CISC 3250
Systems Neuroscience

Matlab, part 4: Projection/Correlation Analyses
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JMH 332

Matrices in matlab

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

What is A*b?

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

Matrix math

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

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

LOC localizer: experimental design

Each second:
• new object OR
• new noise OR
• “blank screen” (fixation)

Our data: “block design”
Rapid sequence of objects
Pause
Rapid sequence of noise
Building the voxel response

Voxel response
neuroData
at each second neural response to stimuli
timesObj, at each second:
• 0 for no-object,
  1 for yes-object
• Drift and offset

Comparing vectors
Can compare 2 vectors
• by correlating \( \text{corr}(a, b) \)
  – between -1 and 1
  – high \(|\text{correlation}|\) = high connection between vectors
  – \(+1\) significant mutual rise/mutual fall
  – \(-1\) significant complementary rise-fall
  – In bio-signal recording, \(|r|>0.2\) can be considered big!
• by multiplying \( a \times b' \)
  – high product = high similarity

Building the voxel response

General Linear Model

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

Measured voxel output \( v \)
\[ v = [v_{t=1} \ v_{t=2} \ ... \ v_{t=93}]^T \]

\[
M = \begin{bmatrix}
O & C & L \\
\end{bmatrix}
\]

\[
M \begin{bmatrix}
\beta_o \\
\beta_c \\
\beta_L \\
\end{bmatrix}
= v
\]

\[
B = M^{-1}v
\]

Scatter-plots
Visualizing how two variables vary together

<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>

\[
\text{plot}(\text{var1},\text{var2},'.')
\]

\[
\text{scatter}(\text{var1},\text{var2})
\]
Visual comparison

timesObjs2, at each second:
• 0 for no-object
• 1 for yes-object

Voxel response
neuroData2
at each second neural response to stimuli

Numeric comparison

Single voxel response:
voxResp1=squeeze(neuroData2(24,26,4,:));

Compare with picture appearance times:
corr(voxResp1, timesAnyStim');

Consider correlations at multiple locations:

for x=1:32,
  for y=1:32
    for z=1:16,
      voxVec=squeeze(neuroData2(x,y,z));
      corrMat(x,y,z)=corr(voxVec,timesAnyStim');
    end
  end
end

Numeric comparison

Single voxel response:
voxResp1=squeeze(neuroData2(24,26,4,:));

Compare with object appearance times, not noise:
objNotNoise=timesObjs2-timesNonsense2;
corr(voxResp1, objNotNoise');

Consider correlations at multiple locations:

???
Numeric comparison

Single voxel response:
\[ \text{voxResp1} = \text{squeeze} \left( \text{neuroData2}(24, 26, 4,:) \right) \];

Compare with object appearance times, not noise:
\[ \text{objNotNoise} = \text{timesObjs2} - \text{timesNonsense2} \];
\[ \text{corr} \left( \text{voxResp1}, \text{objNotNoise}' \right) \];

Consider correlations at multiple locations:
\begin{verbatim}
for x=1:32,
  for y=1:32
    for z=1:16,
      \text{voxVec} = \text{squeeze} \left( \text{neuroData2}(x, y, z) \right);
      \text{corrMatO}(x, y, z) = \text{corr} \left( \text{voxVec}, \text{objNotNoise}' \right);
    end
  end
end
\end{verbatim}