DNA, What a Tangled Web You Weave!
LESSONS FROM ONE SMALL MATCH

Susan Goss Johnston

What are your DNA research goals? Those goals will influence your choice of test and testing company, as well as the techniques you use to analyze your test results.

I have two major DNA research goals. First, I would like to identify which ancestor to thank – or blame – for each segment of my DNA. Second, I would like clues to the identity and birth family of some 5x- and 6x-great-grandmothers. The first goal obviously requires DNA segment data. Because the second goal deals with sixth through eighth cousins, at best, shared matches do not provide enough specificity to reach a valid conclusion as to genetic ancestry. Both goals require a chromosome browser – and Ancestry does not provide one. Is there any method that will group small shared matches according to probable shared DNA segment? An attempt to resolve conflicting information about a 12 cM match uncovered a successful method – the DNA matrix.

The Focus Match

The Focus Match in this problem is one of several members of a GEDmatch cluster that was found on chromosome M10.[1] We share one 12 cM segment and 123 matches on Ancestry. Those matches include 24 designated paternal, 4 unassigned, and the remainder designated maternal matches. The 4 unassigned matches share two segments with me, the rest share only one.

The only reason I designated this small match a Focus Match is that Ancestry provided what looked like conflicting evidence about it. Ancestry defined the Focus Match as a *maternal* match. However, Ancestry's ThruLines stated that we are 6th cousins and our common ancestral couple is Jeremiah Rappleye=Sarah Williamson. This line is one of my *paternal* lines. Like most of us, I do have paternal and maternal lines that trace back to the same ancestor(s), but this line is not one of them.

Adding to the puzzle, among these 123 matches were four members of a family that belonged to a large maternal cluster on chromosome M07. No other members of that cluster appeared among the 123 matches. What was going on with this Focus Match?

Shared Match List Categories

The shared match list is a list of DNA matches found on both your match list and your Focus Match's list. Although there is a subconscious assumption that you and your Focus Match share a common ancestor with each of these shared matches, that is not necessarily true. The shared match list may include any or all of the following groups. Before spending time and effort researching every match on a shared match list, determine into which category each match belongs.

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[1] Maternal chromosome 10.

- Shared Segment groups. You share Segment A with the Focus Match. The Focus Match shares Segment A with Match 1. You share Segment A with Match 1. Theoretically, this shared DNA segment came from the same common ancestor, and these matches are genealogically and genetically related. (This is the classic triangulated group.)

- To determine the common ancestor, trace each match back until all match trees converge. If this ancestor is unknown to you, trace the descendants down until one of those descendants fits your known family's geography or genealogy.

- Shared Ancestor groups. You share a common ancestor with the Focus Match. The Focus Match shares the same common ancestor with Match 2. You share the same common ancestor with Match 2. The three matches are genealogically related, but may not have the same DNA segments in common.

- Research these matches as if they were members of a Shared Segment group. However, if the common ancestor is a distant one, it may be a genealogical ancestor, but not a genetic ancestor. A conclusion stating that your 6x-great-grandmother is Ancestor Q based on a group of triangulated matches may not be valid.

- Mismatch groups. You share Segment B and Common Ancestor X with the Focus Match. The Focus Match shares Segment C and Common Ancestor Y with Match 3. You share Segment D and Common Ancestor Z with Match 3. The three matches have no DNA or ancestor in common.

- Any genealogy conclusion based on this category of shared matches is invalid. If Shared Match 3 might be significant in your research, make him or her the Focus Match. Construct the new DNA matrix and proceed from there.

If you share more than one DNA segment with your Focus Match, each segment could have come from a different common ancestor. Each DNA segment creates a new Shared Segment group, and each must be evaluated separately. Depending on each DNA segment's size, those independent Shared Segment groups may or may not be visible in the DNA matrix.

The DNA Matrix[2]

Sometimes one can get a clearer picture of the shared matches if one constructs a DNA matrix. This is a spreadsheet that displays the amount of DNA you and the Focus Match share with everyone on the shared match list, and *the amount of DNA each member of the list shares with every other member.* Ancestry's *ProTools* provides this shared DNA information, but one can create a matrix that shows which shared match list members share with other members without ProTools. Creating the DNA matrix from an Ancestry shared match list is a simple manual process, but it can take considerable time to complete My step-by-step process is demonstrated in this handout's appendix.[3]

The Completed Focus Match Matrix
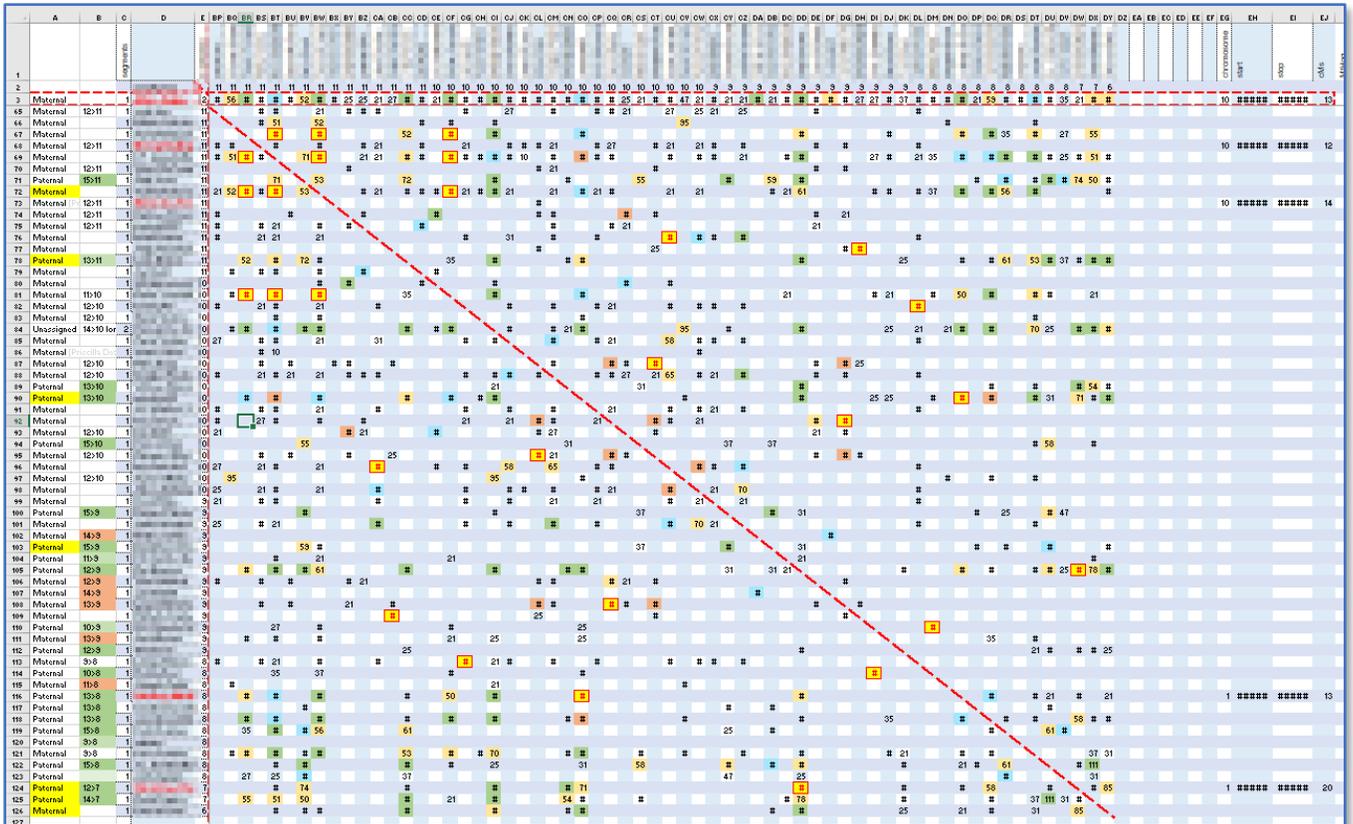
Although one can see that a pattern might form in this matrix, that pattern is not readily apparent. Matches that share DNA with each other must now be grouped together.

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[2] The DNA matrix presented here is one Andy Lee calls a 3-D matrix. In addition to showing the fact that two shared matches share DNA with each other, it includes how much DNA the two share.
[3] GEDmatch can display a DNA matrix within its Tier One tools, and a matrix limited to ten matches can be created for free with its 3D-chromosomer browser. Family Tree DNA displays a matrix that is limited to ten matches. DNA matrices from all other databases must be created manually at this time.
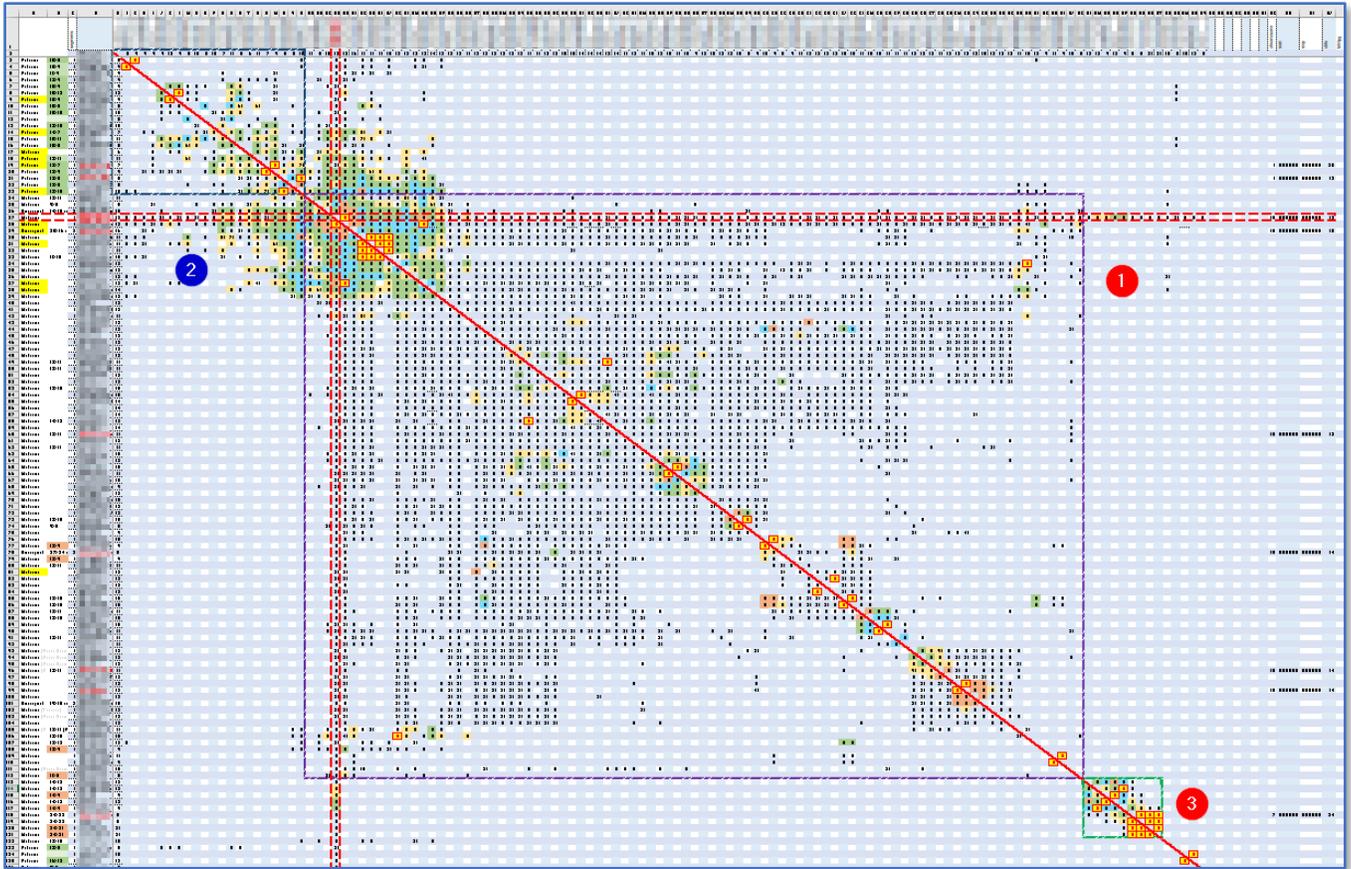
Interpreting the Results

This DNA matrix produced three clear groups of matches, but what do they mean? Assuming a DNA matrix produces groups, the category to which each group belongs should be identified. This requires a combination of genealogy, searches for the shared matches in other DNA databases, and chromosome painting. Note that the Focus Match is bordered in red in the matrix.

- Compare the number of segments shared with the Focus Match and the number of groups seen in the matrix. There can be at most one group for each shared segment. Since I share only one segment with the Focus Match, only one of these three groups might represent a Shared Segment group. The other two groups must belong to a different category.

- A search for the Ancestry matches from Group **1**, the large group in the center, in other testing company databases, identified six that shared the identical chromosome M10 segment shared by the Focus Match and me. Therefore, it is likely that this group represents a Shared Segment group. Because Ancestry's shared match list only includes matches that share at least 20 cM with the Focus Match, much of the blank areas in this group would "fill in" with matches sharing 19 cM or less with the Focus Match.

- Group **3**, the small group in the lower right of the matrix, consists of closely related matches only. (The bright yellow colors show matches that share more than 1000 cM with each other.) When a small group includes few matches in the 20-30 cM range, it may fall in the "Mismatch" category (Shared Match 3).

Building the trees for all matches in this group shows that this is the case for these shared matches. The Focus Match and I share neither ancestors nor DNA in common with these matches.

- ▪ Group **2**, the group in the top left corner, comprises only paternal matches, but most of its members also share DNA with some members of Group **1**. Constructing trees for these matches showed they all descend from Jeremiah Rappleye and Sarah Williamson – the same couple shown in Ancestry's ThruLines. Therefore, this group fits the pattern of Shared Ancestor matches: all share the same common ancestor with the Focus Match and me, but there is no common DNA segment among us. The highly colored area that overlaps the two groups identifies matches that are related as second cousins (2C) or closer. Whether they are my paternal or maternal matches, they all descend from the same couple: Elias Gardner and Lauraetta Staples. Taken together, the shared matches in Groups 1 and 2 illustrate a pattern Dana Leeds calls "Mountains and Valleys" (Figure 1). Usually, this is seen when you are the person descended from the couple in the valley. In this example the Focus Match is that central person. I appear twice: among descendants sharing the chromosome M10 segment and among Rappleye=Williamson descendants with whom I share a chromosome P01 segment. The Focus Match shares DNA, but not the chromosome P01 segment, with the Rappleye=Williamson descendants.
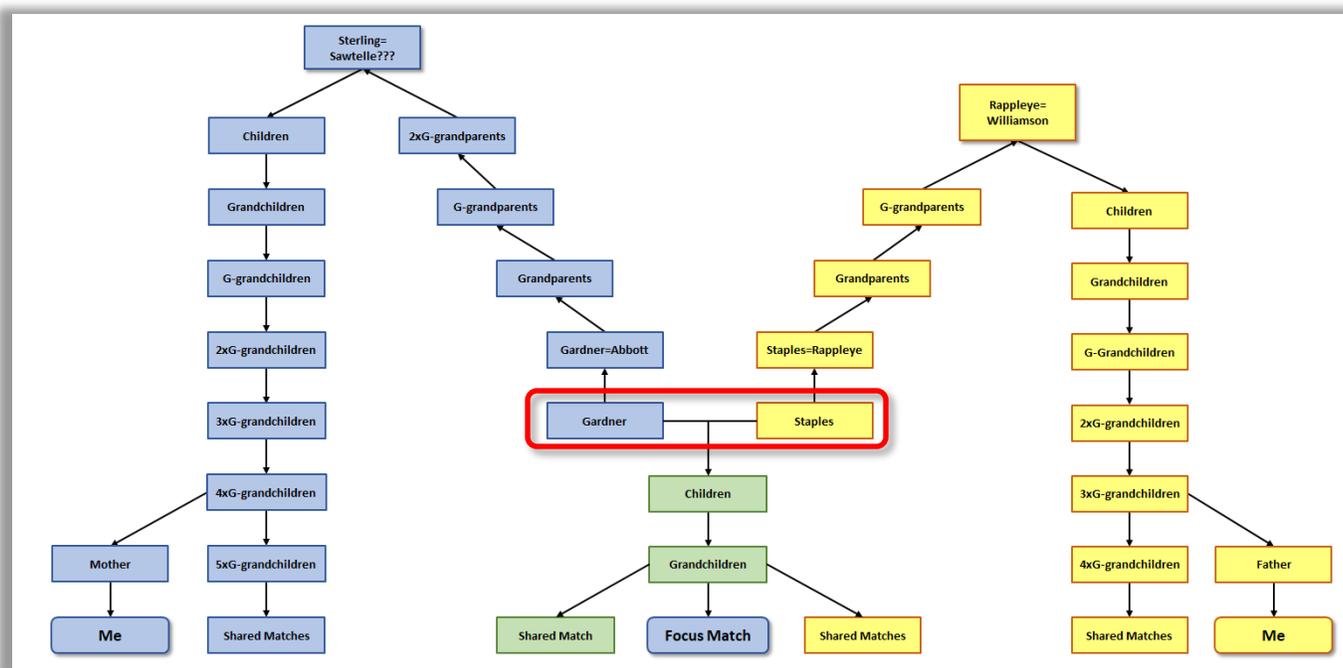

Figure 1. "Mountains and Valleys: pattern

Is This Reproducible?

To test the conclusions I reached about this Ancestry DNA matrix, I repeated the technique with a MyHeritage match. Since MyHeritage provides chromosome segment data, I could see if the groups actually correlated with the segments. The chosen Focus Match shares 138 cM and seven segments with me. In this test, I limited the shared matches in the matrix to those sharing at least 15 cM with me.

The DNA matrix produced what looks like six clear groups plus some smaller groups. These were correlated with segment data and there was almost perfect correlation between the six groups and the segment data. When I examined the one segment that did not produce a group, I discovered that the Focus Match had no matches on that segment.

There was also a small Shared Ancestor group. All members of that group shared a common ancestral couple, Parker=Kendall, with me and with the Focus Match, but there was no common DNA segment among us. Several very small "Mismatch" groups were also seen.
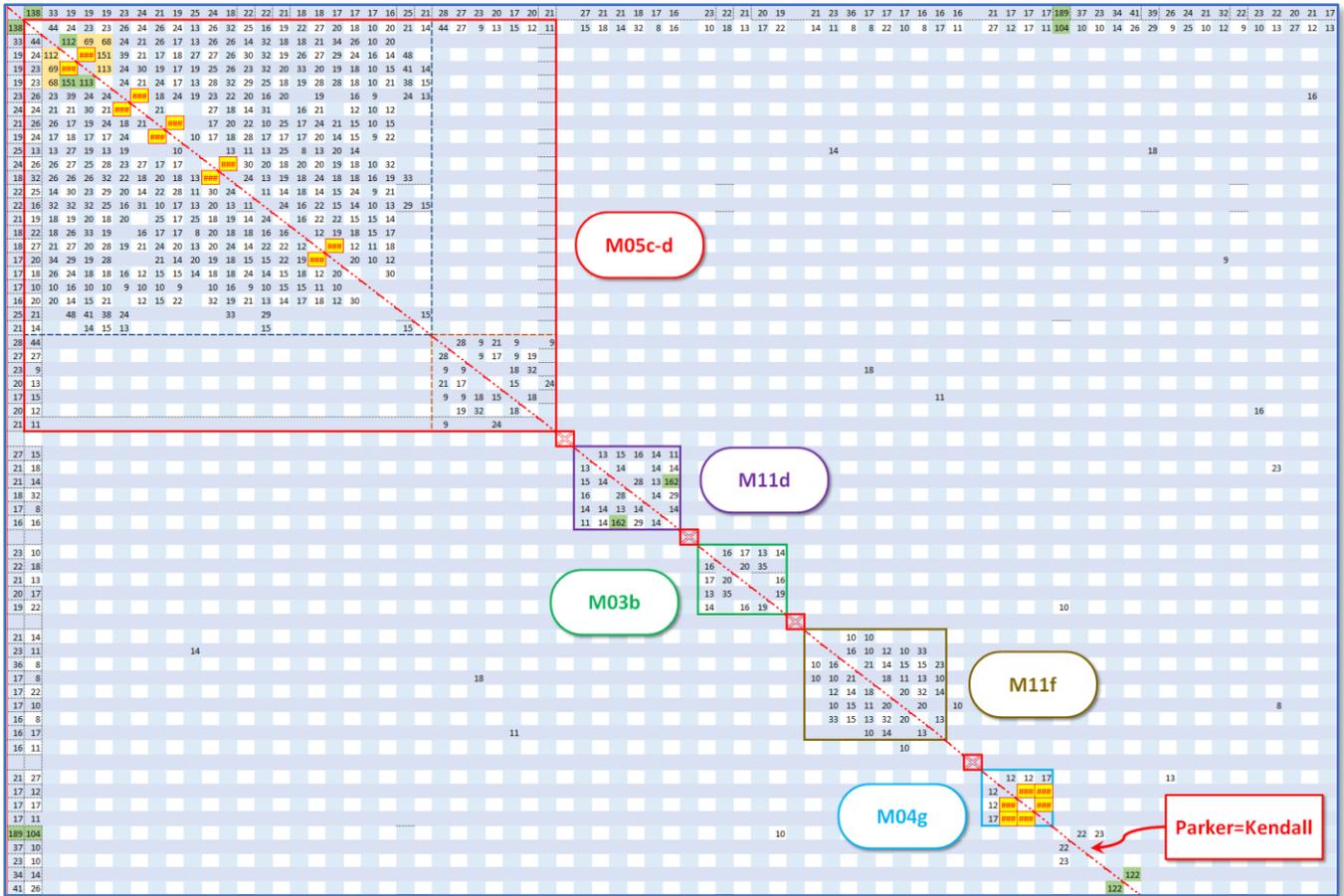
Method Limitations

- Ancestry does not show shared matches who share less than 20 cM with the Focus Match. This means that all matrices will be incomplete. This incomplete information may make identifying the type of matrix group difficult.

- The Focus Match is unlikely to share at least 20 cM with every match within the Shared Segment group. To find other members of the group, you will need to create additional DNA matrices with another Focus Match known to be in the Shared Segment group.

- Some potential Focus Matches have shared match lists that are too large to work with. Other potential Focus Matches have shared match lists that are too small to create visible groups.

- Creating a DNA matrix for an Ancestry match may take a lot of time.

Reasonable Parameters

- Your Ancestry DNA Focus Match should be a "problem" match.
  - Is there conflicting information, as in this example? Creating the Focus Match's matrix may resolve the conflicts.
  - Is the match designated Unassigned or Both Sides? Creating the Focus Match's matrix may separate matches by DNA segments.
  - If you analyze the match, are you likely to obtain information that will help solve a problem?

- The Focus Match usually fits these parameters.
  - You and the Focus Match have between 40 and about 120 shared matches. Any fewer and the DNA matrix is unlikely to produce groups. Any more and data entry becomes very tedious.
  - You and the Focus Match share about 15-40 cM (give or take).
  - You and the Focus Match share 1-3 segments.
- Do not choose a Focus Match that is closely related to you. Too many matches will fit the "Same Ancestor – No Common DNA" pattern (Shared Ancestor groups). You are unlikely to find Shared Segment groups.
- Do not choose a very small match. You are likely to get too many "No Common Ancestor – No Common DNA" matches (Mismatch groups) to create a discernible pattern.

Conflicts Resolved – Questions Answered

- Just like Ancestry said, the DNA my Focus Match and I share came through my maternal line, so she is a maternal match. Ancestry states that its designation of side for most people is about 95% accurate. In my case, its accuracy seems to be a little higher.
- ThruLines compares *genealogy* trees of DNA matches. It does not compare *genetic* trees of those matches. Even assuming accurate genealogy trees, the ThruLines ancestor shared by you and a DNA match might not be the DNA ancestor you share. That was the case here. As ThruLines said, our MRCA (Most Recent Common Ancestor) is Jeremiah Rappleye and Sarah Williamson, my paternal ancestors. The Focus Match and I do not share DNA through this line, however.
- The father and three sons in our shared match list do not share common DNA with me and the Focus Match, nor do they share a common ancestor with me and the Focus Match. They form an example of the "Mismatch" group (Shared Match 3). I do not belong to the group shared by them and the Focus Match. The Focus Match does not belong to the group shared by them and me.

Final Word

- The DNA matrix may show the shared matches that are most relevant to your research.
- The DNA matrix may eliminate immediately all shared matches that are irrelevant to your research.
- The DNA matrix may remind you that your DNA inheritance is complicated. You and your Focus Match may share a well-documented genealogical line, but that does not prove that line is also your shared genetic line.
- Don't forget that if you and your DNA match share multiple DNA segments, you may also share multiple genetic ancestors.

Selected Online Bibliography

Lee, Andy. "3 Methods to Cluster DNA Matches." *YouTube*. https://www.youtube.com/watch?v=hpzQjqGmOeo : accessed September 2025. The section called "3D Matrix Clustering" begins at 7:49.

_____. "I Am Related to Him and Her? Triangulating Ancestry DNA Matches." *YouTube*. https://www.youtube.com/watch?v=ffJ_k34eIEE : accessed September 2025.

Leeds, Dana. "Who Is in a Cluster?" *Dana Leeds: Creator of the Leeds Method*. Blog post, 20 September 2019. https://www.danaleeds.com/who-is-in-a-cluster/ : accessed September 2025.

Lee, Andy. "An Overview of GEDMatch's Comparison Matrices in Multiple Kit Analysis." *Family History Fanatics*. https://www.familyhistoryfanatics.com/gedmatch-matrices : accessed September 2025. (Tier One Tool).

Lee, Andy, "GEDmatch 3D Chromosome Browser for Genetic Genealogy Explained." *YouTube*. https://www.youtube.com/watch?v=HR25cXhxj5g : accessed September 2025. (Free GEDmatch tool).

"Family Finder Matrix Guide." *Family Tree DNA*. https://help.familytreedna.com/hc/en-us/articles/4411225071247-Family-Finder-Matrix-Guide#h_01HF79EXR4162QTYA0S24HPSGH : accessed 2025.

Perl, Jonny. "Shared DNA at a glance: the new DNA matrix tool." *DNA Painter*. https://dnapainter.com/blog/shared-dna-at-a-glance-the-new-dna-matrix-tool/ : accessed September 2025.

Bartlett, Jim. *Segmentology*. https://segmentology.org/: accessed September 2025.

Elder, Diana. "Pedigree Triangulation: What is it and How Can it Solve Brick Walls?" *Family Locket*. https://familylocket.com/pedigree-triangulation-what-is-it-and-how-can-it-solve-brick-walls/ : 25 July 2019.

Estes, Roberta. "ThruLines Suggests Potential Ancestors – How Accurate Are They?" *DNA Explained*. https://dna-explained.com/2023/01/26/thrulines-suggests-potential-ancestors-how-accurate-are-they/ : 25 January 2023. An excellent analysis of the limitations and possibilities of Ancestry's ThruLines.

Conditional Formatting in Excel. Applying conditional formatting is an excellent way to see patterns in your Excel data. My spreadsheet employs the following: (1) coloring alternate rows and columns; (2) highlighting cells based on their values; (3) highlighting a cell based on data in another cells. There are many online tutorials and videos that explain and demonstrate these and many other possibilities.

Terms Used in this Presentation

DNA matrix. A visual table showing the amount of DNA shared between different individuals.

False matches. Shared matches that are based on a false DNA segment.

Genetic network. In genealogy, a group of individuals with shared DNA that share common ancestors.

Match triangulation. See "triangulated group" or "shared segment matches."

Mismatches. Three or more matches who all share DNA – but who share no DNA segment in common and who share no ancestors in common.

Pedigree triangulation. A method that identifies the common ancestor among at least three shared DNA matches by comparing family trees. (See Diana Elder, "Pedigree Triangulation: A Key Methodology for Genetic Genealogy" (https://rvgslibrary.org/SIB/files/Pedigree%20Triangulation.pdf : accessed September 2025).

Shared ancestor matches. A set of three or more genetic matches that share a common ancestor. They do not necessarily share a common DNA segment (see "pedigree triangulation").

Shared match list (a.k.a. "In common with"). A list of matches that appear on both the tester's match list and the Focus Match's match list (a.k.a. Best Match, second tester). All matches on a shared match list share at least one bit of DNA with the tester and the Focus Match, *but* that bit of DNA is not necessarily the same DNA.

Shared segment matches. A set of three or more genetic matches who share an identical DNA segment on the same location of a chromosome, indicating that the segment was inherited from a common ancestor (a.k.a. "triangulated group").

Triangulated group. A set of three or more genetic matches who share an identical DNA segment on the same location of a chromosome, indicating that the segment was inherited from a specific common ancestor.

Creating the DNA Matrix – Example

Panel 1 (spreadsheet structure — names only, no data)

	Segments	You	Focus Match	Shared Match 1	Shared Match 2	Shared Match 3	Shared Match 4	Shared Match 5	Shared Match 6	Shared Match 7	Shared Match 8	Shared Match 9	Shared Match 10
You													
Focus Match													
Shared Match 1													
Shared Match 2													
Shared Match 3													
Shared Match 4													
Shared Match 5													
Shared Match 6													
Shared Match 7													
Shared Match 8													
Shared Match 9													
Shared Match 10													

- Prepare your spreadsheet. Excel is used throughout this presentation.
- Enter yourself, the Focus Match, and *every* shared match on the shared match list in a column.
- Copy and paste those names to the top row using Excel's Paste-Transpose function or the Paste Special>Values+Transpose function.
- Tip: For data entry, the shared matches should always be listed larger to smaller relative to you.

Panel 2 (You and Focus Match cM entered)

	You	Focus Match	Shared Match 1	Shared Match 2	Shared Match 3	Shared Match 4	Shared Match 5	Shared Match 6	Shared Match 7	Shared Match 8	Shared Match 9	Shared Match 10
You		138	33	22	19	28	27	21	20	17	16	189
Focus Match	138		44	25	23	44	15	14	13	15	16	104
Shared Match 1	33	44										
Shared Match 2	22	25										
Shared Match 3	19	23										
Shared Match 4	28	44										
Shared Match 5	27	15										
Shared Match 6	21	14										
Shared Match 7	20	13										
Shared Match 8	17	15										
Shared Match 9	16	16										
Shared Match 10	189	104										

- Enter shared cM amounts for you and the Focus Match for all shared matches in the relevant columns.
- Copy and paste the data to the corresponding rows.
- Tip: Conditional formatting to apply different colors to alternate rows and columns makes data entry easier.
- Tip: A diagonal border marking the column-row intersection for each match is very helpful.

Panel 3 (matrix filled in for shared matches)

		You	Focus Match	Shared Match 1	Shared Match 2	Shared Match 3	Shared Match 4	Shared Match 5	Shared Match 6	Shared Match 7	Shared Match 8	Shared Match 9	Shared Match 10
You		138	33	22	19	28	27	21	20	17	16	189
Focus Match	138		44	25	23	44	15	14	13	15	16	104
Shared Match 1	33	44										
Shared Match 2	22	25					14			68		
Shared Match 3	19	23							21		9	
Shared Match 4	28	44						15				11
Shared Match 5	27	15		14						29		
Shared Match 6	21	14				15						162
Shared Match 7	20	13			21						15	
Shared Match 8	17	15		68			29					
Shared Match 9	16	16			9				15			
Shared Match 10	189	104				11		162				

- Go to the first shared match on the list and repeat the process.
- Continue the process sequentially with each shared match on the list until the matrix is complete.
- Do not add or subtract names to the Shared Match list – even if you think they do, or do not, belong.
- Tip: Conditional formatting based on amount of shared DNA adds visual information and helps prevent data entry errors.

	D	E	F (You)	G (Focus Match)	H (Shared Match 2)	I (Shared Match 5)	J (Shared Match 8)	K (Shared Match 3)	L (Shared Match 7)	M (Shared Match 9)	N (Shared Match 4)	O (Shared Match 6)	P (Shared Match 10)	Q (Shared Match 1)	R	S
1	Segments		You	Focus Match	Shared Match 2	Shared Match 5	Shared Match 8	Shared Match 3	Shared Match 7	Shared Match 9	Shared Match 4	Shared Match 6	Shared Match 10	Shared Match 1		
2		You		138	33	22	19	28	20	17	27	21	16	189		
3	7	Focus Match	138		44	25	23	44	13	15	15	14	16	104		
4	3	Shared Match 2	33	44			14	68								
5	2	Shared Match 5	22	25	14		29									
6	1	Shared Match 8	19	23	68	29										
7	1	Shared Match 3	28	44					21	9						
8	2	Shared Match 7	20	13				21		15						
9	2	Shared Match 9	17	15				9	15							
10	4	Shared Match 4	27	15								15	11			
11	3	Shared Match 6	21	14							15		162			
12	2	Shared Match 10	16	16							11	162				
13	13	Shared Match 1	189	104												
14																
15			11	11	4	4	4	4	4	4	4	4	4	2	0	
16																

- When the matrix is complete, "cluster" the shared matches.

- If you move a row, you must immediately move the corresponding column.

- Moving multiple rows or columns together requires they be contiguous.

- To move a row:
  - Highlight the row (or column).
  - Move the cursor along the row edge until it turns into crossed arrows.
  - Hold down the shift key and move to the desired location.
  - Release the shift key.

- *Immediately* repeat the process to move the corresponding column.

- After the move, the diagonal marker line should appear unchanged.

Example DNA Matrix Patterns

Focus Match shares two segments:
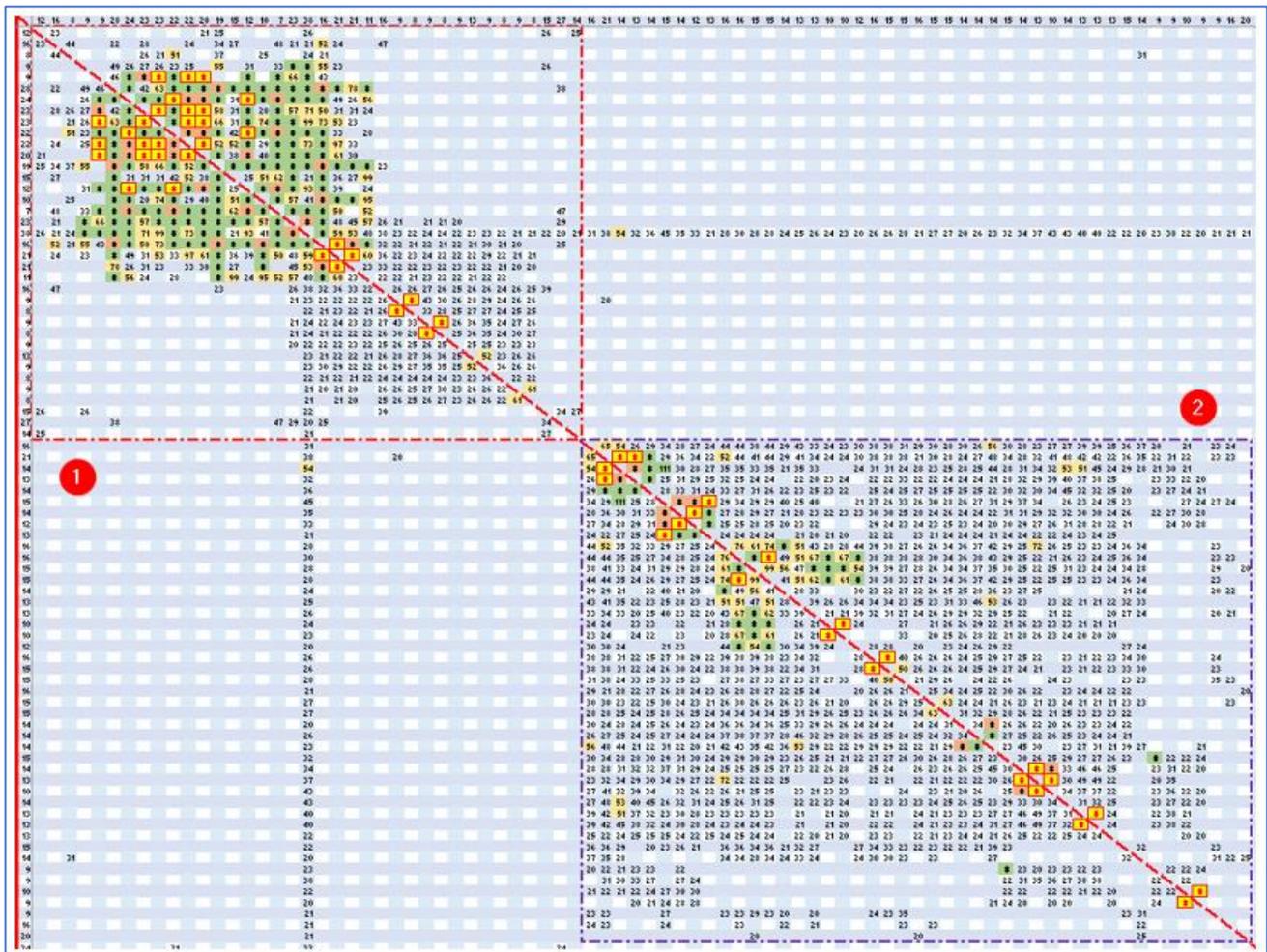
- Two groups are shown.
- Group 1 comprises maternal matches, five identified as sharing the same chromosome M20 segment. It is likely to "fill in" if sub-20 cM matches were included.
- Group 2 comprises paternal matches. Genealogy says most of these are Case=Olmstead descendants.
- Both groups appear to be Shared Segment groups; the Group 2 segment has not been identified, yet.
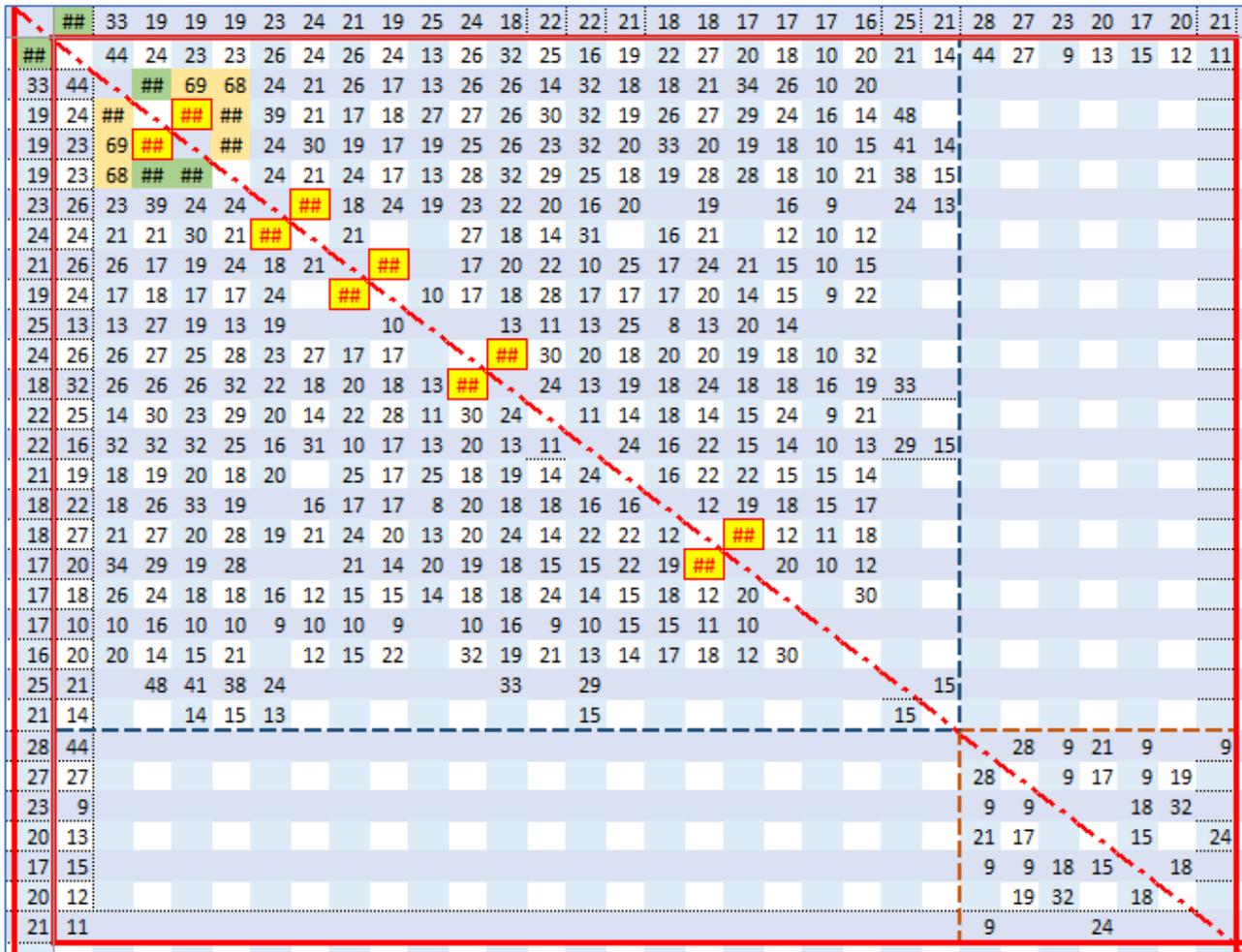
Focus Match shares two segments:
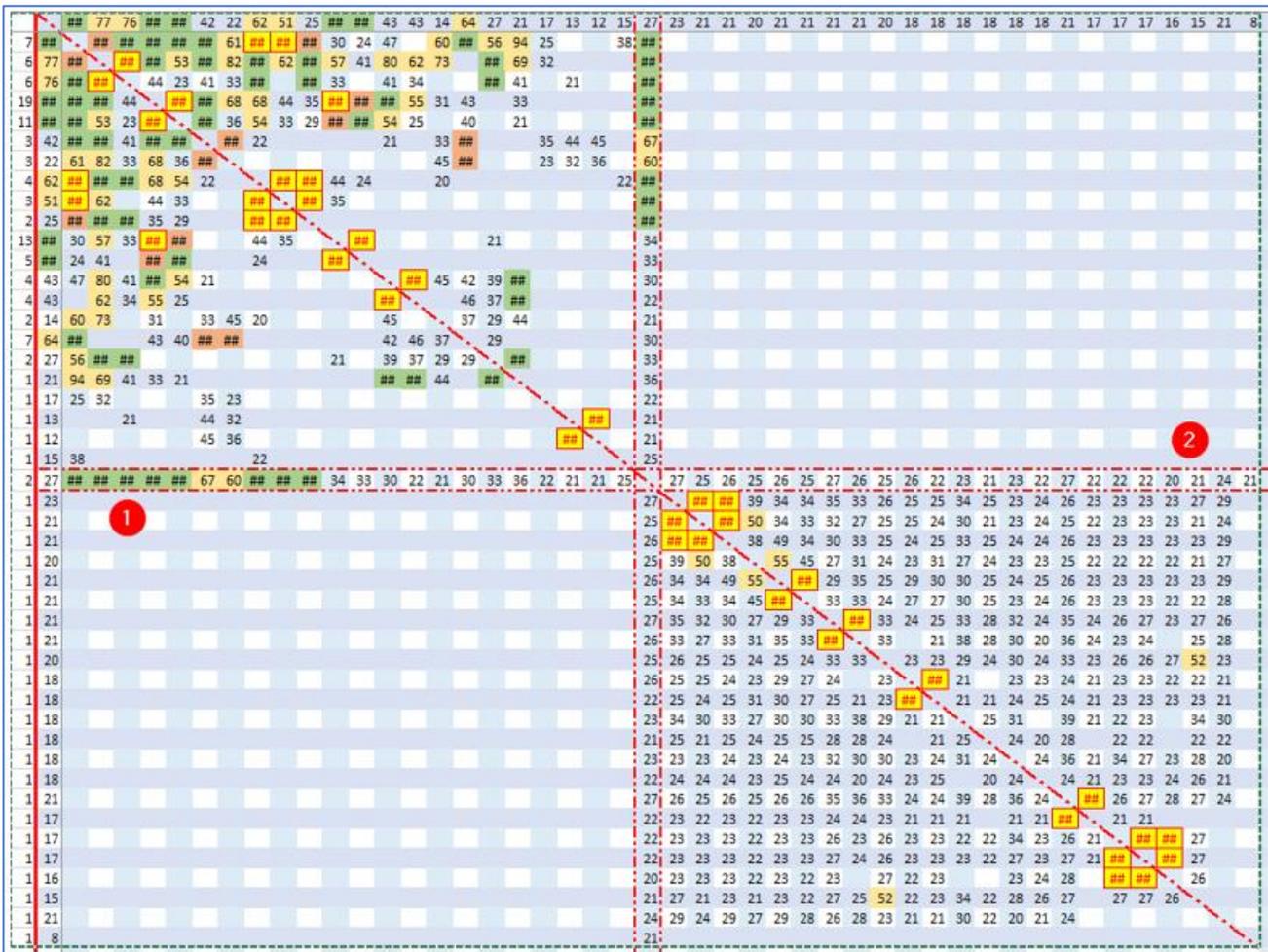
- Two groups are shown.
- Group 2 includes four matches that share a chromosome M04 segment. This appears to be a Shared Segment group.
- Most of the matches in Group 1 are closely related. Matches this close usually share several segments in common, so finding evidence of a unique Shared Segment group is unlikely. This group is a Shared Ancestor group: "Common Ancestor – No Common DNA".

Focus Match shares one 52 cM segment

- Will this "fill in"? Or are these subclusters?
- Painting available segments suggests these might be subclusters. The DNA Painter segment is 53.4 cM from start to end points, closely matching the size of the Focus Match's segment.

Focus Match shares one 62 cM segment

- Since the Focus Match shares only one segment, this must be a crossover, subclusters, or a "fill in". There is no overlap.

- Painting identified segments suggests a crossover, and genealogy suggests this crossover is Hadley=Flanders.

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