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
}
```

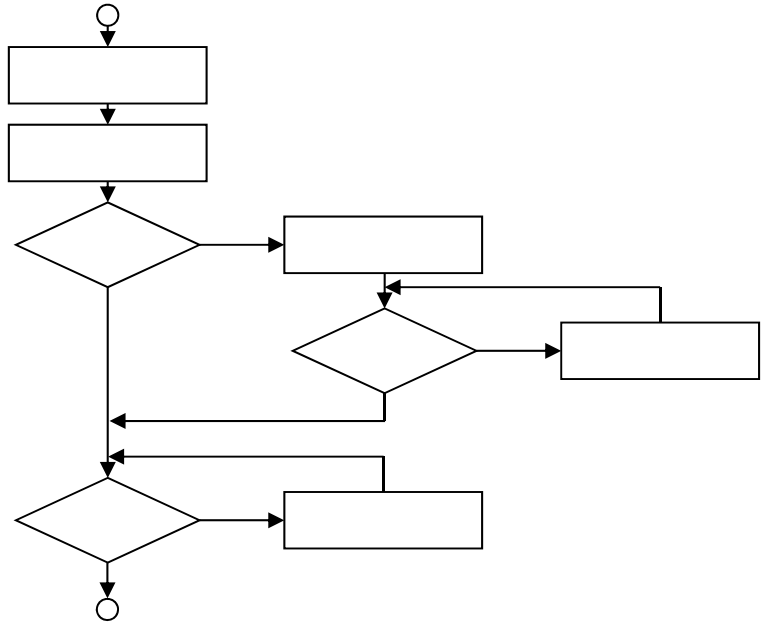
Combining control structures

Stacking

– one after another

Nesting

– one inside another



These are all the programming tools you need to solve any (solvable) problem!

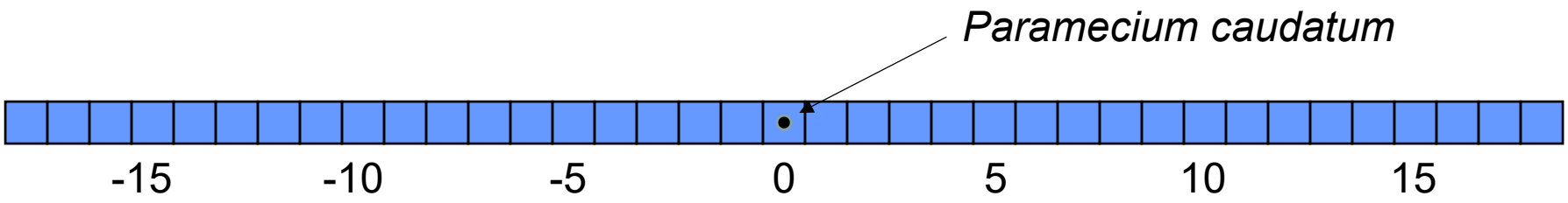
Next: additional, powerful programming tools for convenience or to solve specific problems.

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)



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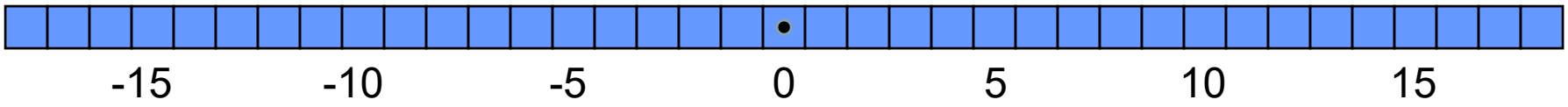


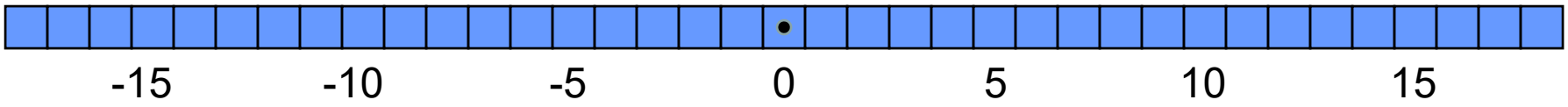
Subatomic scale of abstraction (reality)?

- particles, forces

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

Design a model algorithm

e.g. animal movement (1D)



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~~- particles, forces~~

Too hard

Design a model algorithm

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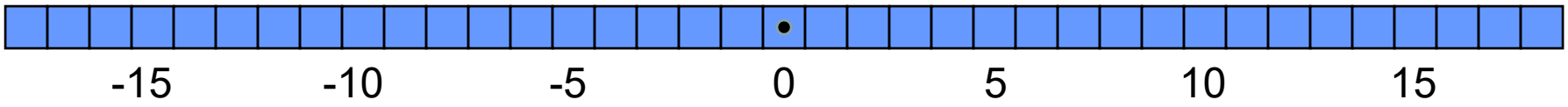

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Too hard

Molecular scale of abstraction?

- cellular interactions

Design a model algorithm

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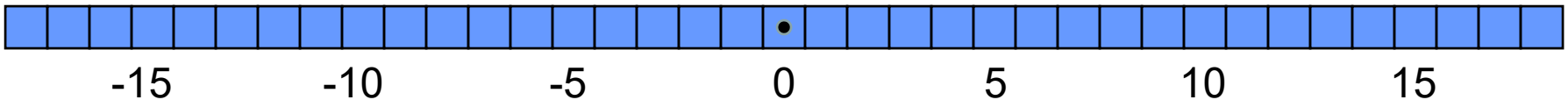

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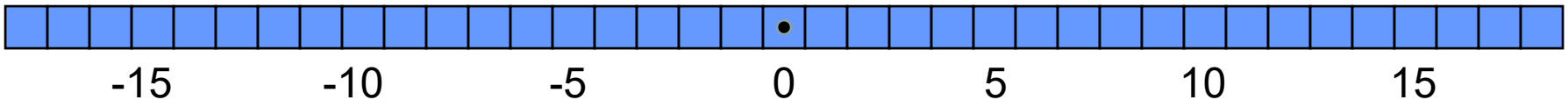
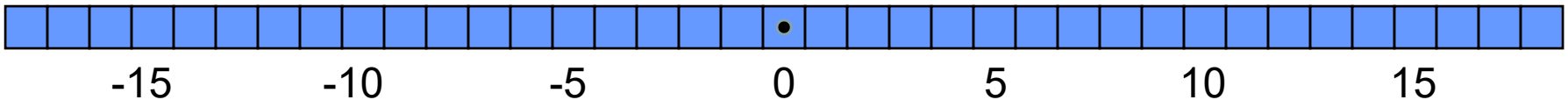


Individual scale of abstraction?

- 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

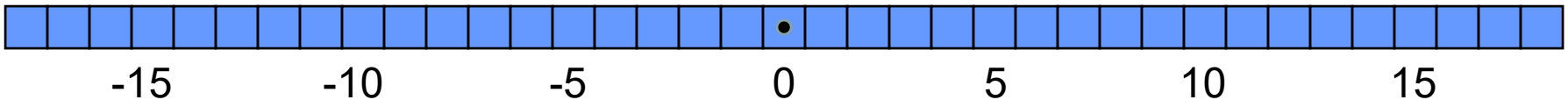
- Uniform distribution
  - numbers 0 to 1 with equal probability
- Simulate event with probability P
  - draw r from uniform distribution
  - if r < P, event occurs
- Uniform distribution in R:
  - `runif(n)`
  - n random numbers, in a vector

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

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

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