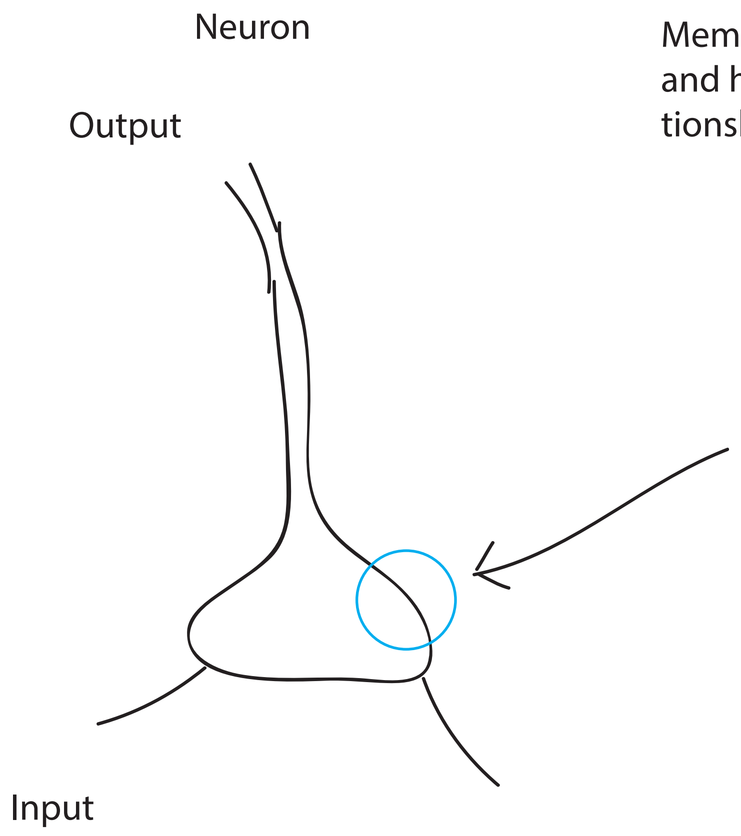
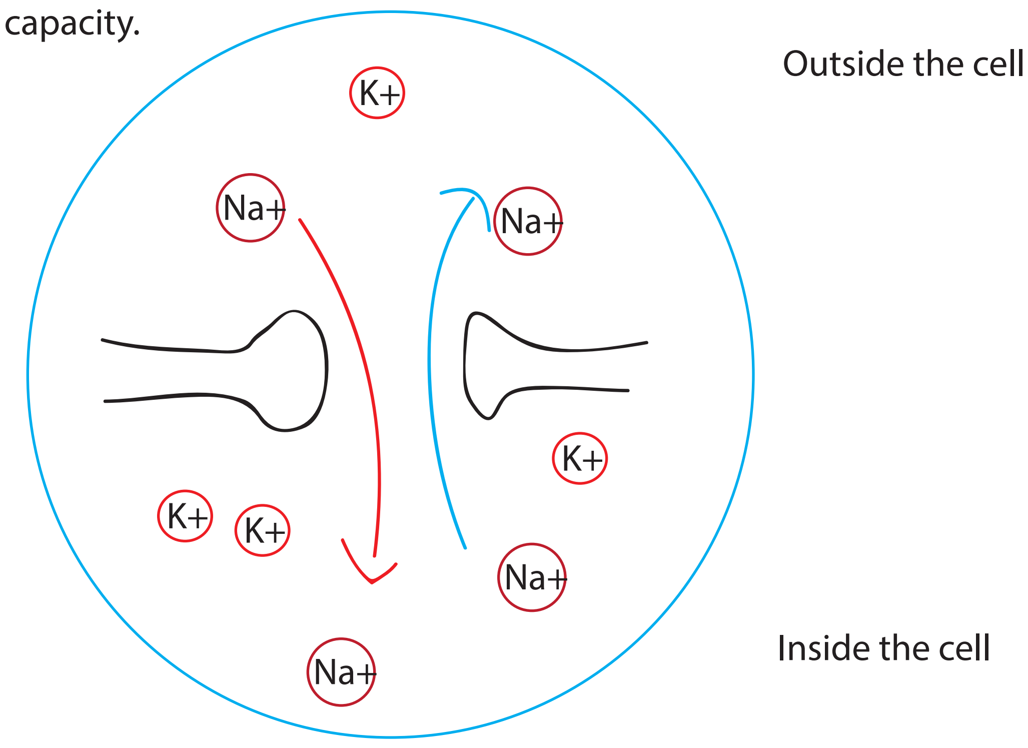
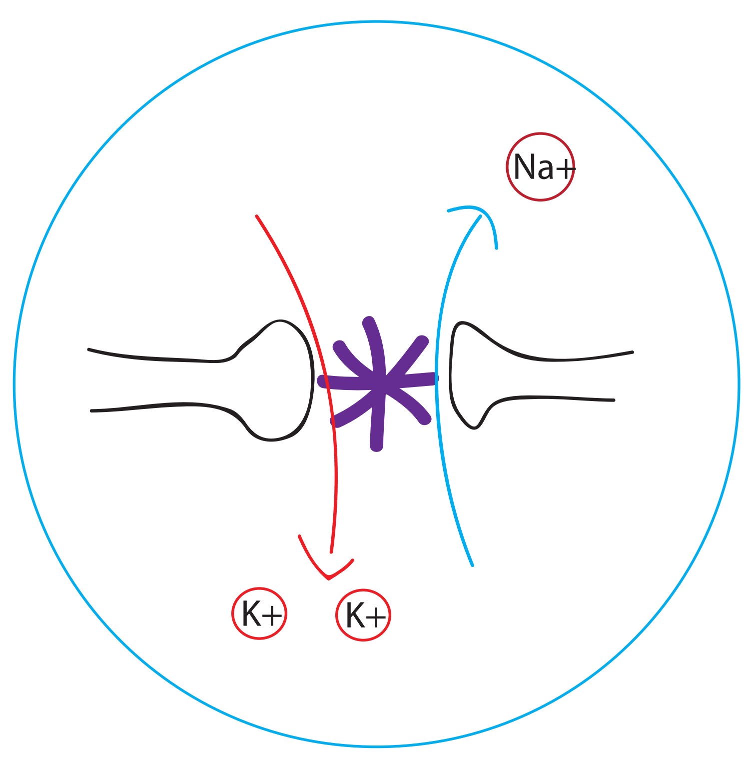
Membrane is made of different types of gates (channels). Theis behavior and how they influence each other is what gives the neuron it's computa-tionsl capacity.





Passive Ion Channel:
Concentration of ions is mainteined constant on two sides of the membrane.
The ions move across the channel according to the diffusion law.



Active Ion Channel:
Doesn't care about the concentration of ions.
Always exchanges some particles for others.
Always on.

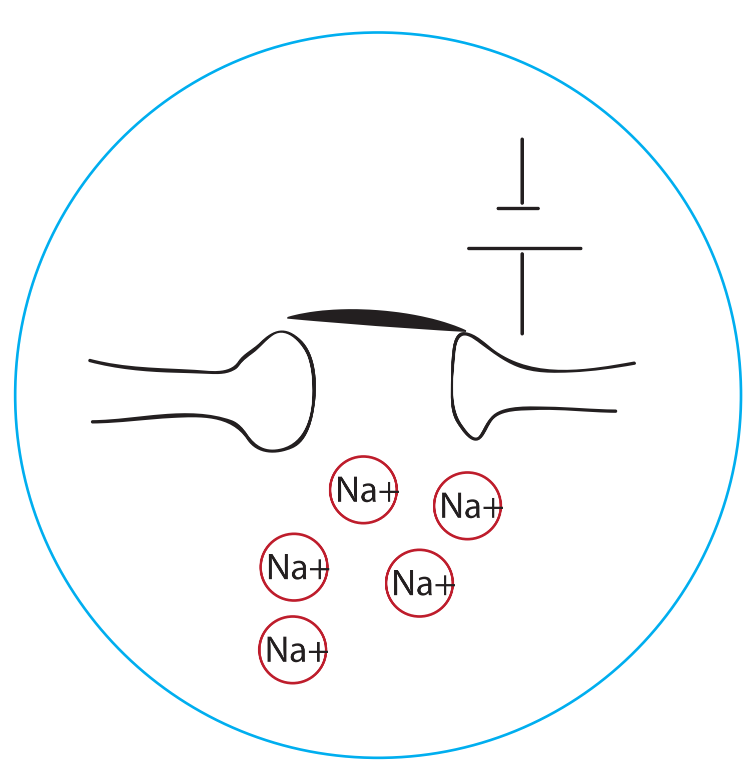
Summing up:

!What we model is the difference in potential (i.e. voltage) between inside and outside of the membrane. Then we use this mechanism to do computational stuff.

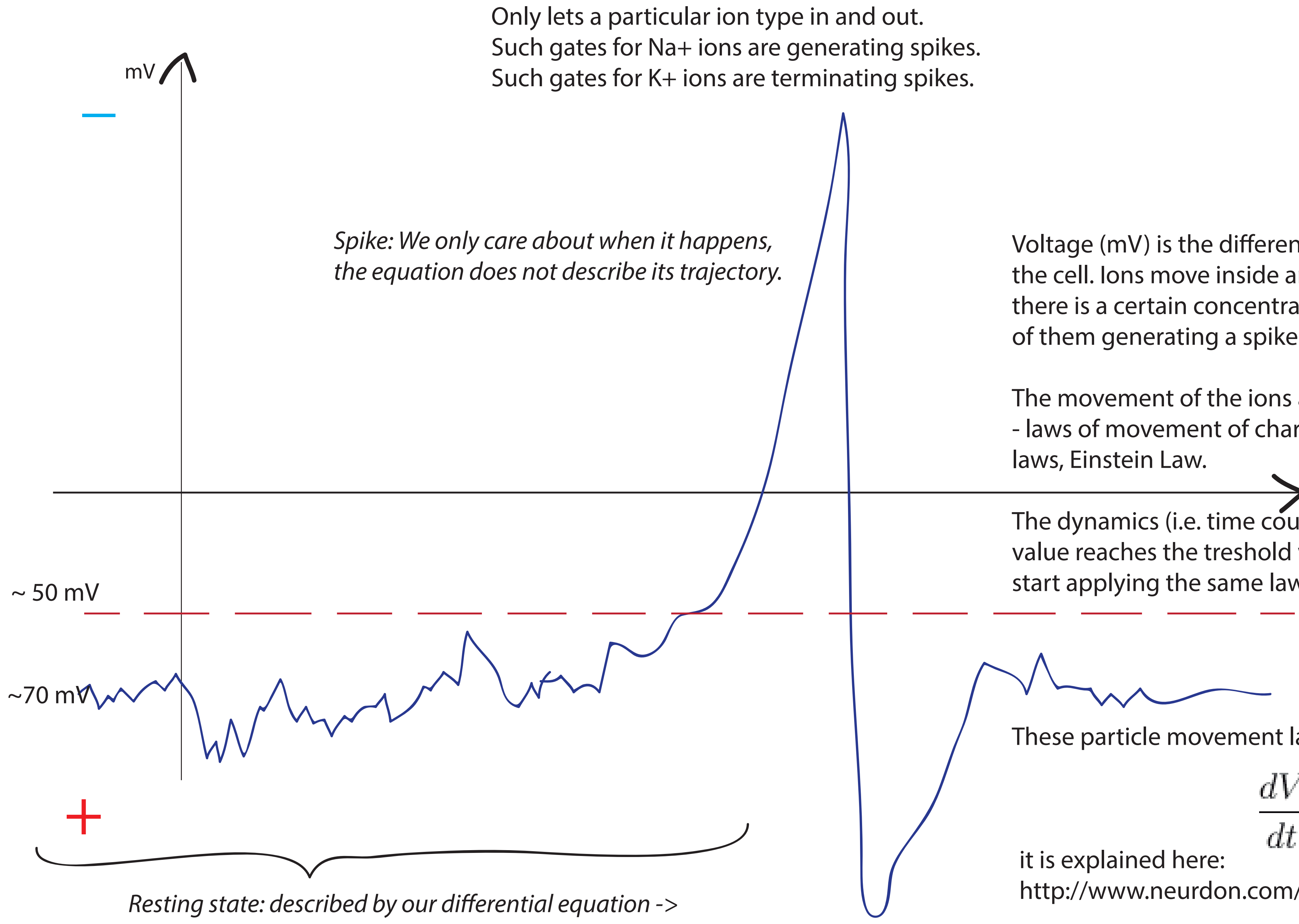
This model involves the input to the cell (IRm), but mind that without input spikes can happen too.

By controlling the input we can controll the spiking rate.

By nowing the dynamics of the membrane we can also predict the time of each spike.



Voltage Dependent Ion Channel:
Opens only when the voltage inside the cell is at ~50 mV.
Only lets a particular ion type in and out.
Such gates for Na+ ions are generating spikes.
Such gates for K+ ions are terminating spikes.



Voltage (mV) is the difference in concentration of ions inside and outside of the cell. Ions move inside and outside through different types of gates. When there is a certain concentration of ions inside, the cell rapidly bursts out a lot of them generating a spike.

The movement of the ions across the membrane is described by a set of laws - laws of movement of charged particles in a free medium: Diffusion and Drift laws, Einstein Law.

The dynamics (i.e. time course) of a spike are simplified, basically when the value reaches the treshold we mark down the spike, wait for some time and start applying the same laws again

These particle movement laws simplify into this differential equation:

$$\frac{dV}{dt} = \frac{1}{\tau_m}(-V + IR_m)$$

it is explained here:
http://www.neurdon.com/2011/01/19/neural-modeling-with-python-part-1/