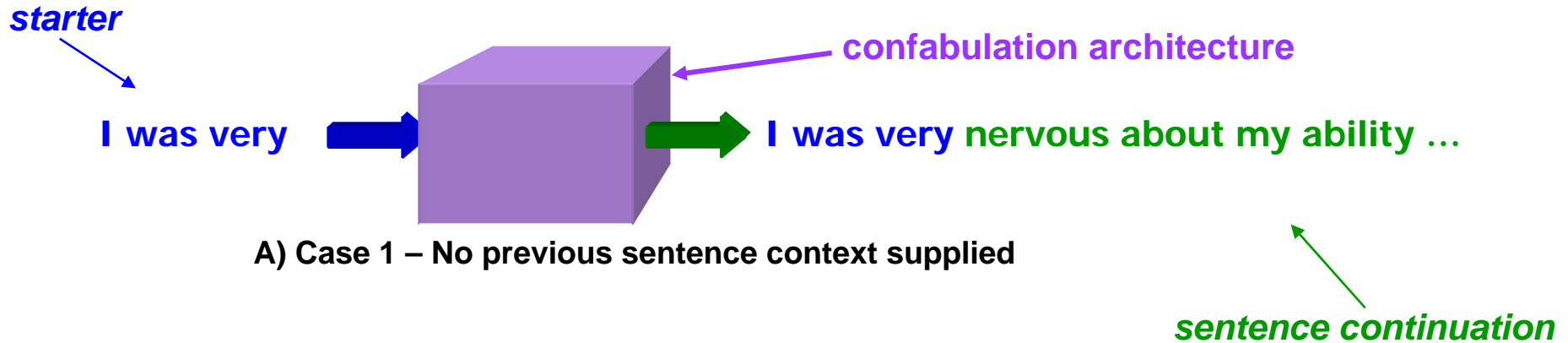
'Next-Word Selection' Confabulation Experiment (add 1 word), see [1]

- ▶ she could determine (whether, exactly, if, why, how, precisely) 8
- ▶ if it was not (immediately, clear, enough, true, properly, stupid) >999
- ▶ earthquake activity was [centered]
- ▶ a lack of (urgency, oxygen, understanding, confidence, communication, enthusiasm) 407
- ▶ regardless of expected [outcome, length]
- ▶ cars drove down a (lane, freeway, highway, dirt, taxi, tying) 9
- ▶ driving west on interstate [highway, freeway]
- ▶ snow fell in (freezing, montana, portions, northwestern, northeastern) 11
- ▶ tune card fly bold [ ]
- ▶ threats of terrorist [attacks, retaliation, strikes, violence]
- ▶ the machine (tools, tool, guns, gun, operator, shop) 33
- ▶ children can learn [lessons, math, english]
- ▶ students can learn [lessons, math, english]
- ▶ college students can learn [math]
- ▶ knowledge of historical [facts, subjects, styles]
- ▶ her responsibility for taking [sole, matters]

COMPUTER SIMULATED CONFABULATION

Sentence Continuation Multiconfabulation Experiment (add 4 words to a *starter*)

starter

confabulation architecture

I was very → **I was very nervous about my ability …**

A) Case 1 – No previous sentence context supplied

sentence continuation

The forward missed the penalty shot. ← *context sentence*

I was very → **I was very upset with his team's …**

B) Case 2 – Previous sentence context supplied

sentence continuation
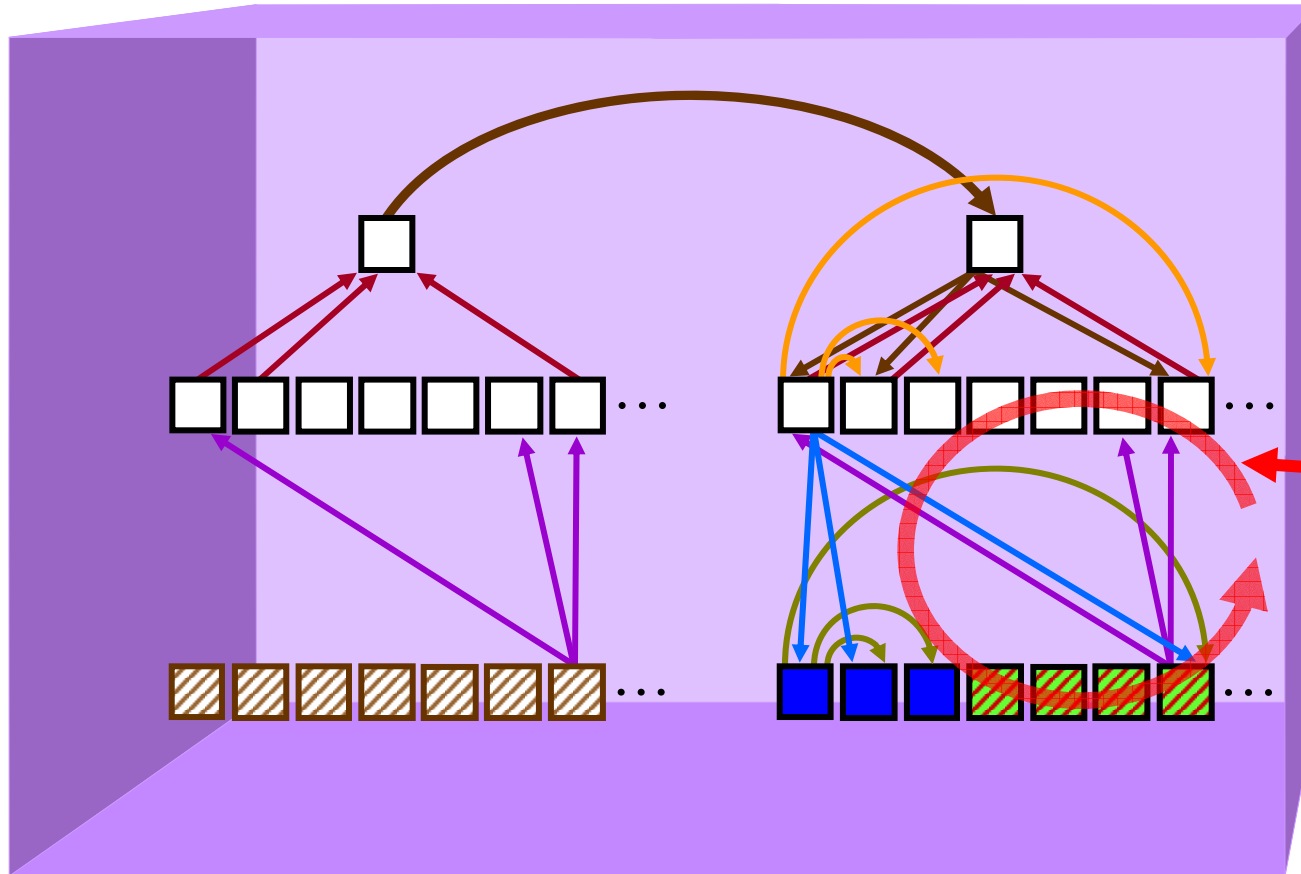
COMPUTER SIMULATED MULTICONFABULATION

Sentence Continuation
Confabulation Architecture

multiple contemporaneous, mutually interacting, confabulations applying millions of items of knowledge in parallel to yield a final *consensus* of conclusions

82 modules, 1071 knowledge bases, ≈ 2 Billion knowledge links

COMPUTER SIMULATED MULTICONFABULATION

thalamocortical module

Sentence Continuation Thought Process

knowledge base

sentence meaning content summary modules

phrase modules

P1 P2 P3 P4 P5 P6 P7

word modules

W1 W2 W3 W4 W5 W6 W7
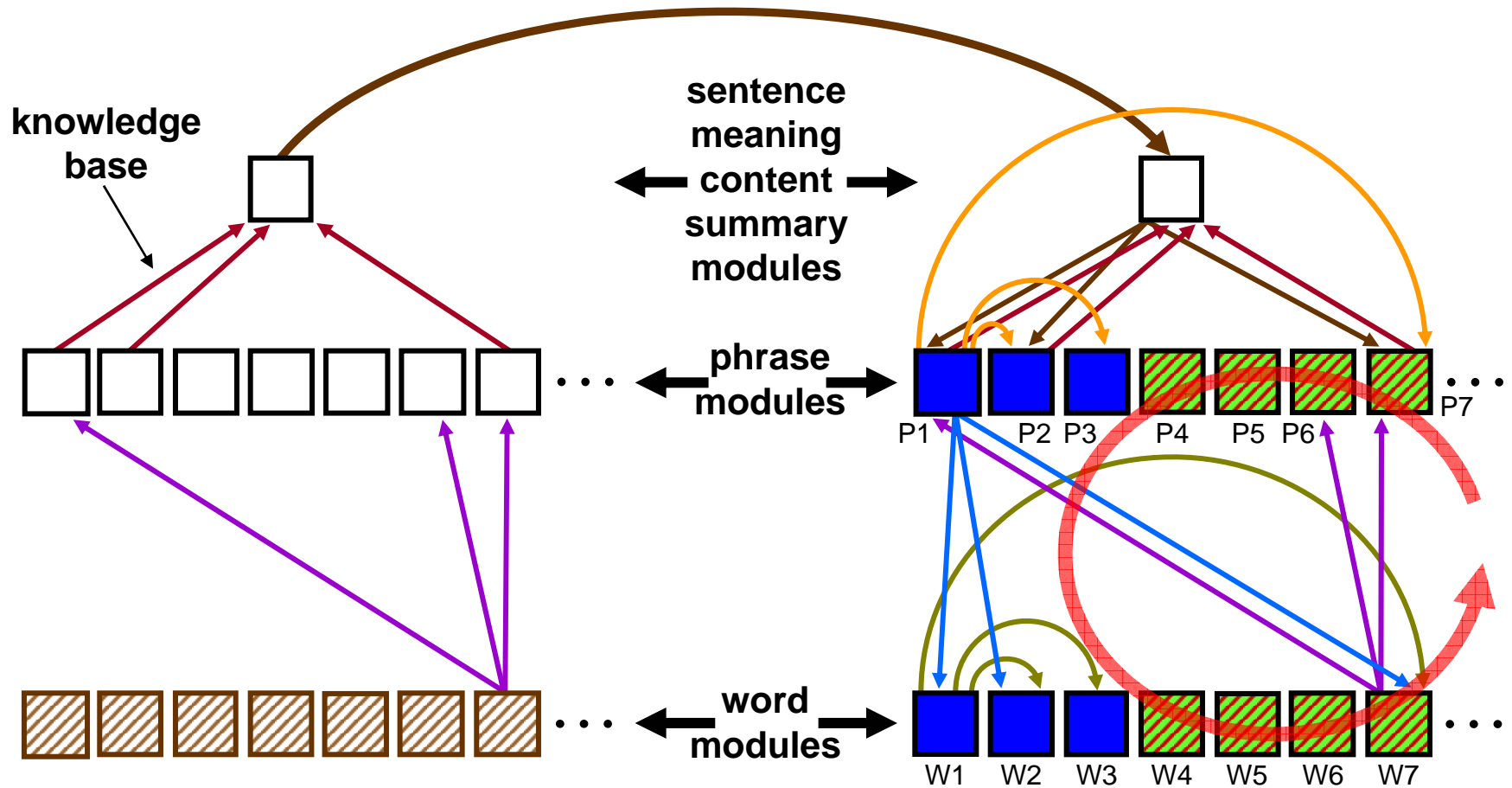
Context Sentence Module Grouping

Continuation Sentence Module Grouping

context sentence

The football quarterback fumbled the snap .

Shortly thereafter he ADD FOUR WORDS HERE

starter

SENTENCE CONTINUATION THOUGHT PROCESS
CONCRETE EXAMPLE

Sentence Continuation Thought Process

previous (context) sentence meaning content representation

P1   P2   P3   P4   P5   P6   P7

W1   W2   W3   W4   W5   W6   W7

The football quarterback fumbled the snap .

context sentence

THOUGHT PROCESS STEP 1

Sentence Continuation Thought Process

The football quarterback fumbled the snap .

Shortly thereafter he

starter

P1 P2 P3 P4 P5 P6 P7

W1 W2 W3 W4 W5 W6 W7

THOUGHT PROCESS STEP 2

Sentence Continuation Thought Process

Shortly **thereafter** **he**

P1	P2	P3	P4	P5	P6	P7
1	**1**	**1**	**1000**			

W4	W5	W6	W7

Note: Each symbol used has an average of about 200 knowledge links emanating from it; per knowledge base.

THOUGHT PROCESS STEP 2

Sentence Continuation Thought Process

P1   P2   P3   P4   P5   P6   P7

1   **1**   **1**   **1000**

1,000 items of knowledge being used

≈ 600,000 items of knowledge being used

≈ 150,000 items of knowledge being used

758   **3000**

W4   W5   W6   W7

THOUGHT PROCESS STEP 3

Sentence Continuation Thought Process

THOUGHT PROCESS STEP 4

Sentence Continuation Thought Process

P1 P2 P3 P4 P5 P6 P7

1 1 1 17

2

14 3000

W4 W5 W6 W7
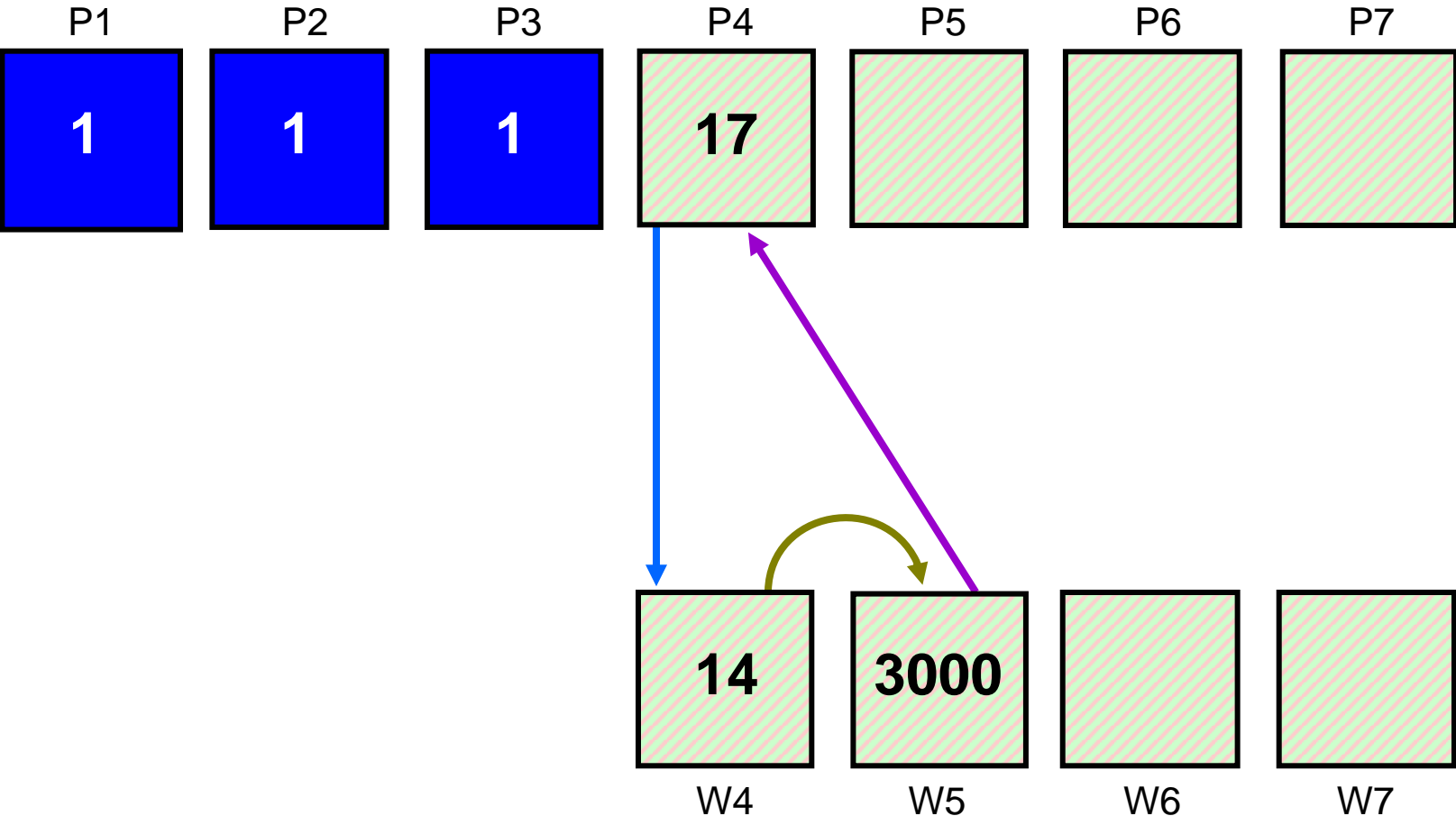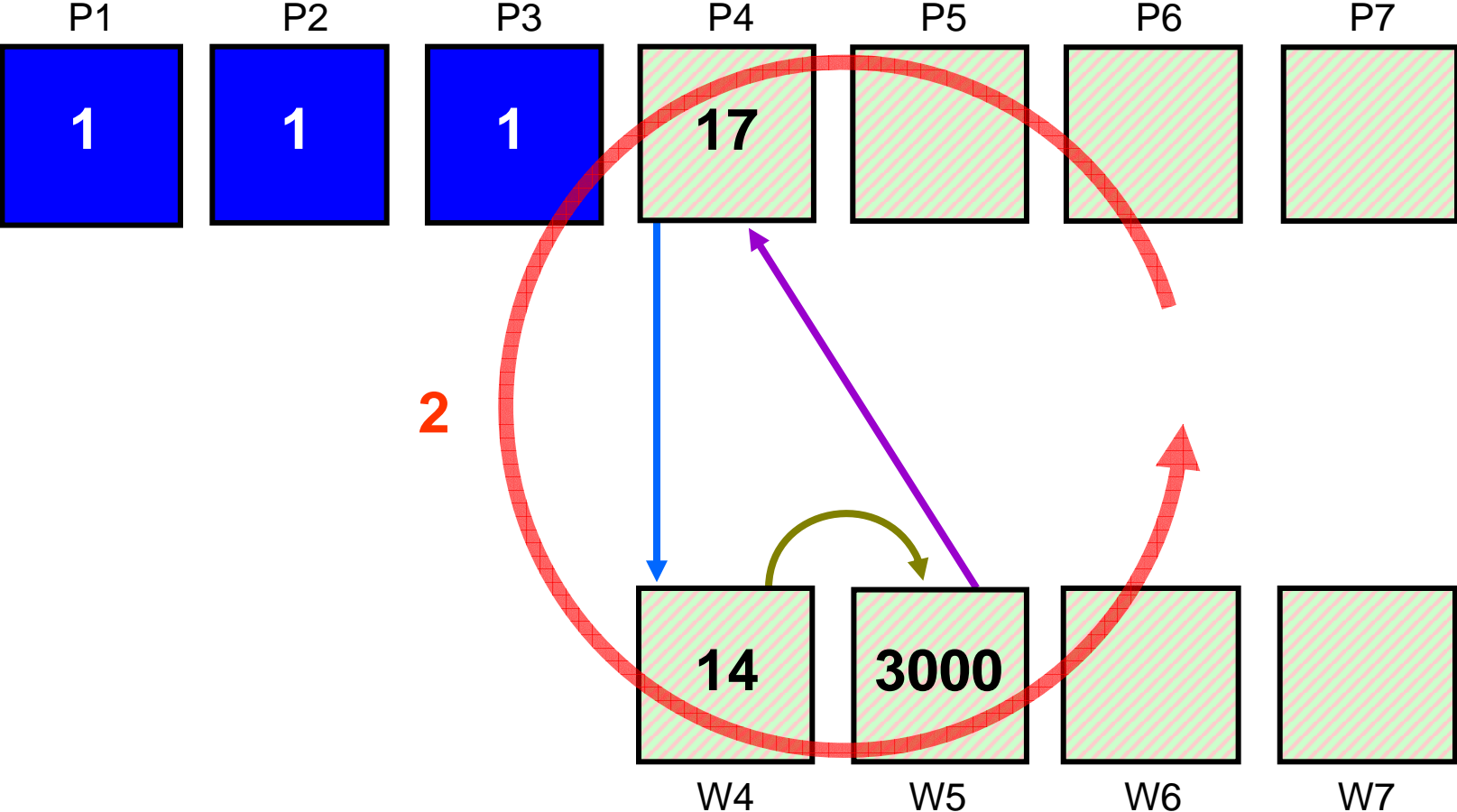
THOUGHT PROCESS STEPS 3 - 4

Sentence Continuation Thought Process
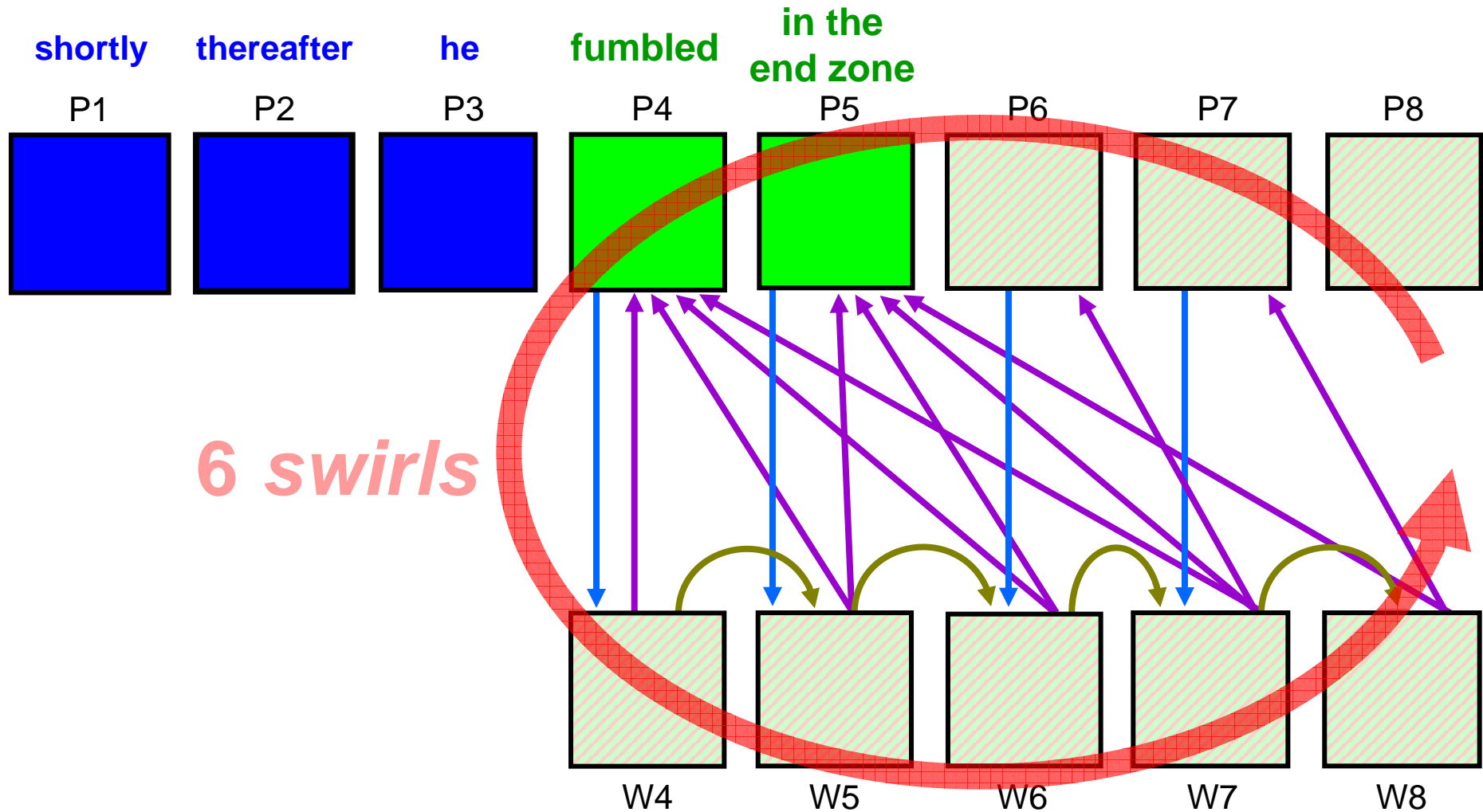
The football quarterback fumbled the snap .

Shortly thereafter he fumbled in the end zone …

FINAL ANSWER

Sentence Continuation Thought Process

NO context sentence

The New York ADD FOUR WORDS HERE

starter

SENTENCE CONTINUATION THOUGHT PROCESS
CONCRETE EXAMPLE #2

Sentence Continuation Thought Process

starter

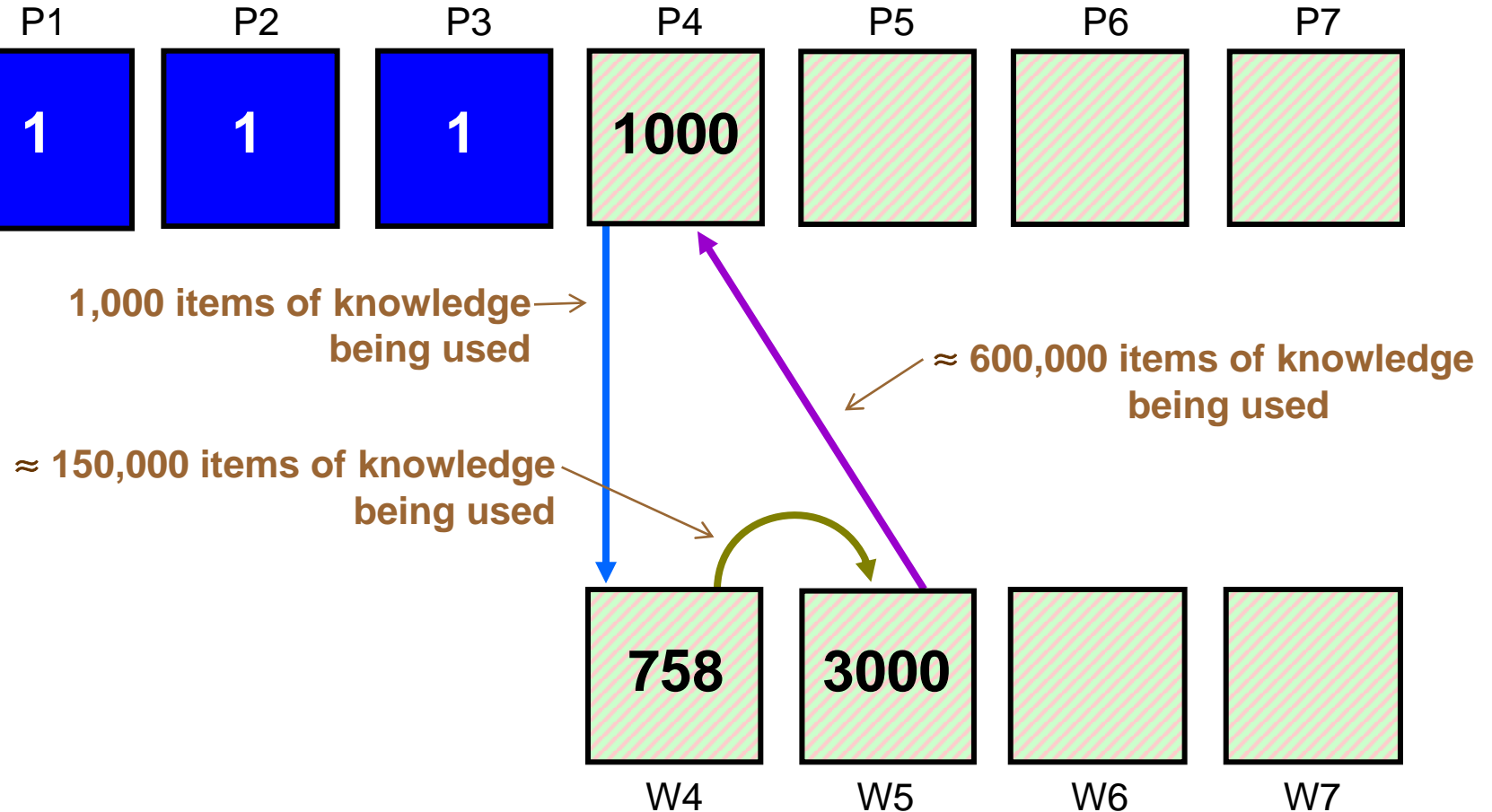P1 P2 P3 P4 P5 P6 P7

The New York

W1 W2 W3 W4 W5 W6 W7
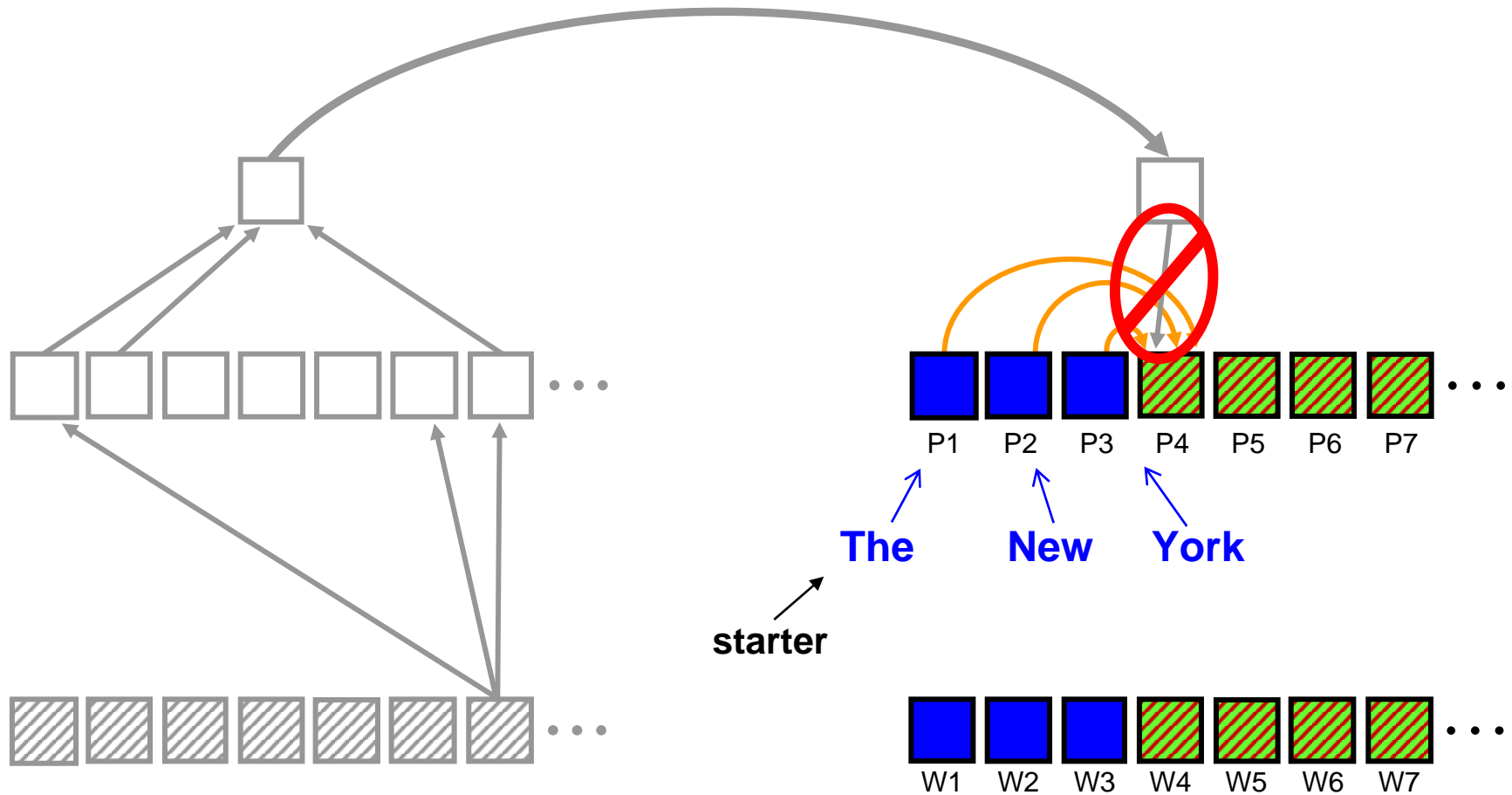
THOUGHT PROCESS STEP 2
CONCRETE EXAMPLE #2

The New York Times' computer model collapses …

FINAL ANSWER
CONCRETE EXAMPLE #2

Context sentence

Stocks proved to be a wise investment .
The New York ADD FOUR WORDS HERE

Same starter

SENTENCE CONTINUATION THOUGHT PROCESS
CONCRETE EXAMPLE #3

Sentence Continuation Thought Process

previous (context)
sentence meaning
content representation

P1 P2 P3 P4 P5 P6 P7

starter → **The   New   York**

Stocks proved to be a wise investment .

context sentence

W1 W2 W3 W4 W5 W6 W7

THOUGHT PROCESS STEP 2
CONCRETE EXAMPLE #3
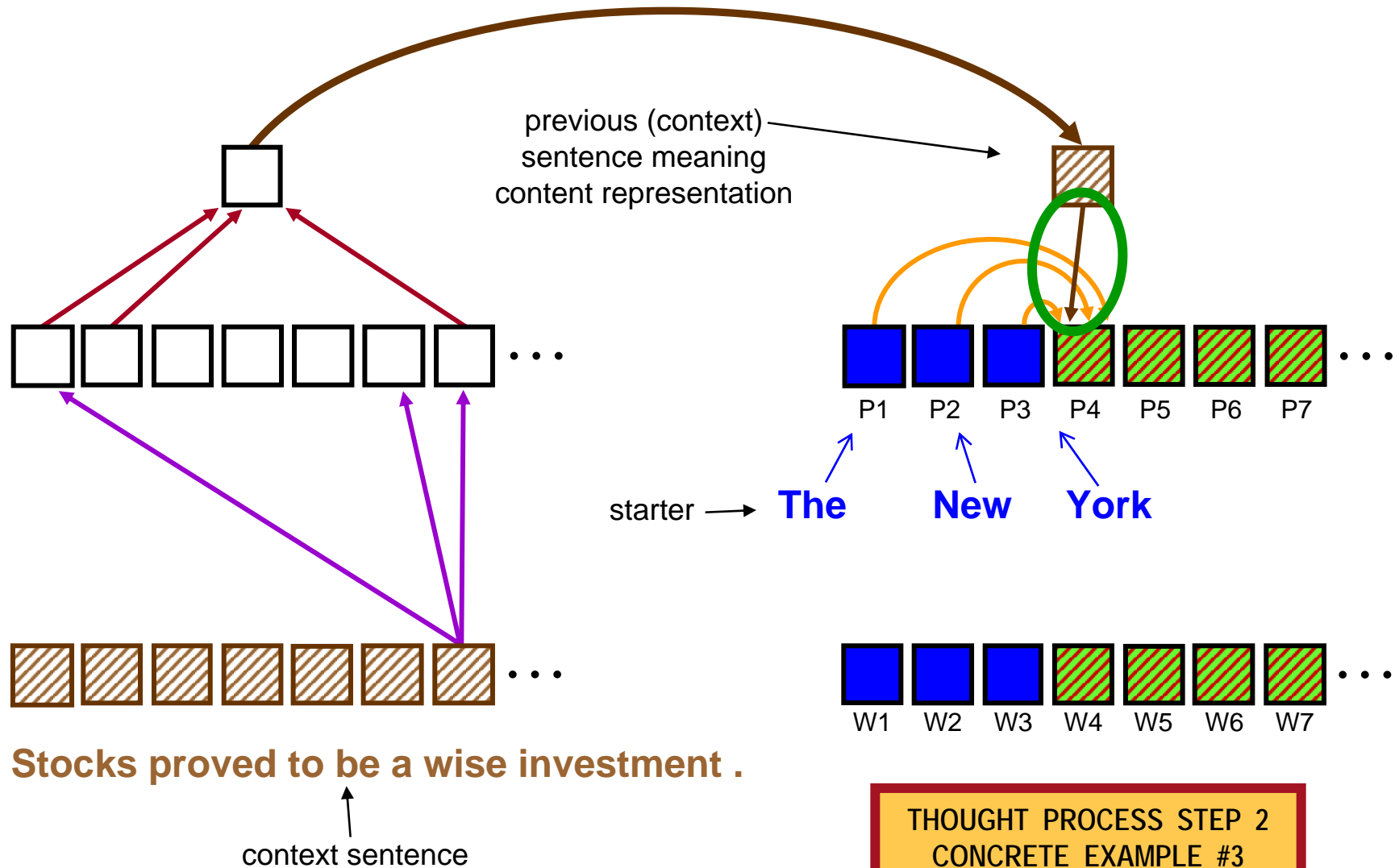
Stocks proved to be a wise investment .
The New York markets traded lower yesterday …

FINAL ANSWER
CONCRETE EXAMPLE #3

Sentence Continuation
Experimental Results

The New York Times' computer model collapses …

Stocks proved to be a wise investment .
The New York markets traded lower yesterday …

Downtown events were interfering with local traffic .
The New York City Center area where …

Coastal homes were damaged by tropical storms .
The New York City Emergency Service System …

Medical patients tried to see their doctors .
The New York University Medical Association reported …

MULTICONFABULATION

When the United Center Party leader urged …

The car assembly lines halted due to labor strikes .
When the United Auto Workers union representation …

The price of oil in the Middle East escalated yesterday .
When the United Arab Emirates bought the …

Sentence Continuation
Experimental Results

But the Roman Empire disintegrated during the …

She learned the history of the saints .
But the Roman Catholic population aged 44 …

She studied art history and classical architecture .
But the Roman Catholic church buildings dating …

I was very nervous about my ability …

Democratic citizens voted for their party's candidate .
I was very concerned that they chose …

Restaurant diners ate meals that were served .
I was very hungry while knowing he …

In spite of yesterday's agreement among analysts …

The Mets were not expected to win .
In spite of the pitching performance of …

MULTICONFABULATION

Sentence Continuation
Experimental Results

The President was certain to be reelected .
In spite of his statements toward the …

She had no clue about the answer .
In spite of her experience and her …

It meant that customers could do away …

The stock market had fallen consistently .
It meant that stocks could rebound later …

I was not able to solve the problem .
It meant that we couldn't do much …

The company laid off half its staff .
It meant that if employees were through …

The salesman sold men's and women's shoes .
It meant that sales costs for increases …

MULTICONFABULATION

Sentence Continuation Experiment Lessons

▶ **Multiconfabulation allows effective massively parallel application of relevant knowledge at blazing speed**

▶ **Grammar and syntax are clearly emergent properties of confabulation – as hypothesized long ago by Miller, Lenneberg, and Chomsky**

▶ **Additive knowledge combination endows thought with enormous flexibility – whatever constraints or considerations need to brought to bear are simply added in!**

▶ **If there is no viable conclusion; confabulation yields a null output. Being able to say "I don't know" is enormously powerful**

▶ **Confabulation exhibits phenomenal generalization power – novel, sensible combinations of familiar elements can almost always be dealt with effectively**

CONFABULATION THEORY CHARACTERISTICS

Confabulation Theory Characteristics

▶ **In Confabulation Architectures there are NO:**

- ▶ Algorithms

- ▶ Software routines (beyond the simulations of the functional elements)

- ▶ Rules

- ▶ Ontologies

- ▶ Priors

- ▶ Bayesian networks, etc.
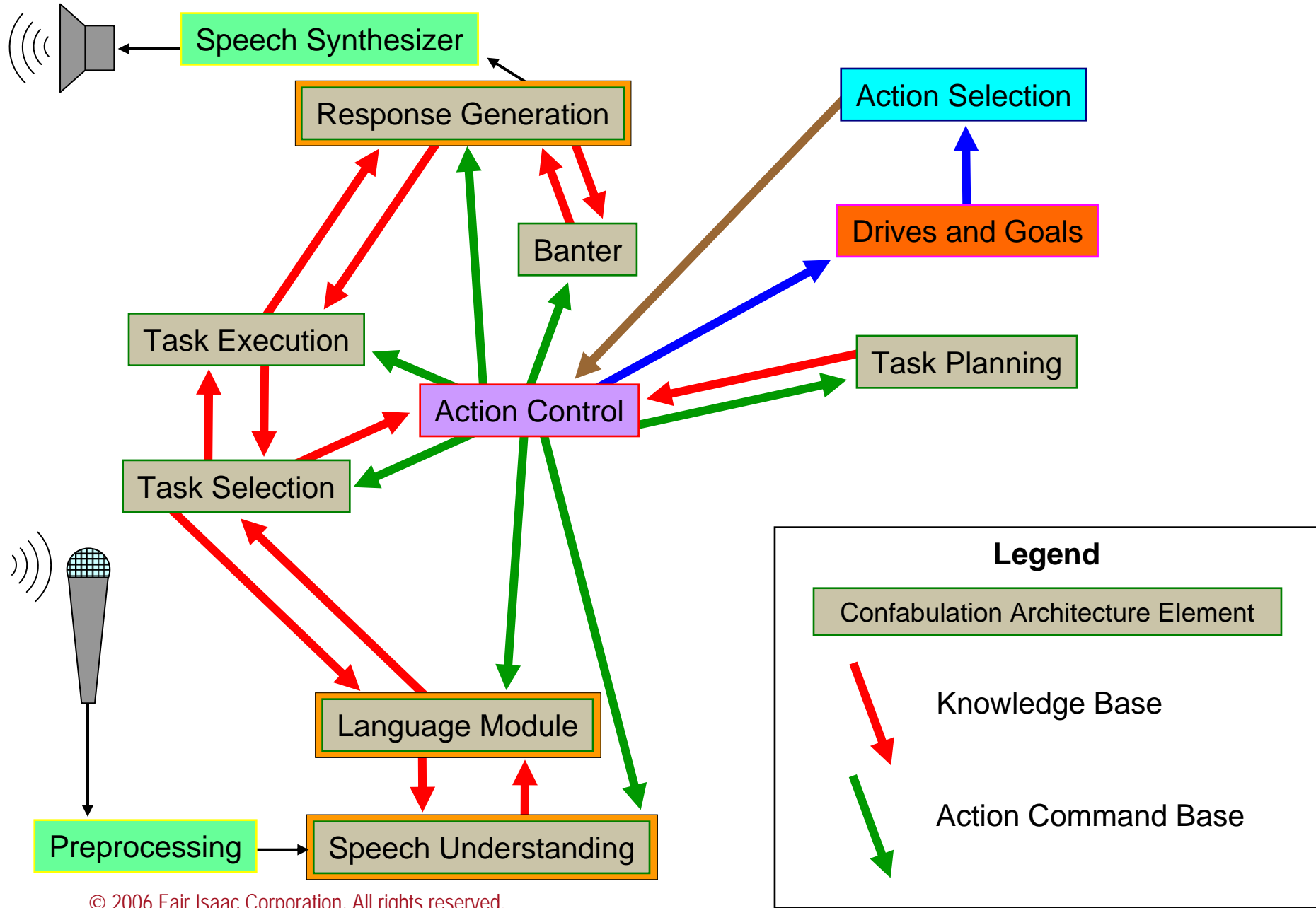
CONFABULATION THEORY CHARACTERISTICS

Confabulation Theory Characteristics

▶ **Confabulation Theory:**

- ▶ Each of 4,000 human cortical modules describes one object *attribute*

- ▶ Each module has thousands of *symbols* to describe its attribute

- ▶ A *knowledge link* forms between each pair of meaningfully co-occurring symbols

- ▶ *Additive* target module symbol knowledge link input excitation combination

- ▶ *Confabulation*: winner-take-all selection of most-excited target module symbol

- ▶ Simple, fast, mutual-consultation *multiconfabulation* convergence

- ▶ Immediate triggering of the action commands linked from confabulation conclusion

CONFABULATION THEORY CHARACTERISTICS

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▶ **Confabulation Neuroscience**

▶ **Simulating Confabulation on a Computer**

   ▶ A Single Confabulation

   ▶ Multiconfabulation

   ▶ Speech Understanding

▶ **Practical Applications**

   ▶ *Chancellor* Project

Chancellor

Fair Isaac *Chancellor* Project Roadmap

1. **Conversational Response Generation**
   - **1A.** Meaning content representation modules
   - **1B.** Response generation thought processes
   - **1C.** Transition from proper text English to colloquial spoken English

2. **Consumer Service Task Management**
   - **2A.** Task partition learning and subtask completion state detection
   - **2B.** Subtask execution management

3. **Conversational Banter Mode**
   - **3A.** Superb human conversationalist / raconteur performance capture

4. **Speech Understanding**
   - **4A.** Transition to colloquial spoken English language
   - **4B.** Cocktail party front end and speaker recognition
   - **4C.** New speaker learning and login tools

5. **Superb Human Consumer Service Agent Performance Capture**
   - **5A.** Implement instrumented pilot-application call center
   - **5B.** Train task management subsystem

6. ***Chancellor* Prototype**
   - **6A.** Integrate Confabulation Architecture
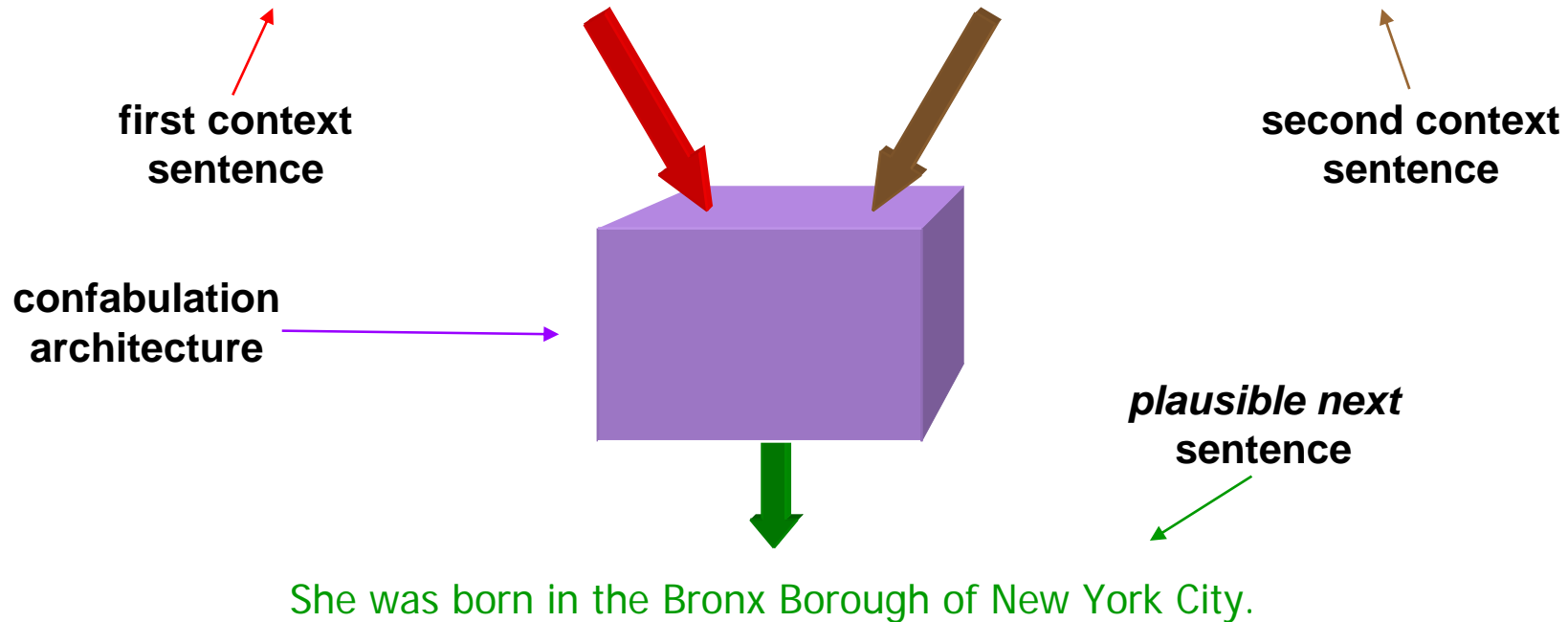   - **6B.** Build, test ↔ improve, and demonstrate *Chancellor* prototype

Sentence Generation: Add a *Plausible Next Sentence* to two previous Context Sentences

Several other centenarians at Maria Manor had talked about trying to live until 2000, but only Wegner made it.

Her niece said that Wegner had always been a character – former glove model , buyer for Macy's, owner of Lydia's Smart Gifts downtown during the 1950s and '60s – and that she was determined to see 2000 .

first context sentence

second context sentence

confabulation architecture

plausible next **sentence**

She was born in the Bronx Borough of New York City.

Chancellor Project
CONVERSATIONAL RESPONSE GENERATION

Plausible Next Sentence Experimental Results

Seeing us in a desperate situation, the Lahore airport authorities switched on the runway lights and allowed us to land with barely one to two minutes of fuel left in the aircraft, he said.
At Lahore, Pakistani authorities denied Saran's request to accept wounded passengers and women and children, but they refueled the plane.
Airport authorities said they were not consulted beforehand.

Michelle strengthened from a Category 2 to a Category 4 storm Saturday, with winds reaching 140 mph, but it was expected to weaken before it reached Florida.
The storm or its effects could strike the Keys and South Florida tonight or early Monday, said Krissy Williams, a meteorologist at the National Hurricane Center in Miami.
Forecasters warned residents to evacuate their homes as a precaution.

But the constant air and artillery attacks that precede the advance of Russian troops have left civilians trapped in southern mountain villages, afraid to venture under the bombs and shells raining on the roads, Chechen officials and civilians said.
Residents of the capital Grozny who had fled the city in hopes of escaping to Georgia, which borders Chechnya to the south, have been stuck in the villages of Itum-Kale, 50 miles south of Grozny, and Shatoi, 35 miles south of Grozny.
Russian forces pounded the strongholds in the breakaway republic.

Chancellor Project
CONVERSATIONAL RESPONSE GENERATION

Plausible Next Sentence Experimental Results

A total of 22 defendants were convicted after the five-month trial of possessing explosives and plotting terrorist acts, but all were acquitted on charges that they were linked to the Al Qaeda terrorist network.

Jordanian authorities now have a second chance on the Hijazi case.

The defendants are accused of conspiring with the outlawed rebel group.

The doctrine is frank about Russia's economic weaknesses, calling for efforts to strengthen the economy in order for the country to remain a major power.

It acknowledges that it is in Russia's interest to maintain its economic links to the outside world and there is no suggestion that it intends to abandon free market principles.

President Boris Yeltsin has expressed his willingness to compromise.

Investigators say one man who got his license through a fixed test was Ricardo Guzman, the driver of a truck involved in a 1994 wreck in Wisconsin that killed six children in a burning minivan.

Prosecutors say Bauer, now retired, hastily shut down the probe of the accident and blocked other investigations that might have embarrassed Ryan.

The driver fled the scene after the collision.

Chancellor Project
CONVERSATIONAL RESPONSE GENERATION

Plausible Next Sentence Experimental Results

The National Corn Growers Association says Gore is likely to have an ear of corn following him too if EPA sides with California officials, who oppose using ethanol.
Ten days before the Iowa caucuses, Gore was more than 20 points ahead of Bradley in various Iowa presidential polls.
Gore's aides said they would not have any problems.

The incident threatens relations between the Americans and Kosovo civilians, whom the peacekeepers were sent to protect after the 78-day NATO bombing campaign.
We don't want them here to give us security if they are going to do this, said Muharram Samakova, a neighbor of the girl's family.
NATO has struck a military airfield near Pale.

Now, I must admit that I'm not so sure the Palestinians really wanted to reach a framework agreement, Eran said Tuesday.
Eran wondered aloud whether the Palestinian strategy might be to negotiate as much land as possible in the remaining transfers, then declare statehood unilaterally – as the Palestinians have threatened to do before when talks bog down.
Netanyahu said the Palestinians would be barred from jobs in Israel.

Chancellor Project
CONVERSATIONAL RESPONSE GENERATION

Chancellor™ – Cat Food for Zeus

Chancellor
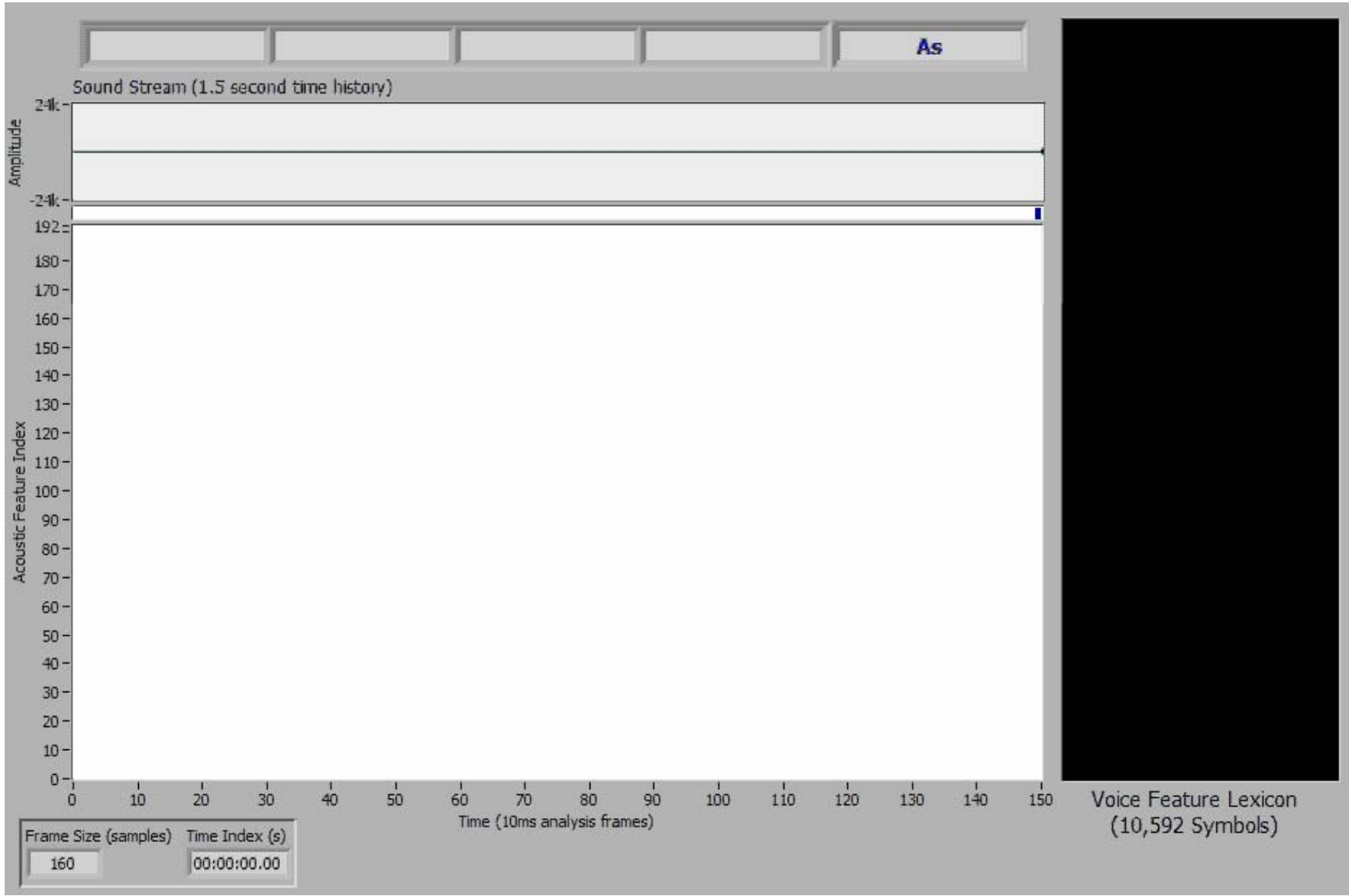
Fair Isaac *Chancellor* Project

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6. *Chancellor* **Prototype**

    6A. **Integrate Confabulation Architecture**

    6B. **Build, test ↔ improve, and demonstrate** *Chancellor* **prototype**

Speech Synthesizer

Response Generation

Action Selection

Banter

Drives and Goals

Task Execution

Task Planning

Action Control

Task Selection

Preprocessing

Language Module

Speech Understanding

Legend

Confabulation Architecture Element

Knowledge Base

Action Command Base

Research Sponsors

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Summary

▶ **Confabulation Theory Overview**

    ▶ Cortical Representation of the Objects of the Mental World

    ▶ Acquisition and Storage of Cognitive Knowledge

    ▶ Confabulation

    ▶ The Origin of Behavior

    ▶ Confabulation Mathematics

▶ **Confabulation Neuroscience**

▶ **Confabulation on a Computer**

    ▶ A Single Confabulation

    ▶ Multiconfabulation

    ▶ Speech Understanding

▶ **Practical Applications**

    ▶ *Chancellor* Project

Confabulation Theory Details

▶ **1. Underlying Mathematics and Rationale, Single Confabulation Experiments:**

  ▶ Hecht-Nielsen, R. (2005) "Cogent confabulation." *Neural Networks* **18**:111-115.

▶ **2. Implementation Details and Confabulation Theory Exposition:**

  ▶ Hecht-Nielsen, R. (2006) **Mechanization of Cognition**, in: Bar-Cohen, Y. [Ed.] **Biomimetics** (pp. 57-128) Boca Raton, FL: CRC Press.

▶ **3. Confabulation Architecture Cocktail Party Processor**

  ▶ Sagi, B., Nemat-Nasser, S. C., Kerr, R., Hayek, R., Downing, C. & Hecht-Nielsen, R. (2001) "A biologically motivated solution to the cocktail party problem." *Neural Computation* **13**:1575–1602.

▶ **4. Replicator Neural Networks: An Early Step Towards Confabulation**

  ▶ Hecht-Nielsen, R. (1995) "Replicator neural networks." *Science* **269**:1860–1863.

pdfs of these documents are available at:
http://r.ucsd.edu

The Mechanism of Thought

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Abstract

A winners-take-all competition process, termed confabulation, is proposed as the fundamental mechanism of all aspects of cognition (vision, hearing, planning, language, control of thought and movement, etc.). Here, multiple, contemporaneous, mutually interacting computer-simulated confabulations – in which millions of items of relevant knowledge are applied in parallel – are considered. At the beginning of such a *multiconfabulation*, billions of distinct, potentially viable, conclusion sets are considered. At the end, only one remains. This fast, massively parallel, additive application of relevant knowledge (a new kind of information processing) is hypothesized to be the core explanation for the information processing effectiveness, flexibility, and speed of thought.

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