

# Unit 4: Base-Level Activation

(P increment

=goal>

isa count

state counting

number =num1

=retrieval>

isa count-order

first =num1

second =num2

==>

=goal>

number =num2

+retrieval>

isa count-order

first =num2)



Harvest from  
Retrieval  
Buffer



Request to  
Retrieval  
Module

# Activation Computations

- Both latency and probability of recall depend on an underlying subsymbolic quantity - activation
- (sgp :esc t)
- Activation Equation

$$A_i = B_i + \underbrace{\sum_j W_j S_{ji}}_{\text{Spreading activation}} + \underbrace{\sum_k P_k M_{ki}}_{\text{Partial matching}} + \underbrace{\varepsilon_1 + \varepsilon_2}_{\text{Noise}}$$

Diagram illustrating the Activation Equation:

$A_i = B_i + \sum_j W_j S_{ji} + \sum_k P_k M_{ki} + \varepsilon_1 + \varepsilon_2$

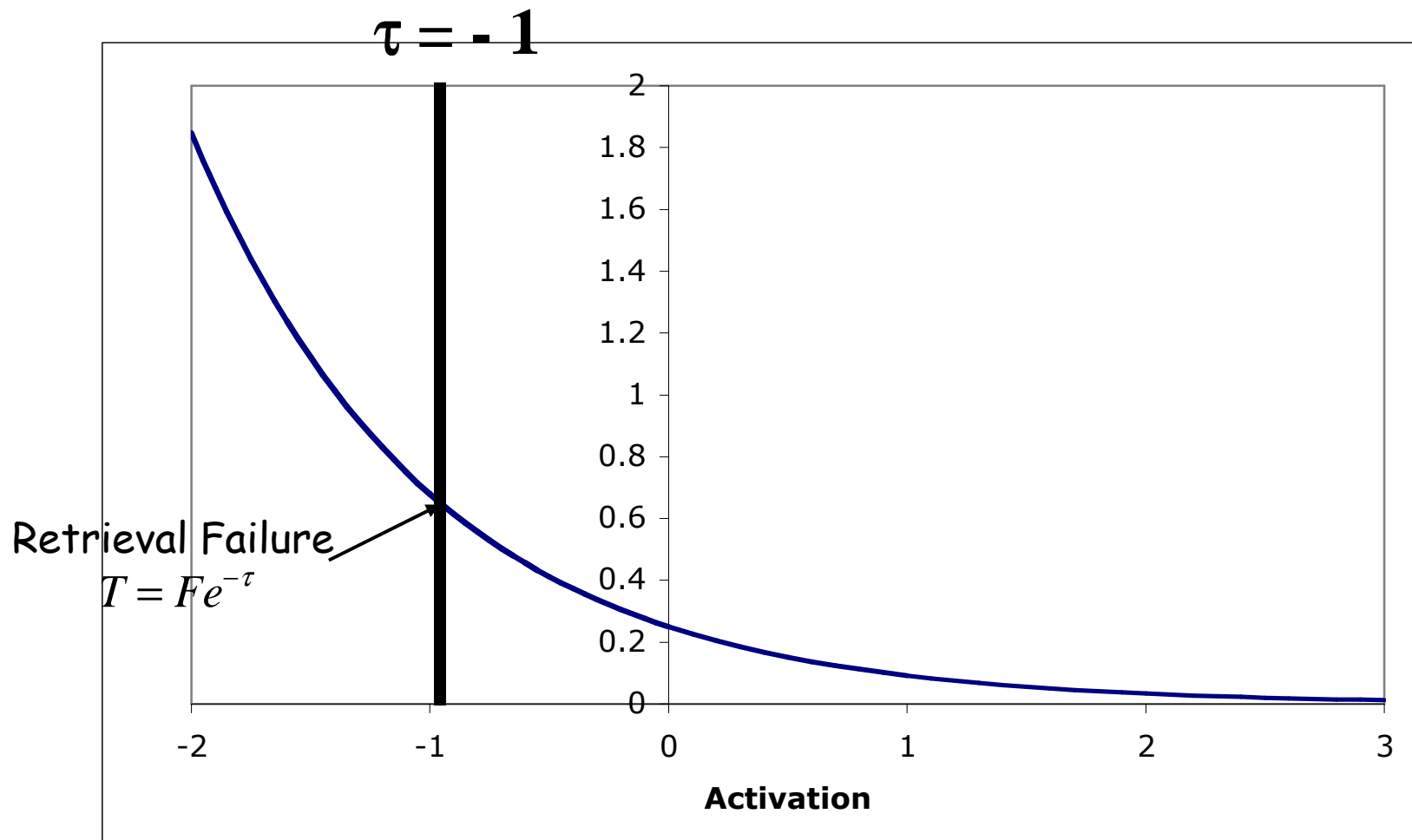
The equation is annotated with arrows and brackets indicating the components:

- $B_i$  is labeled "Base-level activation".
- $\sum_j W_j S_{ji}$  is labeled "Spreading activation".
- $\sum_k P_k M_{ki}$  is labeled "Partial matching".
- $\varepsilon_1 + \varepsilon_2$  is labeled "Noise".

# Response Time

$$T = Fe^{-A}$$

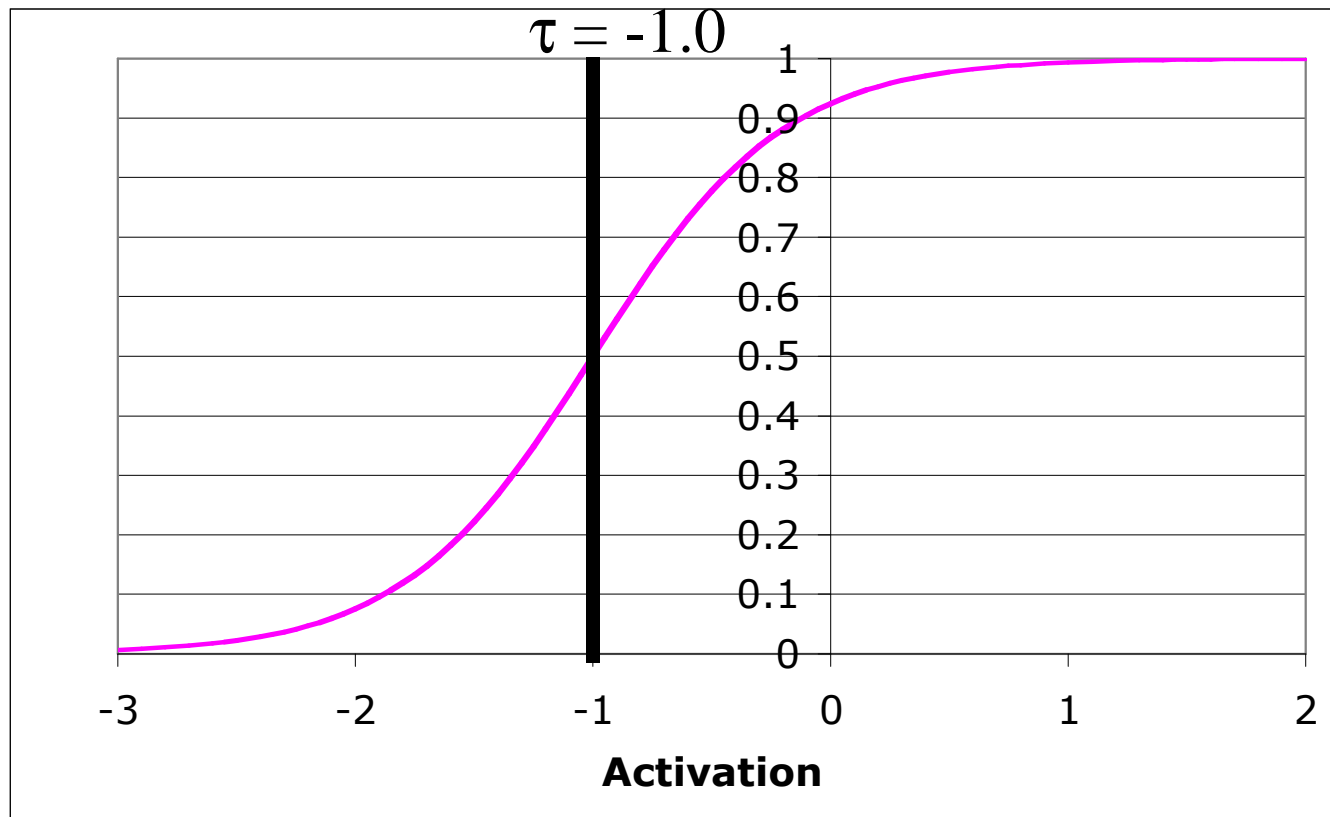
$$F = 0.25 \text{ sec}$$



# Probability of Recall

$$A_i = B_i + \varepsilon \quad \text{Logistic approximation to normal} \quad s = \frac{\sigma\sqrt{3}}{\pi}$$

$$P = \frac{1}{1 + e^{-(B_i - \tau)/s}} \quad s = .4$$



# Base-Level Activation

- Base-level activation depends on the history of usage of a chunk that attempts to estimate how likely it is to be needed.
- 2 Factors define the history in ACT-R
  - How recently you used it in the past
    - Recency
  - How much you practiced it
    - Frequency

# Base-Level Learning

$$B_i = \ln \left( \sum_k^n t_k^{-d} \right)$$

1. To prevent extreme values of activation and to make activation more suitable for activation operations, it is more appropriate to think of activation as log odds.
2. This means negative activations are possible.
3. Activation is an interval scale not a ratio scale -- I.e., like temperatures it does not have a natural zero.

# What Is an Event Presentation?

- Whenever a chunk is cleared from a buffer it is entered into declarative memory.
- The first time a chunk is created it will be entered into memory with its first presentation
- If a chunk is cleared from a buffer and a copy already exists the chunks are merged and the merged chunk gets an extra presentation.
- When a chunk is retrieved from declarative memory an additional presentation will be credited when it is cleared from the retrieval buffer.

# Encoding

? (sgp :v t :TRACE-DETAIL low)

(T LOW)

? (do-trial "a" "2" "c" "k")

0.000	GOAL	SET-BUFFER-CHUNK GOAL GOAL REQUESTED NIL
0.000	VISION	SET-BUFFER-CHUNK VISUAL-LOCATION LOC0
0.050	PROCEDURAL	PRODUCTION-FIRED ATTEND
0.135	VISION	SET-BUFFER-CHUNK VISUAL TEXT0
0.185	PROCEDURAL	PRODUCTION-FIRED READ-FIRST
0.185	SPEECH	<b>SUBVOCALIZE TEXT a</b>
0.185	VISION	SET-BUFFER-CHUNK VISUAL-LOCATION LOC2
0.235	PROCEDURAL	PRODUCTION-FIRED ATTEND
0.320	VISION	SET-BUFFER-CHUNK VISUAL TEXT2
0.385	IMAGINAL	SET-BUFFER-CHUNK IMAGINAL PROBLEM0
0.485	PROCEDURAL	PRODUCTION-FIRED READ-SECOND
0.485	SPEECH	<b>SUBVOCALIZE TEXT 2</b>
0.485	VISION	SET-BUFFER-CHUNK VISUAL-LOCATION LOC4
0.535	PROCEDURAL	PRODUCTION-FIRED ATTEND
0.620	VISION	SET-BUFFER-CHUNK VISUAL TEXT4
0.685	AUDIO	SET-BUFFER-CHUNK AURAL-LOCATION
0.735	PROCEDURAL	PRODUCTION-FIRED READ-THIRD
0.735	SPEECH	<b>SUBVOCALIZE TEXT c</b>



# Counting

0.985	PROCEDURAL	PRODUCTION-FIRED START-COUNTING
0.985	SPEECH	<b>SUBVOCALIZE TEXT a</b>
0.985	DECLARATIVE	SET-BUFFER-CHUNK RETRIEVAL A
1.235	PROCEDURAL	PRODUCTION-FIRED INCREMENT-RESULT
1.235	SPEECH	<b>SUBVOCALIZE TEXT 0</b>
1.235	DECLARATIVE	SET-BUFFER-CHUNK RETRIEVAL ZERO
1.485	PROCEDURAL	PRODUCTION-FIRED INCREMENT-COUNT
1.485	SPEECH	<b>SUBVOCALIZE TEXT b</b>
1.485	DECLARATIVE	SET-BUFFER-CHUNK RETRIEVAL B
1.735	PROCEDURAL	PRODUCTION-FIRED INCREMENT-RESULT
1.735	SPEECH	<b>SUBVOCALIZE TEXT 1</b>
1.735	DECLARATIVE	SET-BUFFER-CHUNK RETRIEVAL ONE
1.985	PROCEDURAL	PRODUCTION-FIRED INCREMENT-COUNT
1.985	SPEECH	<b>SUBVOCALIZE TEXT c</b>
1.985	DECLARATIVE	SET-BUFFER-CHUNK RETRIEVAL C
2.235	PROCEDURAL	PRODUCTION-FIRED FINAL-ANSWER-YES
2.235	MOTOR	<b>PRESS-KEY k</b>
2.235	GOAL	SET-BUFFER-CHUNK GOAL GOAL0
2.535	-----	Stopped because no events left to process

# Learned Chunks

```
> (collect-data 1)
CORRELATION: 0.289
MEAN DEVIATION: 1.309
```

```
          2 (64)   3 (64)   4 (64)
Block 1  2.301 (64) 2.806 (64) 3.287 (64)
Block 2  2.290 (64) 2.804 (64) 3.301 (64)
Block 3  2.286 (64) 2.797 (64) 3.290 (64)
NIL
```

? (sdm isa problem)

```
PROBLEM0-0
ISA PROBLEM
ARG1 "b"
ARG2 "3"
RESULT "e"
```

```
PROBLEM1-0
ISA PROBLEM
ARG1 "f"
ARG2 "4"
RESULT "j"
```

```
PROBLEM4-0
ISA PROBLEM
ARG1 "c"
ARG2 "4"
RESULT "g"
```

Declarative parameters for chunk PROBLEM0-0:

```
:Retrieval-Activation NIL
:Retrieval-Time NIL
:Activation 2.175
:Permanent-Noise 0.000
:Base-Level 1.548
:Creation-Time 2.735
:Reference-Count 96.000
```

Declarative parameters for chunk PROBLEM1-0:

```
:Retrieval-Activation NIL
:Retrieval-Time NIL
:Activation 1.592
:Permanent-Noise 0.000
:Base-Level 1.549
:Creation-Time 6.215
:Reference-Count 96.000
```

Declarative parameters for chunk PROBLEM4-0:

```
:Retrieval-Activation NIL
:Retrieval-Time NIL
:Activation 0.133
:Permanent-Noise 0.000
:Base-Level 1.552
:Creation-Time 16.005
:Reference-Count 96.000
```