Matlab, part 4: Projection/Correlation Analyses

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Matrix math

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

Assuming right matrix is a single column
In general, # of left matrix columns must equal # of right matrix rows

Matrices in matlab

\[
A = \begin{bmatrix}
1 & 2 \\
3 & 4
\end{bmatrix};
\]
\[
b = [4; 5];
\]

What is \( A*b \)?

Transpose: \([4; 5] \quad == \quad [4 5]'\)

\( a' \) flips rows and columns

LOC localizer: experimental design

Each second:
- new object OR
- new noise OR
- “blank screen” (fixation)
Building the voxel response

Voxel response

at each second neural response to stimuli
times

0 for no-object, 1 for yes-object

Drift and offset

Matlab code
% Want: k1*O+k2*C+k3*L=sigOut1;
% i.e.: M*kVec = sigOut1;
% Define M "design matrix"
M = [ blockPatt; driftL; driftC ];
% M is 3 x 93, we want 93 x 3 matrix
Mtrans = M';
x = pinv(Mtrans)*sigOut1;
% inv only works on square mat -
% num rows = num cols,
% pinv on any matrix

More Matlab code
% Find patterns in sigOut1
M = [ blockPatt; driftL; driftC ];
Mtrans = M';
x = pinv(Mtrans)*sigOut1;
% Patt-correct time blocks,
% Patt2-unrelated time blocks
M = [ blockPatt; driftL; driftC; blockPatt2 ];
Mtrans = M';
x4 = pinv(Mtrans)*sigOut1;

Building the voxel response

General Linear Model

Design matrix M
• On/off information O
• Constant offset C
• Linear drift L

Measured voxel output
\[ \begin{bmatrix} v_{t=1} & v_{t=2} & \ldots & v_{t=93} \end{bmatrix}^T \]

\[ M = \begin{bmatrix} O & C & L \end{bmatrix}, \quad \begin{bmatrix} \beta_o \\ \beta_c \\ \beta_L \end{bmatrix} = v \quad B = M^{-1}v \]
Comparing vectors

Can compare 2 vectors
- by correlating $corr(a, b)$
  - between -1 and 1
  - high $|$correlation$| = $ high connection between vectors
- by multiplying $a \cdot b'$
  - high product = high similarity

Scatter-plots

Visualizing how two variables vary together

```matlab
plot(var1, var2, '.
scatter(var1, var2)
```

Reaction time
Cortical response

<table>
<thead>
<tr>
<th>Reaction time</th>
<th>Cortical response</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>45</td>
<td>25</td>
</tr>
<tr>
<td>150</td>
<td>6</td>
</tr>
<tr>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>125</td>
<td>14</td>
</tr>
<tr>
<td>33</td>
<td>12</td>
</tr>
<tr>
<td>200</td>
<td>3</td>
</tr>
</tbody>
</table>

Convolution in Matlab

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