Today

- Terminal and shell
- Counter controlled repetition
- Combining conditions and counters
- Data generating process

Working in the terminal

- Shell (e.g. bash, or zsh on Mac)
  - command line interface (CLI) to the operating system (OS)
  - interpreter program
- Terminal
  - application where the shell runs
- Console in VSCode and RStudio
  - like a shell but only interacts with R or Python
  - doesn't interact with the OS

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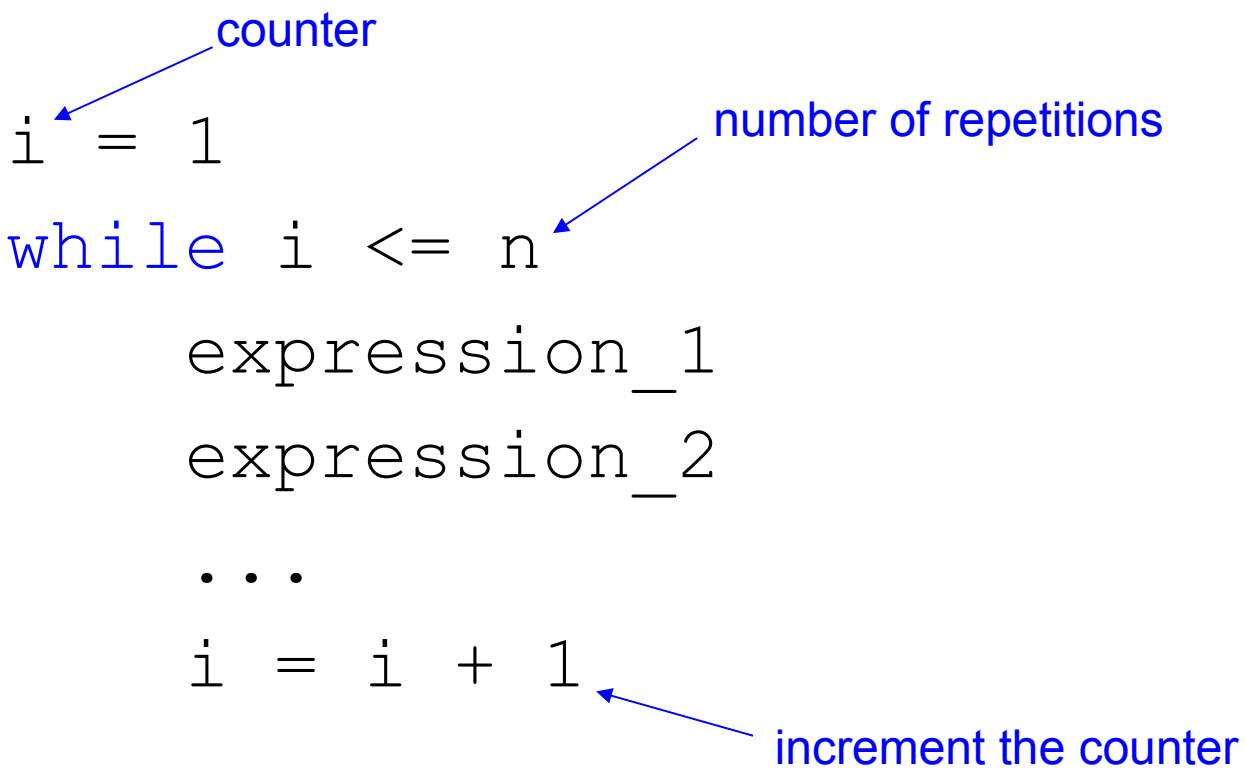
Which do I have?
echo $SHELL

bash

- Bourne Again Shell
  - open source implementation of Bourne's sh (unix 1970s)
  - commands to do stuff in the operating system (file management etc)
  - demo, incl git

while repetition structure

- Counter controlled repetition



Exercise: while, counter control

```
i = 1                          counter
while i <= n                   n repetitions
    ... expressions
    i = i + 1                  increment counter
```

Exercise: counter controlled repetition
A population starts with 2 individuals. Each generation, it doubles in size. What is the population size after 20 generations?
Use the `while` structure. The algorithm should finish by printing the answer. You can't use an exponentiation operator.
Pseudocode first, then flowchart ... then Python.

Both counters & conditions

- How many generations does it take to exceed 10,000?

Both counters & conditions

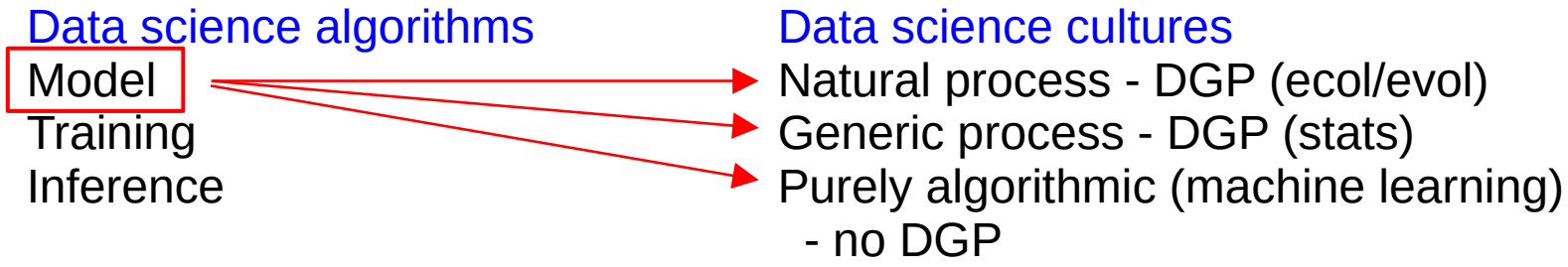
- Stop if population size > 1e9
- or
- generation > 100

Where do data come from?

- Data generating process
- An actual physical process involving fundamental particles of the universe
- Includes
  - ecological/evolutionary process
  - observing process

Data generating process

- Key to scientific understanding
  - How does the system work?
- How to model the DGP?



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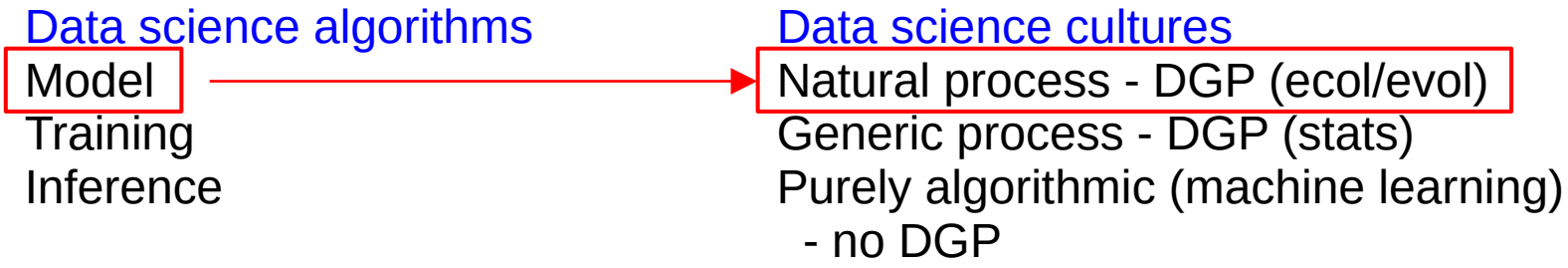
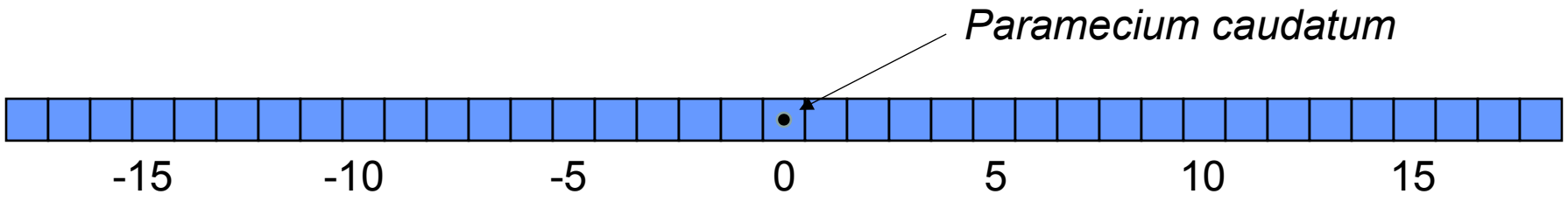


Data generating process

- Key to scientific understanding
  - How does the system work?
- How to model the DGP?
- Simplify, abstract
- Scales of abstraction

Design a model algorithm

e.g. animal movement (1D)



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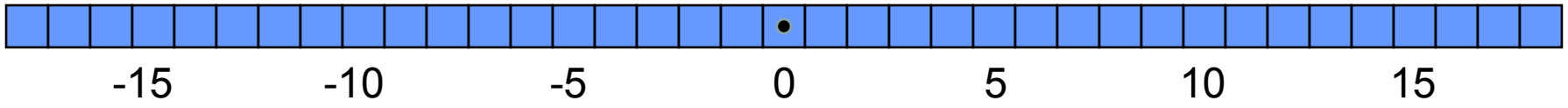

Subatomic scale of abstraction (reality)?

- particles, forces

... including all the ways these processes cause us to collect the data

Design a model algorithm

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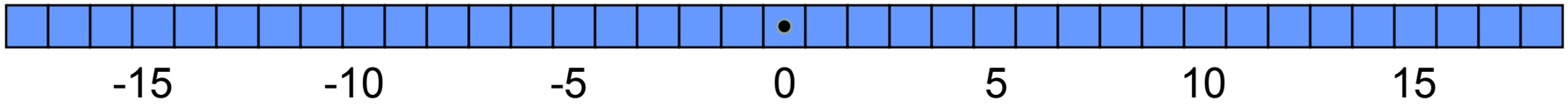

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Too hard

Design a model algorithm

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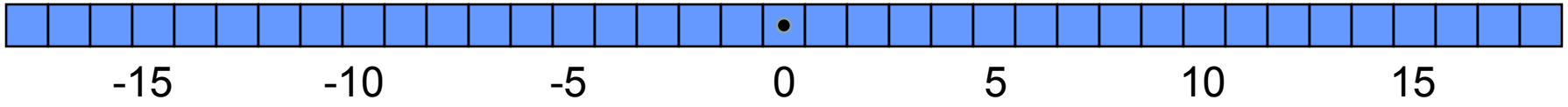

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Molecular scale of abstraction?
- cellular interactions

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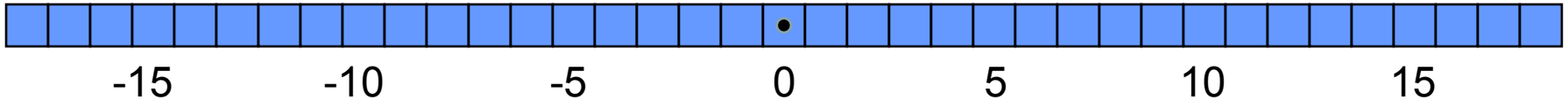

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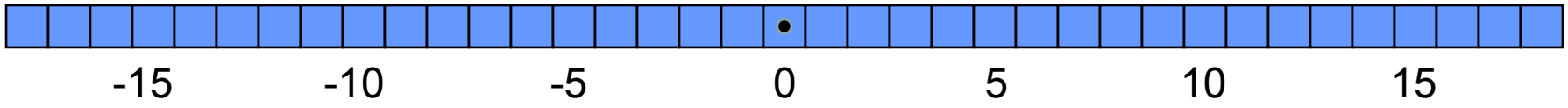
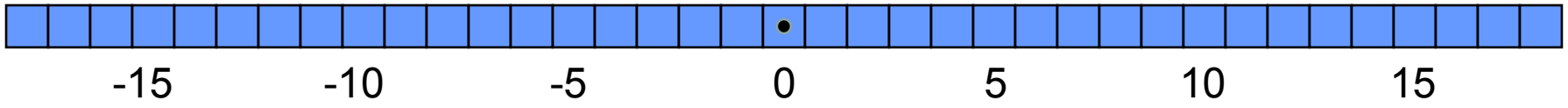


Individual scale of abstraction?

- behavior, feedback, motivation
- lots we don't know

Design a model algorithm

e.g. animal movement (1D)



Individual scale of abstraction

Δt: $P_{\text{move}} = 0.2$, equal probability left or right

Model a stochastic process

- Uniform distribution
  - numbers 0 to 1 with equal probability
- Simulate event with probability P
  - draw u from uniform distribution
  - if u < P, event occurs
- Uniform distribution in R:
  - `runif(n=1)`
  - draw one random number between 0-1

Stochastic processes

- Substitute for all the stuff we don't know
- Uncertainty about finer-scale processes
- Is the world deterministic or stochastic?
  - my view: depends on scale
  - individual scale is stochastic
  - individuals perceive the world as uncertain

Design a model algorithm

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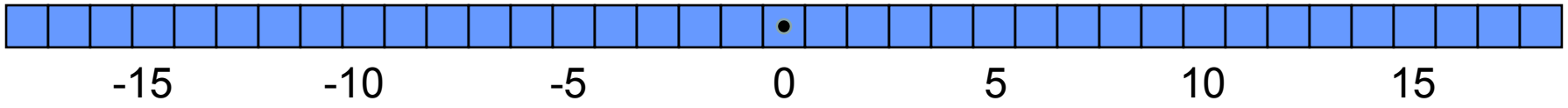

Individual scale of abstraction

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Where will the paramecium be at *t*?
Pseudocode first.