

# **SNOBOL-Tone (ST) - A Sound Pattern-Matching Programming Language**

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Stammering - Stuttering

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Bourse Fall

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Electro Cardiogram

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Polygraph

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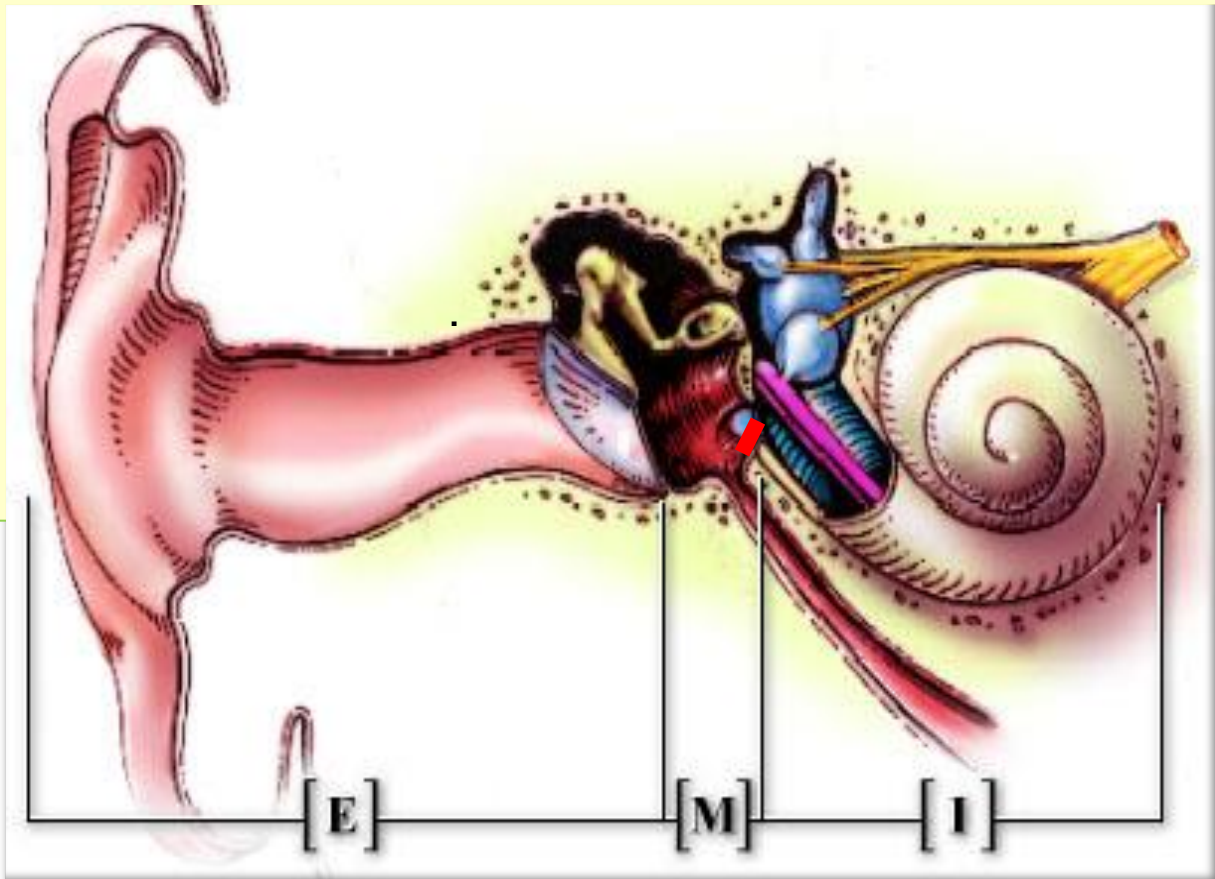


# Introduction

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# Nature Mimic (Spiral Snail)

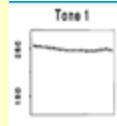


Peripheral ear  
(spiral snail):  
Transforming the  
amplitude into  
the frequency  
domain.

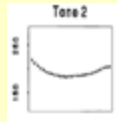
# Tone Pattern Matching

## Code-example

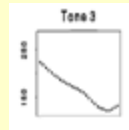
Tone1=



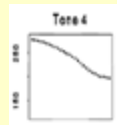
Tone2=



Tone3=



Tone4=



A7=Tone4, **Frequency** 1400Hz-2000Hz, **Amplitude As B**

D\_tone=(Tone1 v Tone3) & Y12

M1="original.mp3"

M1 (A7 D\_tone)

# SNOBOL-Tone – ST

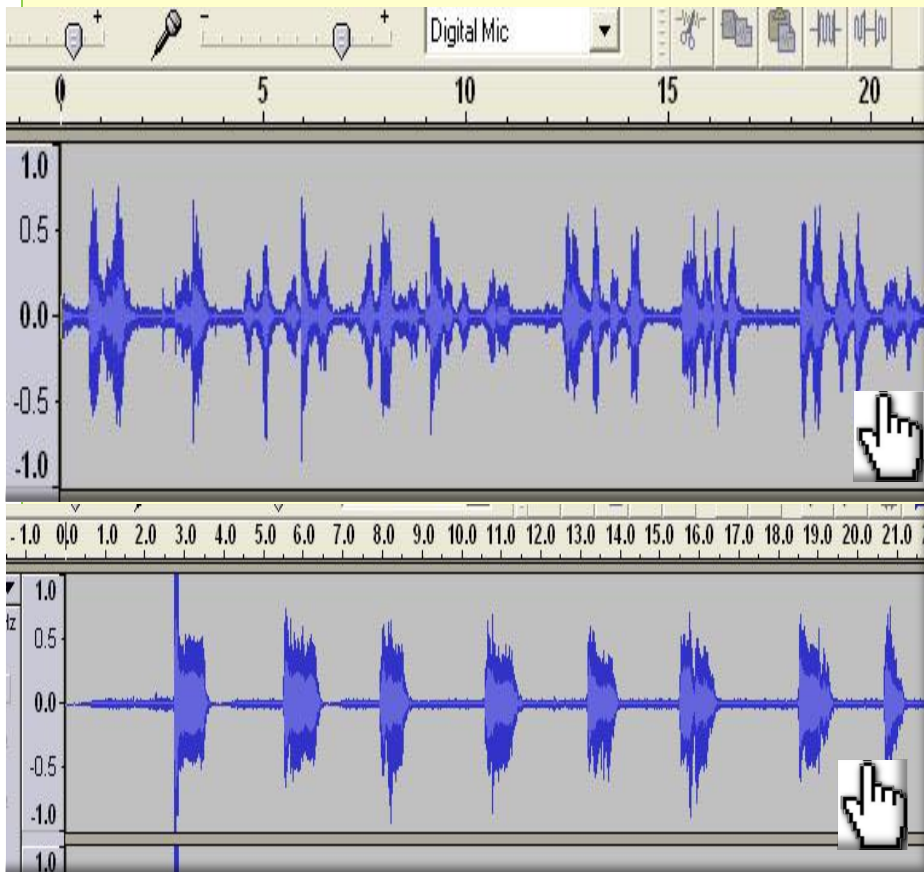
## Language Characteristics

- ***Pattern definition***

- 1. Pattern Matching: Identification, performing***
- 2. Substitution***
- 3. Methodology: procedural, object oriented, a new treatment of stream signal;***
- 4. Libraries: functions, software packages***
- 5. Data Bases: phonemes***



# Speech Signal - Sounds



“ •  
A Chinese •  
Monolog •

Syllable “Ma” •  
"[\Audacity\audacity.exe](#)" •



# Theoretical Background

- Mathematics
- Computer Science
- Electronic Engineering



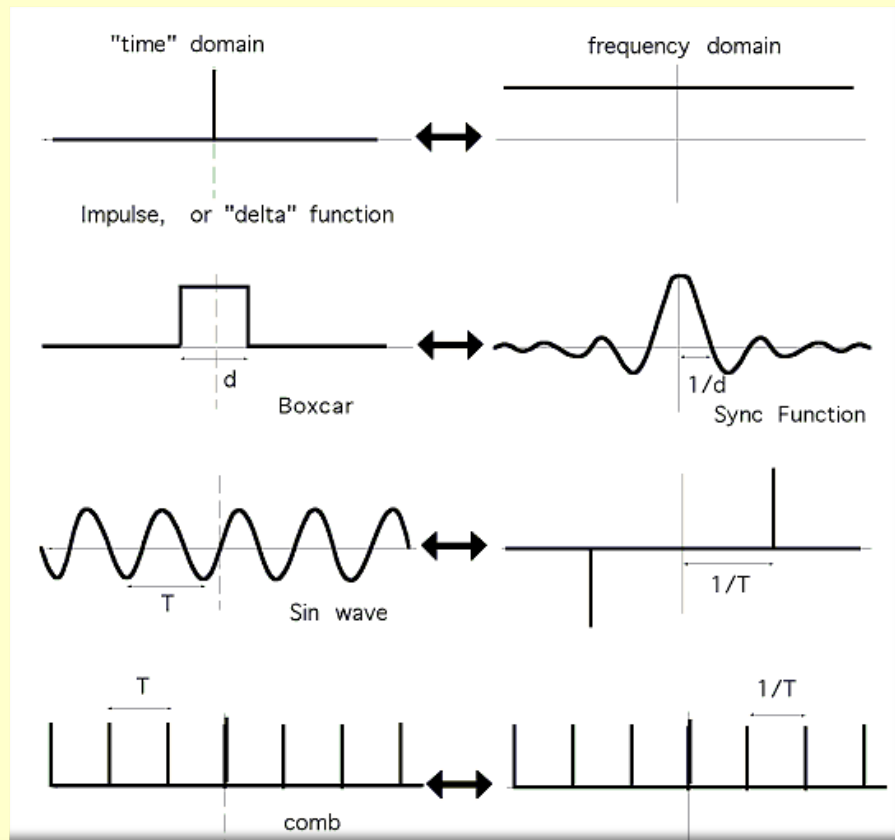
# Mathematical background

## Weierstrass Approximation Theory

1. Approximating to any function with a series of Polynomials
2. Fourier Series
3. Wavelets

$$\psi(t) = f\left(\frac{t - c_k}{2^k}\right)$$

# Transform Fourier



# Practical tools

## Discrete Fourier Transform (DFT)

The sequence of  $N$  complex numbers  $x_0, \dots, x_{N-1}$  is transformed into the sequence of  $N$  complex numbers  $X_0, \dots, X_{N-1}$  by the DFT according to the formula:

$$X_k = \sum_{n=0}^{N-1} x_n e^{-\frac{2\pi i}{N}kn} \quad k = 0, \dots, N-1$$

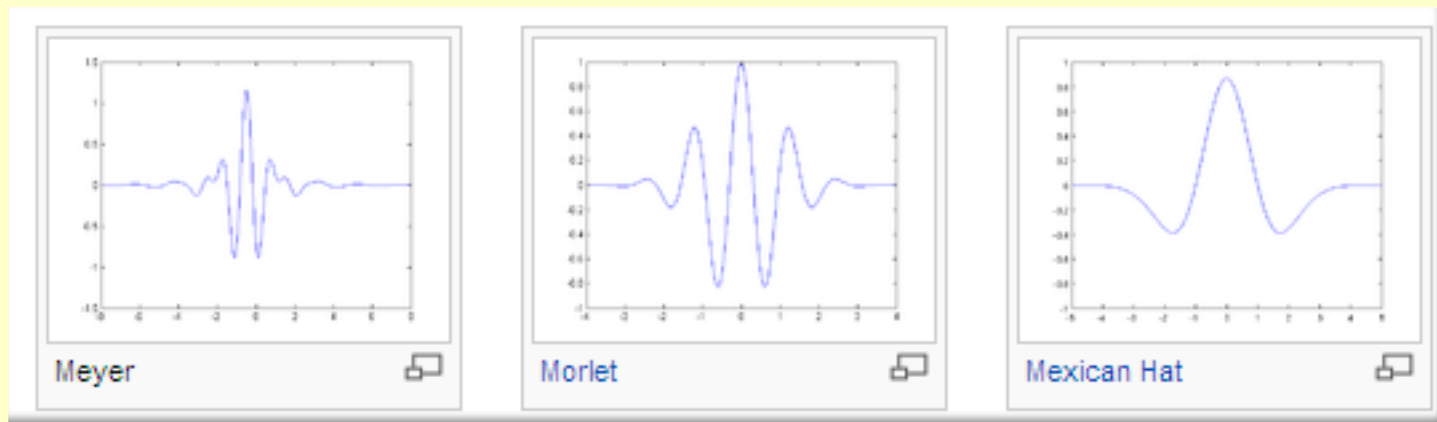
where  $i$  is the imaginary unit and  $e^{\frac{2\pi i}{N}}$  is a primitive  $N$ th root of unity. (This expression can also be written in terms of a DFT matrix; when scaled appropriately it becomes a unitary matrix and the  $X_k$  can thus be viewed as coefficients of  $x$  in an orthonormal basis.)

The transform is sometimes denoted by the symbol  $\mathcal{F}$ , as in  $\mathbf{X} = \mathcal{F}\{\mathbf{x}\}$  or  $\mathcal{F}(\mathbf{x})$  or  $\mathcal{F}\mathbf{x}$ .

The inverse discrete Fourier transform (IDFT) is given by

$$x_n = \frac{1}{N} \sum_{k=0}^{N-1} X_k e^{\frac{2\pi i}{N}kn} \quad n = 0, \dots, N-1.$$

# Wavelets - Examples



$$\psi(t) = 2\text{sinc}(2t) - \text{sinc}(t) = \frac{\sin(2\pi t) - \sin(\pi t)}{\pi t}$$

# Examples

1. Stammering – Stuttering
2. Bourse Fall
3. Electro-Cardiogram
4. Polygraph
5. Seismograph
6. Translation



# Example: (A)

## Stammering - Stuttering



Lionel Logue, the speech therapist visited by King George VI in the film, *The King's Speech* is pictured right.

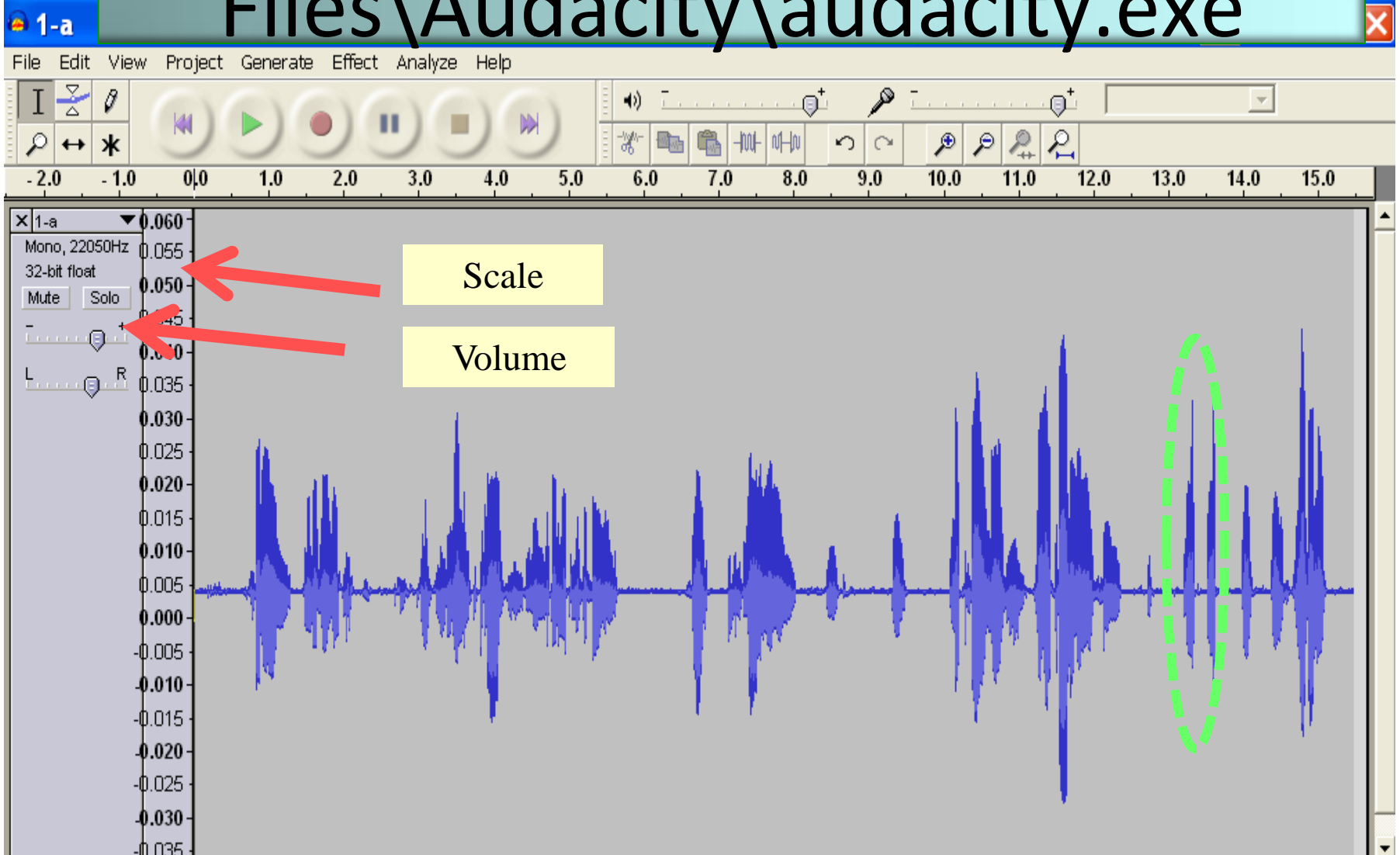


Stammering – or as they tend to say in the US, stuttering – is characterised by a disrupted stop-start speech flow. Sometimes people repeat words, extend them or omit them completely.

Most people who stammer have what is called developmental stammering which begins in childhood around three to four. Sometimes stammering is acquired later as result of a head injury, stroke or neurological disease.



# C:\Program Files\Audacity\audacity.exe





# Audio File

Audio

/ •



# SNOBOL Analog

1. Pattern= String \$A space A
2. Loop: String Pattern = A :S(Loop)
3. -----



# SNOBOL Tone Analog

1. pat1= Threshold(-3,3)
2. Pattern= Tone \$A pat1 A
3. Loop: Signal Pattern = A :S(loop)
4. -----

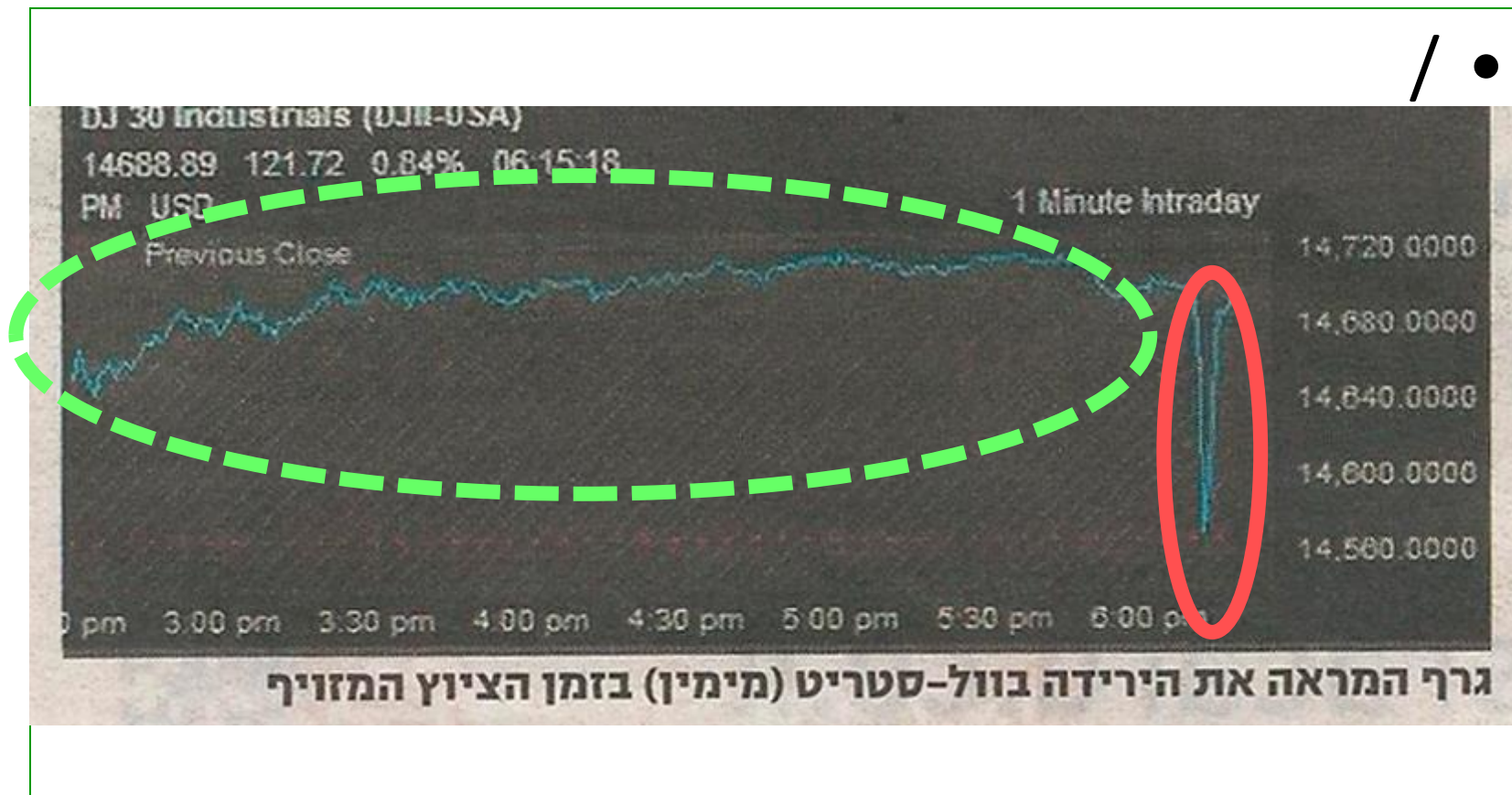


# SNOBOL Input/Output - Transcription

- Input: String = “xyc\_\_ck d dije efs”
- Output: String= “xyckdijefs”



# Bourse Fall



# ***SNOBOL*** Analogy

1. digit = 0 | 1 | 2 | ... | 7 | 8 | 9 |
2. Eps = 3
3. String = "1452141636325421893"
4. Pattern= digit \$A1 digit \$A2 digit \$A3
5. Loop: String Pattern :F(End)
6.  $Abs((A1-A2) - (A3 - A2)) < Eps$  :F(jump)
7. String Pattern = A2 A3 :(Loop)
8. Jump: print "Found a leap:" A1 "," A2 "," A3
9. End: // End of procedure

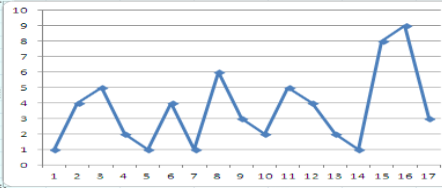


# SNOBOL Input/Output

- Input: String = "14521416363254**218**93"
- Output: String= "**218**"



# ***SNOBOL-Tone*** Analogy

1. pulse = 0.1 // **Digitization Resolution**
2. Eps = 3
3. Signal= 
4. Pattern= pulse \$A1 pulse \$A2 pulse \$A3
5. Loop: Signal Pattern :F(End)
6.  $Abs((A1-A2) - (A3 - A2)) < Eps$  :F(jump)
7. Signal Pattern = A2 A3 :(Loop)
8. Jump: print "Found a leap:" A1 "," A2 "," A3
9. End: // **End of procedure**





# Electro Cardiogram



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# Search Peak

- For which  $t$  – value there is a peak?
- Frequency of the pulse.



# ***SNOBOL*** Analogy

```
digit = 0 | 1 | 2 | ... | 7 | 8 | 9 |  
String = "1452141636325421890"  
max_digit = -999 // The Peak  
Loop: String digit $temp =           :F(End)  
      if max_digit > temp           :S(Loop)  
      max_digit=temp                 :(Loop)  
End: print "Found Peak: " max_digit  
      // End of procedure
```



# SNOBOL Input / Output

- Input: String = "14521416363254**218**93"
- Output: String= "**218**"

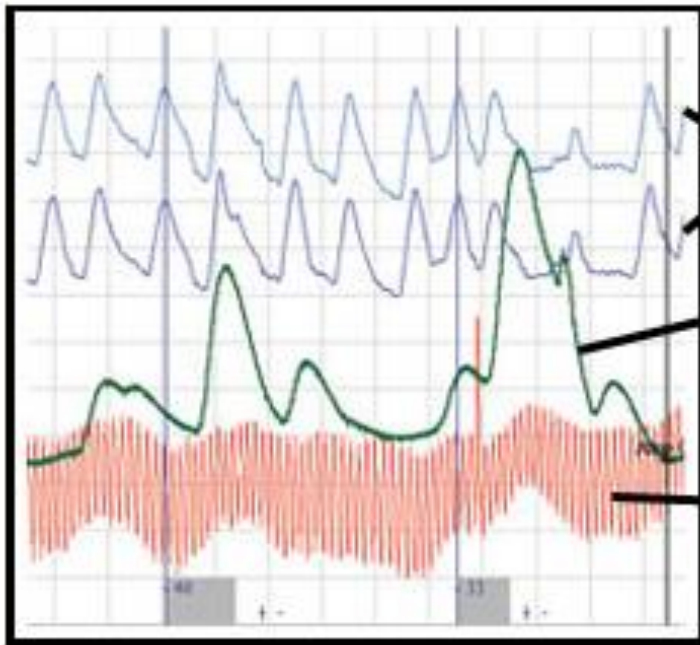


# *SNOBOL-Tone* Analogy (C)

- TBD



# Polygraph



**Respiratory rate**

**Electro-dermal activity  
(sweatiness of fingertips)**

**Blood pressure/heart rate**

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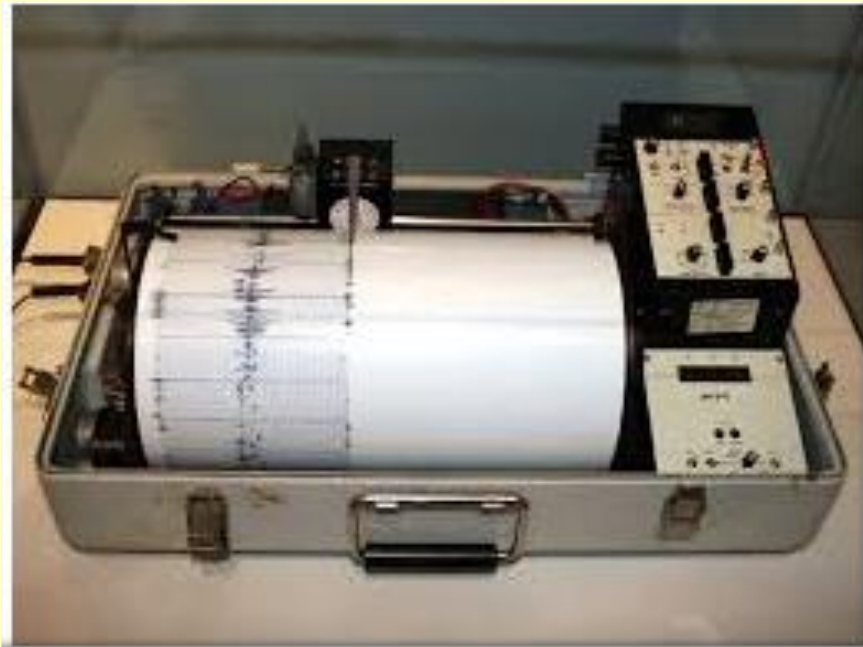


# Test

- Comparison of the response to the two kinds of questions:
  - neutral,
  - Problematic
- Expected response:
  - calm, steady pulse;
  - Tachycardia



# Seismograph

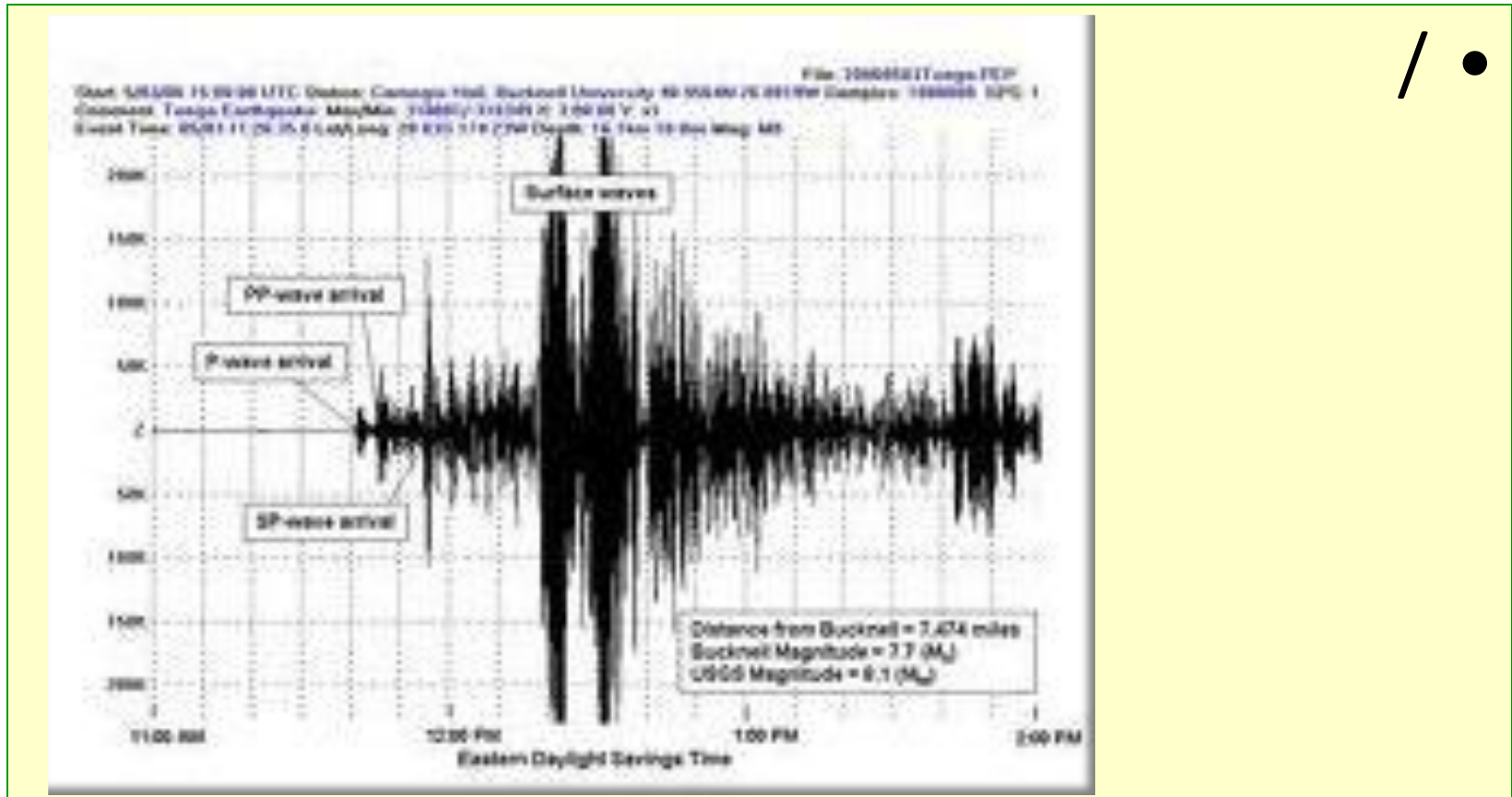


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# Seismograph Output Example



# The Richter Scale

## of an earthquake

- The Richter magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs (adjustments are included to compensate for the variation in the distance between the various seismographs and the epicenter of the earthquake). The original formula is:<sup>[15]</sup>
- where  $A$  is the maximum excursion of the Wood-Anderson seismograph, the empirical function  $A_0$  depends only on the epicentral distance of the station,  $r$ . In practice, readings from all observing stations are averaged after adjustment with station-specific corrections to obtain the  $M_L$  value.

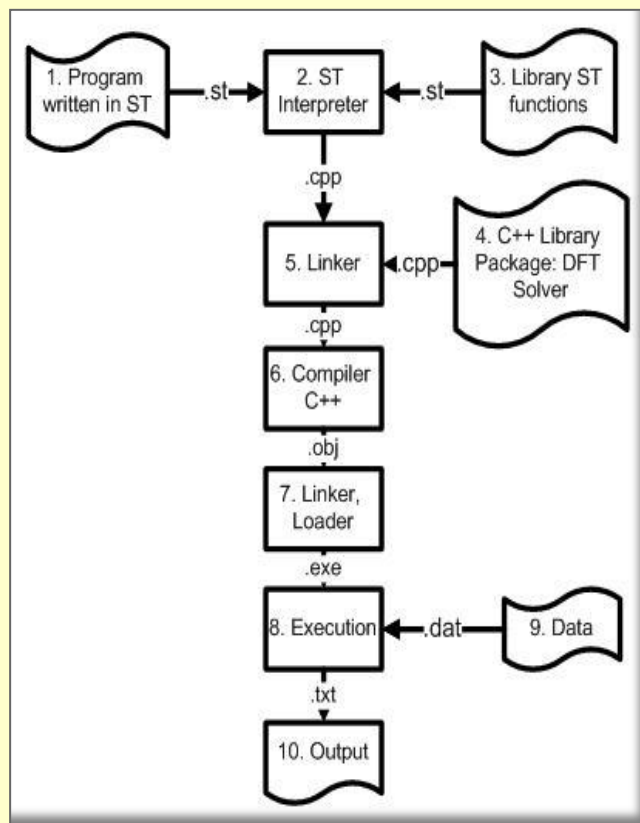


# Summary

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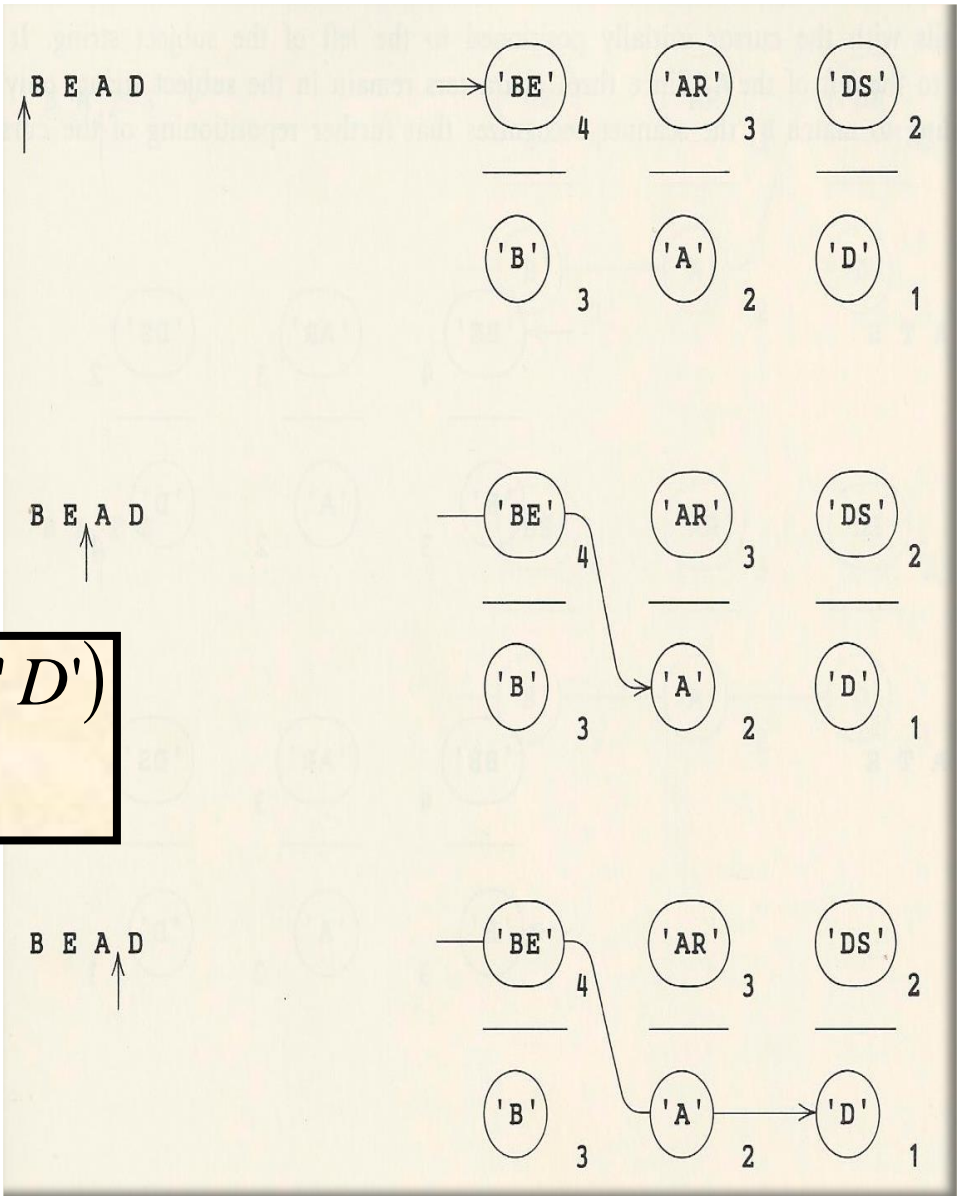
# Block Diagram



Block Diagram



# Matching Mechanism



$$BD = ('BE'|'B')('AR'|'A')('DS'|'D')$$

'BEAD' BD

- BD - Pattern



# Discussion

## ***Programming Languages***

1. Perl
2. Python

## ***Manipulation packages:***

1. Csound
2. Audio DS
3. Audacity



# Conclusions

- SNOBOL-Tone analogically develops the string-matching and tree-matching [2], using tone-matching or generally speaking the signal-matching; its theoretical infrastructure is given



# References

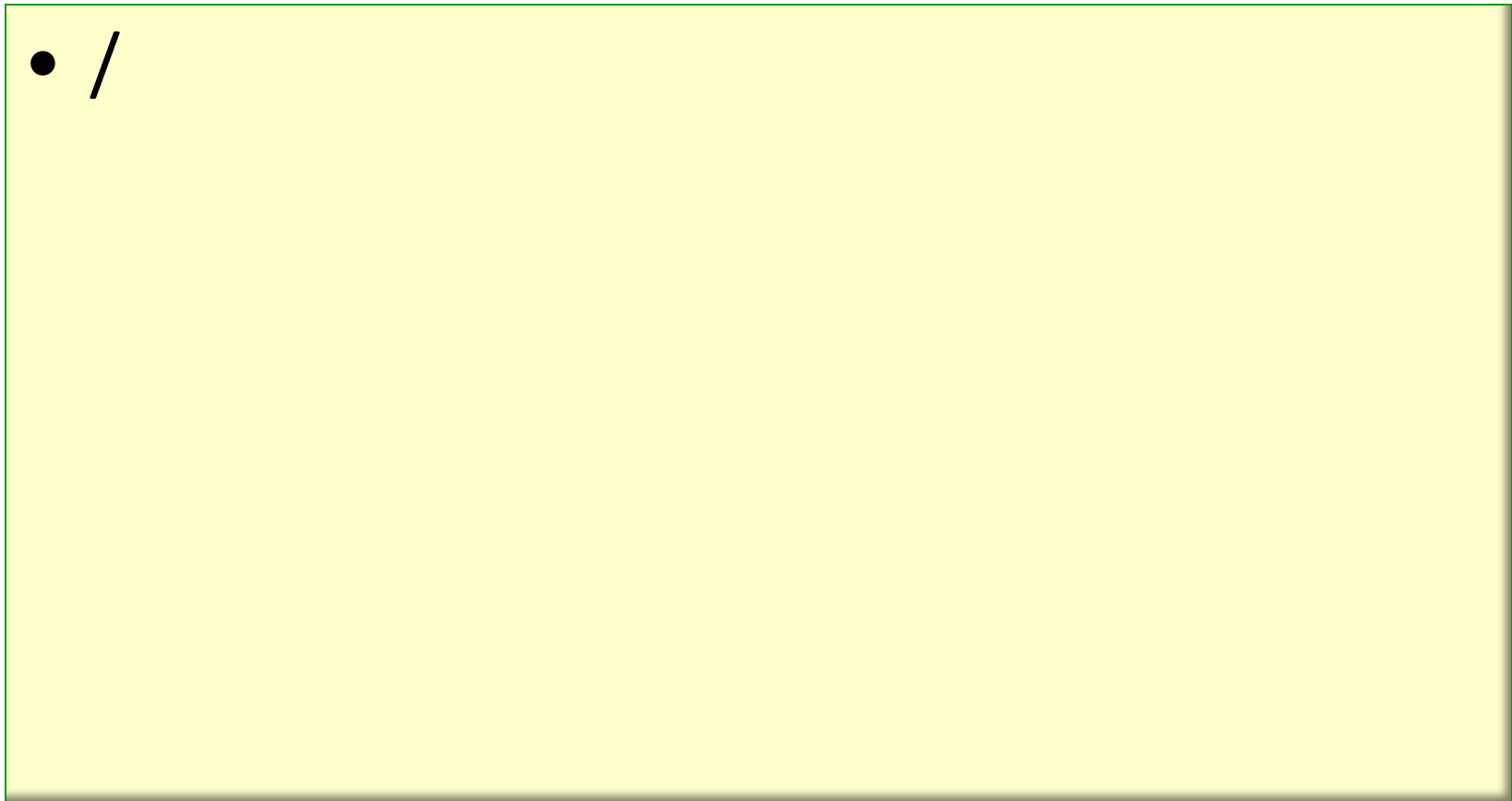
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2. D. Ophir, ***DDDL: A Descriptive, Didactic and Dynamic Programming Language***; Israeli-Polish Mathematical Meeting, September 11<sup>th</sup>-15<sup>th</sup>, 2011, Łódź, Poland.
3. Dan Ophir, SNOBOL+ a language for tree-pattern-matching; M.Sc. Thesis, Weizmann Institute of Science, 1972.
4. Lawrence Rabiner, Biing-Hwang Juang, **Fundamentals of Speech Recognition**, 1993.



THANK YOU







# template

אגמא •

*R – relation schema*

