Mathematics was well developed in the ancient world:
- quadratic equations ~ 1700BC in Mesopotamia
- geometry ~ 500BC in the Greek world
- algebra ~ 1200AD in China, India, ..

The Greeks discussed randomness in a qualitative way: Democritus (460BC), Epicurus (341BC) …

Yet, mathematical theory of probability came very late:
- Gerolamo Cardano (b. 1501, Pavia); *Ars Magna* 1545 - published solutions of cubic and quartic equations (derived by Tartaglia & Ferrari)
  - 1526 *Liber de ludo aalea* - a gambler’s handbook
  - Pascal & Fermat (1654)
  - Bernouilli *Ars Conjectandi* (1713) & de Moivre *The Doctrine of Chances* (1718)
  - Laplace *Théorie analytique des probabilités* (1812)

In physics, probability entered very late:
- Gauss’ theory of errors (~ 1800)
- statistical mechanics (Boltzmann, 1871)
- this probabilistic theory was not accepted until the 20th C
- Einstein (1905) linked macroscopic Brownian motion with atomic properties
- quantum mechanics brought genuine randomness into physics in the 1920’s

Statistics and probability were driven by biological questions:
- Francis Galton pioneered *biometrics*
- Karl Pearson developed the mathematics of the normal distribution in order to understand inheritance of continuous traits
- Fisher (1918)
  - showed how continuous variation could be partitioned into components: ANOVA
  - developed modern *statistical inference*

The course focuses on *stochastic models* rather than *statistical inference* - but these are closely connected
What is “probability”?

What do we mean by probability?

- **Frequency in a long series of trials …**
  - symmetry arguments (coins, dice, chromosomes…)
  - how can we define the probability of a *particular* set of data? A unique event?

- **Degree of belief**
  - probability cannot be entirely subjective
  - rational degree of belief (a “fair bet”)?
  - can we think of the probability of a theory
    - Bayesian interpretation…

- **Probability as propensity**
  - fitting a probabilistic model

  e.g. the probability of a hot summer (Schar et al., Nature, 2004)