

## 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:

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

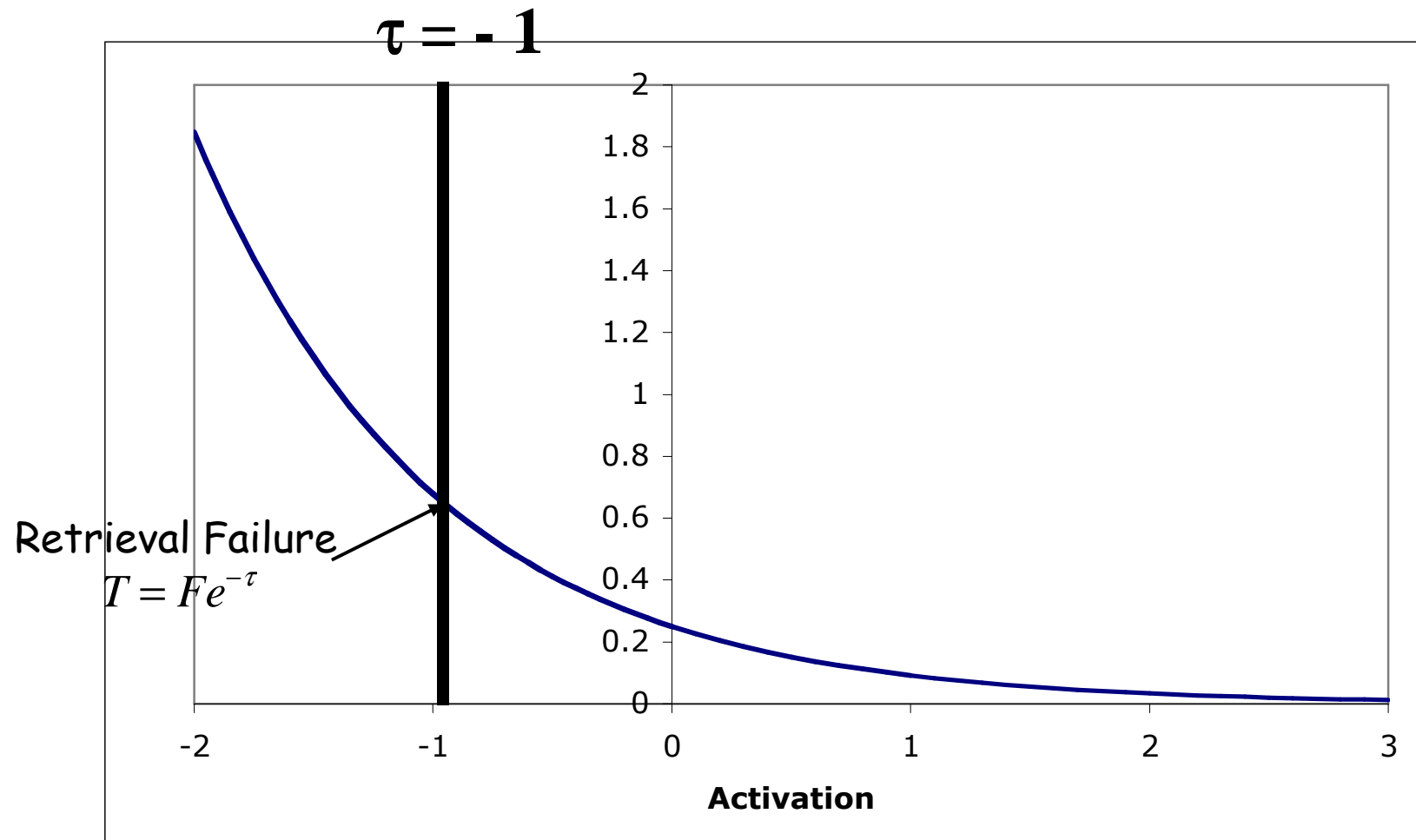
Labels and arrows indicating the components:

- $B_i$  is labeled "Base-level activation" with a downward arrow.
- $\sum_j W_j S_{ji}$  is labeled "Spreading activation" with a bracket underneath.
- $\sum_k P_k M_{ki}$  is labeled "Partial matching" with a bracket underneath.
- $\varepsilon_1 + \varepsilon_2$  is labeled "Noise" with two arrows pointing to each term.

# Response Time

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

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



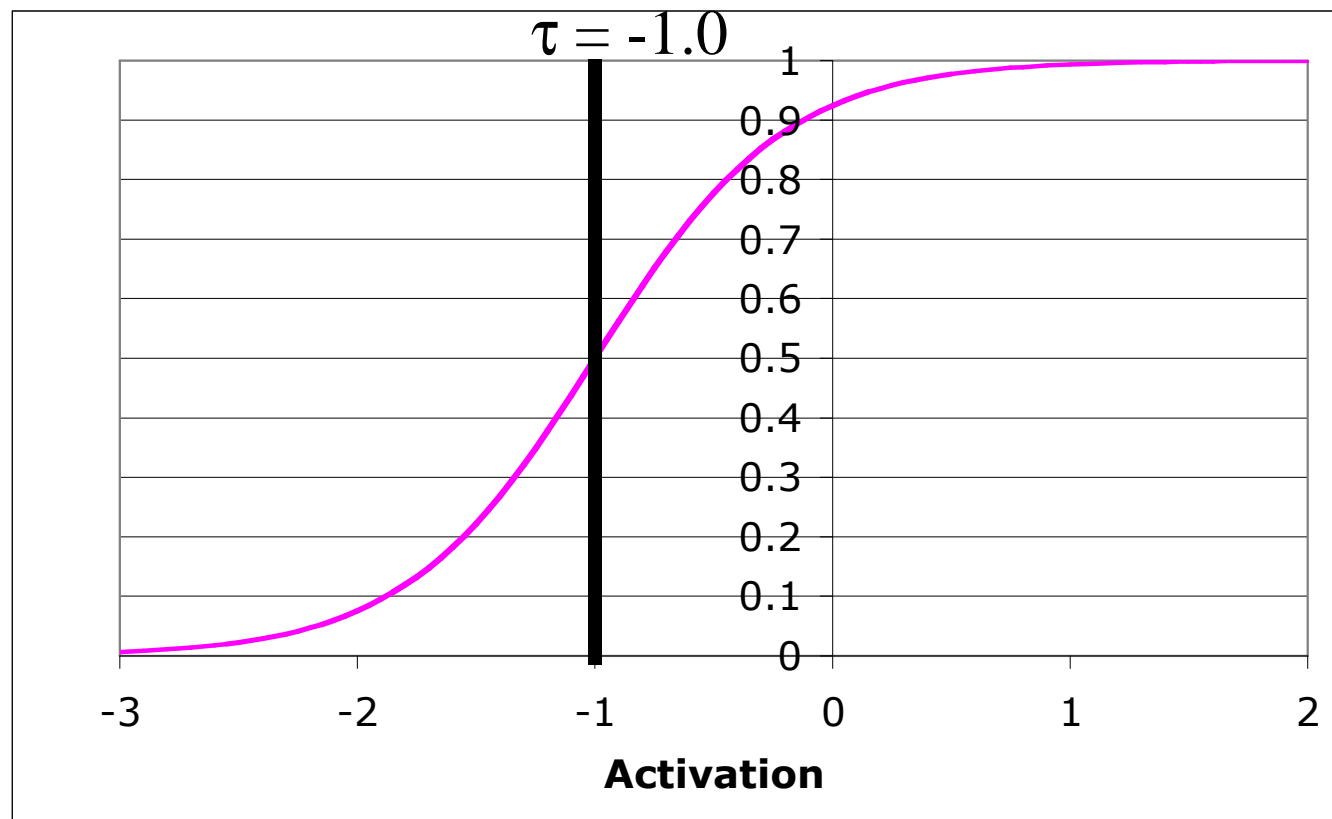
# Probability of Recall

$$A_i = B_i + \varepsilon$$

Logistic approximation to  
normal

$$s = \frac{\sigma\sqrt{3}}{\pi}$$

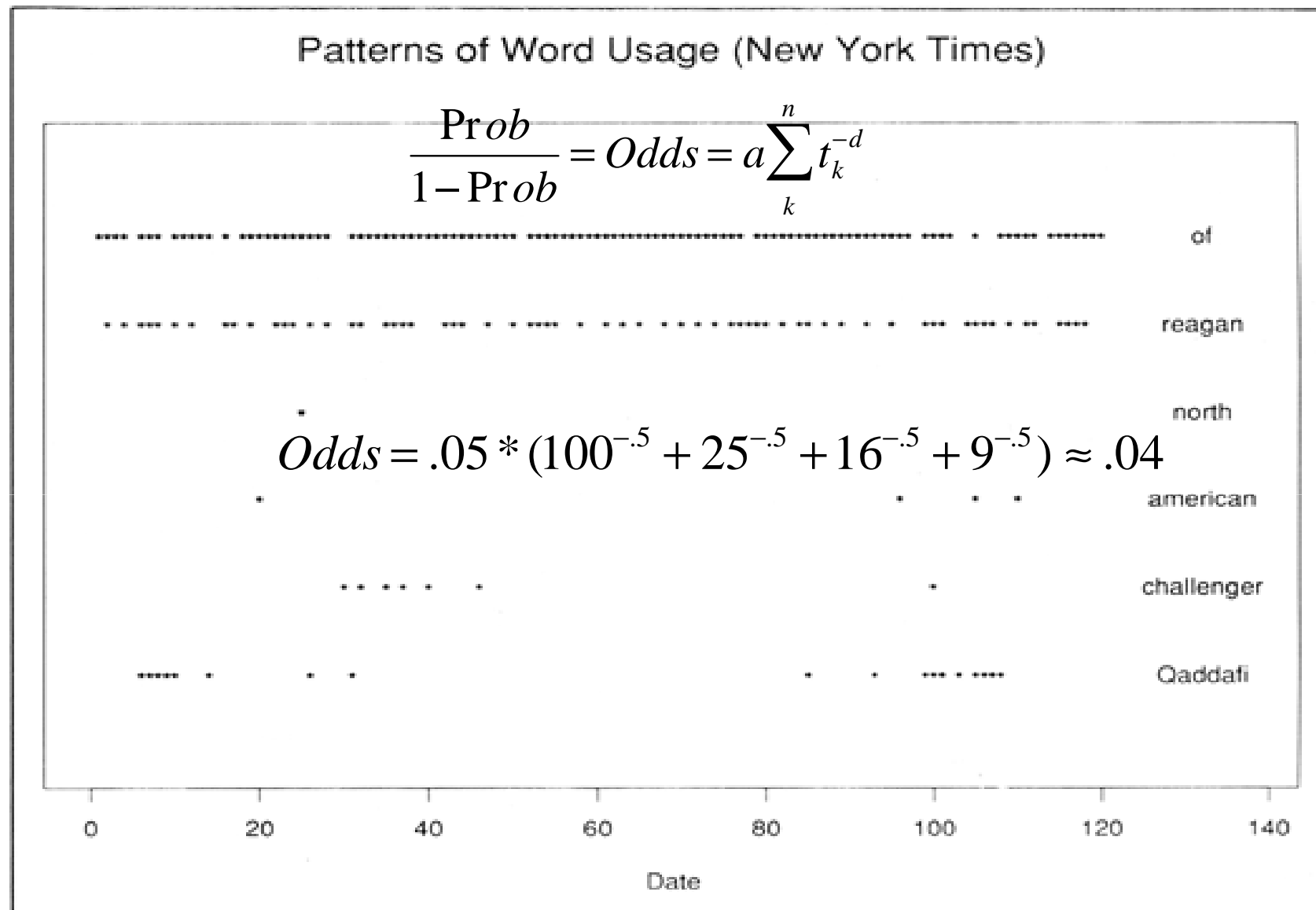
$$P = \frac{1}{1 + e^{-(B_i - \tau)/s}} \quad s = .4$$



# 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

# Anderson & Schooler, 1991



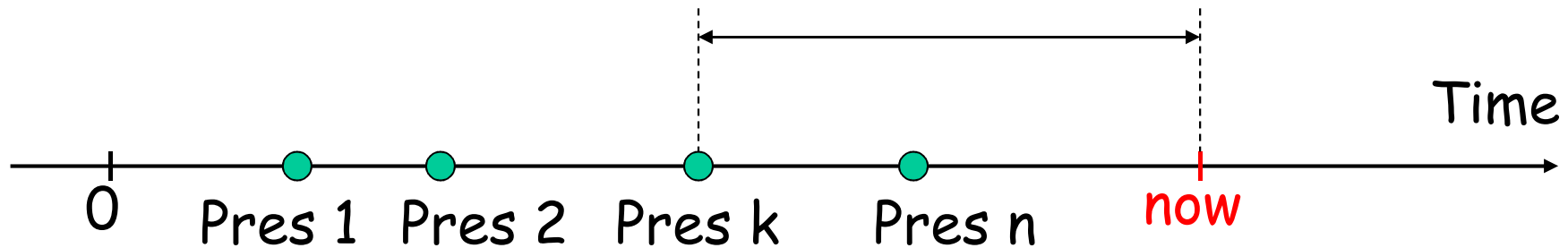
8/ Fig. 5. Patterns of usage of various words in the *New York Times* data base over a 100-day period. 6

# 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.

# Base-Level Learning



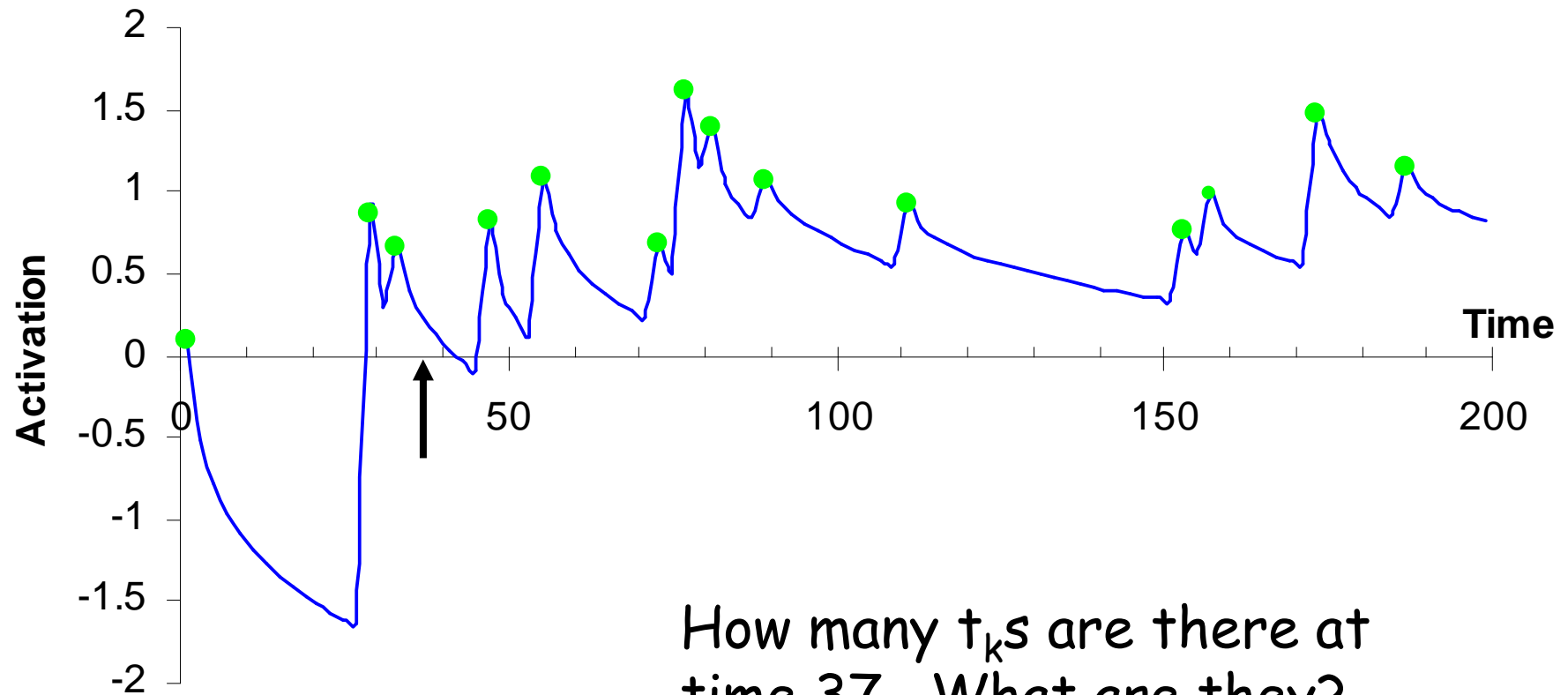
$$B_i = \ln \left( \sum_k^n t_k^{-d} \right)$$

time since the k-th  
presentation of  
the chunk i

decay parameter  
(sgp :bll 0.5)

Mathematically transform the  
ages to compute the current  
strength of a memory





How many  $t_k$ s are there at time 37. What are they?

If they are 4, 9, and 36 and  $d = .5$  what is  $B_i$ ?

$$\ln(1/4^{.5} + 1/9^{.5} + 1/36^{.5}) = 0$$

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

# 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.

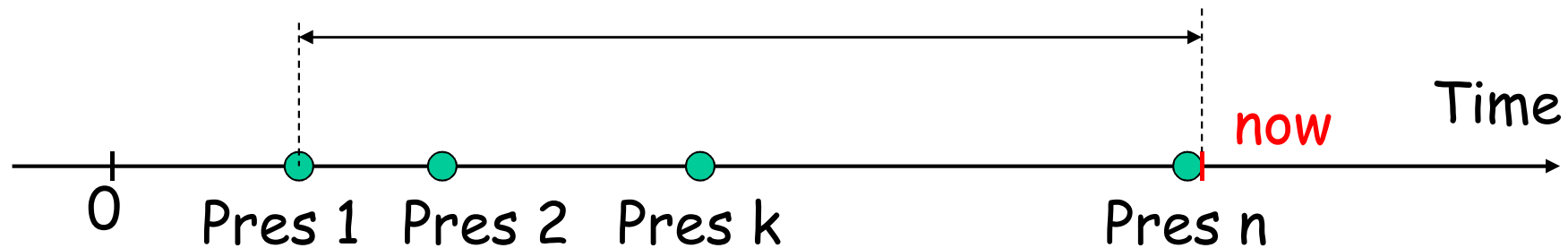
# Optimized Learning

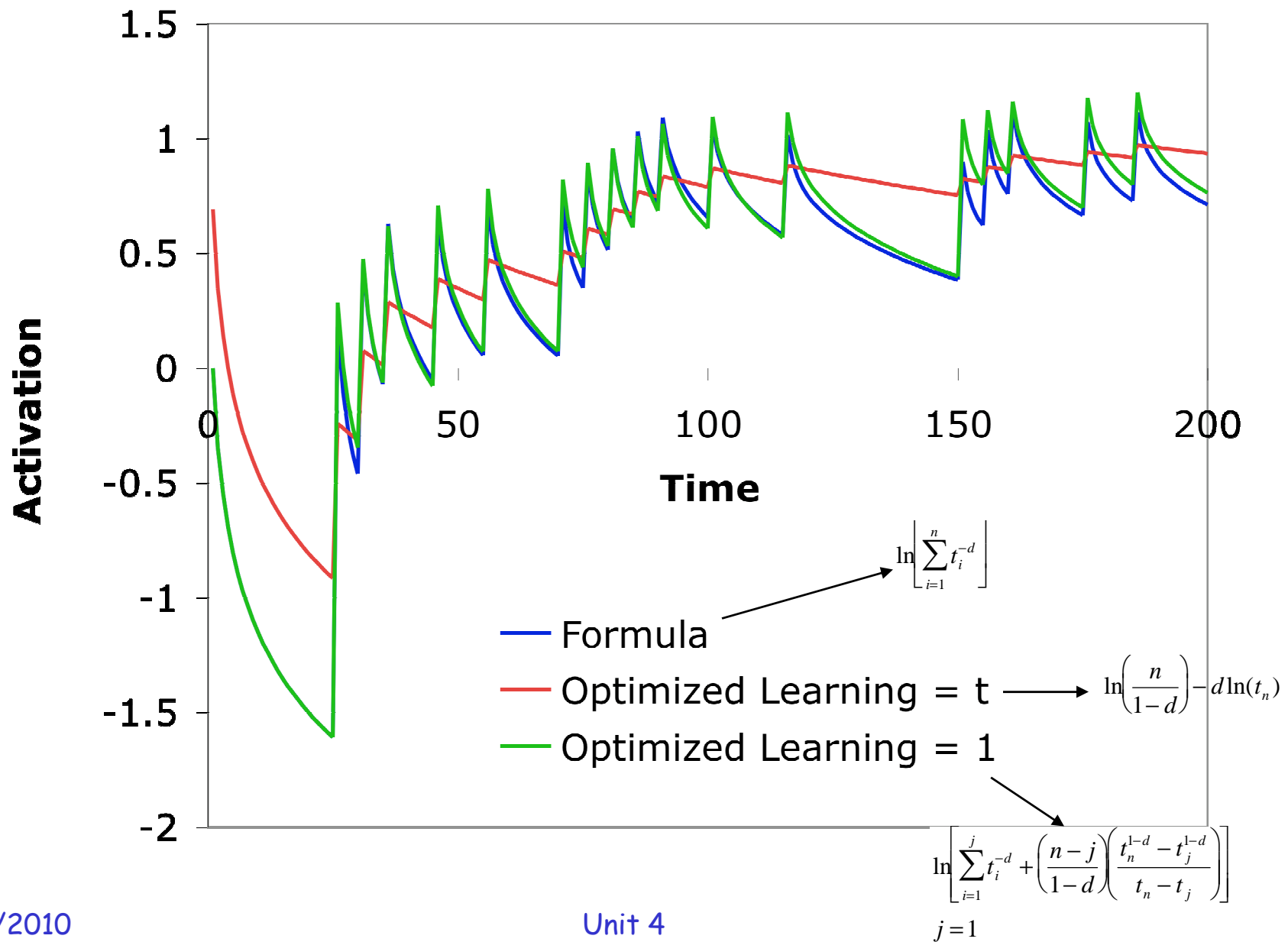
- When a chunk could be potentially retrieved, ACT-R needs to compute new base levels for all possibly matching chunks.
- Since this computation is a summation and might need to be computed for dozens of chunks it can be a slow process in some models
- Optimized learning is a much faster approximation
- (sgp :ol t)
- Can accurately keep last n presentations by (sgp :ol n)

# Optimized Learning Equation

- Optimized learning works best when the  $n$  presentations are spaced approximately evenly

$$B_i \approx \log\left(\frac{n}{1-d}\right) - d \cdot \log(T)$$





# Paired Associate Example

Trial	Accuracy	Latency
1	.000	0.000
2	.526	2.156
3	.667	1.967
4	.798	1.762
5	.887	1.680
6	.924	1.552
7	.958	1.467
8	.954	1.402

Relevant parameters:

- Retrieval Threshold (-2.0)
  - Break-even 50/50 point
- Activation Noise (0.5)
  - Slope of learning curve
- Latency Factor (0.4)
  - Magnitude of latency
- Decay Rate (0.5 - constant)
  - Parameter commitment?
  - Vs. knowledge/strategy?

Anderson, J.R. (1981). Interference: The relationship between response latency and response accuracy. *Journal of Experimental Psychology: Human Learning and Memory*, 7, 326-343.

# Assignment: Zbrodoff's Experiment

- Task
  - Alphabet arithmetic
  - Possible addends: 2, 3 or 4
  - True or false response to stimuli
- Example:  $A + 2 = C$
- Frequency manipulation:
  - Control -- each problem x 2
  - Standard - 2-add x 3, 3-add x 2, 4-add x 1
  - Reverse -- 2-add X 1, 3-add X 2, 4-add x 3

# Stimuli

- The Stimuli Set for the control condition was:

- (a 2 c k) (d 2 f k) (b 3 e k) (e 3 h k)
- (c 4 g k) (f 4 j k) (a 2 d d) (d 2 g d)
- (b 3 f d) (e 3 i d) (c 4 h d) (f 4 k d)
- (a 2 c k) (d 2 f k) (b 3 e k) (e 3 h k)
- (c 4 g k) (f 4 j k) (a 2 d d) (d 2 g d)
- (b 3 f d) (e 3 i d) (c 4 h d) (f 4 k d)

- Repeated 8 times per block
- For 3 Blocks of 192 trials each



# Data

## Control

	Two	Three	Four
Block 1	1.840	2.460	2.820
Block 2	1.210	1.450	1.420
Block 3	1.140	1.210	1.170

## Standard Group (smaller problems more frequent)

	Two	Three	Four
Block 1	1.840	2.650	3.550
Block 2	1.080	1.450	1.920
Block 3	0.910	1.080	1.430

## Reverse Group (larger problems more frequent)

	Two	Three	Four
Block 1	2.250	2.530	2.420
Block 2	1.470	1.460	1.110
Block 3	1.240	1.120	0.870

# Initial File - Just Counting

## Control Group

	Two	Three	Four
Block 1	1.840	2.460	2.820
Block 2	1.210	1.450	1.420
Block 3	1.140	1.210	1.170

> (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)

# Key Productions

(P read-third

=goal>

ISA goal  
state attending

=imaginal>

isa problem

arg1 =arg1

arg2 =arg2

=visual>

ISA text  
value =char  
status nil

?vocal>

state free

==>

=imaginal>

+vocal>

isa subvocalize

string =char

=goal>

target =char

state count

)

(P start-counting

=goal>

ISA goal  
state count

=imaginal>

isa problem

arg1 =a

arg2 =val

?vocal>

state free

==>

+vocal>

isa subvocalize

string =a

=imaginal>

result =a

=goal>

count "0"

state counting

+retrieval>

ISA sequence

identity =a)

# 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	SUBVOCALIZE TEXT a
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	SUBVOCALIZE TEXT 2
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	SUBVOCALIZE TEXT c

# Counting

0.985	PROCEDURAL	PRODUCTION-FIRED START-COUNTING
0.985	SPEECH	SUBVOCALIZE TEXT a
0.985	DECLARATIVE	SET-BUFFER-CHUNK RETRIEVAL A
1.235	PROCEDURAL	PRODUCTION-FIRED INCREMENT-RESULT
1.235	SPEECH	SUBVOCALIZE TEXT 0
1.235	DECLARATIVE	SET-BUFFER-CHUNK RETRIEVAL ZERO
1.485	PROCEDURAL	PRODUCTION-FIRED INCREMENT-COUNT
1.485	SPEECH	SUBVOCALIZE TEXT b
1.485	DECLARATIVE	SET-BUFFER-CHUNK RETRIEVAL B
1.735	PROCEDURAL	PRODUCTION-FIRED INCREMENT-RESULT
1.735	SPEECH	SUBVOCALIZE TEXT 1
1.735	DECLARATIVE	SET-BUFFER-CHUNK RETRIEVAL ONE
1.985	PROCEDURAL	PRODUCTION-FIRED INCREMENT-COUNT
1.985	SPEECH	SUBVOCALIZE TEXT c
1.985	DECLARATIVE	SET-BUFFER-CHUNK RETRIEVAL C
2.235	PROCEDURAL	PRODUCTION-FIRED FINAL-ANSWER-YES
2.235	MOTOR	PRESS-KEY k
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

# Parameter Search

Add a counting strategy

> (collect-data 20)

CORRELATION: 0.929

MEAN DEVIATION: 0.656

2 (64) 3 (64) 4 (64)

Block 1 1.265 (64) 1.444 (64) 1.338 (64)

Block 2 1.094 (64) 1.077 (64) 1.093 (64)

Block 3 1.043 (64) 1.047 (64) 1.039 (64)

Varying  $\tau$ , leave others (lf, d, s) constant

> (collect-data 20)

CORRELATION: 0.987

MEAN DEVIATION: 0.174

2 (64) 3 (64) 4 (64)

Block 1 1.870 (64) 2.179 (64) 2.558 (64)

Block 2 1.376 (64) 1.520 (64) 1.632 (64)

Block 3 1.215 (64) 1.282 (64) 1.359 (64)

Control Group

Two

Three

Four

Block 1 1.840 2.460 2.820

Block 2 1.210 1.450 1.420

Block 3 1.140 1.210 1.170

Useful functions:

- collect-data - whole set
- do-block - single block
- do-set - single set of 24
- do-trial - single trial

Set-all-base-levels call

:ncnar parameter - t to nil

Compile your model code

# The Google Environment

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"3+4" Search

About 1,260,000,000 results (0.27 seconds) Advanced search

Everything  
More

Any time  
Past 2 days

All results  
Related searches  
Sites with images  
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More search tools

[3/4 - Wikipedia, the free encyclopedia](#) ☆

3/4 may refer to: The Fraction (mathematics) three quarters or 0.75 in decimal; A ¾ Time signature, see triple metre · Three quarter pants · 3/4 perspective ...  
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The 3-4 defense is a basic defensive formation that is widely used today. This page explains which players are used, and illustrates their alignment on the ...  
[football.about.com/cs/a/34defense.htm](#) - Cached - Similar

[3 + 4](#) ☆

(Continues from the intermission). In the previous examples I sometimes referred to the familiar Smalltalk library classes such as OrderedCollection as if ...  
[blog.3plus4.org/](#) - Cached - Similar

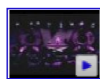
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Jul 9, 2010 ... 3/4. by mistermix. The US has lost 75% of Gitmo habeas cases. ... 68 Responses to "3/4". 1. July 9th, 2010 at 8:28 am. Cat Lady ...  
[www.balloon-juice.com/2010/07/09/34/](#) - Cached

[YouTube - Rammstein - Links 2,3,4](#) ☆



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people who say this is nazi dont know anything about the band. in fact, the band had nothing to do with the way this video was made. purchase ...  
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Sep 24, 2002 ... A WebQuest About WebQuests. Grades 3-4 Version. by Bernie Dodge · Ed Tech Department, San Diego State University ...  
[webquest.sdsu.edu/webquestwebquest-3-4.html](#) - Cached - Similar

[Elin to Get 3/4 of Tiger Woods' Fortune, Report Says | PopEater.com](#) ☆

Jul 1, 2010 ... Tiger Woods and wife Elin Nordegren have hammered out a blockbuster divorce settlement that will reportedly net the ex-model \$750 million. ...  
[www.popeater.com/.../tiger-woods-elin-nordegren-divorce-settlement/](#) - Cached

[The 14 3/4 Biggest Ideas of the Year - Magazine - The Atlantic](#) ☆

A guide to the intellectual trends that, for better or worse, are most shaping America right now.  
[www.theatlantic.com/magazine/archive/2010/07/the...3-4.../8147/](#) - Cached

1 2 3 4 5 6 7 8 9 10

[Next](#)

X+Y	0	1	2	3	4	5	6	7	8	9
0	647	381	179	136	122	152	87	67	68	110
1	471	1260	2230	616	504	449	286	217	261	185
2	234	455	430	1490	307	309	161	144	128	132
3	166	353	226	299	1260	333	184	137	141	102
4	133	272	168	194	213	1030	210	141	131	103
5	132	258	153	141	137	261	821	179	155	120
6	94	191	132	124	115	122	147	731	162	119
7	74	185	125	111	103	124	111	139	697	113
8	74	158	101	92	86	95	82	80	111	613
9	70	133	85	81	71	85	66	66	69	90