Next Steps DNA Bootcamp

With Michelle Leonard

We hope you enjoyed the first webinar in the 'Next Steps' DNA Bootcamp. Here is the extended week one handout which includes a list of your ***optional*** DNA Bootcamp tasks.

DNA Bootcamp Webinar One Tasks:

TASK 1

Segment Data Task:

- **Study the four generation chromosome pair inheritance chart to understand how DNA breaks down into segments over generations**
- **Create a similar chart for yourself and plug your ancestral names into it to get a feel for what may have happened on one of your own chromosome pairs – you can do this on paper or digitally (it doesn't need to be fancy!)**
- **It might also be fun to try to work out ballpark percentages for how much DNA has been inherited from each of the eight great grandparents on my chart!**

TASK 2

23andMe Chromosome Browser Tasks:

- **Check out how you match ten or more of your highest matches via 23andMe's one-to-one chromosome browser using the 'View DNA Details' box on the individual match page**
- **Try out the 'Advanced DNA Comparison' tool and look at the same one-to-ones but this time also study the DNA Segment Data table**
- **Add several sets of five known and unknown matches to compare with your test using the 'Advanced DNA Comparison' tool**
- **Swap over the base 'Compare' person so you can see how it looks with the other four people as the base person instead**
- **What have you gleaned from this exercise? Jot it down in a 'Bootcamp' research log and let's discuss it at the follow-ups**

TASK 3

MyHeritage Chromosome Browser Tasks:

- Check out your shared segments with ten or more of your highest matches via MyHeritage's one-to-one chromosome browser on the individual match pages
- Try out the 'One-to-Many' chromosome browser and look at the same one-to-ones but this time also study the DNA Segment Data tables available at the bottom of the page
- Add several sets of 5-7 known and unknown matches to compare with your test using the 'One-to-Many' chromosome browser
- If you have access to more than one MyHeritage kit, repeat this process with a different base person
- Investigate the 'automated triangulated segments' icon
- What did you learn during this exercise? Add notes to your research log

TASK 4

FTDNA Chromosome Browser Tasks:

- FTDNA has an amalgamated one-to-one and one-to-many chromosome browser; first try out the one-to-one capability and then add several sets of 5-7 matches into the browser to check out how it all works
- Make sure you look at the 'Detailed Segment Data' table under the separate heading within the browser
- Try out the 'Matrix tool' to see if people with overlapping segments match each other (in some way!) or not
- Try using the 'Not In Common with' tool to identify matches who share DNA on the same segment on different chr copies
- What did you learn while doing this exercise?

TASK 5

Triangulation:

- This task merges with all the chromosome browser tasks because that's where you will identify triangulations
- While investigating your segment data in the site chromosome browsers did you come across any triangulations along the way?
- If so, did this tell you anything you didn't already know or help you in any way?
- Remember not to obsess over trying to find triangulations as all the other segments are just as useful!

PREPARATION TASKS

Preparation Task:

- If you have only tested at Ancestry and are only working with Ancestry data, it's important to get into at least one of the other databases in order to take part in the tasks in relation to segment data/chromosome browsers
- You can upload your Ancestry raw data to MyHeritage and FTDNA for free but you will need to pay the small unlock fees to access the chromosome browsers
- You can also upload Ancestry raw data to third party tools website GEDmatch (this is optional but I will be covering it and will include optional tasks for it in later webinars - make sure you are comfortable with the T&Cs)

Preparation Tasks:

- In the upcoming webinars we will be delving into third party tools so make sure you have created accounts at the following sites so you can play along:
  - DNA Painter: free to use but there is also a subscription option
  - GEDmatch: also free but I will also be covering the Tier 1 set of tools which costs $15 per month as of 1st May (the price has remained at $10 per month/$100 annually for recurring subscribers)
  - DNAGedcom client: silver access costs $5 per month (or $50 annually) and I would recommend getting a month's access at this level to try it out but this is optional
  - Genetic Affairs: there are subscription levels from $5 per month but a new account offers 200 free credits which is more than enough to try it out

Please make sure you read the Terms and Conditions at each third-party tool website and that you are comfortable with them. It is important to make sure you are fully informed before you use any DNA website and that is especially true for GEDmatch which has had its share of controversies over the past few years.

NOTE: The webinar nights will be packed with information but don't feel overwhelmed as I know it's impossible to take so much in at one sitting – I have designed the bootcamp so that you can attend the live events and just listen along the first time then watch the replays in bite-size chunks stopping at each task to work on it (if you wish!) before carrying on to the next section and task. Please don't feel any pressure to complete the tasks by a certain time; they are suggestions to help you get hands on with your DNA results but entirely optional and it is fine for everyone to learn at their own pace!

DISCLAIMER: All examples throughout this course are genuine but DNA match information has been anonymised to protect the privacy of living individuals

If you have the original Bootcamp 'DNA Workbook', I recommend re-reading it for a recap and especially paying attention to the following pages which cover several of the 'Next Steps' webinar one topics:

1. What is segment data? (page 43)
2. Chromosome browsers (pages 44-45)
3. Triangulation (pages 48-49)

NOTE: these subjects relate more to this Bootcamp, but the Workbook was in production before 'Next Steps' was envisaged and, therefore, basic information was included on them at that time.

What is DNA segment data?

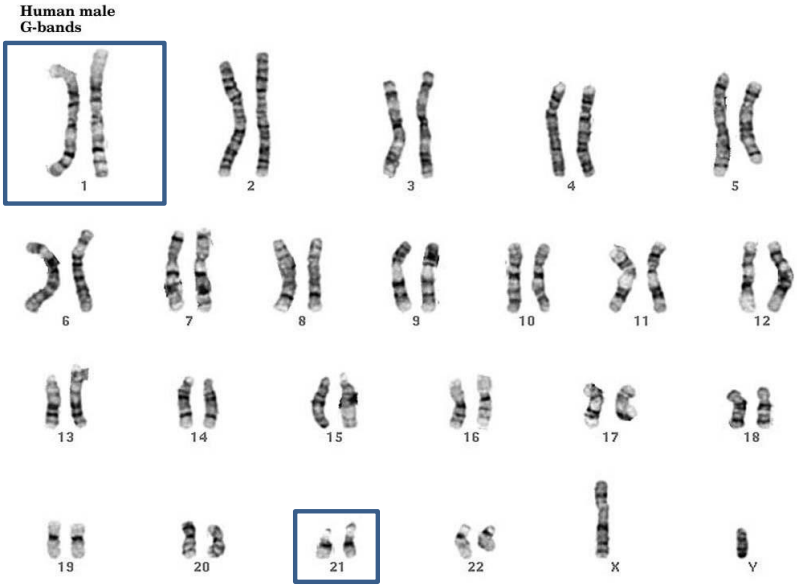
DNA Segment data is a term used to describe exact portions of DNA within the 22 PAIRS of autosomes and the X-chromosome(s) that are inherited from our ancestors. When we receive autosomal DNA test results, all the different testing companies provide basic information on the total number of centiMorgans (cMs) and segments we share with our matches. DNA Segment data comprises of more detailed information on these specific segments (i.e. which chromosomes the segments are located on and the exact locations on those chromosomes at which each segment begins and ends). When a match shares a specific segment on a particular chromosome this is called a matching segment – each segment has a specific start and end location along the chromosome and is measured in cMs. If a common ancestor or ancestral couple can be identified between two matches, the segments they share can generally be assigned to these specific ancestors and this is called mapping your DNA! If more than one set of common ancestors is identified or endogamy or pedigree collapse are involved, however, then more caution is required when assigning segments to particular ancestors.

KEY POINTS:

- DNA segment data is only available on 23andMe, MyHeritage, FTDNA and the third-party tools website GEDmatch – Ancestry and LivingDNA do not provide it
- Ancestry only displays the total amount of DNA shared in cMs and the basic number of segments shared whereas LivingDNA only provides the total number of cMs shared
- DNA segment data is only applicable to autosomal DNA tests and not Y-DNA or Mitochondrial DNA tests
- X-chromosome DNA segment data is only available on 23andMe, FTDNA and GEDmatch – MyHeritage does not currently include it

It is important to understand autosomal DNA inheritance before working with DNA segment data and the key point to always keep in the forefront of your mind is that the 46 chromosomes we inherit are passed down in 23 PAIRS; this means we have a maternal chromosome one and a paternal chromosome one and so on. Also bear in mind that the autosomes are numbered in terms of size with chromosome one being the largest and chromosome twenty-one the smallest closely followed by chromosome twenty-two; it was originally thought chromosome twenty-two was the smallest, but genome sequencing subsequently revealed it was actually chromosome twenty-one hence we have ended up with this numbering anomaly.

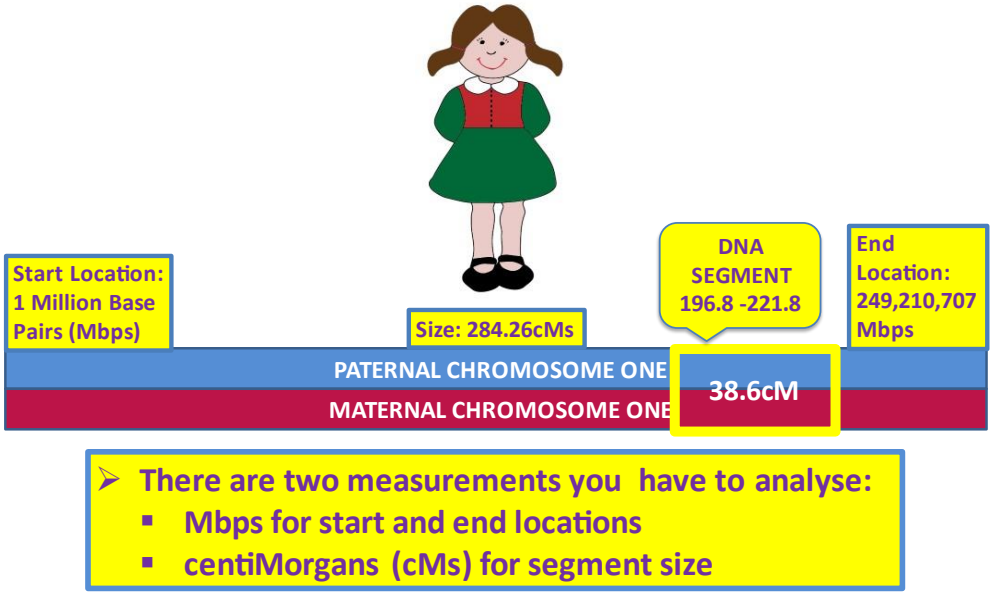
Chromosomes (two copies of each!)



Set of 23 Chromosome Pairs (Male)

It is important to understand the different measurements and terms involved when working with DNA segment data:

What are segments measured in?

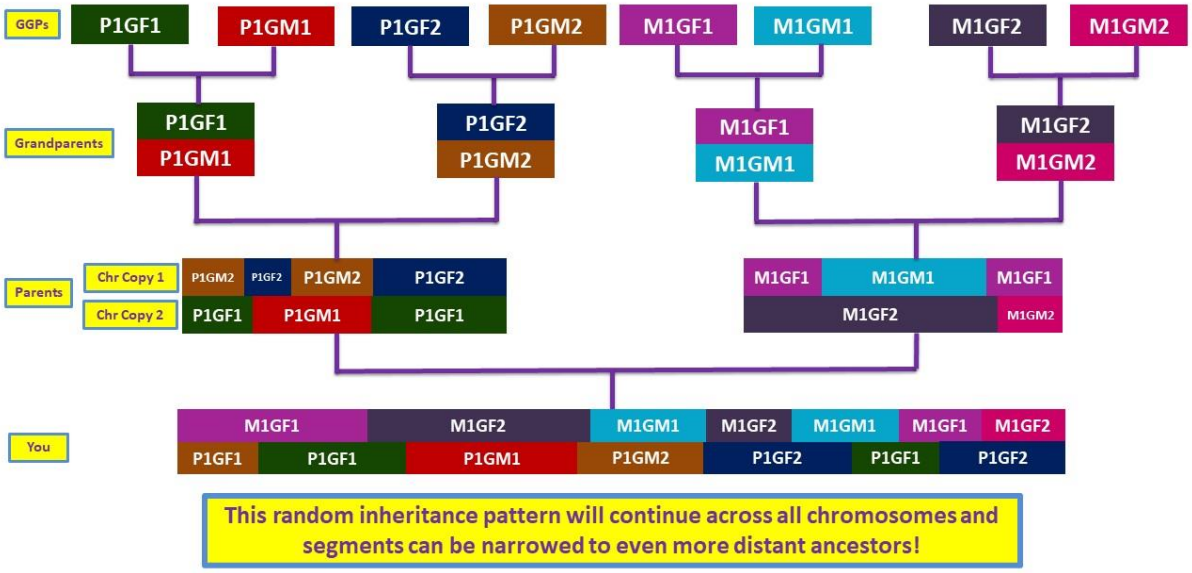


- There are two measurements you have to analyse:
  - Mbps for start and end locations
  - centiMorgans (cMs) for segment size

KEY POINT: throughout the course I will use my 'shorthand' versions for start and end locations – the shorthand is simply shortening the number of million base pairs (Mbps) using a decimal point after the million portion of the number (e.g. a start location of 196,810,312 is shortened to 196.8 and an end location of 221,841,109 is shortened to 221.8 thus shortening the segment information down to a more manageable 196.8 to 221.8).

Four Generation Chromosome Pair Inheritance Chart

How does DNA break up into segments?



KEY POINTS:

- This four-generation chart demonstrates the random inheritance pattern of one autosomal chromosome pair (e.g. maternal chromosome 15 and paternal chromosome 15) from great grandparent level down to you
- The data in the chart is hypothetical and does not represent specific ancestors or a particular chromosome so the number of the chromosome is not important
- The eight great grandparents have only been assigned one colour to represent the entirety of their DNA even although they also, like all our ancestors, will have had two copies of this chromosome (one from each of their parents). This is just to make the chart manageable in size terms but do remember the colour for the great grandparents represents an amalgamation of their copies in much the same way we see on a chromosome browser.
- I have used my pedigree codes to name the eight great grandparents: P1GF1 is the great grandfather at the top (the paternal grandfather's father) while M1GM2 is the great grandmother at the bottom (the maternal grandmother's mother) of a pedigree chart
- From the 'grandparents' section down, the top line represents one copy of the chromosome and the bottom line represents the other copy: on the 'parents' and 'you' sections I have switched around which side is on top just to demonstrate that in most cases we won't know which copy is the maternal one and which is the paternal one
- The 'You' section does not have the codes attached since the segments are too small in some places to add readable text
- Try out creating a hypothetical chart of your own (see Task 1) just to get a feel of how autosomal DNA could have been passed down to you from your great grandparents

What can you do with DNA segment data?

- Identify segments inherited from specific ancestors
- Use this information to narrow unidentified and new matches down to lines on your tree
- Infer sides
- Triangulation
- Conventional chromosome mapping
- Inferred chromosome mapping
- Visual Phasing

KEY POINT: the million-dollar question when it comes to DNA segment data is whether it is useful for DNA research or not! The answer is that working with DNA segment data is **NOT** essential to success with DNA testing for genealogy, but it can be interesting and it is worth understanding how it all works even although, for most matches, sticking to the basic techniques will yield the most success. At the end of the day using shared matches, clustering and copious tree-building will always be the most useful techniques for identifying matches. DNA segment data can be useful in certain instances, however, and it becomes more useful, the more confirmed matches you are able to identify. You can also maximise its usefulness by creating a reference to use with it! I liken using segment data without that to trying to work with DNA matches without a well-built tree and we will be covering how to create this reference in the coming webinars.

How do the DNA testing companies display DNA segment data? They do so via a tool called a chromosome browser.

Chromosome Browsers

Chromosome browsers are tools that deliver a visual representation of the exact segments of DNA shared between test testers and one or more of their DNA matches. They provide information on the start and end locations of matching segments and the amount of cMs associated with those segments. FTDNA, 23andMe, MyHeritage and GEDmatch all provide both one-to-one and one-to-many Chromosome browsers while Ancestry and LivingDNA do not offer a browser of any kind.

Which companies provide segment data?

Chromosome browsers display twenty-three lines to represent the twenty-three chromosome pairs (twenty-two pairs of autosomes plus the X-chromosome which is a pair for women and singular for men). Although we each have twenty-three pairs of chromosomes, the browsers can only display one line per pair because it is currently not possible to automatically separate out the maternal and paternal copies of the chromosomes. Never forget both exist, however, and two people matching you on the same segment on the same chromosome could be matching on either your maternal copy or your paternal copy. It is possible they match each other but equally possible they do not, so it is essential to work out if they do via comparing them to each other if that facility is available. Chromosome browsers can be used to narrow connections down to certain lines of your tree, infer sides and help with mapping segments of DNA back to specific ancestors.

There are two types of chromosome browser:

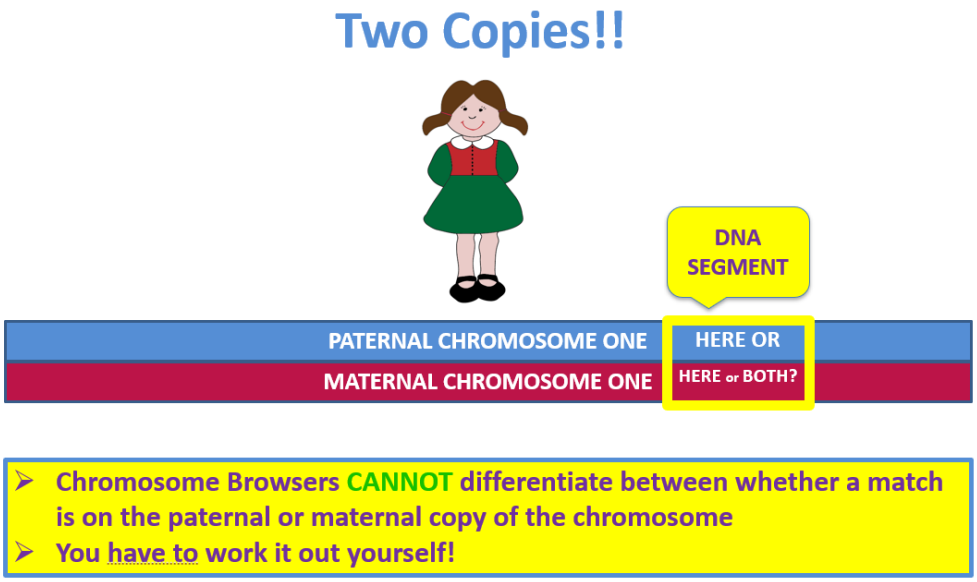
1. One-to-one chromosome browsers compare the test taker and one other match
2. One-to-many chromosome browsers allow comparisons between the test taker (or another base person in some cases) and multiple other matches

There are also two components to every chromosome browser:

1. The chromosome image view
2. The segment data table that accompanies the visual

Each chromosome browser has its own method of displaying data and some have very useful extra features that you should employ when navigating them. The core information (the visual browser image and DNA data table) is available on every site that offers a browser but not all provide the same level of information.

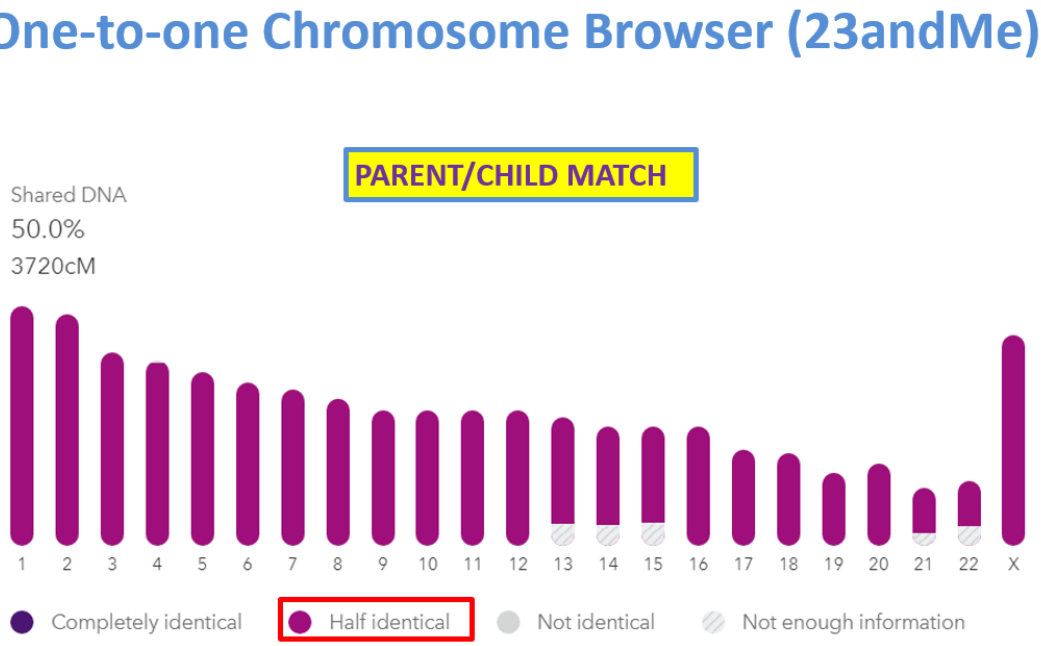
KEY POINT: The number one piece of information you must remember when working with a chromosome browser is that it is not possible for the browser to separate out the maternal and paternal copies and, therefore, there will only be ONE line to represent both.



Please refer to preparation task one if you have only tested at Ancestry and only currently work with Ancestry test results.

23andMe Chromosome Browser

23andMe's chromosome browser is an excellent and comprehensive tool that provides additional information and functionality not offered by any of the other testing sites. Below is an image of the side-on one-to-one chromosome browser that can be accessed on the individual match page within the 'Your Genetic Relationship' section. Click on 'View DNA Details' and, if the match has allowed access to this information or accepted a connection request, you will be able to view the visual:



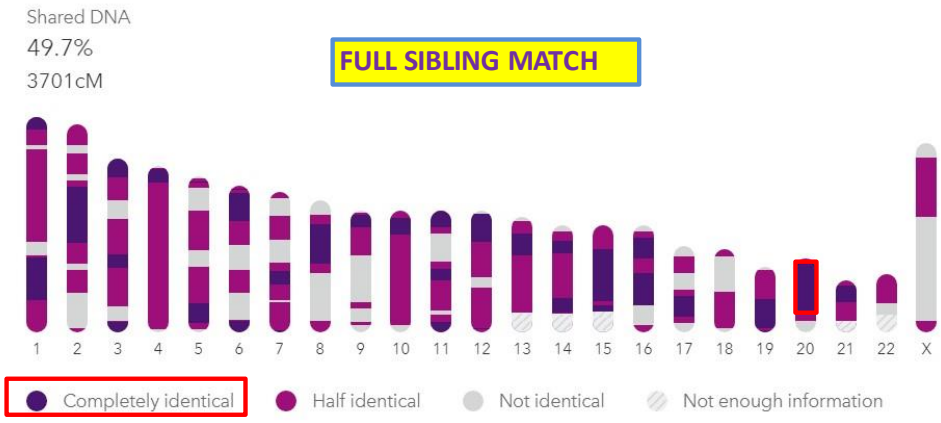
This is a basic one-to-one browser image of a parent-child match and, as with all browsers, the first thing to notice is that there is only one line to represent both copies of each chromosome. The areas on the chromosomes on which the match shares with the test taker are filled in either with the colour to represent 'half identical' or the colour to represent 'completely identical' sharing. Any segments that aren't shared are greyed out as 'non identical' and any areas that don't contain enough DNA data (known as 'SNP poor' regions) to accurately be assessed are overlaid with the 'not enough information' pattern.

23andMe is the only testing site to offer information on whether a match is half-identical (matching only on one chromosome copy) or completely identical (matching on both chromosome copies). GEDmatch also offers a visual representation of this but it is not provided on FTDNA or MyHeritage.

In this case, of course, the parent passes down entire copies of 23 chromosomes to the test taker, so every chromosome is overlaid with the 'half identical' colour. The test taker received the other copy of those chromosomes from their other parent so, unless the parents are related, a parent-child match should always be half identical across all chromosomes.

Another important aspect on 23andMe is that the X-chromosome is included; in the case of a parent-child match this will also always be half-identical across the entire chromosome for all parent-child combinations other than father-son – a father passes a Y-chromosome to a son instead so there will be no X-chromosome sharing at all on a father-son chromosome comparison.

One-to-One Chromosome Browser (23andMe)

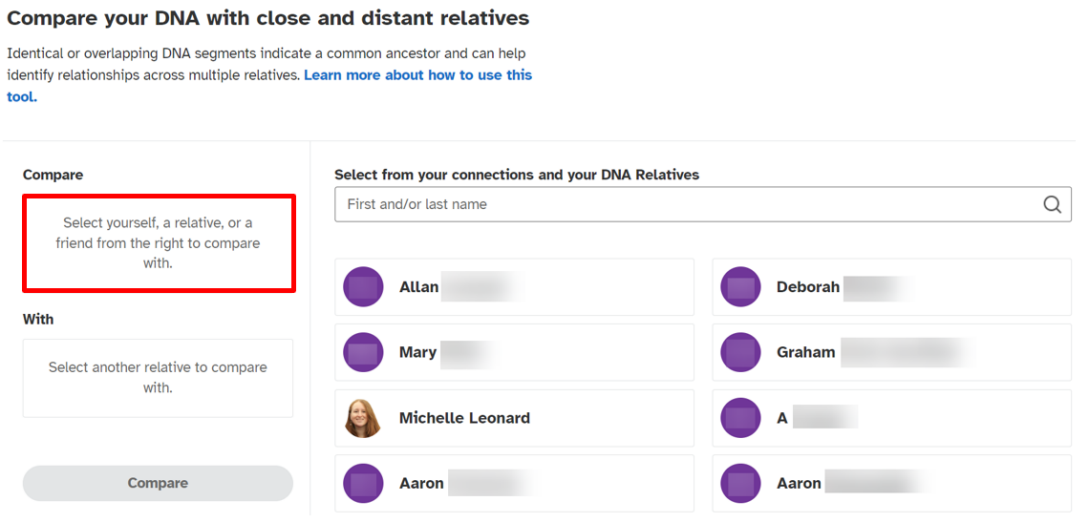


Very few matches will share 'completely identical' segments with you because to share DNA on both copies of your chromosomes requires there to be a relationship on both sides of your ancestry and most of our relatives, close or distant, will only match us via one side of our ancestry. This means 'half identical' is likely to be the outcome for the vast majority of our matches. The one major relationship, however, that will always share completely identical regions is a full sibling since they are closely related via both parents. The only other possible reasons for completely identical regions would be if the match is a double cousin with relationships to both sides, if parents were related to each other or if there is widespread endogamy at play.

The basic one-to-one chromosome browser on the individual match page is an excellent starting point but it doesn't include the DNA segment data table so I would recommend navigating to the 'Advanced DNA Comparison' tool via the 'Family & Friends' menu on the top bar in order to explore 23andMe's more detailed chromosome browser offering:

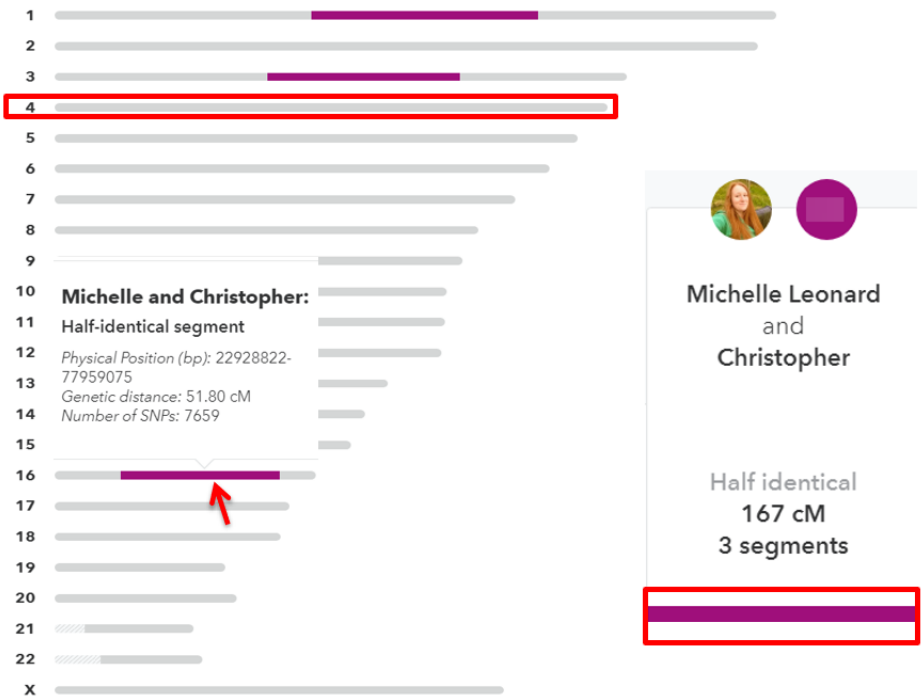
The 'Advanced DNA Comparison' tool allows you to choose a base person under the 'Compare' box:

Advanced DNA Comparison



23andMe is the only site that allow matches other than the test taker to be the base match for comparisons and this can be hugely useful in determining if matches all match each other or not. The match in the 'Compare' box defaults to the test taker but can easily be swapped for a different match on the left-hand list. In the 'With' section you can choose up to five matches to compare with. This will then compare everyone in the 'With' section with the base person but not each other. To start with let's look at another one-to-one but this time using the 'Advanced DNA Comparison' tool:

One-to-one Chromosome Browser (23andMe)



This is the visual of how I match a 2C1R. The first thing to note is that the browser visual is now vertical as opposed to side-on and this is the most common display method across the sites. A colour key is given to the match and all segments shared are overlaid in that colour on the browser – this key is very useful when comparing more than one match. You can also hover over the shared segments to see basic information such as start and end locations, cM amount and whether the

segment is half or completely identical. Then underneath the visual, you will find the detailed segment data table:

Detailed Segment Data Table (23andMe)

Comparison	Chrom.	Start Position	End Position	Genetic Distance (cM)	Number of SNPs	Identity
Michelle Leonard / Christopher	1	88868662	167121665	64.32	10237	Half
Michelle Leonard / Christopher	3	73536586	140103136	49.92	10821	Half
Michelle Leonard / Christopher	16	22928822	77959075	51.80	7659	Half

The table lays out the chromosome number, start position, end position, size in cM, number of SNPs and also includes the information on whether the segment is half or completely identical.

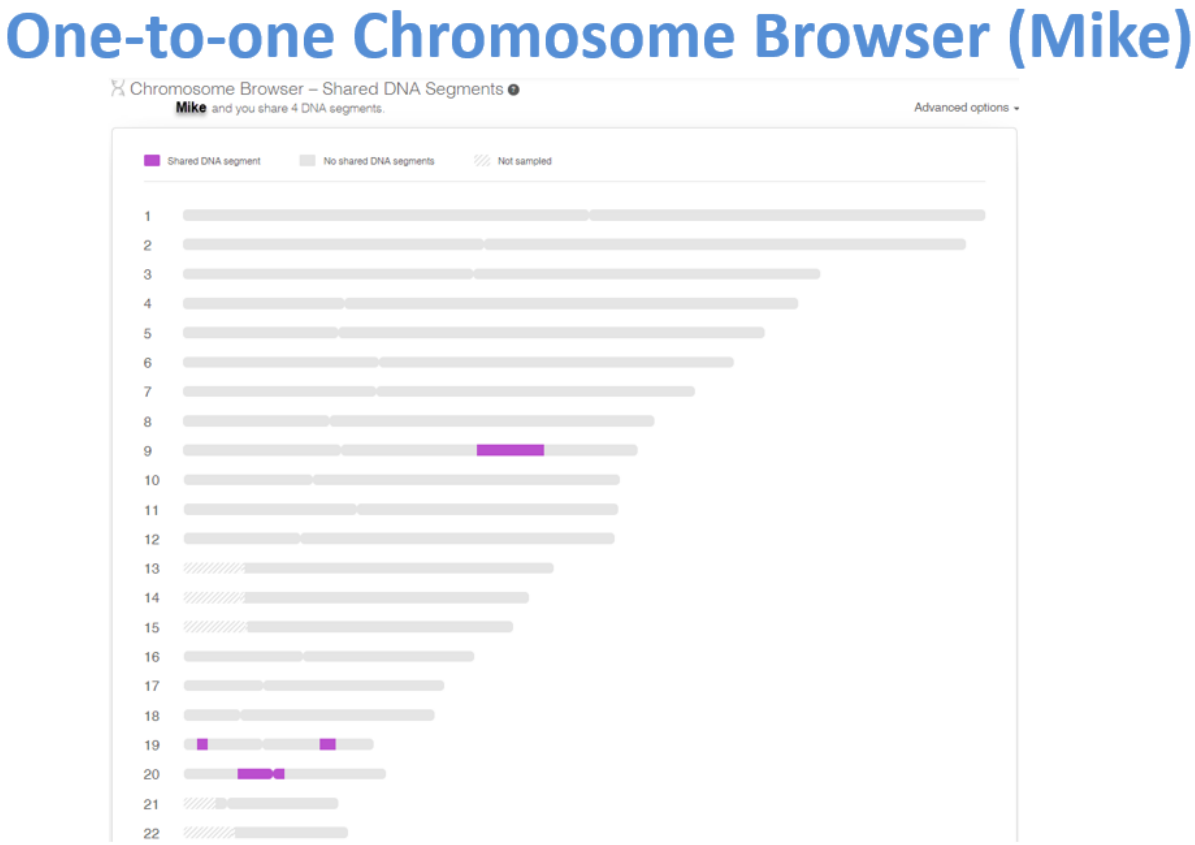
Here is an image showing a one-to-many comparison with me as the base person being compared to five other matches - the maximum allowed in the 23andMe chromosome browser:

One-to-Many Chromosome Browser (23andMe)

There is now one line for each comparison match and they are each given a distinct colour – once again you must remember that the one line represents an amalgamation of both copies of their chromosomes and the fact some of them share overlapping segments does not mean they must match on the same copy. In fact, in this case Rick and Katrina turned out to be sharing on my paternal copies alongside my paternal half-sister while Phil and Liz share on my maternal copies and match my mum on the same segments.

MyHeritage Chromosome Browser

The MyHeritage chromosome browser is similar to the 23andMe one with a few exceptions. In order to view a basic one-to-one visual, simply click on 'Review DNA Match' on the main match list and then scroll all the way down to the bottom of the individual match page:



In keeping with other browsers, this provides a vertical view of the 22 autosomes and the shared segments are highlighted. MyHeritage does not include X-DNA data so the browser ends at Chromosome 22.

The detailed segment data table is not displayed on this page but you can download the information to a spreadsheet under 'Advanced options'. You can also hover over the segments for basic information on start and end locations and segment size. Whether a segment is half or completely identical is not included. For a more detailed view, however, I would recommend going to the dedicated chromosome browser tool page where you will find the one-to-many browser:

You can compare up to seven matches in the one-to-many browser but the key difference between this one and the 23andMe version is that only the test taker or results for another test they manage on the same MyHeritage account can be placed as the base person in the 'Compare' box. This limits the comparisons that can be conducted.

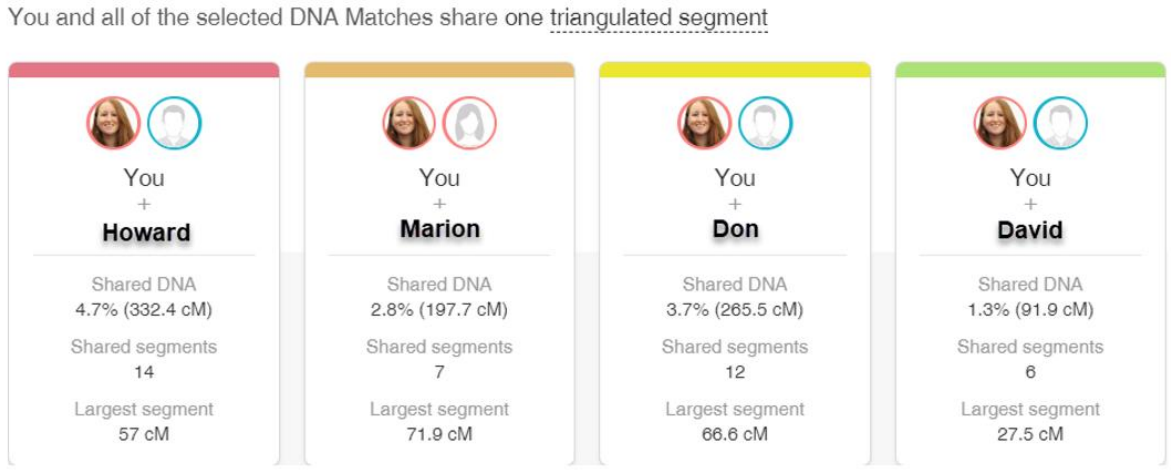
The detailed segment data table is located underneath the chromosome browser visual on the tool. If I wanted to see the table for Mike (the match we looked at on the individual match page) I could place him in the 'Add DNA matches' box, scroll past the visual and find the table as follows:

Mike and you share 4 DNA segments

Chromosome	Start location	End location	Start RSID	End RSID	Centimorgans	SNPs
9	91183368	112271779	rs12346988	rs17730594	22.8	11,392
19	4236996	7528734	rs4740	rs2287918	9.5	2,048
19	42262891	47236783	rs3795020	rs73565188	7.1	2,560
20	17050169	31469577	rs6080549	rs6058930	11.6	5,760

The table includes all the basic information on start and end locations and segment size you would expect to find but there are two additional columns. The RSID number is a unique label ("rs" followed by a number) used by researchers and databases to identify specific SNPs (Single Nucleotide Polymorphisms). It stands for Reference SNP Cluster ID and is the naming convention used for most SNPs. It is not important for genealogical research so it is best to bypass it and focus on the start and end locations and cM number instead.

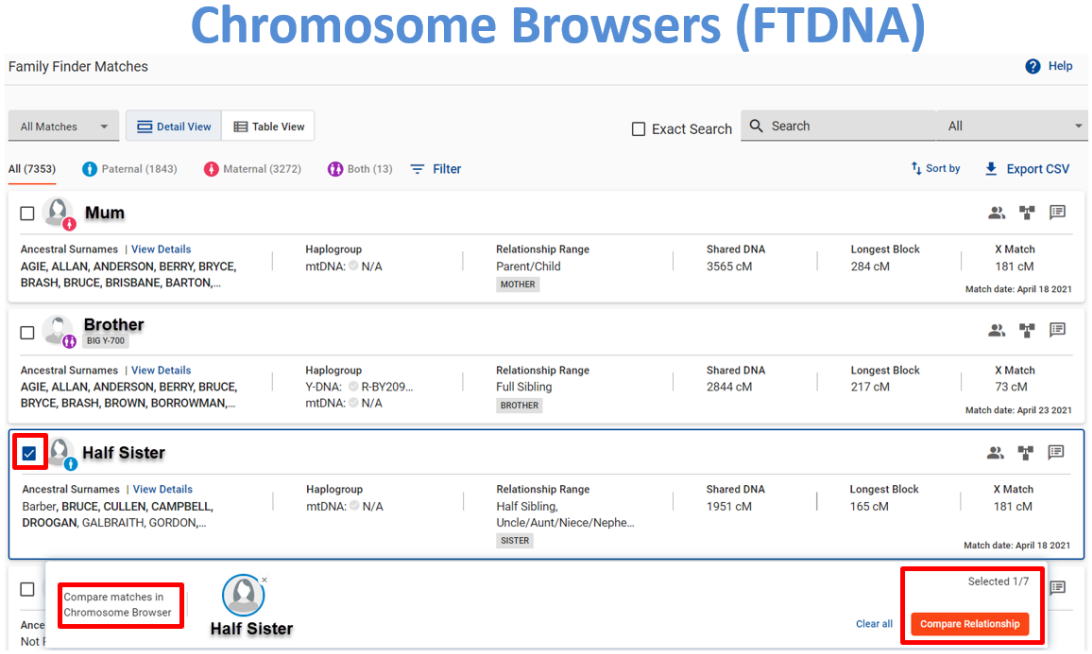
Let's look now at the MyHeritage one-to-many chromosome browser – here I am the base person and I am comparing myself with four comparison matches:



This is very similar to the 23andMe one-to-many browser – each match is given their own colour and line on the image that represents their two chromosome copies amalgamated. There is an additional tool, however, in the form of automated triangulated segments as shown on chromosome three.

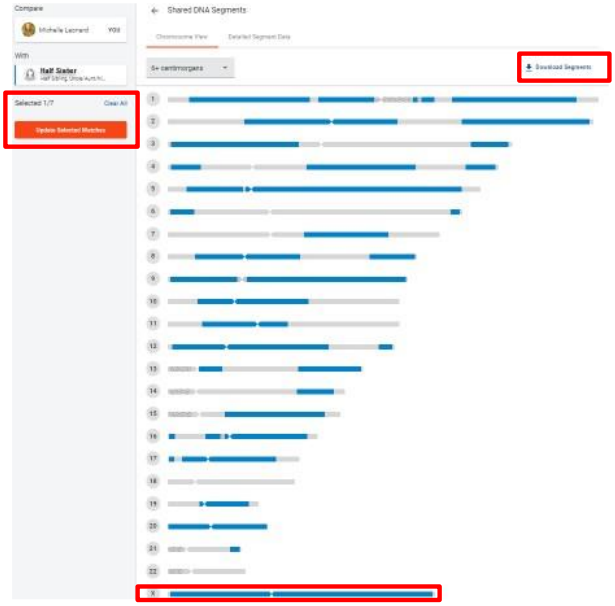
FTDNA Chromosome Browser

FTDNA does not have separate one-to-one and one-to-many chromosome browsers but one browser that covers all bases. You can access the FTDNA chromosome browser either on the main dashboard or via adding matches to the small box to the right-hand side of the match profile picture:



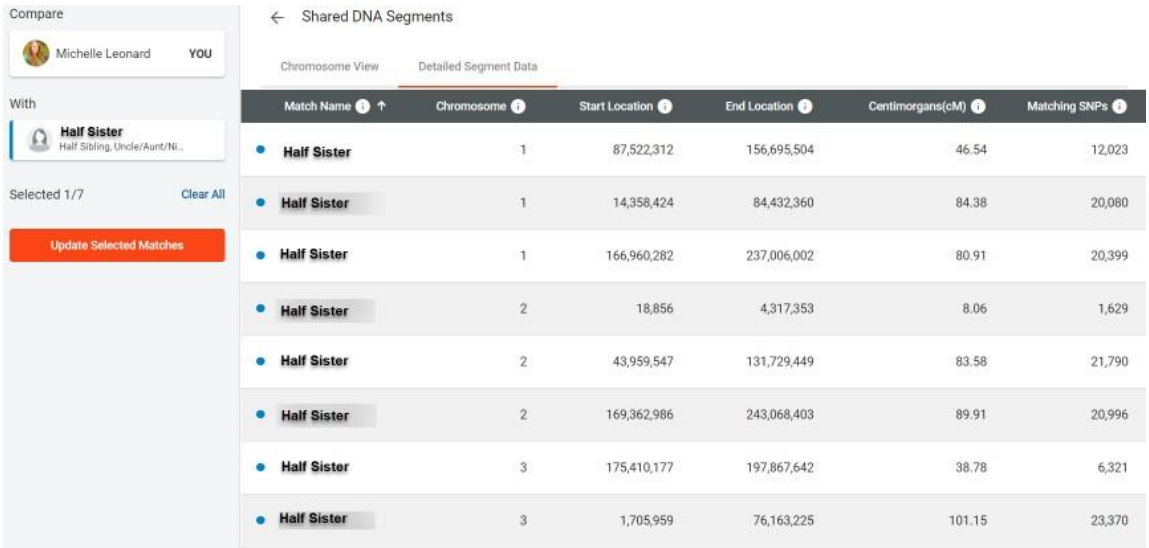
If you add just one match, then you will be re-creating a one-to-one chromosome browser like I have done here by adding just my half-sister:

One-to-One Chromosome Browser (FTDNA)



The key thing to note here is that, like 23andMe, FTDNA do include X-chromosome data. The 'detailed segment data' table is not placed underneath the visual on FTDNA but instead simply click on 'Detailed Segment Data' next to 'Chromosome View' at the top of the browser to move between the two different views:

Detailed Segment Data Table (FTDNA)

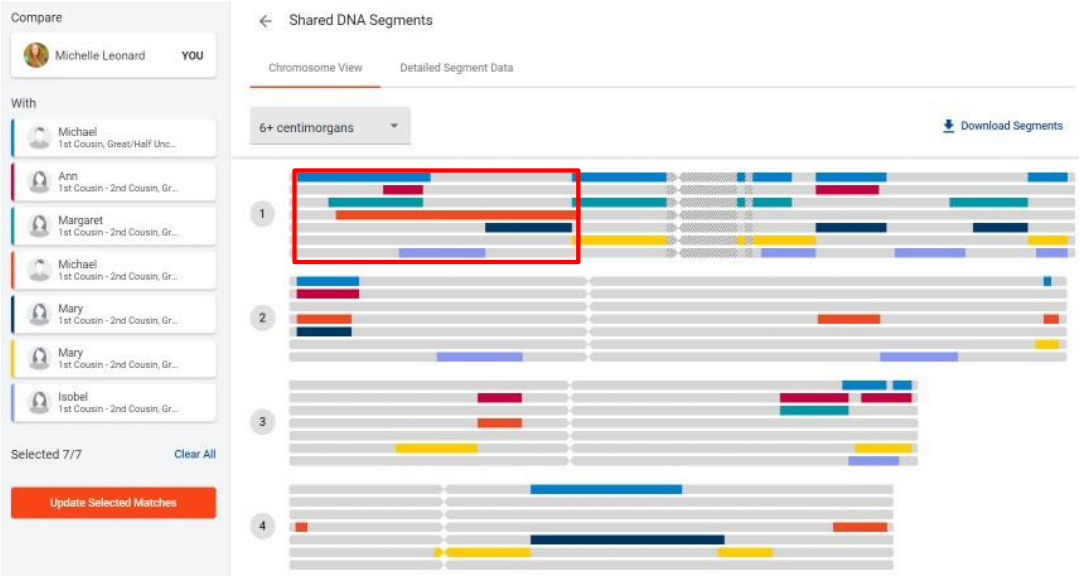


Match Name	Chromosome	Start Location	End Location	Centimorgans(cM)	Matching SNPs
Half Sister	1	87,522,312	156,695,504	46.54	12,023
Half Sister	1	14,358,424	84,432,360	84.38	20,080
Half Sister	1	166,960,282	237,006,002	80.91	20,399
Half Sister	2	18,856	4,317,353	8.06	1,629
Half Sister	2	43,959,547	131,729,449	83.58	21,790
Half Sister	2	169,362,986	243,068,403	89.91	20,996
Half Sister	3	175,410,177	197,867,642	38.78	6,321
Half Sister	3	1,705,959	76,163,225	101.15	23,370

The table provides the chromosome number, start and end locations and segment size. All of these tables also include SNP size and this is not as important at the testing companies as all have reasonable SNP size thresholds.

You can compare up to seven matches at a time in the FTDNA Chromosome Browser:

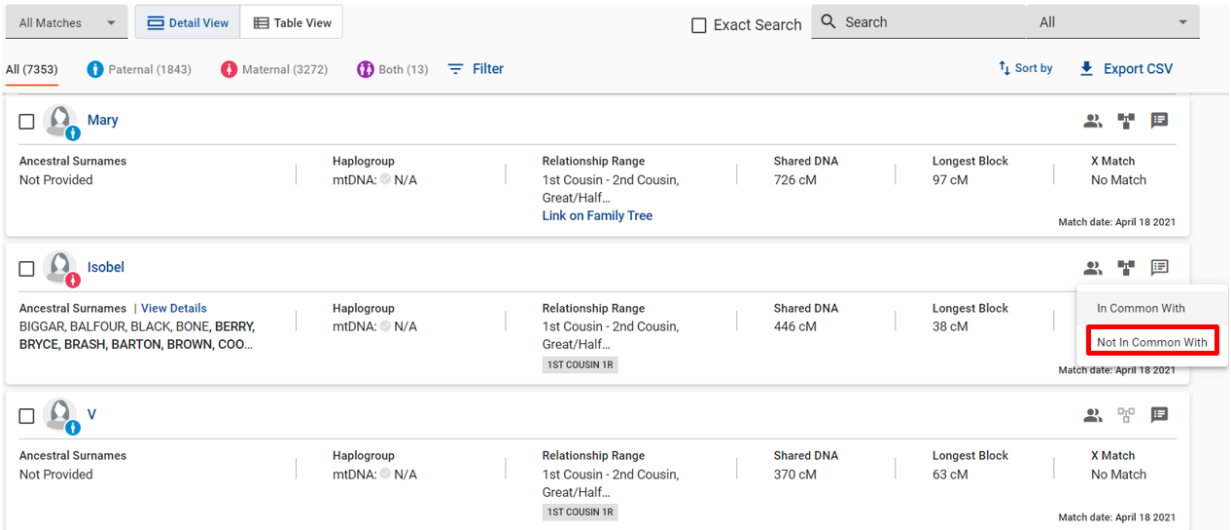
One-to-Many Chromosome Browser (FTDNA)



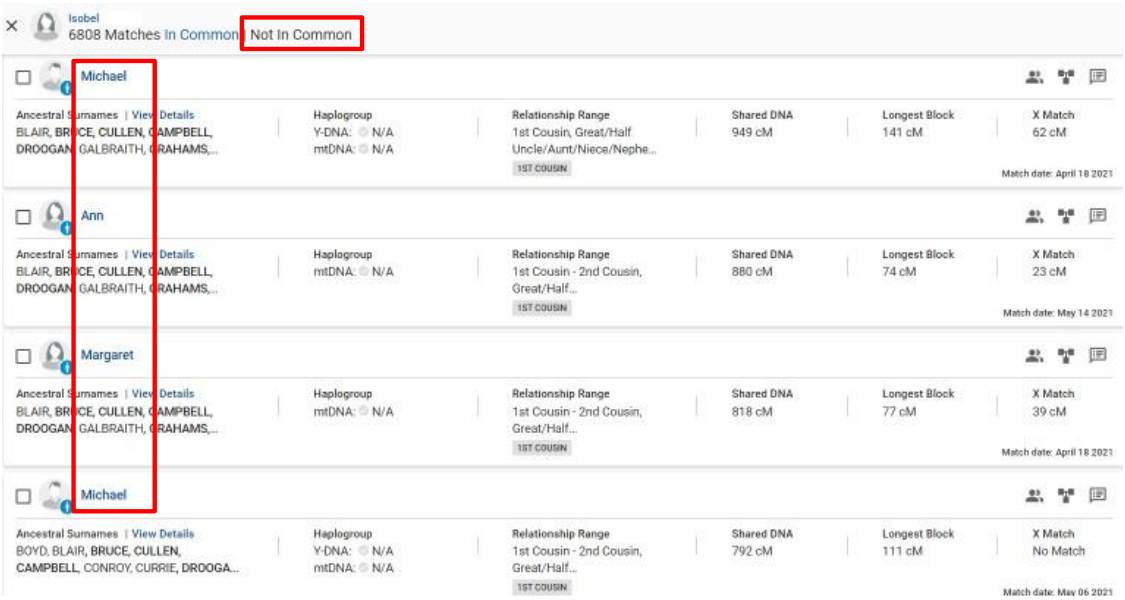
The test taker is listed as the base person in the 'Compare' box by default and this cannot be changed; even if you have access to additional FTDNA accounts, you must go to those individually in order to see that test taker as the base person. This is much more limiting than the 23andMe version but similar to the MyHeritage version unless you have many other family members tested on the same account there. This limitation means it is not possible to check which segments matches share with each other or if they share the same segments on the same chromosome copy. There are two additional checks you can run to get a better idea on these probabilities though.

Inferring Sides Using Segment Data

In the above browser image, the last comparison match is 'Isobel' and she is clearly sharing DNA on the same segment of chromosome one as many of the other comparison matches. The other comparison matches are all on my paternal copy of chromosome one, but Isobel could be matching on either copy. In a situation like that, I recommend using the 'In Common With' and 'Not In Common With' tools to try to work out which side the match is on:



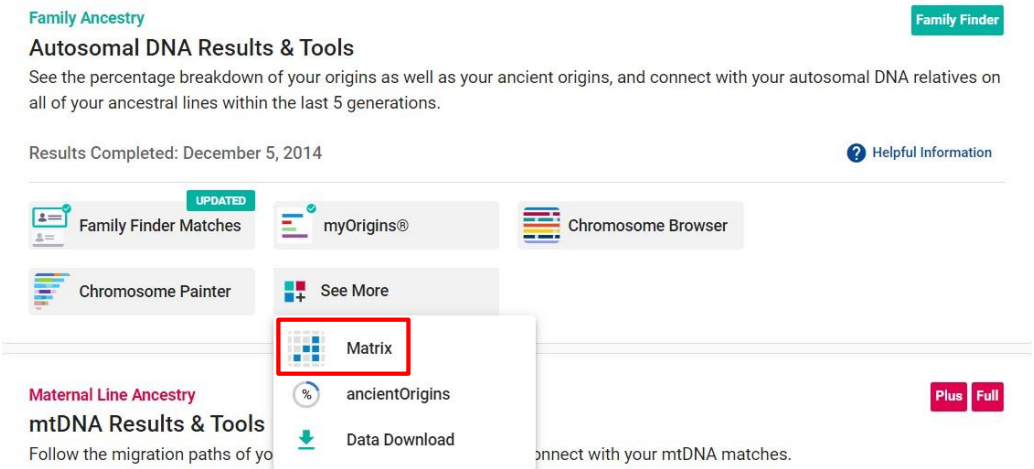
FTDNA's NOT ICW List



Looking at the 'Not In Common With' list for Isobel, I can clearly see the paternal matches who all share that segment on Chromosome one with me. Since the 'Not In Common With' list is telling me she does not match them and I know from the chromosome browser that they share overlapping segments on the same chromosome with her, the only logical conclusion is that she must be matching me on my maternal copy of that chromosome and, therefore, be on my maternal side. If the match was a very small one, the other option could be that it is a false (Identical By Chance) segment and matches on neither copy but Isobel is a close match so that doesn't apply here.

The other tool you can use to check if several matches all match each other when they share a segment with you on FTDNA is the 'Matrix' tool:

FTDNA's Matrix Tool



FTDNA's Matrix Tool

We can see below that Isobel doesn't match any of my paternal matches and they all clearly match each other and cluster together in the right way. Be aware that if matches all show up as matching each other, it doesn't necessarily mean they all share the same segment on the same copy – it just makes it more likely that they do.

You can infer sides using segment data at each site that provide it so long as you can identify two matches who fit the following criteria:

1. They do not appear to match each other on their shared match lists (or do appear on the Not ICW list on FTDNA)
2. They both match you on a reasonably sized overlapping segment on the same chromosome (15cM+ is generally safe but there are always exceptions)
3. One of the matches is a confirmed relative match who you can already place as matching you on either the maternal or paternal copy of that chromosome

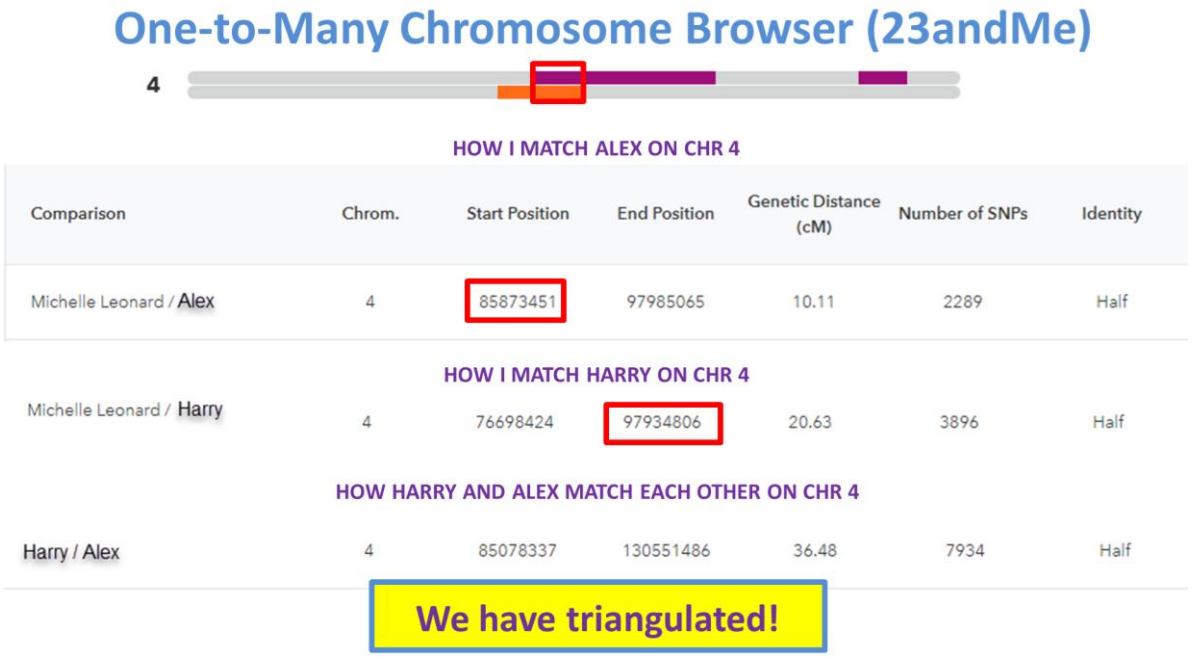
If the two matches fit these criteria, then you can infer that the unknown match must be on the opposite copy of the chromosome and, therefore, the opposite side of your ancestry. Do remember, however, that in many cases you will be able to infer the side just from the shared match list information alone if you have enough confirmed matches to aid you with the narrowing process.

Triangulation

True triangulation occurs when three or more DNA testers all match each other on the same DNA segment on the same copy of the same chromosome. When this transpires it indicates that these matches all have a common ancestor or common ancestral couple from whom they inherited this shared DNA segment as opposed to matching each other in different ways. It is important to differentiate this from three people simply sharing DNA with each other; that is the more common scenario when three people share DNA and I would recommend simply calling this 'shared matching' but you will occasionally see it referred to as simple or messy triangulation. Equally, if you find three or more people who all share DNA with each other and who also share known common ancestors then this could fit the 'simple triangulation' category or even be called 'tree triangulation'.

True triangulation is not possible at Ancestry as it requires segment data, which is not supplied, but it can be partially completed at FTDNA (partially as it requires the co-operation of the match to do a full comparison) and fully realised at 23andMe, MyHeritage and GEDmatch.

Let's look at an example of true triangulation from 23andMe:



Here are the necessary steps to complete the triangulation on 23andMe:

1. Compare myself and Alex
2. Compare myself and Harry
3. Compare Harry and Alex to each other

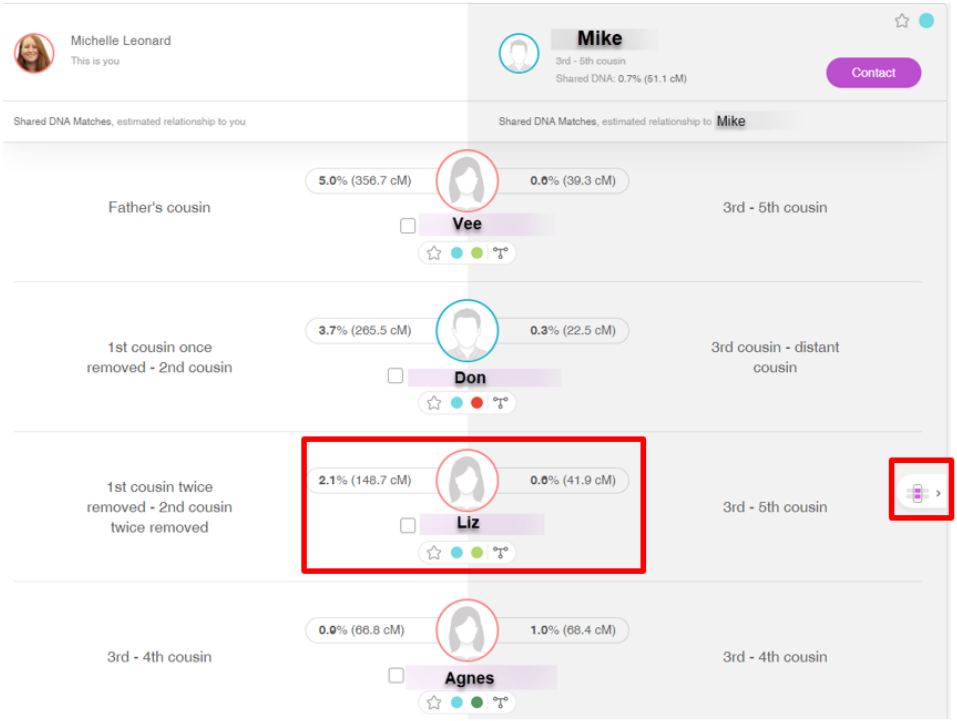
All of these comparisons can easily be achieved using the one-to-many chromosome browser (the Advanced DNA Comparison option). The most crucial part is the additional step of comparing Harry and Alex to each other and, because 23andMe allows me to make someone else the base person, I was able to do that. Since we all match each other on the same segment we have triangulated.

Triangulated segments always begin from the highest start location and end at the lowest end location between the matches as this defines the only part of the segment shared by all. In this case I start matching Alex last so the start location for Alex and me (85.8) is the start of the triangulated segment and I stop matching Harry first so the end location (97.9) between us is the end of the triangulated segment.

I could also have checked the 'Relatives In Common' list between myself and Harry or Alex to see if they appeared as a shared match to each other and to check if the 'DNA Overlap' column indicated a shared segment with a 'Yes'. The 'Yes' does not definitively indicate that they share on the same segment on the same copy but since they are shared matches to each other the chances are much higher that it is the same copy. It's also possible to cross reference across sites if you have known matches who share the same specific segment on a different site that can be used as a bridging match.

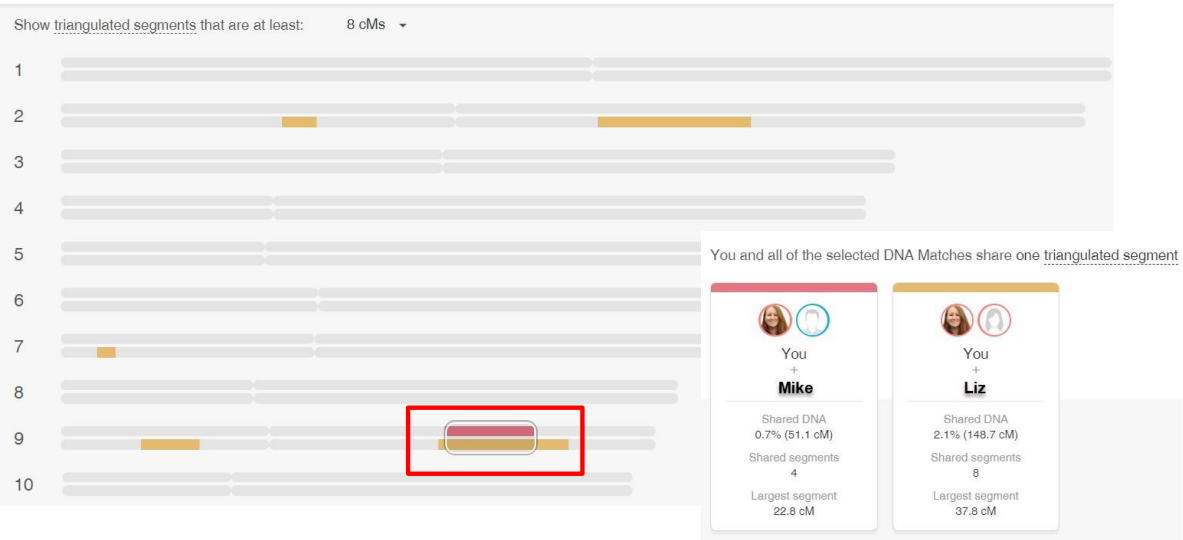
Although you can't make another match the base match on MyHeritage, it is possible to find out if three people truly triangulate or not via the unique automated triangulated segments icon:

Automated Triangulated Segments



Here we can see that my comparison match Mike has a triangulated segment with my known paternal cousin Liz. If I click on the icon, MyHeritage will take me to the one-to-many chromosome browser and highlight the triangulated segment for me:

Triangulated Segment (Mike & Liz)



The visual shows me that there is a segment that Mike, Liz and I all share with each other on the same copy of chromosome nine. Note I share a longer segment with Liz on the same chromosome but only the part we all share is highlighted. MyHeritage also provide an additional segment data

table which gives me the exact start and end locations for the triangulated segment in addition to the individual tables that provide what I share with Mike and Liz separately:

Triangulated Segment Table (Mike & Liz)

Shared DNA segments info

Advanced options

You and all of the selected DNA Matches share one triangulated segment

Chromosome	Start location	End location	Start RSID	End RSID	Centimorgans	SNPs
9	91183368	112271779	rs12346988	rs17730594	22.8	11,392

This is automating the process I went through to work out the start and end locations on 23andMe.

Here is a potential triangulation on the FTDNA chromosome browser:

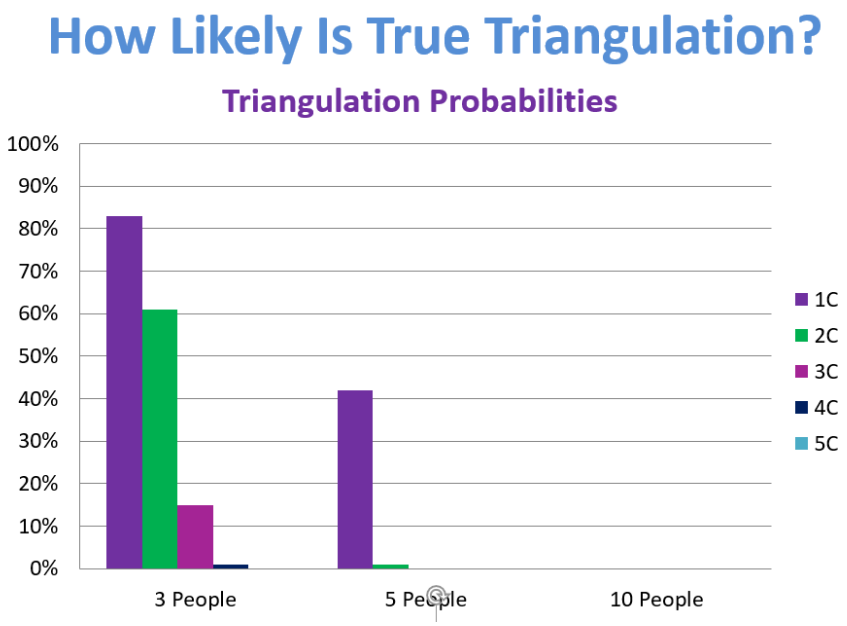
One-to-Many Chromosome Browser

Since it's not possible to make anyone other than the tester the base person on an FTDNA chromosome browser, it's also not possible to do the final necessary comparison between the other matches to prove a true triangulation. Two things you can do, however, is check whether the two matches (in this case Isobel and Kristy) show up in each other's 'In Common With' list or plug them into the 'Matrix' tool. If they are shared matches to each other, that vastly increases the chances that they do share the segment with each other but it is still not fool proof and the only way to gain the evidence to prove a true triangulation is by asking one of them to check how they match the other in their own chromosome browser or by having access to their results to do that yourself. In this case, I had access to Isobel's results, so I was able to perform the vital final comparison between Isobel and Kristy and find that the did indeed triangulate on this segment.

I have outlined how triangulation works and how to spot it in detail so you will understand the process, but I now want to impress upon you why it's actually not a technique you should spend too

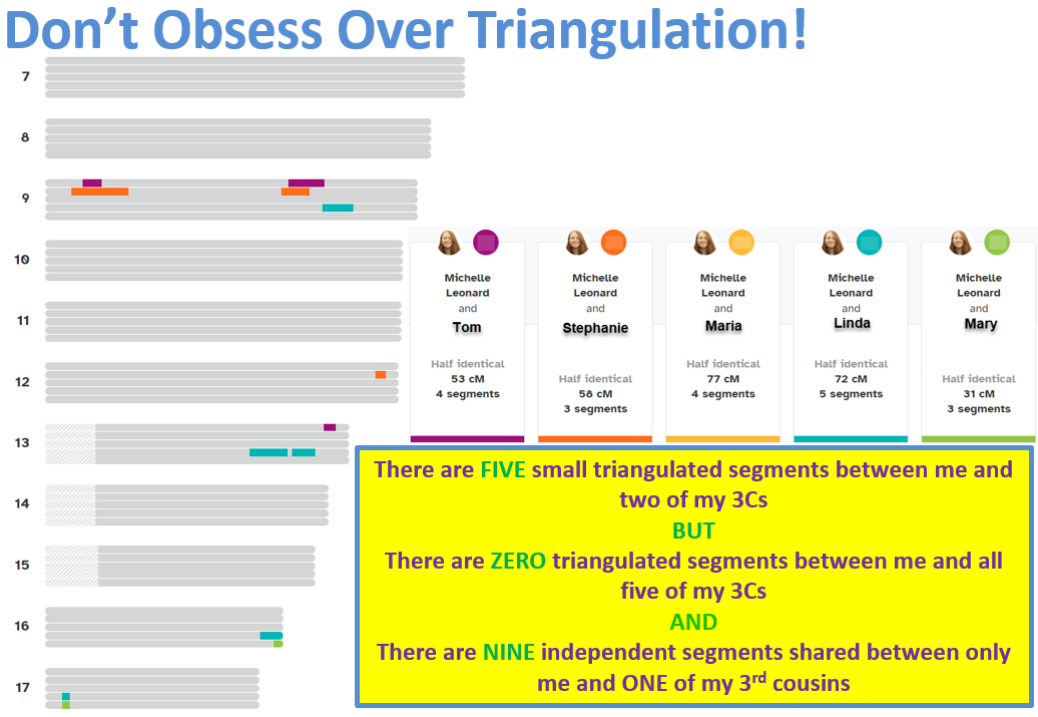
much time trying to use! Here is a graph I have created from data put together by ancestry.com simulations which took place a few years ago:

Triangulation Probabilities Graph



(This data first appeared in the ancestry.com article 'Do all members of a DNA Circle share the same matching segment?' Please note that DNA Circles no longer exist and this article is no longer accessible)

It is clear from this data that true triangulation between more distant cousins is very rare – we all have many thousands of more distant cousins compared to closer cousins so we will, at times, come across triangulations between them due to the sheer numbers involved but we shouldn't focus too deeply on them. Also, when you come across a segment that is shared by a very large number of people then that could be what is known as a pile-up region or population segment.



Another major reason not to obsess over triangulation is because you could miss out on equally helpful data that doesn't triangulate! In the graphic above I have compared myself with four of my third cousins on 23andMe and there are no triangulated segments between all of us, a few between three of us and, crucially, nine independent segments that I only share with one of them. Those nine segments could be just as useful to me than any of the ones that triangulate.

Distant cousins are simply much more likely to share different segments from their common ancestors than the same ones and that is generally a good thing as it gives us more of our ancestors' DNA with which to work. Think about it this way; if you share 3rd great grandparents with two fourth cousins and you all inherited about 3% of your DNA from each of those shared great grandparents, what are the chances that all three of you inherited many of the same segments? Exceptionally low to non-existent as per the probabilities graph.

Using shared matches, building trees and clustering will always be more productive for identifying connections and should always be the starting point for each new match but triangulation can occasionally provide some insight – just never make it the first thing you try to do with a match. If you obsess over triangulations, you will be missing out on all the different segments of your ancestors' DNA that your matches share with you and others – the real power in being able to work with more matches is in being able to work with more of our ancestors' DNA so it's best not to limit our possibilities.

Finally, be careful not to use very close relatives (parents, siblings etc) for triangulations as any IBC (identical by chance/false) matches could also match your close relatives by chance as well

Key Points

- Make sure you understand autosomal DNA inheritance before getting to grips with using segment data across the testing sites
- The key segment data information is the chromosome number, the start and end locations of the segment within the chromosome and the segment size in centiMorgans (cMs)
- Most sites provide number of SNPs as well but it is not as important to assess this
- It's essential to remember that we all have two copies of every chromosome (maternal and paternal copies) and segments could be on either copy (half-identical), both copies (completely identical) or neither (IBC/false!)
- DNA segment data can sometimes help with narrowing matches down – the more segments you can map to ancestors, the more helpful it becomes but always start with the basic shared matches and tree-building techniques
- Chromosome browsers are the tool used to display segment data information
- 23andMe's chromosome browser is the only one across the testing sites to offer information on whether a segment is half-identical or completely identical - GEDmatch also offers a visual representation of this but it is not available on FTDNA or MyHeritage
- 23andMe is also the only site that allows you to make any match the base person in the one-to-many chromosome browser (so long as the match has consented to this option)

- FTDNA and 23andM provide X-DNA data whereas MyHeritage does not
- FTDNA provides an amalgamated chromosome browser
- True triangulation can be completed at 23andMe and MyHeritage – on 23andMe use the 'Advanced DNA Comparison' tool to swap over the base person and do the additional comparisons required and on MyHeritage look for the "automated triangulated segments" icon on the "Shared Matches" list
- Be careful when using the 23andMe advanced DNA comparison one-to-many chromosome browser as it does not show if segments triangulate; you must do an extra comparison to find that out. The MyHeritage one-to-many browser, on the other hand, does show if segments triangulate (there can be anomalies at times due to imputation though)
- Don't obsess over trying to identify triangulations as in most instances it is neither necessary nor likely
- Each segment you do share individually with confirmed matches is important in its own right

The Workbook

If you would like to purchase an official printed copy of the Original DNA Bootcamp Workbook, it is available to be ordered at the following link: https://www.family-tree.co.uk/store/genealogy-tools/family-tree-magazine/dna-workbook/ (It is priced £20; £12 for Family Tree subscribers and also £12 for DNA Bootcamp Students – orders may be placed over the phone using the code DNAWB12 - please call 01778 392008).

The DNA Bootcamp follow-up sessions

Scroll down the hub page (https://www.family-tree.co.uk/information/DNS22) to find the Zoom links, choose your preferred time, and we look forward to seeing you on Thursday at the follow-up sessions. Any queries in the meantime, please email helen.t@family-tree.co.uk

About Michelle

Contact & Social Media Links:
Email: michelle@genesandgenealogy.com
Facebook: www.facebook.com/genesandgenealogy
Twitter: www.twitter.com/genealogylass
LinkedIn: https://www.linkedin.com/in/michelleleonardgenealogist
APG: https://www.apgen.org/profiles/michelle-leonard
Ancestry Hour: http://www.ancestryhour.co.uk/michelle-leonard.html

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