Family trees (*Les arbres généalogiques*)

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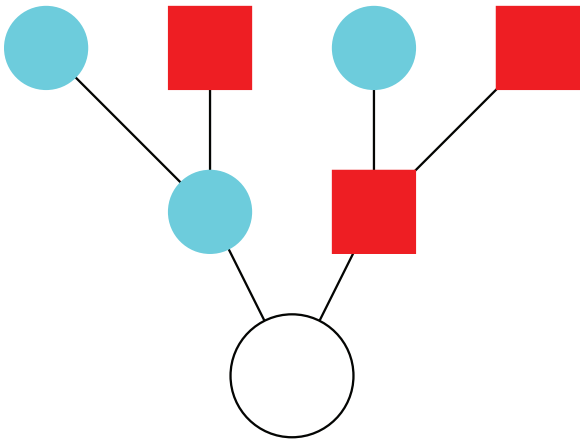
1. How do you write $2 + 2 + 2$ as some number times 2?

2. There is also a notation for $2 \times 2 \times 2$, for example. It is 2^3; here 3 is called an *exponent*. How should we write $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$? What is this number?

3. Each human has two biological parents, one male and one female. These can be arranged into a tree with ● denoting women and ■ denoting men. Draw the symbol for yourself in this tree, and label your parents and grandparents.

4. Now extend the tree to include your great grandparents. How many ancestors do you have in each generation?



5. Suppose each child in this tree was born when their parents were 25 years old. Which of your ancestors were born 100 years before you? How many of them are there?

6. How many of your ancestors were born 250 years before you?

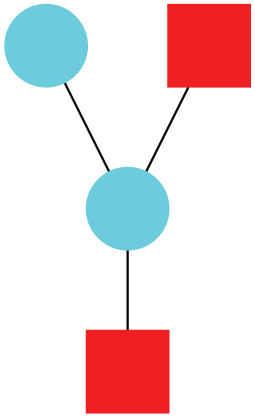
7. This table lists the estimated world population by century, back to 1000CE.* Fill in an estimate of the number of your ancestors in each of these years.

year	world population	your ancestors
1000	295 000 000	
1100	353 000 000	
1200	393 000 000	
1300	392 000 000	
1400	390 000 000	
1500	461 000 000	
1600	554 000 000	
1700	603 000 000	
1800	989 000 000	
1900	1 654 000 000	
2000	6 145 000 000	

Do you notice anything strange about these numbers?

* K. K. Goldewijk, A. Beusen and P. Janssen, "Long-term dynamic modeling of global population and built-up area in a spatially explicit way: HYDE 3.1", *The Holocene* **20** (2010) 565–573.

8. Bees are different than humans: male bees have only one parent, a mother (the queen bee), but female bees have two parents, a mother and a father. Draw the three generations before the ones in this family tree, always putting the mothers to the left of the fathers.



9. How many bees are in each generation in the family tree?

10. If you drew 11 generations of the bee family tree, the top row would be:

Draw a path on this graph paper using this pattern and following these rules:

For each symbol in the pattern draw an edge in the direction you are pointing, blue if the symbol is ●, red if the symbol is ■.

If the symbol is ●, after drawing the edge, turn right if it is in an odd position; otherwise turn left.