Probability

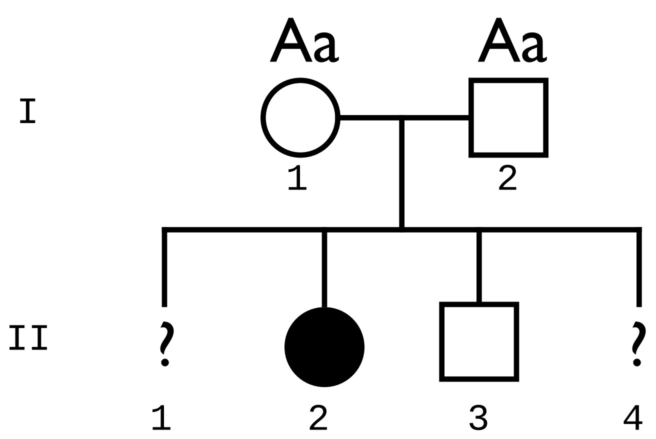
Genetics 371B Lecture 8 — 8 Oct. 1999

Predicting outcomes

The goal: Estimating the chances of a particular outcome actually occurring

Why bother?

Consider this pedigree:



Is `II-1` **female** or **male** ? How probable is each outcome?

Is `II-4` **A_** or **aa**? How probable is each genotype?

Probability:

- of an **inevitable** event=
- of an **impossible** event=

If x, y, and z are the only possible outcomes of an event, $P(x) + P(y) + P(z) =$

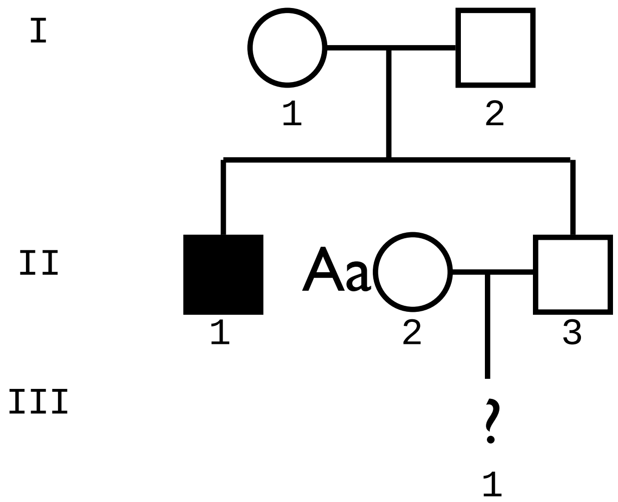
Imposing multiple conditions

Product rule

The probability that two or more **independent** events will occur (event *x* **and** event *y* **and** …)

Examples

What is the probability that III-1 will be **aa**?



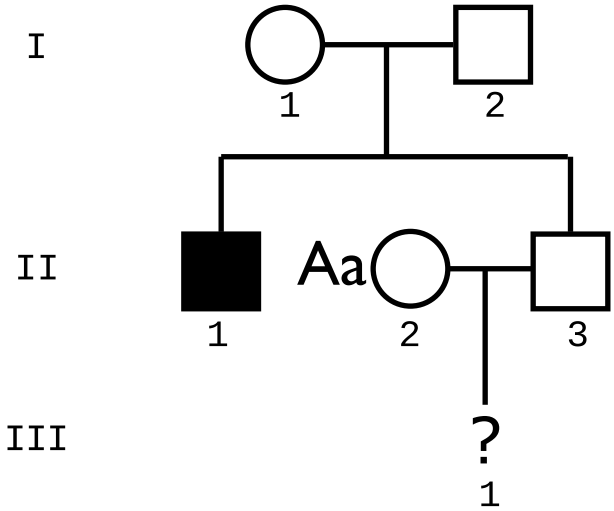
Relaxing the criteria

Sum rule

The probability of an outcome that can be achieved by more than one way (event *x* **or** event *y* **or**…)

- When you pick a card…probability that it is a **red 5**?

- Probability that III-1 is **homozygous** ?



Probabilities of sets of outcomes

Binomial expansion

…to determine the probability of a specific set of outcomes in a number of trials that could each have either of two possible outcomes

e.g., determining the probability of 1 female and 4 male children in a family with 5 children

Equation: $(a + b)^5 = 1$

$a^5 + 5a^4b + 10a^3b^2 + 10a^2b^3 + 5ab^4 + b^5$

1. Find the term where the exponents match the numbers you want

2. Substitute the individual probabilities

fraction of 5-children families expected to have 1 daughter and 4 sons:

Evaluating results...

Assessing the **goodness of fit**

χ^2 **analysis** – How likely is it that the deviation from the predicted values is due to chance alone?

Null hypothesis – that there is no real difference between observed and predicted results

Example: flipping a coin to decide if it's a trick coin…

χ^2 analysis:

1. Compute χ^2 value:

$$\chi^2 = \sum \frac{(\text{observed - expected})^2}{\text{expected}}$$

2. Determine **df** (the # of degrees of freedom)

3. Look up P value in χ^2 table

Exercise:

Are the results of this Drosophila cross consistent with independent assortment of the two genes (sv^+ and spa^+)? Can you explain these results? [**Hint:** refer back to the chromosome theory of inheritance.]

$$\frac{sv^+}{sv}\ \frac{spa^+}{spa} \quad \times \quad \frac{sv}{sv}\ \frac{spa}{spa}$$

$$\downarrow$$

# of progeny	Phenotype of progeny
759	sv^+ spa^+
2	sv^+ spa
0	sv spa^+
770	sv spa

Remember that sv^+ and spa^+ are the dominant phenotypes; sv and spa are recessive.

Chi-square table

P ⇨ df	0.995	0.975	0.9	0.5	0.1	0.05	0.025	0.01	0.005	⇦P df
1	.000	.000	0.016	0.455	2.706	3.841	5.024	6.635	7.879	1
2	0.010	0.051	0.211	1.386	4.605	5.991	7.378	9.210	10.597	2
3	0.072	0.216	0.584	2.366	6.251	7.815	9.348	11.345	12.838	3
4	0.207	0.484	1.064	3.357	7.779	9.488	11.143	13.277	14.860	4
5	0.412	0.831	1.610	4.351	9.236	11.070	12.832	15.086	16.750	5
6	0.676	1.237	2.204	5.348	10.645	12.592	14.449	16.812	18.548	6
7	0.989	1.690	2.833	6.346	12.017	14.067	16.013	18.475	20.278	7
8	1.344	2.180	3.490	7.344	13.362	15.507	17.535	20.090	21.955	8
9	1.735	2.700	4.168	8.343	14.684	16.919	19.023	21.666	23.589	9
10	2.156	3.247	4.865	9.342	15.987	18.307	20.483	23.209	25.188	10