Long-Term & Short-Term Memory

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MOTIVATION

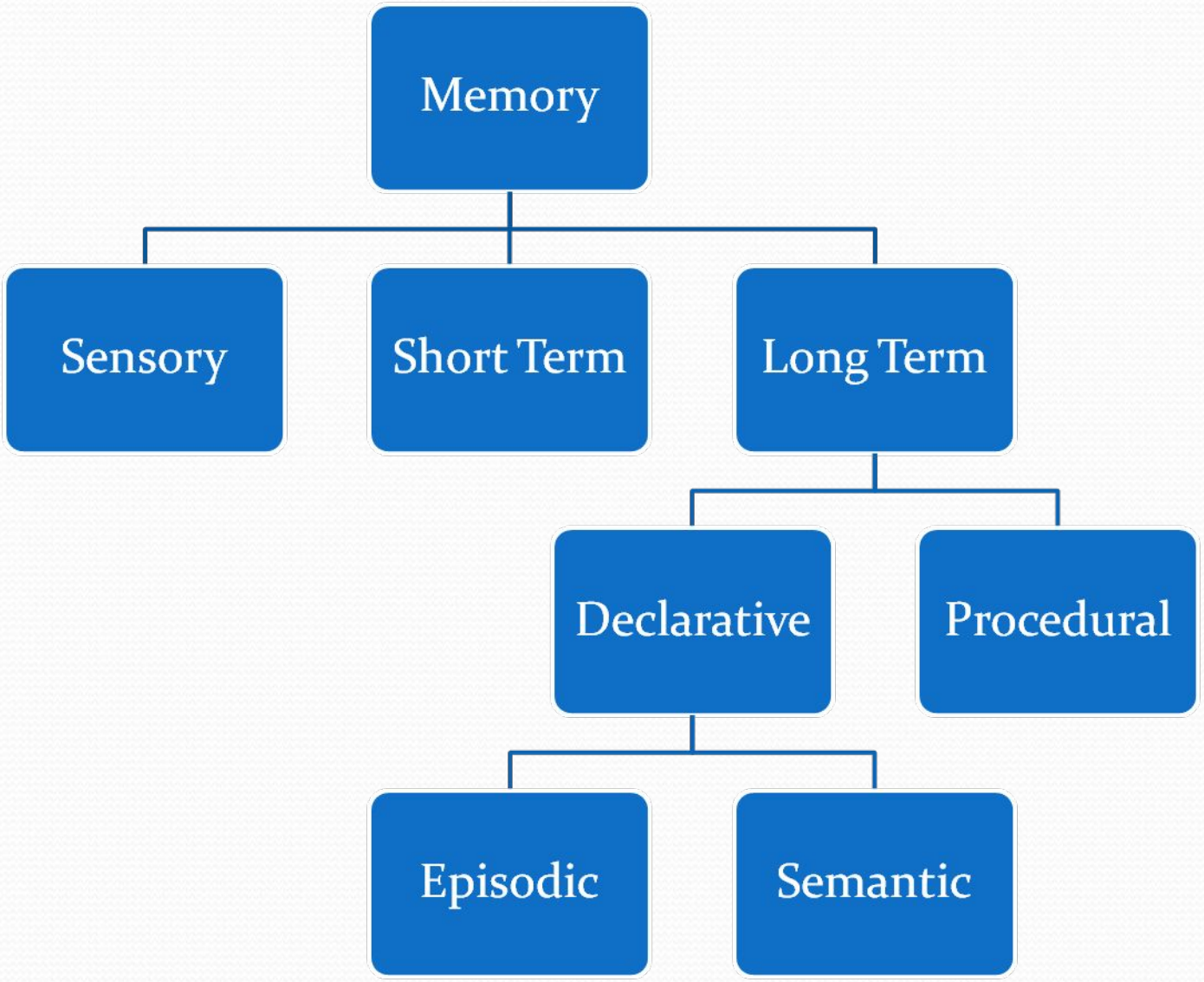
- "… each of us remembers and forgets in a pattern whose labyrinthing windings are an identification mark no less distinctive than a fingerprint" (American Pastoral, Philip Roth)

http://toshinx.files.wordpress.com/2009/03/liar2.jpg

http://www.sapdesignguild.org/resources/optical_illusions/images/sax.gif

INTRODUCTION

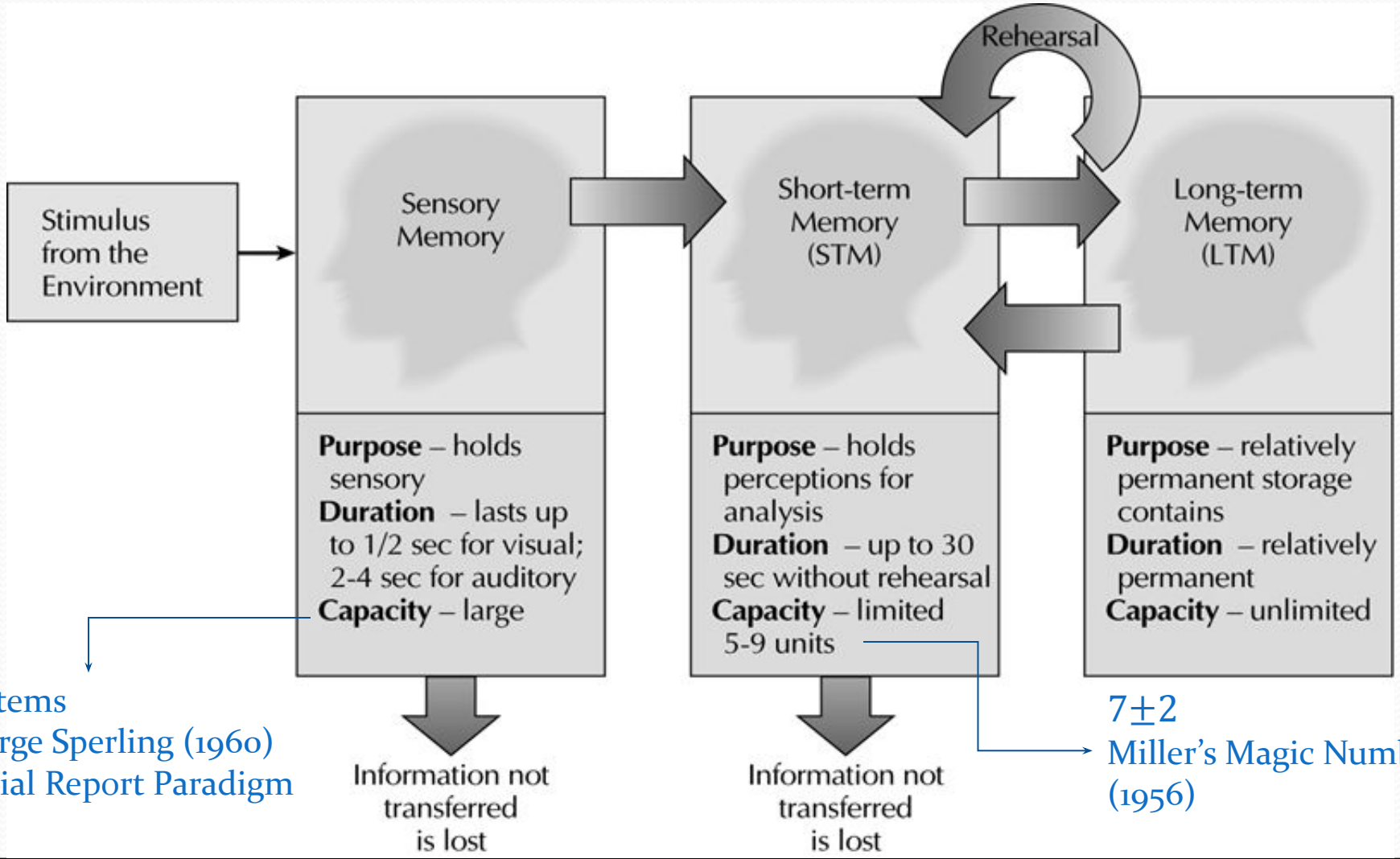
- *Memory* : Storage of information for later retrieval
- Human Memory Processes -> Strong Research Area in Psychology
- Most accepted model of Memory divides the memory into three major parts:
  - Sensory
  - Short Term
  - Long Term


Memory
Sensory
Short Term
Long Term
Declarative
Procedural
Episodic
Semantic

TYPES OF MEMORY

- *Sensory Memory*
  - Retain impressions of sensory information
  - Even after original stimulus ceases
- *Short Term Memory*
  - Capacity for holding a small amount of information
  - Readily available for a short period of time
- *Long Term Memory*
  - Memory that can last as little as a few days or as long as decades.

ATKINSON AND SHIFFRIN MODEL



- 12 items
- George Sperling (1960)
- Partial Report Paradigm

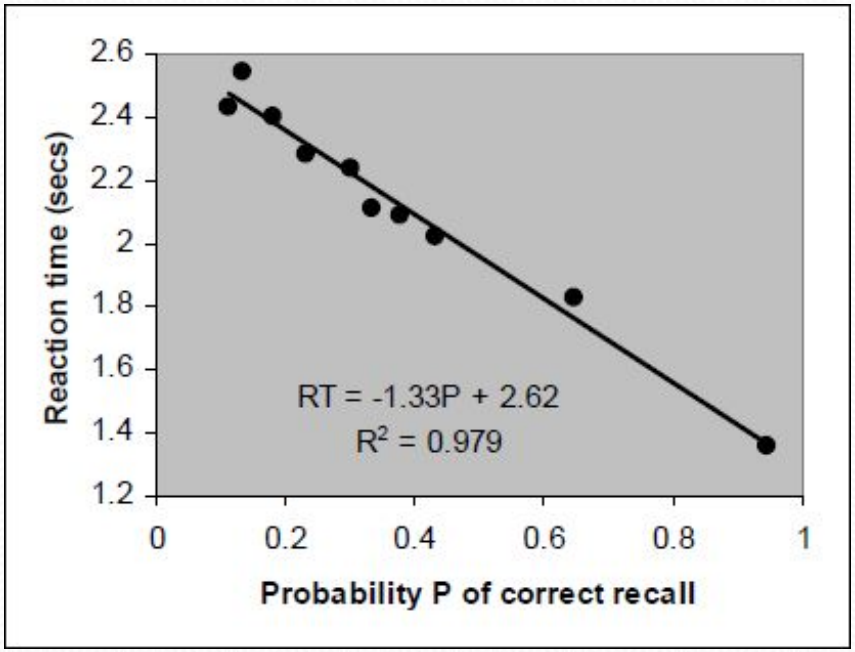
7 ± 2
Miller's Magic Number (1956)

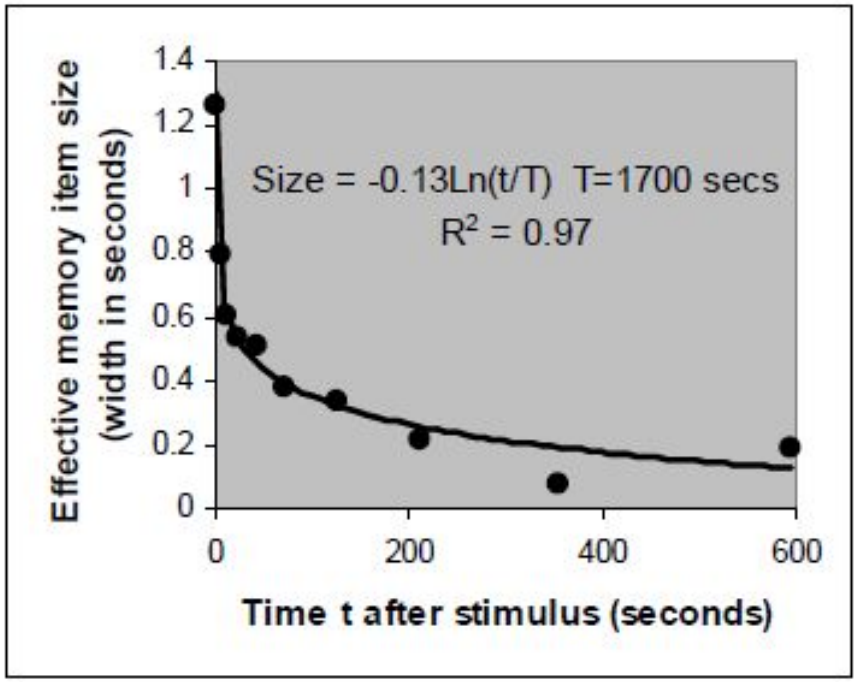
EVIDENCE

- Anterograde amnesia
  - Intact ability to retain small amounts of information over short time scales
  - Ability to form longer-term memories dramatically impaired
- Distractor task
  - Impairs memory for the 3 to 5 most recently learned words of a list while leaving recall for words from earlier in the list unaffected;
- Semantic similarity of the words
  - Affects only memory for earlier list words, not the last few words.
- Conclusion:
  - Short term recall ⇔ Rehearsal
  - Long-term recall ⇔ Semantic similarity

CONTRADICTIONS

- **Tarnow**'s work in 2005
  - The *recall probability vs. latency curve* is a straight line from 6 to 600 seconds, with the probability of failure to recall only saturating after 600 seconds .
  - Two different memory stores => Discontinuity in this curve. Contradicts LTM-STM model.
- Other research
  - Detailed pattern of recall errors very similar for recall immediately after learning and recall after 24 hours.
  - Not expected from Atkinson and Shiffrin model





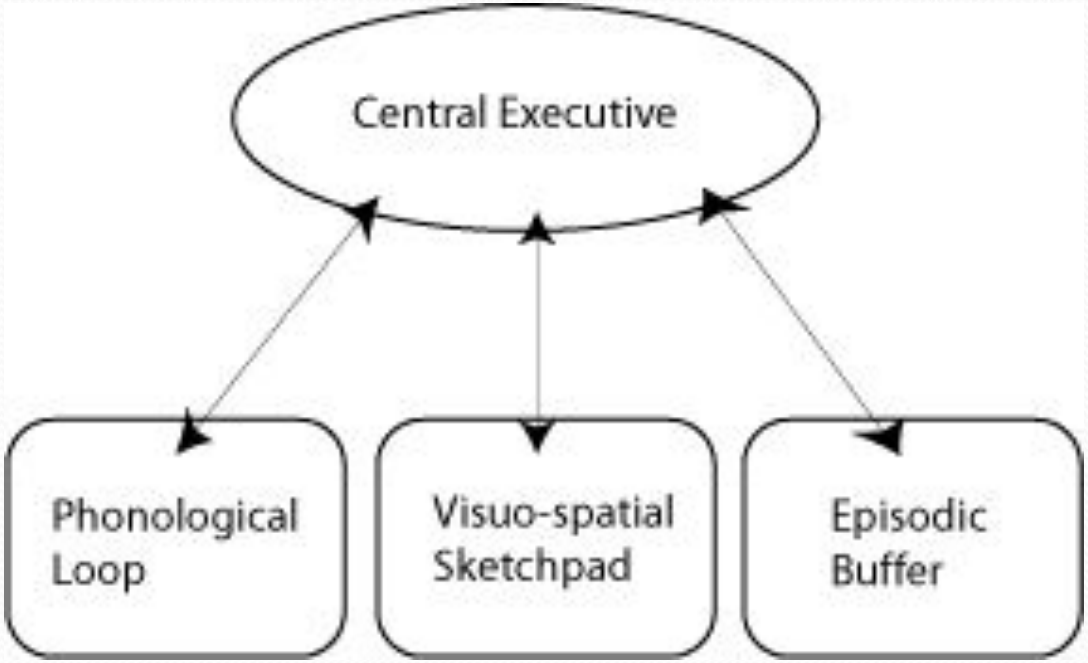
Source: Tarnow, Eugen (2005): *The Short Term Memory Structure In State-Of-The Art Recall/Recognition Experiments of Rubin, Hinton and Wentzel*.

SHORT TERM MEMORY

- *Memory span*
  - The longest list of items that a person can repeat back immediately after presentation in correct order on 50% of trials
- Miller observed this span to be approx 7 (*Miller's Magic Number*) for adults
- Memory span not limited in terms of bits but rather in terms of chunks
- *Chunk*
  - The largest meaningful unit in the presented material that the person recognizes
  - Eg. Numbers like 1947, 1857 can be associated with important years.

WORKING MEMORY

- Baddeley's model



== STM ??

http://en.wikipedia.org/wiki/Baddeley%27s_model_of_working_memory

LONG-TERM MEMORY

- Long term memory encodes information semantically for storage, as researched by Baddeley
- However, memory also encodes by sound for storage
  - “Tip of the tongue" state
- Role of *Sleep* in Long-Term Memory
  - Tarnow's theory, long term memories stored in dream format
  - Electrical excitations of cortex give rise to experiences similar to dreams

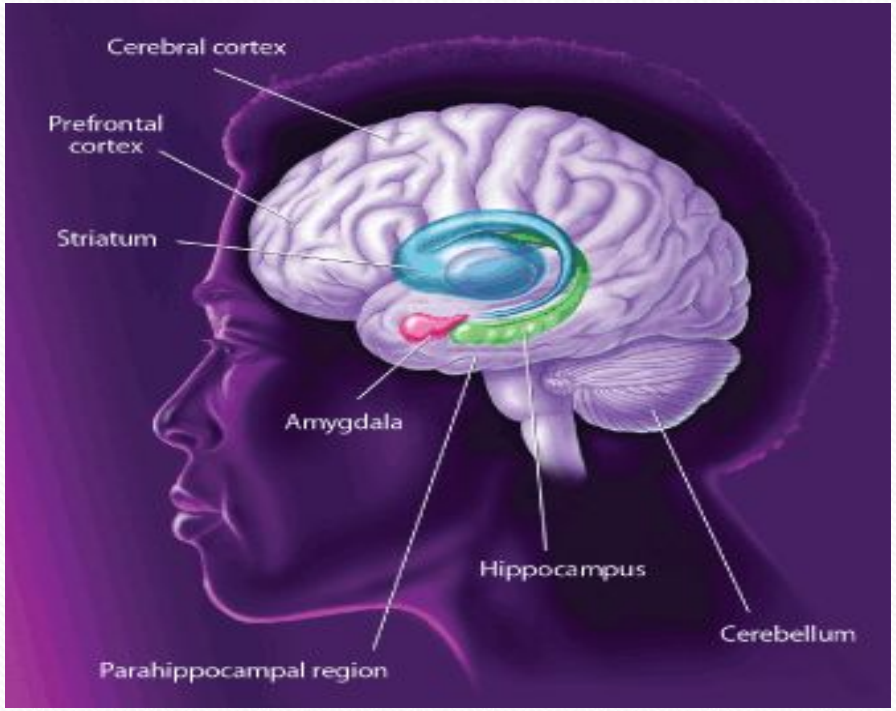
CLASSIFICATION OF LTM

- Declarative v/s Procedural:
  - Declarative
    - Factual Memory
    - Consciously Available
    - Consists of Episodic memory & Semantic memory
  - Procedural
    - Refers to the use of objects or movements of the body
- Prospective v/s Retrospective
- Emotional Memory

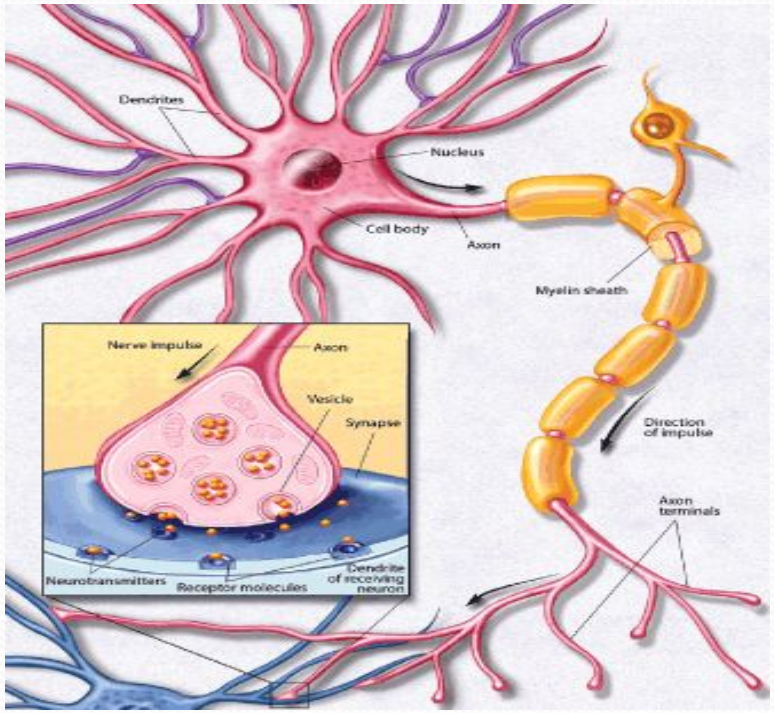
BIOLOGICAL BASIS

- Cerebral cortex receives nerve messages from eyes, ears, and touch sensors.
- The Prefrontal Cortex--Site of Working Memory .
- Reflexive Long Term memory relies on the cerebellum and amygdala.
- Declarative Long Term memory depend on the hippocampus and temporal lobes.
- Long Term Potentiation: STM->LTM is thought to be encoded by modification of synaptic strength.

BIOLOGICAL BASIS



LEARNING AND MEMORY. The hippocampus, parahippocampal region, and areas of the cerebral cortex (including prefrontal cortex) compose a system that supports declarative, or cognitive, memory. Different forms of nondeclarative, or behavioral, memory are supported by the amygdala, striatum, and cerebellum.



NEURON. A neuron transmits electrical signals along its axon.Neurotransmitters bind to receptor molecules on the surfaces of adjacent neurons. The point of contact is known as the synapse.

http://www.sfn.org/index.aspx?pagename=core_concepts_glossary

MEMORY AND A.I.

MEMORY AND A.I. – ISSUES

- Knowledge of the machine increases over time, slowing down its processing capability.
- How does the machine remember the past events along with their context ?
- How to use past events to decide what to perceive from new experiences?
- Continuously modifying the “beliefs” on the basis of new experiences.

(CONTD..)

- Some terms:
- *Knowledge* is the information about a domain that is used for solving problems in that domain.
- A *knowledge-based system* is a system that uses knowledge about a domain to act or to solve problems.
- Knowledge tends to mean general information that is taken to be true.
- *Belief* tends to mean information that can be revised based on new information.

INCREASING SET OF BELIEFS

- The point of view is therefore ***emulationist and not simulationist*.**
- The idea behind it is to build machines that do not necessarily simulate and reproduce the behaviour of the human mind, but are simply able to emulate it selectively, as the final result of several operations.
- Things only with the same context should be present in the working memory.

REMEMBERING PAST EVENTS

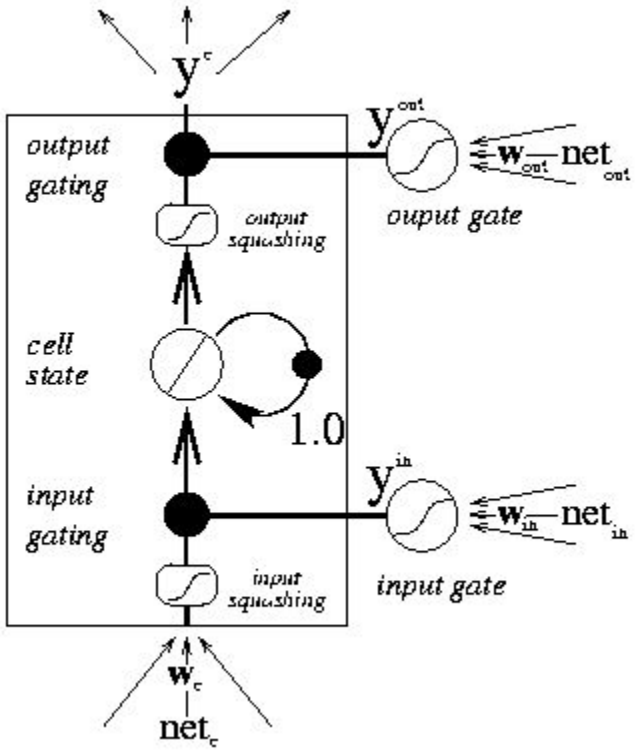
- What is remembering?
- How does the machine remember the past?
- Clancey(1997) writes that what is remembered depends upon the context, or better, what is experienced depends on the context.
- For humans its natural…

FUTURE DECISIONS

- Storing is one thing and being able to retrieve is another. Does it know what it knows?
- Usually, beliefs are overridden and machines forget what they did in the past.
- How do machines remember what is done in the past, if the work of the machine the next day is similar to the day before ?
- How can the remembered past influence current activities?

MEMORY IN A.I.

- Long Short Term Memory (RNN) :
  - A type of Artificial Neural Network.
  - Possesses learning capability, like any other neural network.
  - Contains a simple linear unit with a single self-recurrent connection which preserves the state of neuron.



MEMORY AS ART !

- Subject of interest from Historic times.
- Memory not a static entity. It can be honed by practice.
- *Mnemotechnics:* Used to organize memory impressions, improve recall, and assist in the combination of ideas.
- Techniques involve Architectural Association (Method of Loci), Graphical Mnemonic, Textual Mnemonic etc.

IMPROVING MEMORY

From a Student's perspective:

- Rephrase and explain.
- Be emotionally involved.
- Schedule and read in chunks.
- Use visual aids/word associations.

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THANK YOU