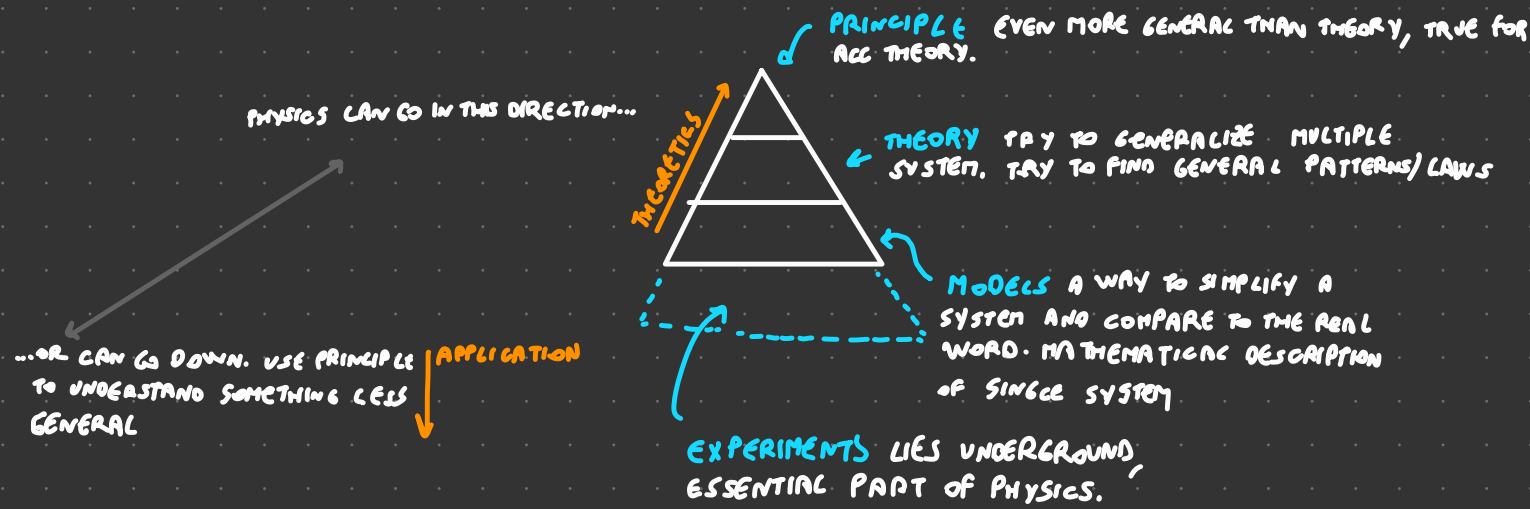


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DYNAMIC PRINCIPLE: TYPE OF MODELS, A WAY TO DO MODELS.

GOAL OF MODELS: PREDICT THE FUTURE STATE OF A SYSTEM GIVEN THE PRESENT ^{OR PAST STATE} STATE. TRY TO PREDICT WHAT WILL HAPPEN IN 1S OR 1H OR 1YEAR.

SOMETIME REVERSEABLE. USE PRESENT TO "PREDICT" PAST

EX: ASTEROID APPROACHING EARTH



EX: CYLINDER w/ GAS



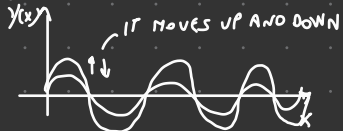
WANT TO PREDICT HOW IT WILL CHANGE WITH TIME

STATE:

- VECTOR
- NUMBER
- A FUNCTION

DYNAMICS: DEPENDENCE OF x W.R.T. t

STRING OF A GUITAR, HOW IT WILL MOVE DURING TIME



CLASSIFY D. SYSTEM IN TERMS OF t AND x BE CONTINUOUS/DISCRETE

NOT A FUNCTION BUT A SINGLE NUMBER

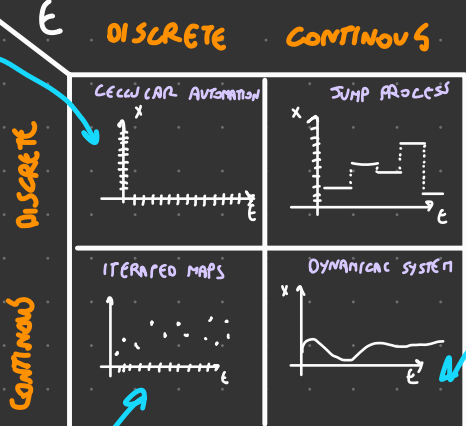
SET OF ALLOWED VALUES THAT x CAN HAVE IT CAN BE PUT IN 1-TO-1 TO REAL NUMBERS IT HAVE FINITE NUMBER OF VALUES

POINT OF x IN A RECTANGLE CONTINUOUS NO UNIT OF POSITION OF x

POINT OF x IN THE \bullet DISCRETE

- TIME NOT CONTINUOUS I HAVE TIME 5 AND TIME 6 BUT IT MAKES NO SENSE TIME 5.5
- x FINITE NUMBER OF x

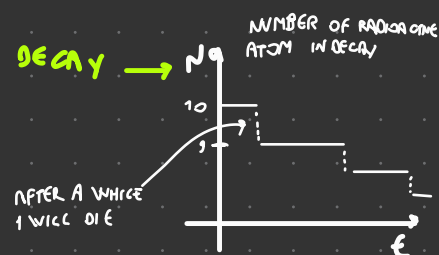
- COMPUTER (TWOING MACHINE)
- CELLULAR AUTOMATON. HAVE FIXED VALUES OF TIME AND A DISCRETE SET OF STATE
- MIGHT BE INFINITE, BUT STILL COUNTABLE



THE ARE CALLED TRANSITION. JUMP PROCESSES. TRANSITION ARE SEEN AS JUMPS BETWEEN DIFFERENT STATE. EX: RADIOACTIVE DECAY

ASTEROID APPROACHING EARTH IS A DYNAMICAL SYSTEM ①

x AND t ARE CONTINUOUS



NO CONSTRAINT TO THE x VALUES, CALLED ITERATED MAPS. CAN BECOME CHOTIC MEASURE EVERY 15TH OF AUGUST THE LENGTH OF A GLACIER

$$N = 0, 1, 2, \dots$$

$$x \in \mathbb{R}$$

ITERATED
MAPS

$$x_N \quad x(N)$$

USE THIS NOTATION

CALLED "THE EQUATION OF MOTION"

$$x_{N+1} = f(x_N) \rightarrow \text{FUNCTION THAT MAPS STATE OF THE SYSTEM.}$$

$$x_{N+2} = f(x_{N+1}) = f(f(x_N))$$

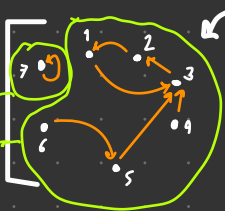
INITIAL STATE x_0

$$x_N = f^N(x_0)$$

$f(f(f(x_0)))$
 $\hookrightarrow N$ TIMES

TERMS (STARTING FROM CELLULAR AUTOMATION)

THIS IS
A GRAPH



7 POSSIBLE STATE
 \rightarrow MOVE FROM ONE STATE TO ANOTHER

CONSTRAINT

- ~~NOT ALLOWED BECAUSE OF DETERMINISTIC. THIS CONDITION WOULD HAVE SOMETHING UNDETERMINED~~
- ~~PREDICTED NO ARROW TO GO OUT MUST BE 1~~

ONE AND ONE ONLY
 \rightarrow ARROW GOING DOWN

- **TRAJECTORY/ORBIT** $\{x_0, x_1, x_2, \dots\}$
(CAN BE INFINITE OR NOT)

- **CYCLES** A TRAJECTORY THAT REPEATS ITSELF INFINITELY

$$x_{N+P} = x_N \quad \forall N \quad P \in \mathbb{N}$$

PERIOD OF THE CYCLE

$\{3, 2, 1\}$ IS A CYCLE \rightarrow PERIOD 3

- **FIXED POINT** CYCLE OF PERIOD 1 (SOMETHING THAT GOES TO ITSELF) ($P=1$)

$$\bar{x} = f(\bar{x})$$

\hookrightarrow MAP THE STATE OF A GIVEN TIME TO THE STATE IT WILL GO ON TO

- **RECURRENT STATE**: STATE THAT I VISIT INFINITELY MANY TIMES
IF I PASS IN 2 I WILL PASS INFINITE TIMES $(7, 3, 2, 1)$ ARE RECURRENT
- **TRANSIENT STATE**: NOT VISIT INFINITE TIMES $(6, 5, 4)$

- **CONNECTED COMPONENT**: SUBSET OF THE GRAPH \leftarrow RELATED TO CONNECTED QUANTITIES

- **REVERSEBILITY**: IF I HAVE (x_0, x_1, x_2, \dots) A GIVEN TRAJECTORY THAT IS ALLOWED THEN ALSO (\dots, x_2, x_1, x_0) IS ALLOWED AS WELL BY THE DYNAMICAL SYSTEM