

## Lecture Outline

### Evolution

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- Why cover evolution?
- What is evolution?
- What evolution is not
- Lamarckian evolution
- Mendellian genetics
- Darwinian evolution

### Why Cover Evolution?

- The most fundamental theory in biology
- For the same reason we studied biological neurons
- Evolutionary computation is very heavily based on biological evolutionary theory
- Most people do not understand evolution

### What is Evolution?

- Evolution is the change in a population over time through the inheritance of random alterations
- The change in frequency of alleles within the population
- A change in a population in response to an environmental change

### What Evolution is Not

- Survival of the fittest
- A random search
- Something that happens to individuals
- A quest for perfection

### Lamarckian Evolution

- Jean-Baptiste Lamarck
- 18th / 19th century French biologist
- Suggested theory of evolution through inheritance of acquired advantageous characteristics
  - e.g., stretching necks & giraffes

## Lamarckian Evolution

- Disadvantageous changes would likely be fatal
- Could not be experimentally proved
- No mechanism known at the time for passing on the characteristics
- Still useful for us, though
  - artificial environments

## Mendellian Genetics

- Gregor Mendel
- 19th century Austrian monk
- Experimented with pea plants
- Demonstrated that traits are passed on via discrete units of inheritance
  - Genes

## Mendellian Genetics

- Selectively self and cross-fertilised pea plants possessing different traits
- Careful quantitative analysis proved that the frequency of the traits in the offspring determined solely by the frequency of traits in the parents

## Darwinian Evolution

- Central principles
  - some organisms possess qualities that better suit them to their environment
  - these qualities are genetic
  - these qualities arise through mutation
  - more suitable for environment = more fit
  - more fit organisms have more offspring
  - advantageous genes increase in frequency over generations

## Darwinian Evolution

- Darwinian Evolution is *not* survival of the fittest
- It does not say that the strong shall live and the weak shall die
  - although this does happen, it's not the point of the theory
- The fittest are more likely to have more offspring

## Darwinian Evolution

- Selection of alleles by nature
  - natural selection
- Fitness is not just suitability to the environment
- Involves reproductive fitness as well
  - a mutation is of no use if it renders the organism unable to reproduce

## Darwinian Evolution

- Most mutations are harmful
  - don't get passed on
  - kill the organism
- Some mutations aren't expressed
  - recessive mutations
  - require specific environment
- Expressed when environment changes
  - e.g. pepper moth

## Darwinian Evolution

- Selective pressure
  - an environmental condition that favours the selection of one trait over another
- Frequency of genes (alleles) will change in response to selective pressure
  - e.g. sickle-cell disease

## Darwinian Evolution

- Origin of species
- Relies on geographic isolation of populations
  - founder effect
- Over time, the populations will diverge
  - Galapagos finches

## Darwinian Evolution

- Emergence of a new species does not require the extinction of the parent species
  - only requires separation between the populations
- When the isolation ends, one species may die out
  - Neanderthals vs. Cro Magnons

## Darwinian Evolution

- Evolution is never ending
  - the environment is never static
- Changes in one species can affect change in others
  - predator - prey evolution

## Summary

- The accumulation in a population of heritable changes that allow a species to adapt to its environment
- Accumulation of changes is driven by selective pressure
- The model of evolution provides a means of creating adaptive intelligent systems
  - evolutionary computation