*KRCP Lecture 8*

*Evolution & Development*

**Brain Evolution**

* Brain size to body issue: Homo sapiens has the largest
* Brain increased exponentially in hominids
* Bigger brain: Mass increased, however, neurons did not increase that much and distribution is also similar; human brain as much more arborized dendrites and synapses

**Radial Unit Hypothesis**

* Explains the human brain expansion

1. Cells divide **symmetrically** in the **Ventricular Zone** (keep same function)
2. After that they divide **asymmetrically** (one cell gets a different function)
3. The cortex is formed from an inside out matter (from the **ventricular zone** to the **cortical layer**, through the sub ventricular zone and the intermediate zone)
4. New neurons migrate to the **Cortical Plate** radially into the newly forming cortex

* Neuron **(radial) migration** happens along **radial glial cells**
* Radial glial cells form **radial units** from the Ventricular Zone (VZ) through the intermediate zone to the Cortical Plate (CP); explains why cortex is organized into **columns**

**Development of the Brain**

* **Synaptogenesis**: increase of synapses (maximum at about one year)
* **Synapse elimination/pruning**: decline of synapses, continues for the first decade of life, competitive process, allows for learning development of higher cognitive functions, “Use it or lose it!”
* **Myelination**: extends way further into life, axons in different areas myelinate at different times (sensory and motor areas first, frontal and parietal areas last)

**Brain Plasticity**

* Brain constantly changes (due to learning, and connectivity)
* Can also repair or reorganize after an accident
* Recruit other areas that are/were used for something else (**phantom-limb experience**: feel amputated limb)

**Basic Genetics**

* **Chromosomes** contain genome (make me an individual)
* Each chromosome consist of **genes** that encode a functional element (protein)
* Code = triplet (of nucleic acids)
* **DNA** = Deoxyribonucleic Acid, storage of genome, consist of 4 base pairs: Adenine, Thymine, Cytosine and Guanine (A and T and C and G pair)
* When we reproduce our DNA is recombined with that of our partner
* **Genotype**: genetic makeup
* **Phenotype**: expression of the genotype
* **Recombination**: Combination of 2 different DNAs; **Crossover**: DNA is recombined ones more by exchange parts of it after recombination
* **Mutation**: parts of the DNA can mutate (change) due to mutagens

**Genetic Algorithms**

* An **individual** is represented by a (binary) **string**, this is the **genotype**
* The expression of the code is the **phenotype**
* **Population**: collection of individuals
* Each individual has a **fitness value** assigned to its phenotype
* **Reproduction**:
  + **Cross-over**: various forms (single/multiple point)
  + **Mutation**: depends on representation
  + **Inversion**: invert the string
* **Selection strategies:**
  + **Elitist**: select top most individuals (very fast, easy/loss of genetic information, genetic degeneration)
  + **Roulette Wheel**: every individual gets share according to its fitness on the wheel, wheel is rotated, individual at selection point is selected (better/close to elitist selection if fitness values are unequal)
  + **Tournament**: select k individuals at random, select best form that selection (very straight forward/a large k boils down to random selection)
* **Pro**:
  + Widely applicable
  + Easy to implement
  + Easy to parallelize
* **Con**:
  + Local minima problem
  + Lots of variation
  + Difficult to find right encoding