

Statistical methods in genetic relatedness and pedigree analysis

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Exercise set I. Introduction to pedigrees, genetics and likelihoods

Exercise I-1

Draw pedigrees by hand, showing the following relationships.

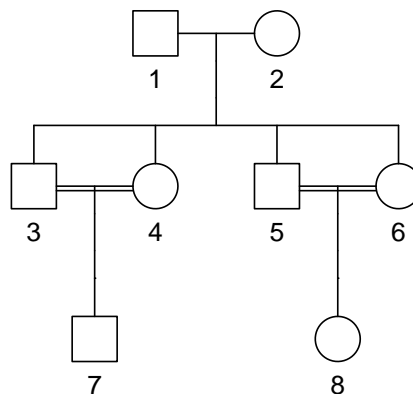
- Grandaunt – grandnephew.
- First cousins twice removed.
- Half second cousins once removed.
- Double half first cousins.

Exercise I-2

- The fathers of Adrian and Belinda are maternal half siblings. Draw the pedigree by hand and describe the relationship between Adrian and Belinda.
- It turns out that Adrian and Belinda have the same mother. Draw the pedigree again and describe the relationship now.
- Is the pedigree inbred?

Exercise I-3

- Recreate the following pedigree in QuickPed.



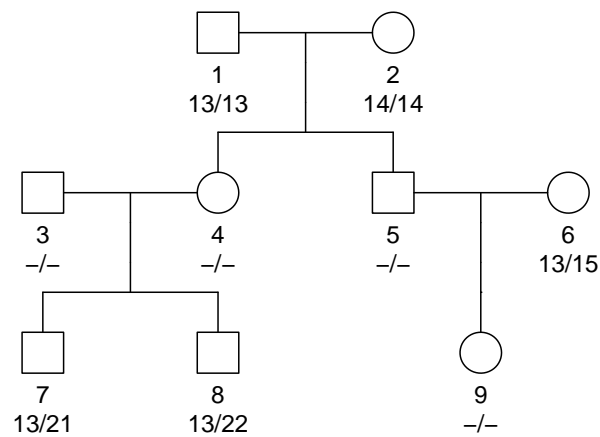
- Use QuickPed to describe the relationships between:

- 1 and 7
- 3 and 7
- 3 and 8
- 7 and 8

(Hint: Use the first button in the **Relationships** frame.)

Exercise I-4

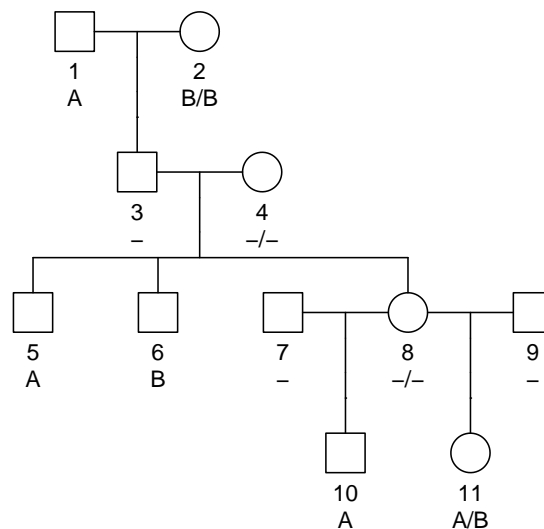
In the pedigree below some members have been typed with a single DNA marker.



- What kind of marker is this: SNP or STR? Autosomal or X-linked? How do you know?
- How many different alleles are observed in the family. What do the allele labels (e.g. 13) mean?
- What are the genotypes of individuals 4 and 5?
- Can you determine the genotype of individual 3?
- What are the possible genotypes for individual 9, and how likely is each of them?

Exercise I-5

In the pedigree below some members have been typed with a X-linked SNP marker.

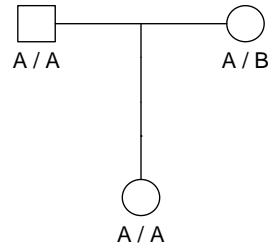


- What is the genotype of individual 3?
- What is the genotype of individual 4?
- What is the genotype of individual 8? Which allele did she inherit from her mother?
- Can you determine the genotype of individual 7? What about individual 9?
- What is the relationship between 10 and 11? Between 5 and 11? 4 and 9?

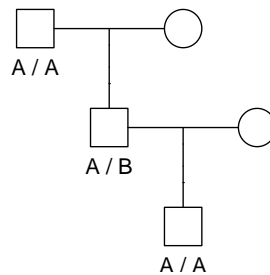
Exercise I-6

In the pedigrees below, the genotypes are for an autosomal SNP in Hardy-Weinberg equilibrium. We assume absence of mutations.

- a) Compute the pedigree likelihood by hand, with $p_A = p_B = 0.5$:



- b) Compute the pedigree likelihood by hand, with $p_A = 0.9$ and $p_B = 0.1$:

**Exercise I-7**

In each question below we consider a SNP marker in Hardy-Weinberg equilibrium, with alleles A and B .

- In a sample of 100 unrelated individuals only one of them has genotype B/B . What is your best guess for the number of individuals with A/A and A/B ?
- In a certain population A/A occurs 4 times more often than B/B . What are the allele frequencies, and what are the genotype frequencies?
- Is it possible to have equal frequencies for the three genotypes A/A , A/B and B/B ? Prove your answer.

Bonus exercises

Exercise I-8 (A weird relationship)

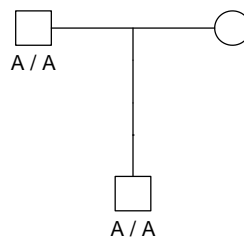
The father (A) of a man (B) marries a young woman (C) and has son (D) with her. The mother (E) of C starts a relationship with B and has a son (F) with him.

- Use QuickPed to create the pedigree.
- What is the relationship between D and F?

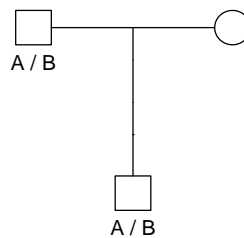
Exercise I-9 (Conditional genotype distributions)

In each case below, a father and a son have been typed with a SNP in Hardy-Weinberg equilibrium, with allele frequencies $P(A) = p$ and $P(B) = q = 1 - p$.

- If both are A/A , what are the probabilities of being A/A , A/B , B/B for the mother?



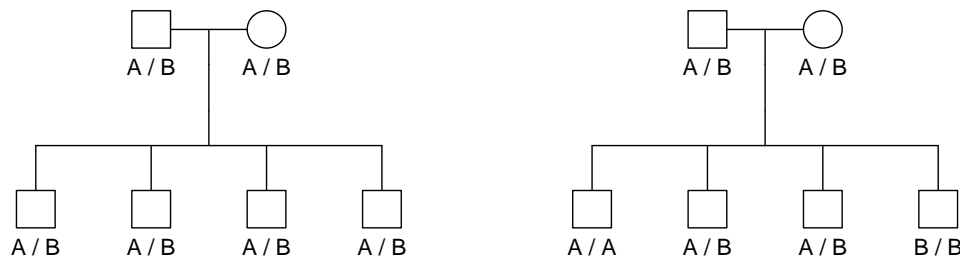
- Now consider the situation where both are heterozygous A/B . Show that the genotype probabilities for the mother are $P(A/A) = p^2$, $P(A/B) = 2pq$ and $P(B/B) = q^2$.



- Why is the previous result somewhat surprising?

Exercise I-10 (A likelihood puzzle)

The two families below have been genotyped with the same SNP in HWE.



- Which of the pedigrees has the highest likelihood? (Hint: You don't need to compute the likelihoods.)
- Explain why the following argument is wrong:

The first pedigree is more likely, since that's where the children's genotypes are closest to the Hardy-Weinberg proportions $AA : AB : BB = 1 : 2 : 1$.