Artificial Life

- thomas.schmickl@uni-graz.at
- self-organization - system that tends to a higher level of order (by itself)
- the order must be from within, not the outside
- interactions between + & - feedback achieves the behavior
- a simple system can be simple, together these agents can solve complex problems
- only works when enough agents are present, 3 grains of sand don't form a dune, but 3,000,000 do
- the swarm affect
- order - less entropy
- more order - less info content
- more order - higher compressibility
- more order - more predictability
- more order - less complexity
- Claude Shannon - founder of information theory
- ↑ victim of AI
- AI consumed alot of money & resources
- sensors, decision maker, actuators, environment
- there is also an inner state that also affects decision, even if senses are the same
- reflex agent - always reacts the same to same stimuli
- broadcast - indirect communication
- point to point - direct
- the environment is an info center, info filter, and collective memory
- Game of Life - 3 neighbors → born
  2,3 neighbors → survive
  all others → die
- NetLogo
-

- globals [ ]
- patches_own [ ]
- pxcor
  pycor
  pcolor
- a procedure starts with to & ends with end
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- Create a log of work
- give screenshot & paragraph of model
- results of model & conclusion

- think about predicting population density for next class

Aritifical Life

- Review of last Class
- emergence – strong vs. weak
- strong – cannot describe at a macro level that can also be micro described
- weak – a system that surprises you
- ⁝ → • • • → ⁝
- Emergence
- in GoL, 2-3 survives so why doesn't density stay at 2.5 on average?
- could also be interpreted as 3.5N, counting the center
- with 3.5N → 43.75%
- with 2.5N → 31.25%
- average those guess
- density is usually 2%, thinking about the microscopic rules
- New Addition to Protocol
- table with 5 columns

cellular automata	outcome	predicted density	observed density	emergence
GoL 3N → alive 4N → born	blinkers dots	36% $50\% = \frac{43.75\% + 56.25\%}{2}$	2% 0.5%	strong
4N → alive 2N → born	chaos	$25\% = \frac{18.75\% + 31.25\%}{2}$	28.5%	

- change the code to see what happens, create your own rules
- document so that it is repeatable

3N → born 2N or 4N → stays alive	walls /maze	37.5%	~ 50.5%	
3N → born	occasional frozen loop	0%	~ 0%	
4N → born ID = .25 0N, 3N, 5N, 6N → alive	islands	50%	28.5%	
5N → born ID = .35 3N, 4N, 6N, 7N → alive	islands	25%	20.4%	
2N, 3N → born ID = .20	chaos	31.25%	39%	
2N, 3N → born ID = .20 4N → alive	maze	37.5%	50.5%	
3N, 4N → born ID = .1	grows into chaos	50%	55%	

- Class results

B → 1 D < 1, > 2	lines	25%	37.5%	weak
B → 2 D	kaliedoscope	~ 36%	~ 35%	weak
B → 6 ID = .65 D < 4, > 7	galleries	~ 90%	33%	~

B → 4 D → <3, >6	sponge	75%	65.5%	weak
B → 0 D → <0, >3	blinks	25%	27%	weak

- there are two equilibriums, 0 & K (carry capacity)
- 0 is called the trivial equilbrium
- transient - after start before rest
-- Areas
- 3 groups - frozen, empty, & living
- average across the world will give a better prediction
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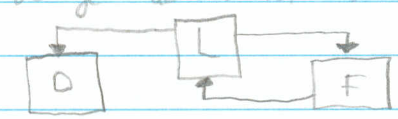
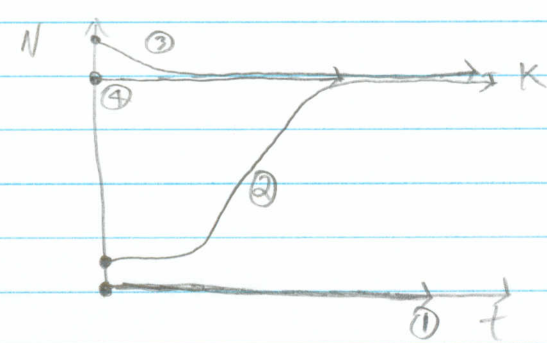


- meso-scopic - in the middle of micro & macro
- each of the three parts would be converted to differential equations (does not work out though)
- only 99% right, the other 1% is
- Verhulst model - $\frac{dN}{dt}$

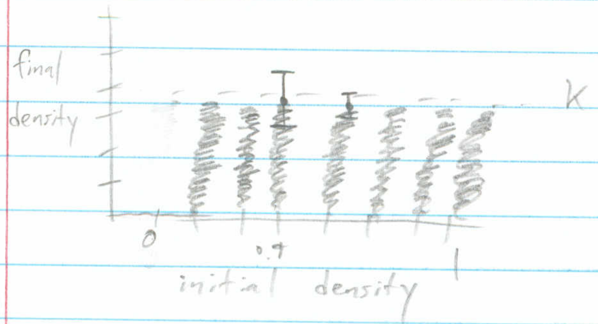
N = # of organisms
R = offspring
K = carrying capacity

$$\frac{dN}{dt} = R \cdot \left(1 - \frac{N}{K}\right) \cdot N$$



$\frac{dN}{dt}$ represents change

1 - at zero
2 - above 0
3 - above K
4 - K



✓ use a 50 x 50 world

- start with a K and create a histogram
- must find change - try between 0 + 0.1 and so on
- re run with the same density + get a different outcome
- use mean + standard deviation
- upload it by next class
- will need to export data via CSV possibly

Artificial Life

- V_e

- $$\frac{dA}{dt} = \underbrace{\frac{k_1 A^2}{H}}_{\text{interaction / inhibitor}} - \underbrace{k_2 A}_{\text{decay}} + \underbrace{k_1 k_3}_{\text{fixed production}} + \underbrace{D_A \frac{d}{dx}^2 A}_{\text{diffusion}}$$

diffusion coefficient

- conditions for stability

$$k_1 \approx k_2 \approx k_5, \quad k_6 \approx k_1 k_3, \quad D_A < D_H, \quad k_4 << k_1$$

- k_1 = activator dependent production rate
k_2 = activator destruction rate
k_3 = activator fixed production
k_4 = inhibitor dependent production rate
k_5 = inhibitor destruction rate
k_6 = inhibitor fixed production

RGBRGBRGB

RRRGGGBBB

$A+B+C=1$

$$-1\left(\left(\frac{A}{A+B+C}\right)\times \lg\left(\frac{A}{A+B+C}\right)+\frac{B}{A+B+C}\times \lg\left(\frac{B}{A+B+C}\right)+\frac{C}{A+B+C}\times \lg\left(\frac{C}{A+B+C}\right)\right)$$