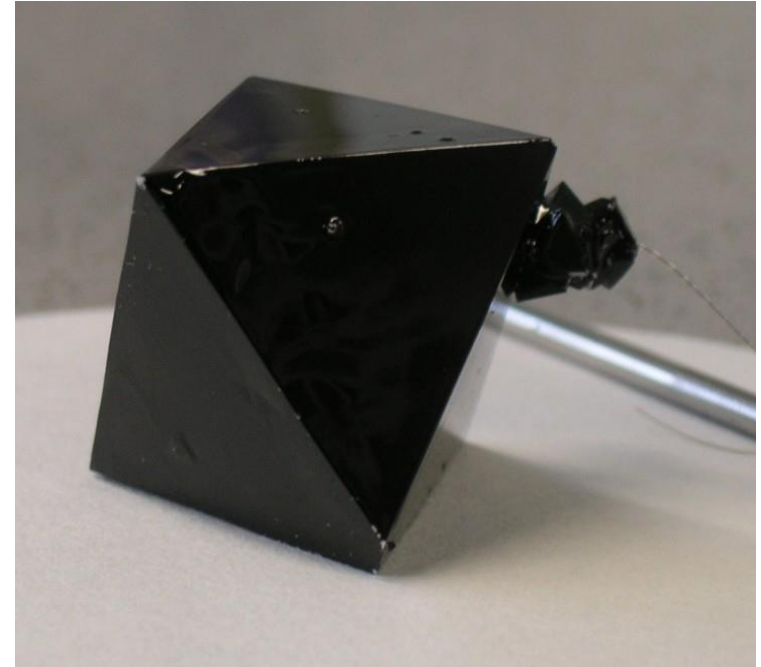


# Numerical Optimization: Inspiration from Nature

Christian Hafner

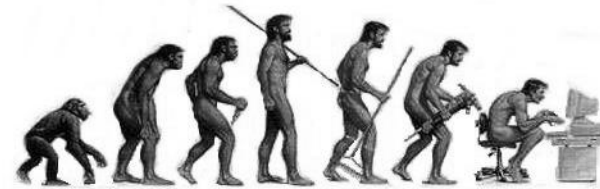
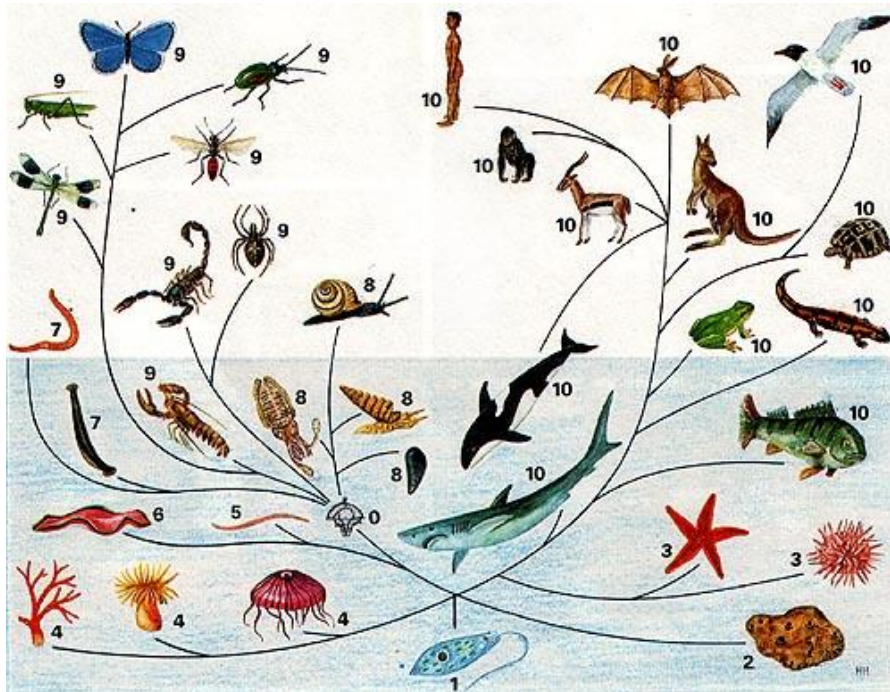


# Crystallization – Simulated Annealing

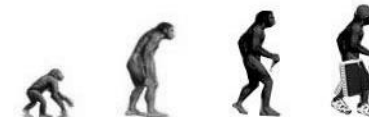


Thermodynamics: Trend to increased disorder  
Ordered structures: Miracle – not yet destroyed – or ???  
Crystals: Increased order with reduced total energy!  
Why do we not see big crystals everywhere?

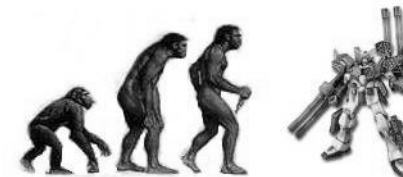
# Evolution – Evolution Strategies etc.



**EUROPE**



**AMERICA**



**JAPAN**

Pure chance would never create plants and animals – driving force?

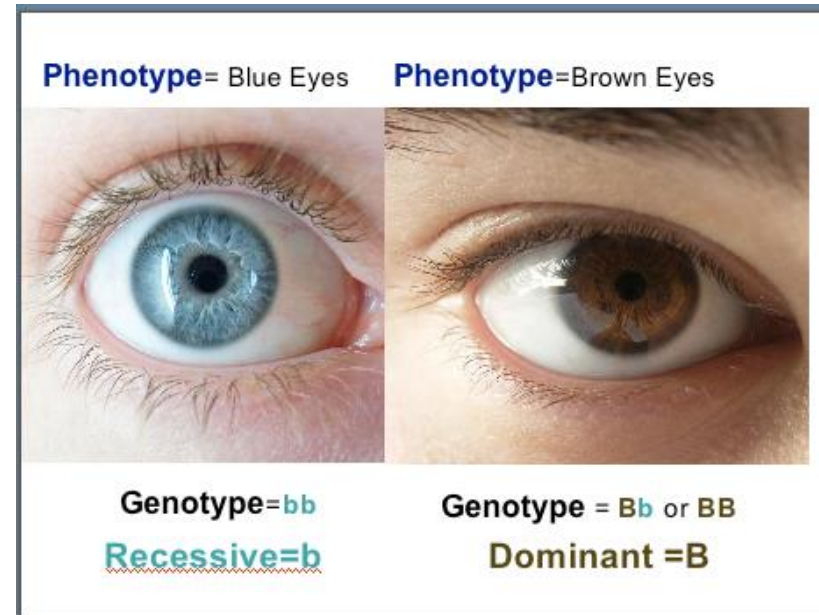
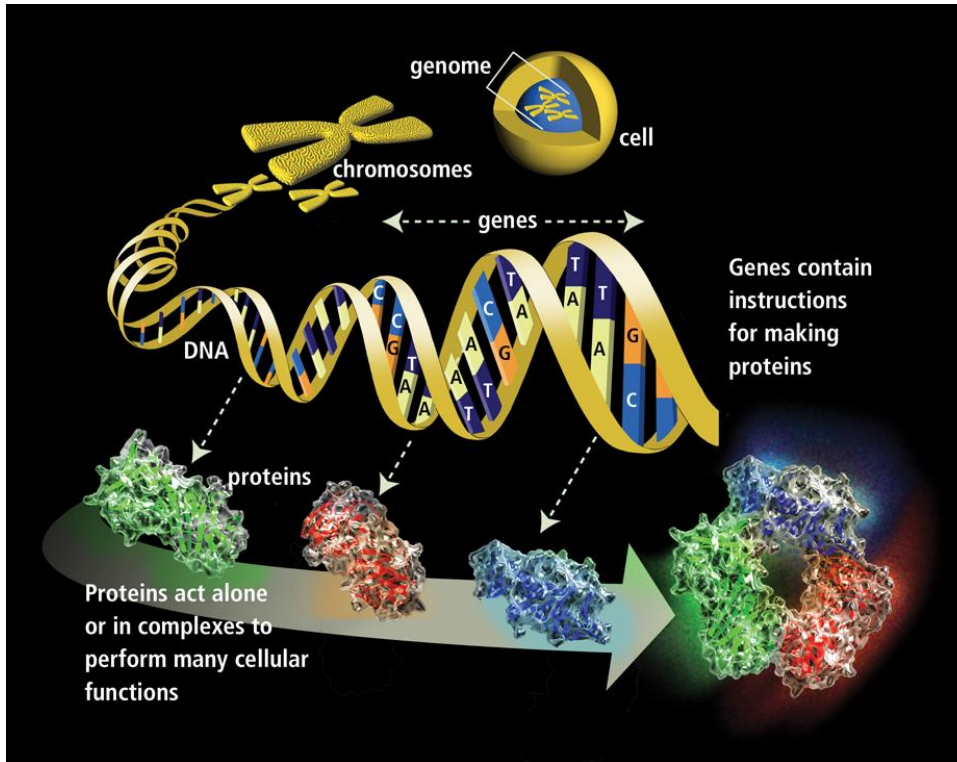
Darwin: Recombinations, mutations, selection: survival of the fittest

Is evolution an efficient strategy to increase fitness?

Will robots be a next step in evolution?



# Genetics – Genetic Algorithms, Genetic Programming



Mechanism behind evolution: Genetics – genotype/phenotype

Close to binary representation of objects in computers

Do genes speed-up evolution? Is sexual reproduction beneficial?

# Collaboration of ants – Ant Colony



Collaboration helps some animals (+ hopefully humans) to be more powerful

Why are not all animals collaborating?

Will selfish animals survive in the long term?

E.g., ants or spiders?

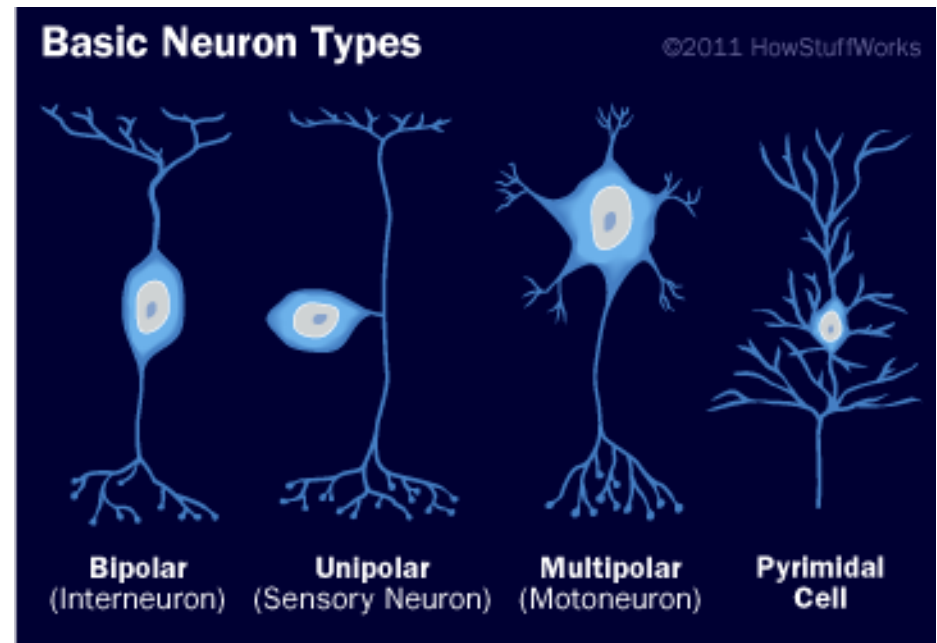
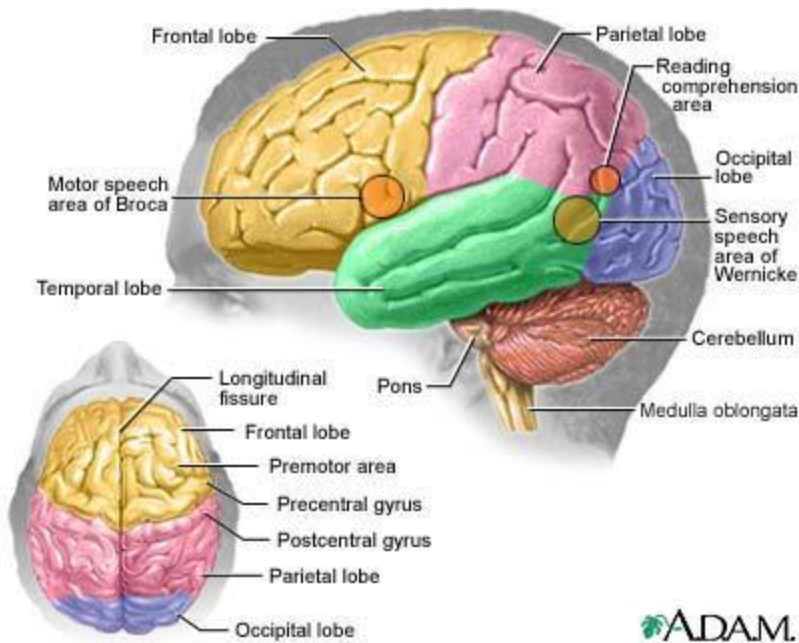


# Swarms – Particle Swarm Optimization



What are swarms good for?  
Is this a good search strategy?

# Brain – Artificial Neural Networks



Huge differences between brain and CPU

Brain is efficient for pattern recognition, prediction, etc.

Has the ability to learn

Consists of many neurons that are organized in a huge network

How to mimic a brain in a computer? – Good for optimization?