Technical Note: 01-20050729
Mapans OD Analysis Addendum

This addendum describes how to use mapans for ocular dominance (OD) analysis.

1. How to open maps with mapans for OD analysis

The program is evoked from the command line of a terminal with one file name (skew_dif file prepared by **mapanm2**), regular options (e.g. *–i –o6* and so on) and the OD analysis specific option *–ODx*, where *x* stands for number of bins to be used for OD analysis. This value is 70 by default, that is *–OD* is equivalent to *–OD70*.

Example:

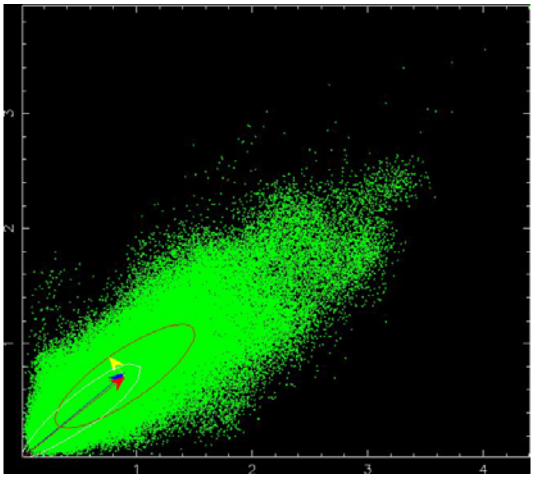
```
mapans –i –o6 -OD t_41s.11_13-10_14.skew_dif
```

Note 1: Option *–O* is used for contour plotting as well. Do not use *–O* option if OD analysis is to be performed. The low pass filter size defined by *–OX* will be set incorrectly resulting in some oddities. In general there is no need to perform contour plotting in parallel with the OD analysis.

Note 2: The number of bins following *–OD* option can be set to any positive integer. However, traditionally the contralateral bias index (CBI) is calculated using 7 bins (Hubel and Wisel). It is recommended to set the number of bins for the OD analysis to a value which is a multiple of 7. This will insure equal number of sub-bins for the CBI bins.

Note 3: It is recommended to load the contralateral eye map first and the ipsilateral eye second when creating a skew_dif map with **mapanm2**. This will generate skew_dif maps correctly set for the OD analysis done by **mapans**. If the opposite sequence is used the first bin will correspond to domination by the ipsilateral eye instead of contralateral and the calculated contralateral bias index will be equal to 1 – CBI, where CBI stands for the correct index.

Note 4: A skew_dif file can be created from counterclockwise (CCW), clockwise (CW), or averaged (CCW+CW) maps. Indices calculated for the averaged maps tend to be an average of indices calculated from the CCW and CW maps. The original maps generated by **iman** should be high-pass filtered (*–H60* or higher) if needed. The maps should not be low-pass filtered. Low-pass filtering should be used for visualization only and not for analysis.



Middle button click over the interactive window (or pressing Shift-d) opens a window displaying the polar distribution of the map pixels (Figure 1). The main interactive window becomes inactive while the distribution window is open.

Figure 1. Scatter plot (distribution) window specific for the OD analysis. The pixels are located in the first quadrant only. White curve – angular distribution of pixels; red – PCA ellipse and its displacement from the center.

Opening a regular map, that is a non-skew_dif map, for the OD analysis will result in a scatter plot distribution similar to that shown in Figure 2. Further analysis done on this map will produce garbage.

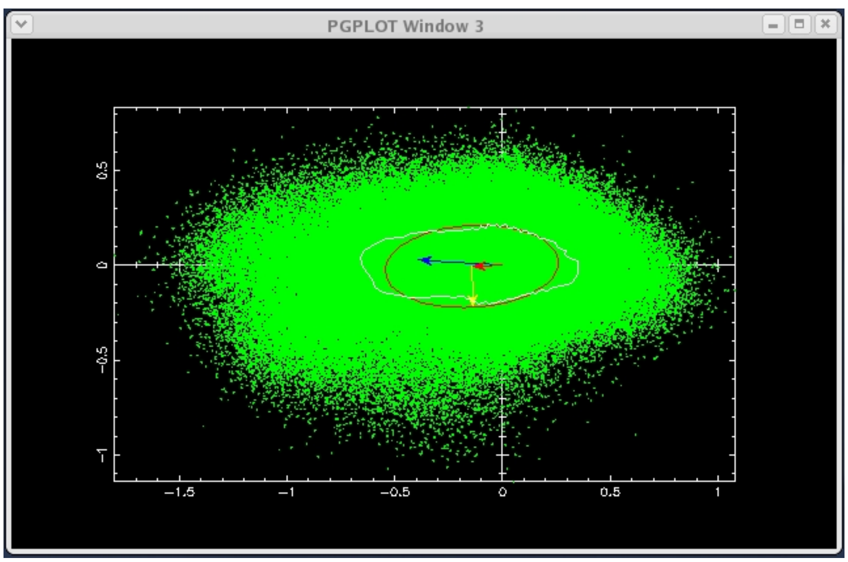
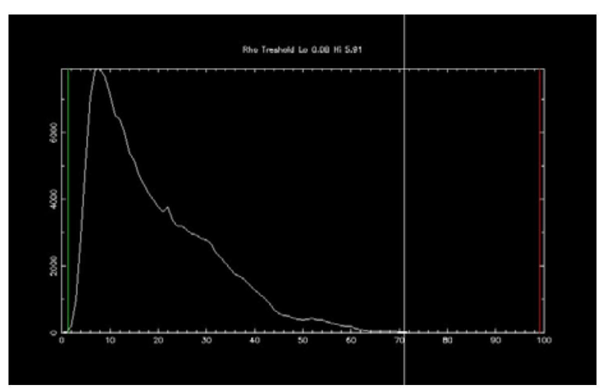


Figure 2. Scatter plot (distribution) window for a regular map. The pixels may be located anywhere in the coordinate system plane.

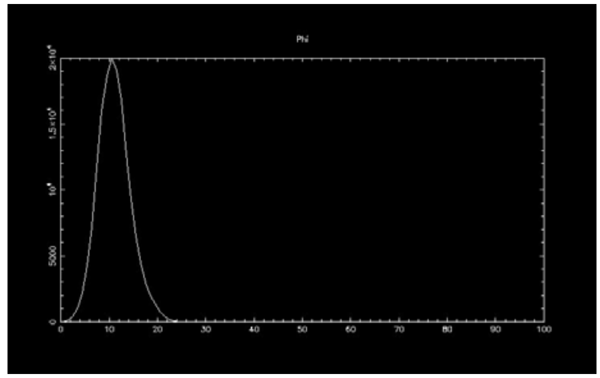
Next, entering Shift-h over the distribution window, which is the interactive window now, will spawn three windows. These windows are:

1) Distribution of absolute values (rho) of the map's pixels (Rho window): rho=sqrt(C*C+I*I), where C and I are the response values for the contralateral and ipsilateral eye respectively. This window becomes interactive. The green vertical line shows the lower threshold cut-off and

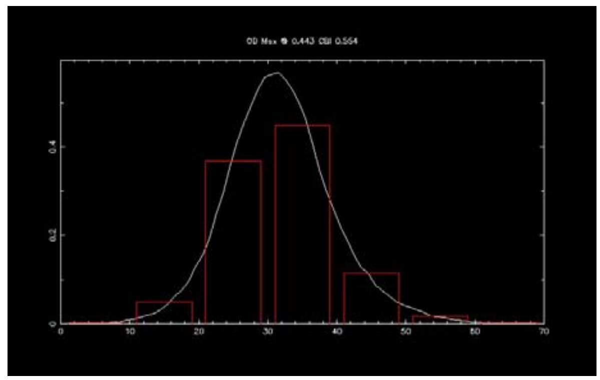


the red one shows the upper cut-off. The actual cut-off values are shown in the caption. The white vertical line shows current cursor position.

2) Distribution of directions (phi) of the map's pixels (Phi window): phi=arctan(I/C). The plot in this window should occupy the first quarter only if a correct skew_diff is loaded.



3) Distribution of ocular dominance values (OD) of the map's pixels (OD window): OD=I/(C+I). This formula maps 100% dominance by the contra-eye onto 0 and 100% dominance by the ipsi-eye onto 1. This mapping is chosen because traditionally cells were assigned an OD score of 1 if they responded only to stimuli presented to the contralateral eye and 7 if they responded only to stimuli presented to the ipsilateral eye. The plot, shown in white, is a fine histogram calculated for the number bins set by *–OD* option, 70 bins in this example. The histogram, shown in red, is the distribution of OD scores. Bin 1 (left-most) corresponds to the number of pixels at which the contralateral eye response dominated (upper 7^{th} part of the OD scores) and bin 7 (right-most) corresponds to the number of pixels at which the ipsilateral eye response dominated (lower 7^{th} part of the OD scores). Linear super-binning is used to produce the traditional OD distribution, that is equal number of the fine OD histogram bins (10 in this examples) is further binned to generate the traditional 7-bin OD histogram. The caption shows the position of the maximum of the fine distribution and the CBI. The newer version shows the monocularity index (MI) as well. The CBI and MI are calculated in accordance with Issa et al. J Neurosci. 1999, 19, 6965:



$$\mathrm{CBI} = \frac{(N_1 - N_7) + \frac{2}{3} \cdot (N_2 - N_6) + \frac{1}{3} \cdot (N_3 - N_5) + N_T}{2 \cdot N_T}; \quad \mathrm{MI} = \frac{(N_1 + N_7) + \frac{2}{3}(N_2 + N_6) + \frac{1}{3}(N_3 + N_5)}{N_T}.$$

where N_T is the total number of selected pixels and N_x is the number of pixels with OD rating $x=1,2,\ldots,7$. A CBI of 0 indicates that the ipsilateral eye dominates the population, whereas a CBI of 1 indicates that the contralateral eye dominates the population. An MI of 0 suggests that the population is driven equally by both eyes, whereas an MI of 1 suggests the population is driven exclusively by one eye or the other.

2. How to control the Rho window

Note: all keyboard inputs are case sensitive.

Left mouse button or **X -** select Low Rho threshold
Right mouse button or **A -** select High Rho threshold
S - save Phi, OD if in OD mode, histogram data, file name is auto generated
h - print this help
q or **Q -** quit interactive dialog
s - save Phi, OD if in OD mode, histogram as a picture (PS) file, user prompted for file name

h – prints out description of available commands in the terminal window.
q or **Q** – quit interactive dialog and closes all distribution windows.
S – saves the data used to plot the histograms. The file name is auto generated.
For example t_41s.11_13-10_14.skew_dif_HistODLo1Hi100: _HistOD is appended to the map file name, Lo1 – 1 corresponds to the lower Rho cut-off (percentage), Hi100 – 100 corresponds to the upper Rho cut-off (percentage).
s – saves Phi, OD if in OD mode, histogram as a picture (PS) file, user prompted for file name in the terminal window where **mapans** was evoked. The Rho window becomes inactive until the file is entered.
Left mouse button or **X** – selects lower Rho threshold, displayed in green.
Right mouse button or **A** – selects upper Rho threshold, displayed in red.

3. Practical notes

1. Upper Rho threshold is rarely used. The most responsive pixels that may correspond to blood vessels should be manually cropped before the OD analysis.
2. Choosing a higher Lower Rho threshold, up to the point where the Rho histogram has maximum, may slightly improve the OD histogram and the CBI. The reason: The pixels with very low Rho correspond to the least responsive pixels for both contra and ipsi eyes. These pixels usually are located in the pinwheel centers and fractures. The readings at these pixels are dominated by noise rather than actual intrinsic signal and tend to be Gaussian-like distributed. Thus the low response noisy pixels tend to shift the OD distribution closer to the center and the CBI closer to 0.5. The correction

introduced by selecting a higher Low cut-off threshold usually is not significant since the number of pixels located at the pinwheel centers and fractures is small relative to the total area of a map.

Appendix.
Format of the data saved in HistOD file

```
#BEGIN SAMPLE SECTION
# Bins 70
# Total Samples 158184
0 0.00000
1 0.00000
2 0.00001
3 0.00002
4 0.00005
5 0.00009
6 0.00020
7 0.00028
8 0.00040
9 0.00079
10 0.00103
...
57 0.00083
58 0.00067
59 0.00042
60 0.00035
61 0.00021
62 0.00015
63 0.00007
64 0.00004
65 0.00004
66 0.00002
67 0.00000
68 0.00000
69 0.00000
#END SAMPLE SECTION
#BEGIN CBI SECTION
# CBI Bins 7
# 0 0.001846
# 1 0.050441
# 2 0.367819
# 3 0.448629
# 4 0.112919
# 5 0.017461
# 6 0.000885
# CBI 0.553957
# MI 0.208163
#END CBI SECTION
```