

The Unified Learning Model – Working Memory and Teaching

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Acknowledgment

- ▶ All slide contents adapted from *The Unified Learning Model* by D.F.Shell et al.

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Previously on the ULM...

- ▶ Learning occurs when the firing ability of neurons changes
- ▶ ULM Core Components
 - ▶ Working memory
 - ▶ Knowledge
 - ▶ Motivation
- ▶ General Rules of Learning
 - ▶ New learning requires attention
 - ▶ Learning requires repetition
 - ▶ Learning is about connections
 - ▶ Some learning is effortless; some requires effort
 - ▶ Learning is learning

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Overview

- ▶ Working Memory (Feb 3)
 - ▶ WM capacity
 - ▶ How WM functions
 - ▶ WM allocation
 - ▶ Relation to General Rules of Learning
 - ▶ Expanding WM capacity
 - ▶ Basic rules of WM
- ▶ Teaching (Feb 8)

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Working Memory Capacity

- ▶ Two main components
 - ▶ WM storage area
 - ▶ Temporary, brief storage of sensory input and/or knowledge retrieved from long-term memory
 - ▶ Storage capacity a function of span and speed
 - ▶ “The magical number seven, plus or minus two” (Miller, 1956)
 - ▶ Storage capacity = 4
 - ▶ WM processing system
 - ▶ Primary component is *attention*
 - ▶ Processing involves combining temporarily stored elements
 - ▶ Processing capacity = 4

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How Working Memory Functions

- ▶ Working memory receives a continuous stream of inputs at the neural level
- ▶ 4 slots – cannot store all incoming inputs
- ▶ Thus, inputs held for a very brief amount of time (a “cycle”)
- ▶ Attention is the key to holding information for more cycles – directs sensory input
- ▶ Working memory also interacts with long-term memory – pattern matching

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Working Memory Allocation

- ▶ Two conditions must be met to allocate working memory:
 - ▶ Slots must be available for sensory input or retrieved memory
 - ▶ Attention or processing has to be directed towards the slotted element

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Relation to General Rules of Learning

- ▶ **New Learning Requires Attention**
 - ▶ When working memory processing attends to something temporarily stored, it is more likely to be permanently stored
 - ▶ Attention by itself is sufficient for later recall
 - ▶ Neurons activated during learning are reactivated during recall
 - ▶ http://www.youtube.com/watch?v=f_9INBPUX9U

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Relation to General Rules of Learning

- ▶ **Learning Requires Repetition**
 - ▶ Repeating attention focus puts element back into temporary storage
 - ▶ Foundation of *rote memorization*
 - ▶ Extended repetition is critical for retrieval
- ▶ **Learning is about Connections**
 - ▶ Working memory processing can connect new sensory info to existing knowledge and break down existing connections

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Expanding Working Memory Capacity

- ▶ Read each row, look away for five seconds, then recite:
 - ▶ x g c w
 - ▶ m q p t x r
 - ▶ z p w x m v b t
 - ▶ m t p j w s d l q
 - ▶ dog farm rocket
 - ▶ onion frame car rodeo

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Expanding Working Memory Capacity

- ▶ Remember the numbers:
 - ▶ 6
 - ▶ 0
 - ▶ 2
 - ▶ 5
 - ▶ 7
 - ▶ 1
 - ▶ 2
 - ▶ 602-5712

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Expanding Working Memory Capacity

- ▶ Four slots, four elements – of what?
 - ▶ Chunks
 - ▶ A connected grouping of knowledge
 - ▶ Dramatically expands working memory

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Basic Rules of Working Memory

- ▶ **Storage Rules**
 - ▶ If something in working memory is attended to, store it in long-term memory (attention effect)
 - ▶ If something is in working memory for multiple cycles, store it in long-term memory (repetition/rehearsal effect)
 - ▶ If things are in working memory together, store them together in long term memory (connection/association effect)
- ▶ **Retrieval Rule**
 - ▶ If something in working memory is the same as something in long-term memory, retrieve the long-term memory contents (pattern matching effect)

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Questions



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Previously on the ULM...

- ▶ **Working memory**
 - ▶ Consists of storage and processing components
 - ▶ Four slot capacity, one element per slot
 - ▶ Drastically expanded with chunking
- ▶ **Storage is based on *attention, repetition, and connections***
- ▶ **Retrieval is based on *pattern matching***

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Overview

- ▶ Working Memory (Feb 3)
- ▶ **Teaching (Feb 8)**
 - ▶ “Good Teaching”
 - ▶ Supporting Motivation
 - ▶ Focusing Attention
 - ▶ Providing Repetition Opportunities
 - ▶ Facilitate Connections
 - ▶ Effortless vs. Requiring Effort

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“Good Teaching”

- ▶ All “good teaching” is anchored in the three principles of the ULM
 - ▶ Learning is a product of working memory allocation
 - ▶ WM’s capacity for allocation is affected by prior knowledge
 - ▶ WM’s allocation directed by motivation
- ▶ **Effective instruction must:**
 - ▶ Provide support for maintaining **motivation**
 - ▶ Focus student **attention** on relevant material and avoid distractions
 - ▶ Provide opportunities for **repetition** of new information or learning processes
 - ▶ Facilitate **connections** to previously learned material and other prior knowledge
 - ▶ Remember that learning is learning

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Supporting Motivation

- ▶ The instructor goal is to direct students to focus working memory on learning the task
- ▶ **Basic methods include:**
 - ▶ Focus students on setting learning goals instead of performance or task goals
 - ▶ Help students develop an incremental theory of intelligence and ability
 - ▶ Foster students’ belief in effort



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Supporting Motivation

- ▶ **More basic methods:**
 - ▶ Help students connect learning to future goals and outcomes
 - ▶ Build students' self-efficacy
 - ▶ Use interest and novelty to attract attention to relevant learning materials rather than distracters

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Focusing Attention

- ▶ **New learning requires working memory and attention**
- ▶ **What focuses attention?**
 - ▶ **Situational Interest**
 - ▶ Directs attention
 - ▶ A property of the environment
 - ▶ Can be directly manipulated by the instructor!
 - ▶ Problems
 - ▶ Nothing has universal situated interest for everyone
 - ▶ Seductive details
 - ▶ **Personal Interest**
 - ▶ Sustains long-term learning in personally meaningful domains
 - ▶ Little direct influence from instructors
 - ▶ Emerges from competence and growth in a discipline

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Providing Repetition Opportunities

- ▶ **Repetition is important for long-term memory**
 - ▶ Need at least four repetitions in varied contexts to learn information (Nuthall and Alton-Lee, 1995)
 - ▶ Need seven encounters with a new word to place it in memory and be able to retrieve it
- ▶ **Timing is important**
 - ▶ Seven times in one lesson is not as effective as seven times over days and weeks
- ▶ **"Drill and Kill"**
 - ▶ Suitable if rote memorization / automated knowledge is the goal
 - ▶ If not, successful teachers try to find ways for students to repeat information beyond rote memorization

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Facilitating Connections



- ▶ **Learning is about connections**
 - ▶ To what was learned in the class
 - ▶ To what was learned in other classes
 - ▶ To other prior knowledge

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Effortless vs. Requiring Effort

- ▶ **Episodic knowledge**
 - ▶ Knowledge of own life ("autobiographical memory")
 - ▶ Attended to automatically in working memory (effortless)
 - ▶ Fragile and susceptible to alteration
- ▶ **Semantic knowledge**
 - ▶ Knowledge that is not episodic - taught in school
 - ▶ Requires effort to attend to and store for later use
- ▶ **Repetition** and **connections** are key to moving knowledge from episodic to semantic memory

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Discussion

- ▶ How can this apply to multiagent systems?
- ▶ How would teaching agents differ from teaching humans?

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Questions

