

CISC 3250

Systems Neuroscience

Matlab, part 3: Vector analysis

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JMH 328A

Matrices and weighted sums

$$r \quad \begin{matrix} 1 & 4 & 1 & 0 \\ \downarrow & \rightarrow & \uparrow & \leftarrow \\ \begin{bmatrix} x \\ y \end{bmatrix} & \begin{bmatrix} 0 \\ -1 \end{bmatrix} & \begin{bmatrix} 1 \\ 0 \end{bmatrix} & \begin{bmatrix} 0 \\ 1 \end{bmatrix} & \begin{bmatrix} -1 \\ 0 \end{bmatrix} \end{matrix}$$

$$1 \begin{bmatrix} 0 \\ -1 \end{bmatrix} + 4 \begin{bmatrix} 1 \\ 0 \end{bmatrix} + 1 \begin{bmatrix} 0 \\ 1 \end{bmatrix} + 0 \begin{bmatrix} -1 \\ 0 \end{bmatrix} = \begin{bmatrix} 4 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 1 & 0 & -1 \\ -1 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 1 \\ 4 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 4 \\ 0 \end{bmatrix}$$

Matrix multiplication:
Sum {left row x right column}

$$\begin{bmatrix} a & b & c \\ d & e & f \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} x[a] + y[b] + z[c] \\ dx + ey + fz \end{bmatrix}$$

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Matrix math

Matrix multiplication:
Sum {left row x right column}

$$\begin{bmatrix} | & | & | \\ v_1 & v_2 & v_3 \\ | & | & | \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = xv_1 + yv_2 + zv_3$$

Altenatively:

$$\begin{bmatrix} a & b & c \\ d & e & f \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} ax + by + cz \\ dx + ey + fz \end{bmatrix}$$

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Matrix math

A= [1 2; 3 4];
b= [4; 5];

What is A*b?

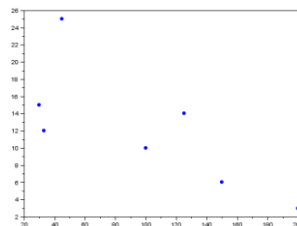
Transpose: [4; 5] == [4 5]'
a' flips rows and columns

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Scatter-plots

Visualizing how two variables vary together

Reaction time	Cortical response
100	10
45	25
150	6
30	15
125	14
33	12
200	3



plot(var1,var2, '.')

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Comparing vectors

Can compare 2 vectors

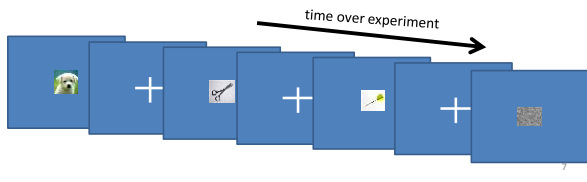
- by multiplying $a*b'$
 - high product = high similarity
- by correlating $\text{corr}(a,b)$
 - between -1 and 1
 - high |correlation| = high connection between vectors

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LOC localizer: experimental design

Each second:

- new object OR
- new noise OR
- “blank screen” (fixation)



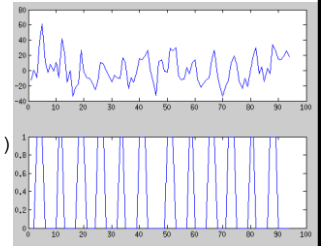
Experiment record

`timesObjs2`, at each second:

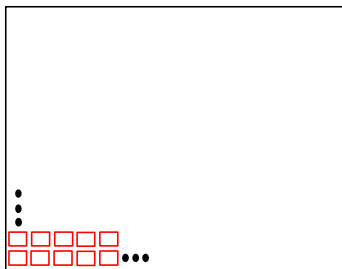
- 0 for no-object
- 1 for yes-object

Voxel response

`neuroData2(24, 26, 4, :)`
at each second neural
response to stimuli



Each combination layer “tiles” visual space



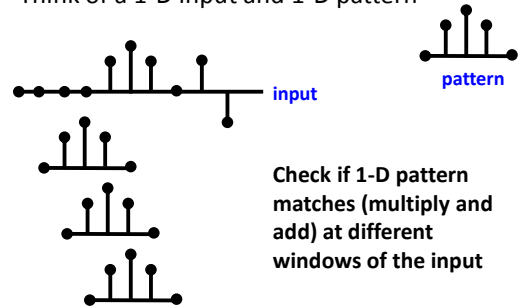
Compute weighted sum
(combination) at every
location

Called “convolution”

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Convolution in Scilab

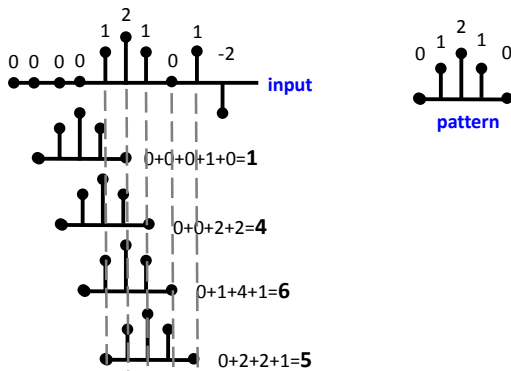
Think of a 1-D input and 1-D pattern



Check if 1-D pattern
matches (multiply and
add) at different
windows of the input

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Convolution in Scilab



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