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# Introduction

This spreadsheet allows the user to perform Visual Phasing of the graphs from GEDmatch. This assumes the user is familiar with the Visual Phasing process (not described here).

# Installation

The first step to use this spreadsheet is to generate all of the GEDmatch graphs. The user runs the One to One Autosomal and the One to One X options in GEDmatch for each pair of kits (both Sibling and Cousin) and saves the Web Page from the browser into the working directory. This working directory also contains the spreadsheet. For 4 siblings, this is 6 cases.

For the SampleData case, the folder looks like:

|                        |                       |                       |                       |
|------------------------|-----------------------|-----------------------|-----------------------|
| McDefMatchImages       | x0881_X0880_4_files   | x0882_X0880_4_files   | x0883_X0880_4_files   |
| McDefMatchTemplate.ods | x0882_C0801_X_files   | x0882_X0880_X_files   | x0883_X0880_X_files   |
| X8801_C0801_X_files    | x0882_C0802_files     | x0883_C0802_files     | x0884_C0802_X_files   |
| X8801_C0802_X_files    | x0882_C0804_files     | x0883_C0804_files     | x0884_C0804_X_files   |
| X8801_C0803_X_files    | x0882_C0806_files     | x0883_C0806_files     | x0884_C0806_X_files   |
| X8801_C0805_X_files    | x0882_C0807_files     | x0883_C0807_files     | x0884_C0807_X_files   |
| X8801_C0806_X_files    | x0882_C0808_files     | x0883_C0808_files     | x0884_C0808_X_files   |
| X8801_C0807_X_files    | x0882_C0809_files     | x0883_C0809_files     | x0884_C0809_X_files   |
| X8801_C0808_X_files    | x0882_C0810_files     | x0883_C0810_files     | x0884_C0810_X_files   |
| X8801_C0809_X_files    | x0882_C0811_files     | x0883_C0811_files     | x0884_C0811_X_files   |
| X8801_C0810_X_files    | x0882_C0812_files     | x0883_C0812_files     | x0884_C0812_X_files   |
| X8801_C0811_X_files    | x0882_C0813_files     | x0883_C0813_files     | x0884_C0813_X_files   |
| X8801_C0812_X_files    | x0882_C0814_files     | x0883_C0814_files     | x0884_C0814_X_files   |
| X8801_C0813_X_files    | x0882_C0815_files     | x0883_C0815_files     | x0884_C0815_X_files   |
| X8801_C0814_X_files    | x0882_C0816_files     | x0883_C0816_files     | x0884_C0816_X_files   |
| X8801_C0815_X_files    | x0882_C0817_files     | x0883_C0817_files     | x0884_C0817_X_files   |
| X8801_C0816_X_files    | x0882_C0818_files     | x0883_C0818_files     | x0884_C0818_X_files   |
| X8801_C0817_X_files    | x0882_C0819_files     | x0883_C0819_files     | x0884_C0819_X_files   |
| X8801_C0818_X_files    | x0882_C0820_files     | x0883_C0820_files     | x0884_C0820_X_files   |
| X8801_C0819_X_files    | x0882_C0821_files     | x0883_C0821_files     | x0884_C0821_X_files   |
| X8801_C0820_X_files    | x0882_X0880_1_X_files | x0883_X0880_1_X_files | x0884_X0880_1_X_files |
| X8801_C0821_X_files    | x0882_X0880_2_X_files | x0883_X0880_2_X_files | x0884_X0880_2_X_files |
| X8801_X0880_1_X_files  | x0882_X0880_3_X_files | x0883_X0880_3_X_files | x0884_X0880_3_X_files |
| X8801_X0880_2_X_files  | x0882_X0880_4_X_files | x0883_X0880_4_X_files | x0884_X0880_4_X_files |
| X8801_X0880_3_X_files  |                       |                       | ronImage.aws          |

The contents of each of the folders is the graphs for that match case. An example is:

Once the GEDmatch data is ready, the user then runs the command line command

*make GEDmatchImages*

to create the new folder and copy all of the graphs to this new folder. Then the user runs the command line command

*make rename*

to rename the graphs. This also makes similar files with the kit1 and kit2 order reversed. The consolidated GEDmatchImages folder which contains the graphs that are used by the spreadsheet after the graphs have been renamed is:

If a new kit is added, the user enters the command

*make clobber*

(to remove the existing GEDmatchImages folder) followed by repeating the two above commands. This will recreate the GEDmatchImages folder with the new kit(s).

# Starting

The first step is to fill the Sibling and Cousin Tables with the kit information. Once that is done, the user clicks the **Reset Sheets** button to remove any existing Chromosome sheets and to recreate based on the data in the Sibling Table. The results are:

| Cousin Table  |              |                           |             |           |            |          |   |          |       |
|---------------|--------------|---------------------------|-------------|-----------|------------|----------|---|----------|-------|
| Skip          | Relationship | Side                      | Short Name  | Full name | Kit Number | Notes    |   |          |       |
| 7             | Code         | Grandparent               | Format      |           |            |          |   |          |       |
| 8             | G1           | Top line Grandparent 1    | G1          |           |            |          |   |          |       |
| 9             | G2           | Top line Grandparent 2    | G2          |           |            |          |   |          |       |
| 10            | G3           | Bottom line Grandparent 3 | G3          |           |            |          |   |          |       |
| 11            | G4           | Bottom line Grandparent 2 | G4          |           |            |          |   |          |       |
| 12            | P1           | Paternal Grandparent 1    | P1          |           |            |          |   |          |       |
| 13            | P2           | Paternal Grandparent 2    | P2          |           |            |          |   |          |       |
| 14            | M1           | Maternal Grandparent 1    | M1          |           |            |          |   |          |       |
| 15            | M2           | Maternal Grandparent 2    | M2          |           |            |          |   |          |       |
| 16            | Internal GF  | Paternal GF               |             |           |            |          |   |          |       |
| 17            | Paternal GM  | Paternal GM               |             |           |            |          |   |          |       |
| 18            | Maternal GF  | Maternal Grandfather      | Maternal GF |           |            |          |   |          |       |
| 19            | Maternal GM  | Maternal Grandmother      | Maternal GM |           |            |          |   |          |       |
| 20            |              |                           |             |           |            |          |   |          |       |
| Sibling Table |              |                           |             |           |            |          |   |          |       |
| Initial       | Short Name   | Full name                 | Kit Number  | M/F       |            |          |   |          |       |
| 24            | A            | Sibling Kit A             | X0001       | M         | 2C         | Material | V | Cousin V | C0016 |
| 25            | B            | Sibling Kit B             | X0002       | M         | 3C1R       | Material | W | Cousin W | C0017 |
| 26            | C            | Sibling Kit C             | X0003       | M         | 3C1R       | Material | Y | Cousin Y | C0018 |
| 27            | D            | Sibling Kit D             | X0004       | M         | 3C1R       | Material | Z | Cousin Z | C0020 |
| 28            |              |                           |             |           | 4C         | Material | E | Cousin E | C0021 |
| 29            |              |                           |             |           | Unk        | Material | F | Cousin F | C0022 |
| 30            |              |                           |             |           |            |          |   |          |       |
| 31            |              |                           |             |           |            |          |   |          |       |
| 32            |              |                           |             |           |            |          |   |          |       |
| 33            |              |                           |             |           |            |          |   |          |       |
| 34            |              |                           |             |           |            |          |   |          |       |
| 35            |              |                           |             |           |            |          |   |          |       |
| 36            |              |                           |             |           |            |          |   |          |       |
| 37            |              |                           |             |           |            |          |   |          |       |
| 38            |              |                           |             |           |            |          |   |          |       |
| 39            |              |                           |             |           |            |          |   |          |       |
| 40            |              |                           |             |           |            |          |   |          |       |
| 41            |              |                           |             |           |            |          |   |          |       |
| 42            |              |                           |             |           |            |          |   |          |       |
| 43            |              |                           |             |           |            |          |   |          |       |
| 44            |              |                           |             |           |            |          |   |          |       |
| 45            |              |                           |             |           |            |          |   |          |       |
| 46            |              |                           |             |           |            |          |   |          |       |

The screenshot shows a LibreOffice Calc spreadsheet titled "VisualPhasingTemplate.ods". The spreadsheet contains several tables and formulas related to pedigree analysis.

**Grandparent Table**

| #  | Grandparent               | Format               |
|----|---------------------------|----------------------|
| 8  | Top line Grandparent 1    | G1                   |
| 9  | Top line Grandparent 2    | G2                   |
| 10 | Bottom line Grandparent 1 | G3                   |
| 11 | Bottom line Grandparent 2 | G4                   |
| 12 | Paternal Grandparent 1    | P1                   |
| 13 | Paternal Grandparent 2    | P2                   |
| 14 | Maternal Grandparent 1    | M1                   |
| 15 | Maternal Grandparent 2    | M2                   |
| 16 | Paternal GF               | Paternal GM          |
| 17 | Paternal GF               | Paternal Grandmother |
| 18 | Maternal GF               | Maternal GM          |
| 19 | Maternal GF               | Maternal Grandmother |

**Cousin Table**

| Skip | Relationship | Side | Short Name | Full name | Kit Number | Notes            |
|------|--------------|------|------------|-----------|------------|------------------|
| 1C   | Paternal     | G    | Cousin G   | Cousin G  | C0001      | Material line    |
| 2C   | Paternal     | H    | Cousin H   | Cousin H  | C0002      | Thru Material GM |
| 3C   | Paternal     | I    | Cousin I   | Cousin I  | C0003      | Thru Material GM |
| 4C   | Paternal     | J    | Cousin J   | Cousin J  | C0004      | Thru Material GM |
| 5C   | Paternal     | K    | Cousin K   | Cousin K  | C0005      | Thru Material GM |
| 6C   | Paternal     | L    | Cousin L   | Cousin L  | C0006      | Thru Material GM |
| 7C   | Paternal     | M    | Cousin M   | Cousin M  | C0007      | Thru Material GM |
| 8C   | Paternal     | N    | Cousin N   | Cousin N  | C0008      | Thru Material GM |
| 9C   | Paternal     | O    | Cousin O   | Cousin O  | C0009      | Thru Material GM |
| 10C  | Paternal     | P    | Cousin P   | Cousin P  | C0010      | Thru Material GM |
| 11C  | Paternal     | Q    | Cousin Q   | Cousin Q  | C0011      | Thru Material GM |
| 12C  | Paternal     | R    | Cousin R   | Cousin R  | C0012      | Thru Material GM |
| 13C  | Paternal     | S    | Cousin S   | Cousin S  | C0013      | Thru Material GF |
| 14C  | Paternal     | T    | Cousin T   | Cousin T  | C0014      | Thru Material GF |
| 15C  | Paternal     | U    | Cousin U   | Cousin U  | C0015      | Thru Material GF |
| 16C  | Material     | V    | Cousin V   | Cousin V  | C0016      | Thru Material GM |
| 17C  | Material     | W    | Cousin W   | Cousin W  | C0017      | Thru Material GM |
| 18C  | Material     | X    | Cousin X   | Cousin X  | C0018      | Thru Material GM |
| 19C  | Material     | Y    | Cousin Y   | Cousin Y  | C0019      | Thru Material GM |
| 20C  | Material     | Z    | Cousin Z   | Cousin Z  | C0020      | Thru Material GM |
| 21C  | Material     | E    | Cousin E   | Cousin E  | C0021      | Thru Material GM |
| 22C  | Material     | F    | Cousin F   | Cousin F  | C0022      | Thru Material GM |

**Sibling Table**

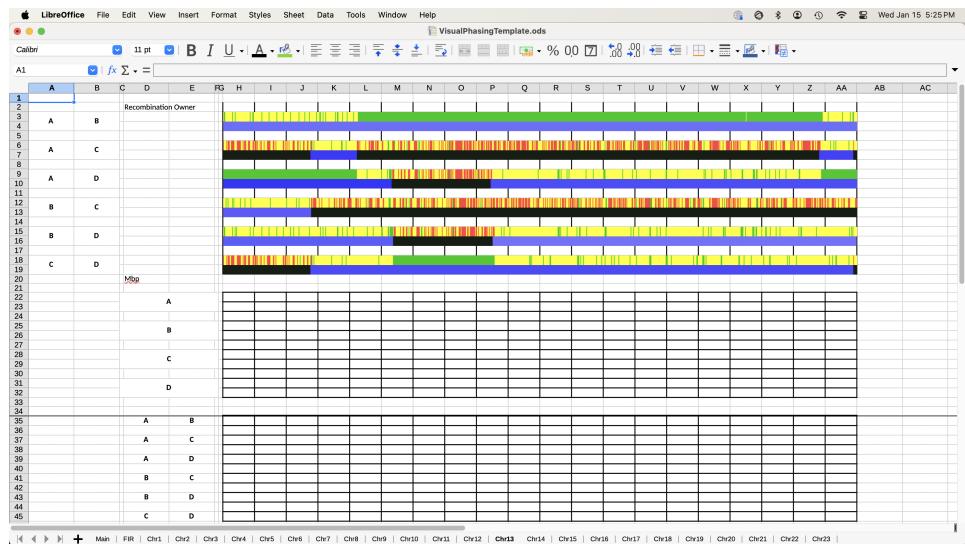
| Initial | Short Name | Full name     | Kit Number | M/F  |
|---------|------------|---------------|------------|------|
| 24      | A          | Sibling Kit A | M          | 3C1R |
| 25      | B          | Sibling Kit B | M          | 4C1R |
| 26      | C          | Sibling Kit C | M          | 3C1R |
| 27      | D          | Sibling Kit D | M          | 3C1R |
| 28      |            |               |            |      |
| 29      |            |               |            |      |
| 30      |            |               |            |      |
| 31      |            |               |            |      |
| 32      |            |               |            |      |
| 33      |            |               |            |      |
| 34      |            |               |            |      |
| 35      |            |               |            |      |
| 36      |            |               |            |      |
| 37      |            |               |            |      |
| 38      |            |               |            |      |
| 39      |            |               |            |      |
| 40      |            |               |            |      |
| 41      |            |               |            |      |
| 42      |            |               |            |      |
| 43      |            |               |            |      |
| 44      |            |               |            |      |
| 45      |            |               |            |      |

Buttons visible on the right side of the spreadsheet include:

- Reset Sheets
- Load Images
- Show Cousins
- Generate Segments
- Legend Format Update
- Load FIR data

# Loading Images

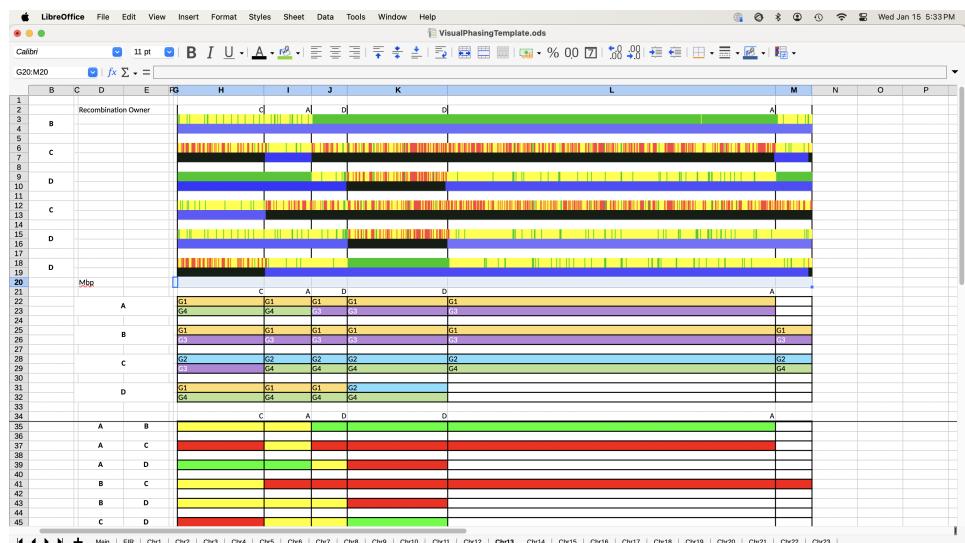
The next step is to load the images to each of the Chromosome sheets. Click the **Load Images** button. The result for Chromosome 13 is:



# Visual Phasing

## Initial Phasing

Then proceed with moving the cell borders to identify recombination points and populate the owner of the recombination points. And start identifying the grandparent for each of the siblings segments.



# Renaming

To rename the grandparent in the painted area, use the **replacePaintValue** macro. Enter the existing text string in cell A1 of the sheet. Enter the new string value in cell A2. Then run the macro. This will replace all occurrences of the string in the painted area.

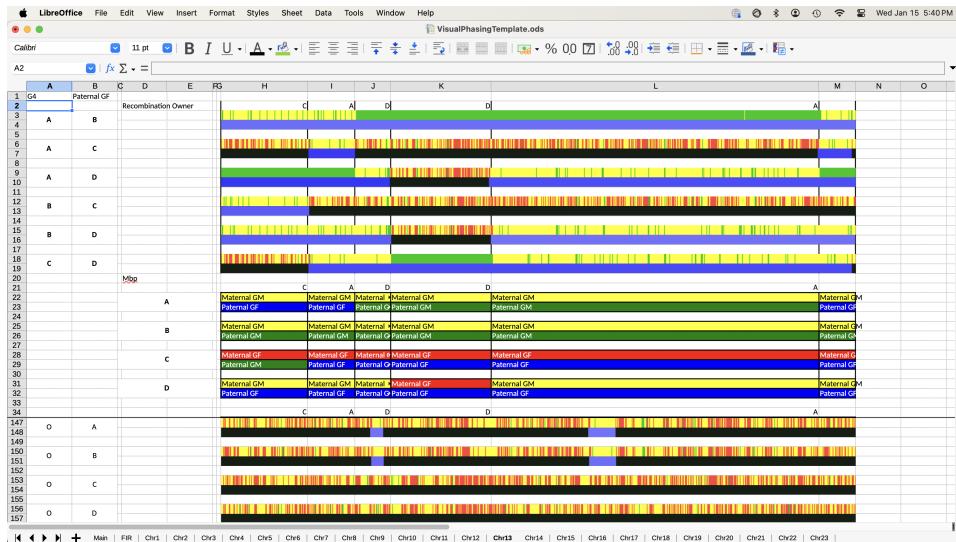
To start the painting process over, run the macro **resetPaintValue**. This will remove all of the strings in the painted area.

# Cousins

To add the Cousin graphs, go to the Main sheet and press the **Show Cousins** button. This adds all of the Cousin graphs to each of the Chromosome sheets. To omit a Cousin graph, put any character in the skip (1st) cell in the Cousins table.

# Final Phasing

When visual phasing is complete, the image should be something like the below.



# Recombination Points

## FIR

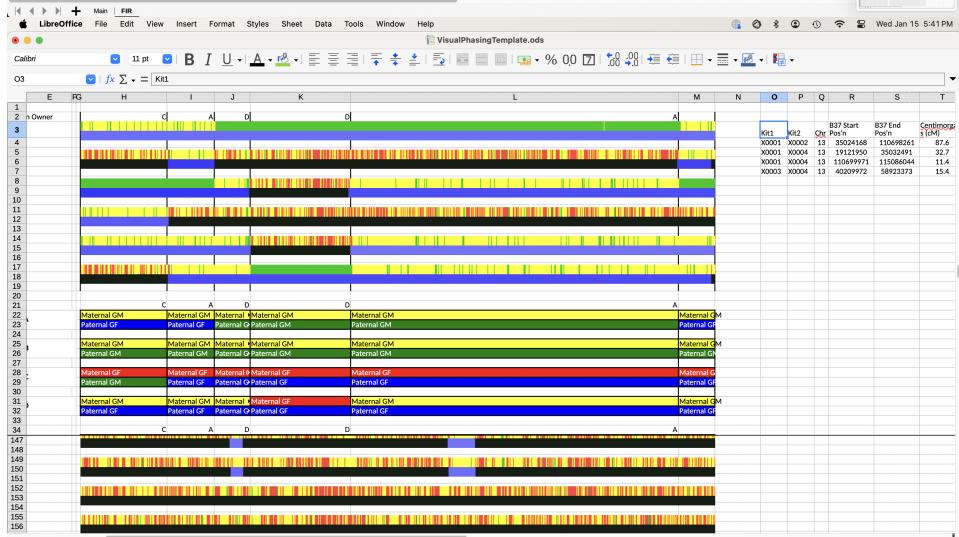
FIR data can be generated in GEDmatch for each of the Sibling pairs. This is OPTIONAL. This data can be copied into the FIR sheet by clicking the **Load FIR Data** and then used as a reference when identifying the Mbp for a recombination point.

LibreOffice File Edit View Insert Format Styles Sheet Data Tools Window Help

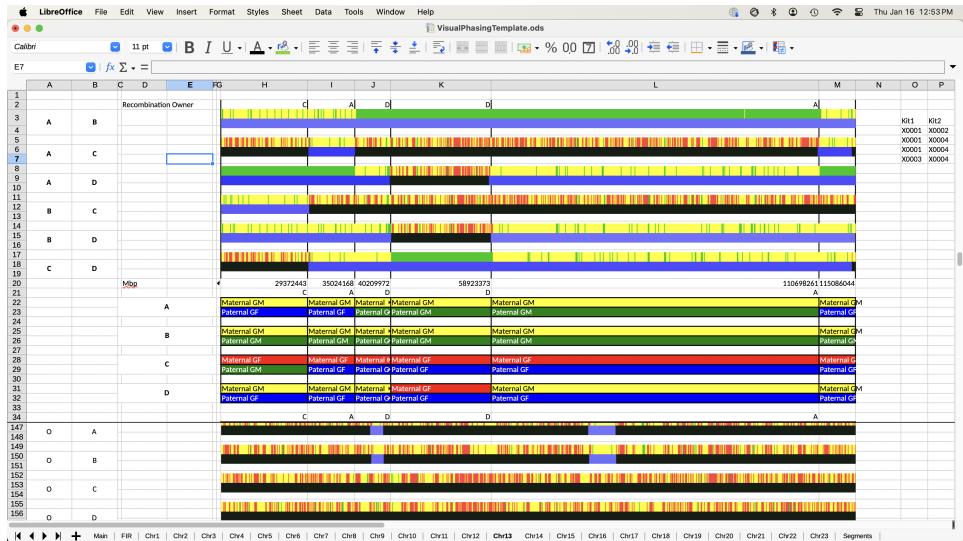
VisualPhasingTemplate.ods

Calibri 11 pt B I U A P S T K1 fx Σ = Kit1

|    | A     | B     | C   | D         | E         | F      | G           | H    | I                 | J             | K           | L | M | N | O | P | Q | R | S | T | U |
|----|-------|-------|-----|-----------|-----------|--------|-------------|------|-------------------|---------------|-------------|---|---|---|---|---|---|---|---|---|---|
| 1  | K1    | K12   | Chr | B37 Start | B37 End   | Chr in | Centimorgan | SNPs | Segment threshold | Stretch limit | SNP density |   |   |   |   |   |   |   |   |   |   |
| 2  | X0002 | X0004 | 1   | 4636767   | 9479192   | 111.3  | 13258       | 185  | 111               | 0.26          |             |   |   |   |   |   |   |   |   |   |   |
| 3  | X0002 | X0004 | 1   | 158902352 | 206595010 | 53.5   | 6630        | 196  | 117               | 0.24          |             |   |   |   |   |   |   |   |   |   |   |
| 4  | X0002 | X0004 | 2   | 12957400  | 13258743  | 21.1   | 2370        | 179  | 104               | 0.24          |             |   |   |   |   |   |   |   |   |   |   |
| 5  | X0002 | X0004 | 2   | 22848917  | 293638781 | 21.4   | 2154        | 207  | 124               | 0.26          |             |   |   |   |   |   |   |   |   |   |   |
| 6  | X0002 | X0004 | 3   | 4602847   | 64477067  | 73     | 9539        | 203  | 124               | 0.25          |             |   |   |   |   |   |   |   |   |   |   |
| 7  | X0002 | X0004 | 3   | 4957075   | 5000000   | 10     | 1141        | 221  | 154               | 0.24          |             |   |   |   |   |   |   |   |   |   |   |
| 8  | X0002 | X0004 | 4   | 71564     | 4276475   | 5.4    | 479         | 192  | 115               | 0.21          |             |   |   |   |   |   |   |   |   |   |   |
| 9  | X0002 | X0004 | 4   | 5717807   | 11428521  | 14.6   | 1284        | 197  | 118               | 0.27          |             |   |   |   |   |   |   |   |   |   |   |
| 10 | X0002 | X0004 | 4   | 2142000   | 2142000   | 0.1    | 4520        | 203  | 122               | 0.23          |             |   |   |   |   |   |   |   |   |   |   |
| 11 | X0002 | X0004 | 5   | 38519     | 2170286   | 6.1    | 411         | 196  | 118               | 0.25          |             |   |   |   |   |   |   |   |   |   |   |
| 12 | X0002 | X0004 | 5   | 3247420   | 3635334   | 5.3    | 626         | 190  | 116               | 0.25          |             |   |   |   |   |   |   |   |   |   |   |
| 13 | X0002 | X0004 | 5   | 3287780   | 119263749 | 50     | 6819        | 209  | 125               | 0.24          |             |   |   |   |   |   |   |   |   |   |   |
| 14 | X0002 | X0004 | 5   | 1494679   | 1500000   | 5.4    | 5300        | 211  | 127               | 0.27          |             |   |   |   |   |   |   |   |   |   |   |
| 15 | X0002 | X0004 | 6   | 15561574  | 170821800 | 26.6   | 3127        | 201  | 121               | 0.28          |             |   |   |   |   |   |   |   |   |   |   |
| 16 | X0002 | X0004 | 7   | 3246019   | 37466970  | 6      | 807         | 213  | 126               | 0.26          |             |   |   |   |   |   |   |   |   |   |   |
| 17 | X0002 | X0004 | 7   | 15546174  | 15546174  | 5.3    | 270         | 210  | 125               | 0.29          |             |   |   |   |   |   |   |   |   |   |   |
| 18 | X0002 | X0004 | 8   | 9550529   | 101862078 | 7.1    | 904         | 205  | 123               | 0.29          |             |   |   |   |   |   |   |   |   |   |   |
| 19 | X0002 | X0004 | 8   | 12462604  | 139260648 | 25.6   | 2889        | 216  | 129               | 0.33          |             |   |   |   |   |   |   |   |   |   |   |
| 20 | X0002 | X0004 | 9   | 4281000   | 4281000   | 1.1    | 310         | 190  | 117               | 0.27          |             |   |   |   |   |   |   |   |   |   |   |
| 21 | X0002 | X0004 | 9   | 46587     | 10369718  | 25.6   | 2973        | 201  | 126               | 0.33          |             |   |   |   |   |   |   |   |   |   |   |
| 22 | X0002 | X0004 | 10  | 138564    | 3072799   | 6.7    | 693         | 205  | 126               | 0.31          |             |   |   |   |   |   |   |   |   |   |   |
| 23 | X0002 | X0004 | 10  | 138564    | 138564    | 4.9    | 427         | 227  | 134               | 0.3           |             |   |   |   |   |   |   |   |   |   |   |
| 24 | X0002 | X0004 | 10  | 18882502  | 114518004 | 23.2   | 3450        | 218  | 131               | 0.27          |             |   |   |   |   |   |   |   |   |   |   |
| 25 | X0002 | X0004 | 10  | 12913913  | 135368163 | 16.8   | 1610        | 225  | 136               | 0.31          |             |   |   |   |   |   |   |   |   |   |   |
| 26 | X0002 | X0004 | 11  | 12546144  | 12546144  | 3.3    | 3627        | 217  | 130               | 0.29          |             |   |   |   |   |   |   |   |   |   |   |
| 27 | X0002 | X0004 | 11  | 7887821   | 83468464  | 5      | 778         | 218  | 130               | 0.28          |             |   |   |   |   |   |   |   |   |   |   |
| 28 | X0002 | X0004 | 11  | 12500573  | 130086338 | 9.3    | 1046        | 216  | 129               | 0.32          |             |   |   |   |   |   |   |   |   |   |   |
| 29 | X0002 | X0004 | 12  | 19527826  | 206595027 | 1.3    | 306         | 220  | 134               | 0.28          |             |   |   |   |   |   |   |   |   |   |   |
| 30 | X0002 | X0004 | 12  | 19527826  | 38519     | 39.3   | 3451        | 217  | 130               | 0.31          |             |   |   |   |   |   |   |   |   |   |   |
| 31 | X0002 | X0004 | 13  | 19121590  | 8861592   | 6.2    | 985         | 211  | 129               | 0.23          |             |   |   |   |   |   |   |   |   |   |   |
| 32 | X0002 | X0004 | 14  | 10182846  | 10743294  | 7.8    | 461         | 204  | 122               | 0.22          |             |   |   |   |   |   |   |   |   |   |   |
| 33 | X0002 | X0004 | 14  | 2014700   | 2014700   | 7.4    | 597         | 227  | 133               | 0.31          |             |   |   |   |   |   |   |   |   |   |   |
| 34 | X0002 | X0004 | 15  | 3879088   | 58779441  | 18.5   | 2730        | 214  | 128               | 0.27          |             |   |   |   |   |   |   |   |   |   |   |
| 35 | X0002 | X0004 | 16  | 7011318   | 74048542  | 73.6   | 8044        | 241  | 145               | 0.29          |             |   |   |   |   |   |   |   |   |   |   |
| 36 | X0002 | X0004 | 16  | 7793453   | 80135823  | 3.4    | 347         | 227  | 133               | 0.29          |             |   |   |   |   |   |   |   |   |   |   |
| 37 | X0002 | X0004 | 17  | 15346     | 1441448   | 5.9    | 323         | 216  | 129               | 0.31          |             |   |   |   |   |   |   |   |   |   |   |
| 38 | X0002 | X0004 | 17  | 4938201   | 6161442   | 3.2    | 284         | 224  | 130               | 0.33          |             |   |   |   |   |   |   |   |   |   |   |
| 39 | X0002 | X0004 | 17  | 2938152   | 3000000   | 4.4    | 4603        | 215  | 128               | 0.28          |             |   |   |   |   |   |   |   |   |   |   |
| 40 | X0002 | X0004 | 17  | 7793453   | 80135823  | 6.9    | 263         | 205  | 123               | 0.14          |             |   |   |   |   |   |   |   |   |   |   |
| 41 | X0002 | X0004 | 18  | 10094503  | 47153899  | 37.8   | 4821        | 231  | 130               | 0.29          |             |   |   |   |   |   |   |   |   |   |   |
| 42 | X0002 | X0004 | 18  | 7387740   | 74048542  | 18.7   | 1863        | 225  | 132               | 0.26          |             |   |   |   |   |   |   |   |   |   |   |
| 43 | X0002 | X0004 | 19  | 269192    | 6774609   | 4.3    | 1311        | 213  | 127               | 0.13          |             |   |   |   |   |   |   |   |   |   |   |

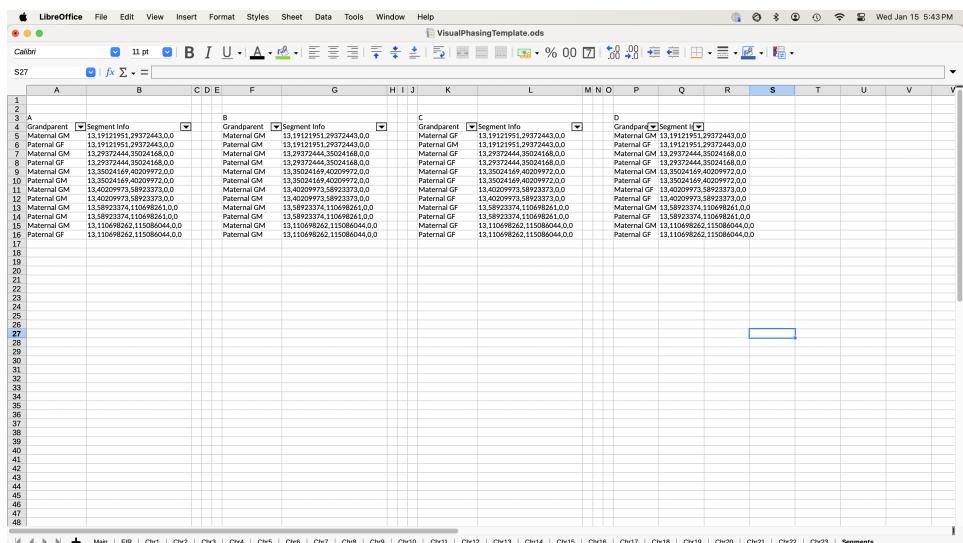


After the recombination points have been identified and the Mbp for each has been entered, the final sheet should be:



## Segment Lists

Segment lists can be generated by clicking the **Generate Segments** button on the Main sheet. For each Chromosome sheet, all of the segments that have an Mbp value and a segment grandparent labeled, an entry will be added to the Segment sheet. This is an OPTIONAL process.



## Appendix

# User Callable Macros

## Macros tied to buttons on the Main sheet

### **RebuildChromosomeSheets**

Remove all Chromosome sheets and regenerate Chromosome sheets. This should be done whenever there are changes to the Sibling Table.

### **LoadAllImages**

Loads all Chromosome sheets with the Sibling graphs. This needs to be done after resetting the Chromosome sheets.

### **LoadCousin**

Load the Cousin data for each Chromosome sheet.

### **UnloadCousin**

Remove the Cousin data for each Chromosome sheet.

### **GenerateSegmentList**

Create a new sheet labeled Segment and fill it with any segment information that has been defined. This data can be used in DNApainter, for instance.

### **Legend Map Changed**

To regenerate all of the painted area colors if the format in the Main sheet Grandparent Table has changed. This is tied to a button in the Main sheet

### **LoadFIR**

Load the FIR data for each Chromosome sheet.

## Macros not tied to buttons on the Main sheet

### **resetPaintValue**

Remove all of the text in the painted area. This allows the user to start the visual paint process again

### **replacePaintValue**

Replace an existing text string (like G1) in the painted area with a new text string (like M1)

### **RemoveChromosomeSheets**

Delete all Chromosome sheets

### **ShowRecombinationPoints**

Generates the recombination Mbp value assuming the graphs are linear in Mbp. The graphs generated by GEDmatch are not, so this is not useful for these. There are other applications that may generate graphs which are linear and can be used. In this case, the max Mbp need to be entered in Row 1, second Column after the painted area. If this is blank, the cell is painted red to indicate the error and the Recombination values are generated as a percentage.