Today

- Recap & questions from homework
- Pair programming?
  - Repetition structures: Q3 Fibonacci sequence
- Data generating process

Structured programming

- Sequence structure
- Selection structure (conditional, branches)
- Repetition structure (iteration, loops)

R selection structures

if single selection structure
```
if ( condition ) {
    expression
}
```

if-else double selection structure
```
if ( condition ) {
    expression1
} else {
    expression2
}
```

if-else if multiple selection structure
```
if ( condition ) {
    expression1
} else if {
    expression2
} else {
    expression3
}
```

R repetition structures in practice

```
while sentinel control
while ( condition ) {
    expression
}
```

```
for counter control
for ( i in 1:n ) {
    expression
}
```

```
until sentinel control
while ( !condition ) {
    expression
}
```

```
foreach vector control
for ( element in vector ) {
    expression
}
```

```
do-while sentinel control (e.g. option 4)
repeat {
    expression
    if ( !condition ) break
}
```

```
foreach vector control with lists
for ( object in list ) {
    expression
}
```
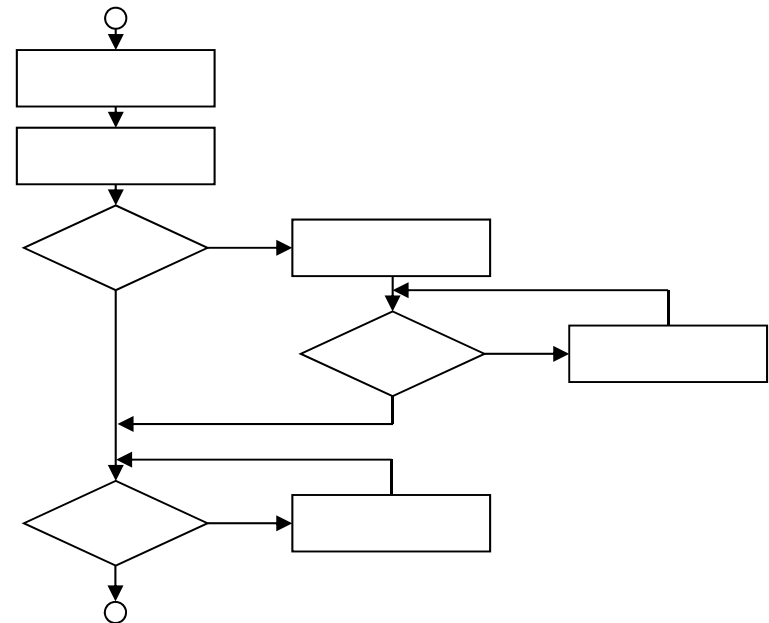
Combining control structures

Stacking
– one after another

Nesting
– one inside another

These are all the programming tools you need to solve any (solvable) problem!
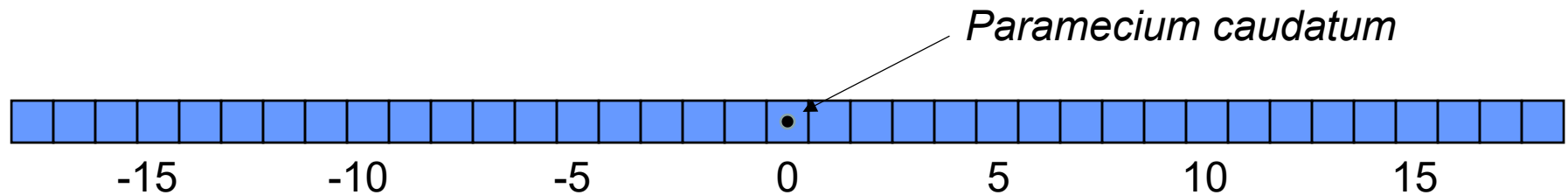
Next: additional, powerful programming tools for convenience or to solve specific problems.

Where do data come from?

- Data generating process
- An actual physical process involving fundamental particles of the universe
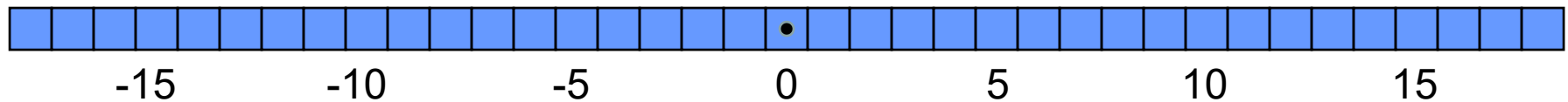- Scales of abstraction to simplify
- Models

Design a model algorithm

e.g. animal movement (1D)

Paramecium caudatum

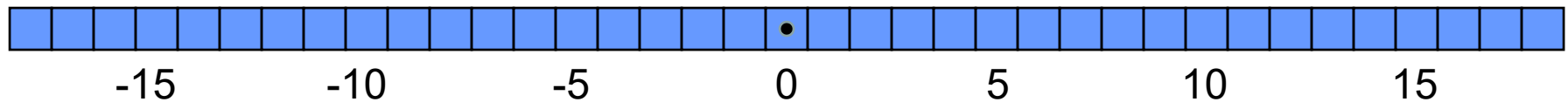# Design a model algorithm

e.g. animal movement (1D)

Subatomic scale of abstraction (reality)?
  - particles, forces

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

Design a model algorithm

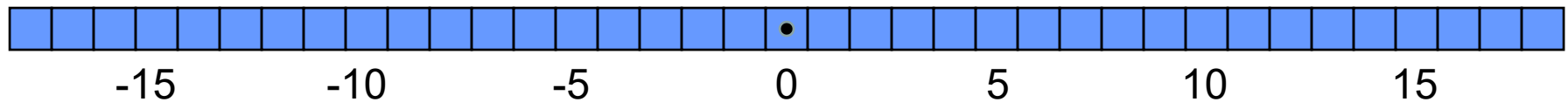e.g. animal movement (1D)

~~Subatomic scale of abstraction (reality)?~~
~~- particles, forces~~ Too hard

Design a model algorithm

e.g. animal movement (1D)

~~Subatomic scale of abstraction (reality)?~~
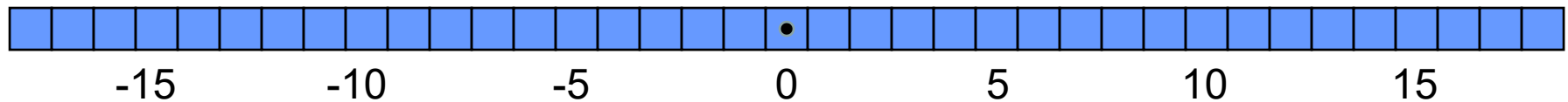~~- particles, forces~~   Too hard

Molecular scale of abstraction?
   - cellular interactions

Design a model algorithm

e.g. animal movement (1D)

~~Subatomic scale of abstraction (reality)?~~
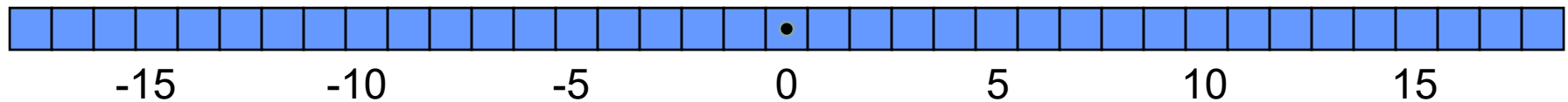~~- particles, forces~~ Too hard

~~Molecular scale of abstraction?~~
~~- cellular interactions~~ Too hard

Design a model algorithm
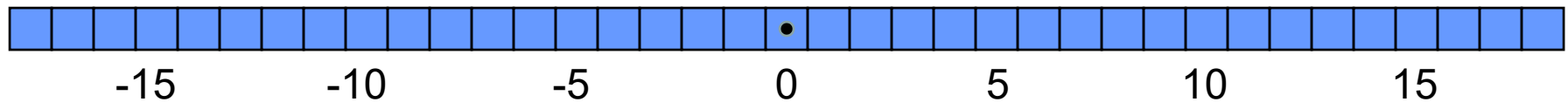
e.g. animal movement (1D)

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

$\Delta t: P_{\mathrm{move}} = 0.2$, equal probability left or right
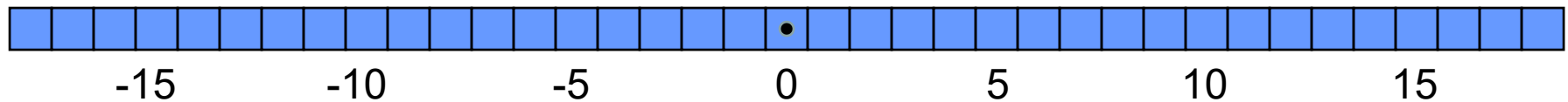
Model a stochastic process

- Uniform distribution
  - numbers 0 to 1 with equal probability
- Simulate event with probability P
  - draw r from uniform distribution
  - if r < P, event occurs
- Uniform distribution in R:
  - `runif(n)`
  - n random numbers, in a vector

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

e.g. animal movement (1D)
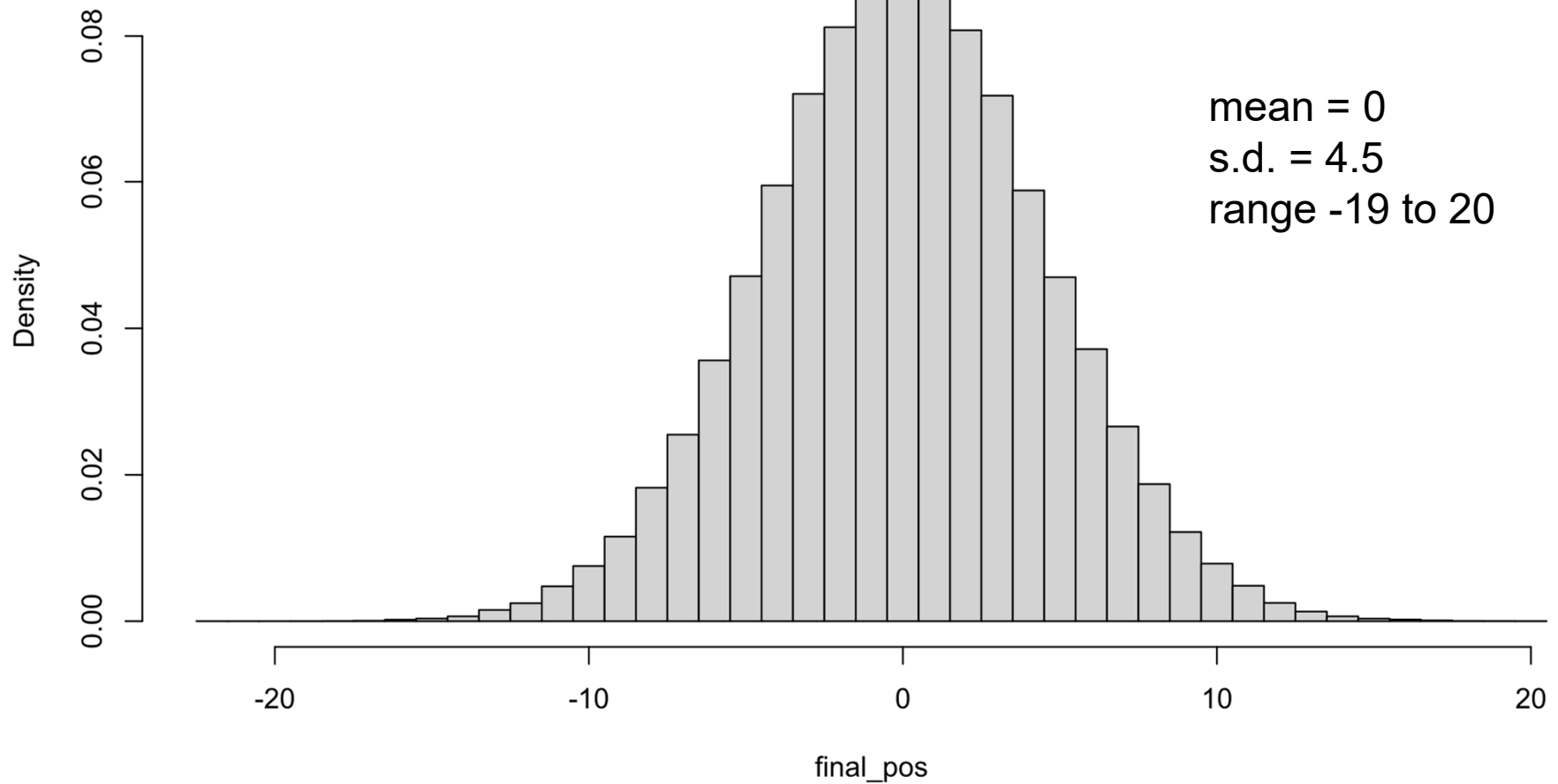

Individual scale of abstraction

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

Where will the paramecium be at t?
Pseudocode first.

Generated data

Histogram of final_pos

mean = 0
s.d. = 4.5
range -19 to 20

A new data generating model

Phenomenological scale of abstraction

Model:
Normal distribution
mean = 0
s.d. = 4.5