NOMAD – Near-infrared Optode Montage Automated Designer

Kyle E. Mathewson
Assistant Professor, Department of Psychology
Faculty of Science, University of Alberta
Anatomy

- [structural MRI]
  - Brain anatomy
  - Fiducial locations

Digitization

- [Polhemus/Vicra]
  - Optode locations
  - Fiducial locations

Optical

- [Boxy]
  - Blocks of continuous data

Behavioral

- [E/PsychToolbox/etc]
  - Timing of critical events (stim, RT, etc)

OPT3D

- Coregistration and Talairach transformation (if not already done)
- Conversion from channels to voxel space
- Group and single subject statistics
- Displays spatial maps, waveforms, etc.

NOMAD

- Montage creation
- Graph Definitions

OCP

- Dcm2nii
- Coregister digitized optodes to MRI
- Transform to Talairach and MNI

P_POD

- Normalization
- Pulse Correction
- Filtering
- Event-related Averaging

kylemathewson.com/optical
Optical Brain Imaging
Headgear, Patches, and Montages
Map Colouring
Multiplexing and Crosstalk

Crosstalk

Spatial Multiplexing
Temporal Multiplexing
Frequency Multiplexing
Multiplexing and Crosstalk
Time Division Multiplexing of Sources

Multiplexing and Crosstalk
Time Division Multiplexing of Sources

Multiplexing and Crosstalk
Source and Detector labels used for setup

Left

Right
<table>
<thead>
<tr>
<th>N</th>
<th>128</th>
<th>256</th>
<th>512</th>
<th>1024</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>3</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>10</td>
<td>3</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>17</td>
<td>17</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>19</td>
<td>19</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>21</td>
<td>21</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>22</td>
<td>22</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>23</td>
<td>23</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>24</td>
<td>24</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>25</td>
<td>25</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>26</td>
<td>26</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>27</td>
<td>27</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>28</td>
<td>28</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>29</td>
<td>29</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>31</td>
<td>31</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>32</td>
<td>32</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>33</td>
<td>33</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>34</td>
<td>34</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>35</td>
<td>35</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>36</td>
<td>36</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>37</td>
<td>37</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>38</td>
<td>38</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>39</td>
<td>39</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>40</td>
<td>40</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>41</td>
<td>41</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>42</td>
<td>42</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>43</td>
<td>43</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

---

OMM - Small Right

---

[Diagram of OMM - Small Right]
Graph Theory
Graph Theory
Graph Theory
Graph Theory
NOMAD – Near-infrared Optode Montage Automated Design
function [mux_numbers, mux_list] = monte_carlo_clq_mux

clq_swapper = 1:n_clqs;
clq_swapper = clq_swapper(randperm(n_clqs));

mux_list = repmat(1:n_muxs,1,n_banks);
mux_list = mux_list(randperm(length(mux_list)));

mux_numbers = zeros(ntg.n_srcs,1);

for current_clq = clq_swapper
    for i_src = 1:n_srcs
        if src_dist(current_clq,i_src) <= max_dist & mux_numbers(i_src) == 0
            for i_mux_list = 1:length(mux_list)
                if isempty(find(mux_numbers(E_mat(i_src,:)) == 1)) == mux_list(i_mux_list,1) & mux_numbers(i_src) == 0
                    mux_numbers(i_src) = mux_list(i_mux_list);
                    mux_list(i_mux_list) = [];
                    break
                end
            end
        end
    end
end
Anatomy
- [structural MRI]
  - Brain anatomy
  - Fiducial locations

Digitization
- [Polhemus/Vicra]
  - Optode locations
  - Fiducial locations

Optical
- [Boxy]
  - Blocks of continuous data

Behavioral
- [E/PsychToolbox/etc]
  - Timing of critical events (stim, RT, etc)

OCP
- Dcm2nii
- Coregister digitized optodes to MRI
- Transform to Talairach and MNI

NOMAD
- Montage creation
- Graph Definitions

P_POD
- Normalization
- Pulse Correction
- Filtering
- Event-related Averaging

OPT3D
- Coregistration and Talairach transformation (if not already done)
- Conversion from channels to voxel space
- Group and single subject statistics
- Displays spatial maps, waveforms, etc.
NOMAD

Near-infrared Optode Montage
Automated Designer

1. Homotopy
- Custom - Dialogue Box will open after pressing Go

Max
- Norm
- Norm+
- Mini
- Old Medium
- New Medium
- White Large
- Black Large
- Small
- Kens Patch
- Custom

Custom Source/Detector Order:
The first line of the file must indicate which rows are sources and which are detectors (e.g., SED/SED/SED/S)

2. Distance
- Max Distance: 60
- Min Distance: 15

3. Channels
- Montages per Subject: 4
- Sources: 16
- Detectors: 4
- Wavelengths: 1
- Max Number: 4

4. OK Go!
Select montage and distribution
There are 3 detectors remaining.

Montage Design

- First, click on either plot to select detector locations (blue) or right-click to remove a location.
- Red areas represent areas within the optimal range of detectors.
- Right-click to select from the red locations each source location (blue).
- White areas are either too far from a detector or too close to a detector.
- Gray areas within range of detectors that already have too many sources.
- Right-click (with caution) to remove a source. Or just the right.
- Press Enter when complete to select next numbers.

Use these to adjust the spacing of the sources and detectors and refresh the window.
NOMAD

Automated Multiplex (MUX) Assignment

1. Pilot Bananas
2. Channel Stats
3. Select Current Montage
   Montage Number
4. Colour!
   Montage Colour
5. Crossstalk Check
  兼容蒙太奇色板
6. Done all Montages!
   Create output files and save

Press to assign mix numbers
Tutorial
Limitations

-it works, but don't know when to stop for very hard graphs

takes a while, because its stupid

-the chance of finding a solution in iteration n is unrelated to chance in n-1

can't be sure you are on the absolute minima


Future Directions