PAT 204/504 (Fall 2025)

Creative Coding

Lecture 3: Keyboard Controls & Randomness

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Keyboard Controls

Built-in Keyboard Functions

Function	Called when
`keyPressed()`	a key is *pressed*
`keyReleased()`	a key is *released*
`keyTyped()`	a key is *clicked* (called repeatedly if held down)

🤔 Guess what this does?

```
void keyPressed() {
  if (key == ' ') {
    saveFrame("screenshot.png");
  }
}
```

key

- `key` stores the most recent key used
  - Either pressed or *released*!

🤔 Guess what this does?

```
void keyPressed() {
  if (key == CODED) {
    if (keyCode == UP) {
      noLoop();
    }
  }
}
```

Disable looping the draw() call

AND Operator (&&)

```
void keyPressed() {
  if (key == CODED) {
    if (keyCode == UP) {
      noLoop();
    }
  }
}
```

```
void keyPressed() {
  if (key == CODED && keyCode == UP) {
      noLoop();
    }
  }
}
```

&& AND
|| OR

key & keyCode

- For special (non-ASCII) keys, keyCode is used
  - **UP**, **DOWN**, **LEFT**, **RIGHT**
  - **ALT**, **CONTROL**, **SHIFT**
  - You don’t need keyCode for BACKSPACE, TAB, ENTER, RETURN, ESC, and DELETE

Controlling `draw()`

- `noLoop()` Disable looping the `draw()` call
- `loop()` Enable looping the `draw()` call
- `frameRate(fps)` Set the frame rate of looping `draw()` calls

keyCode

- How about this?

```
void keyPressed() {
  if (key == CODED) {
    if (keyCode == BACKSPACE) {
      noLoop();
    }
  }
}
```

BACKSPACE is *not* coded

keyCode

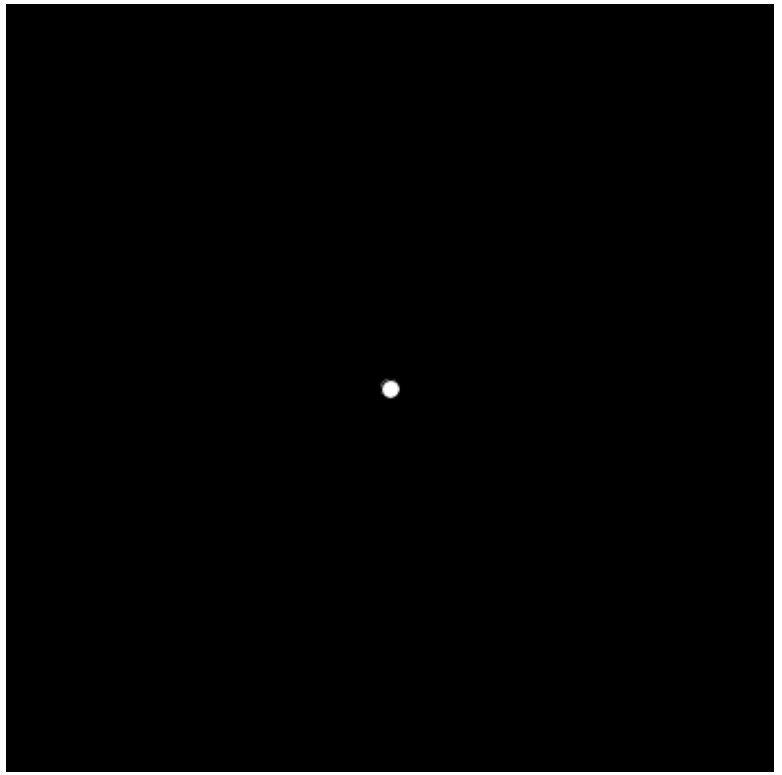
- Use simply **key** for BACKSPACE, TAB, ENTER, RETURN, ESC, and DELETE

```
void keyPressed() {
  if (key == BACKSPACE) {
    noLoop();
  }
}
```

🧐 **Exercise**: Use the Arrow Keys to Control a Ball

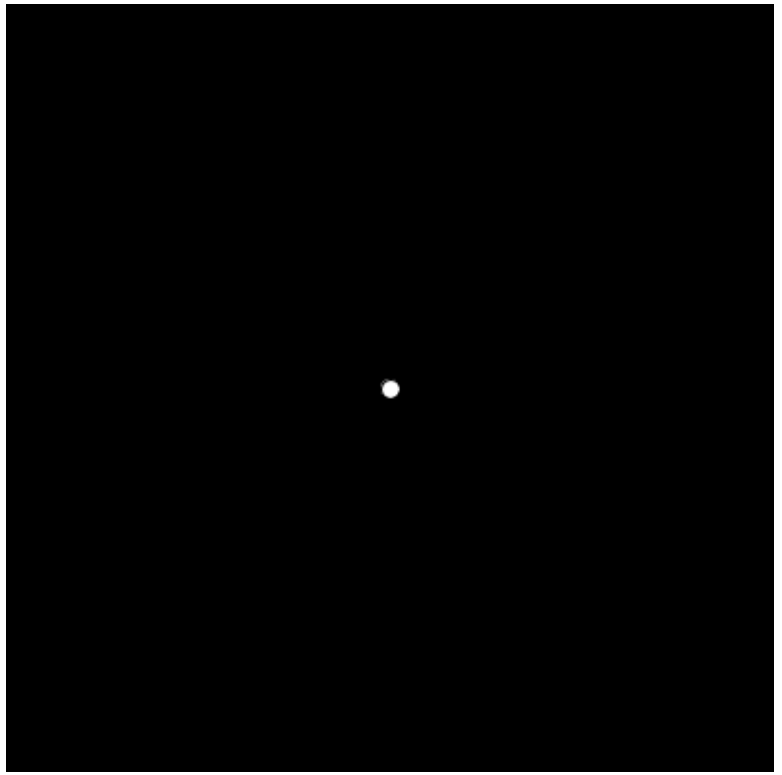
- Create a simple interface where you can move the ball around using the arrow keys
- **Hints**:
  - What **variables** do we need?
  - You'll need **keyCode** for the arrow keys

```
void keyPressed() {
  if (key == CODED) {
    if (keyCode == UP) {
      doSomething();
    }
  }
}
```



🧐 **Exercise**: Use the Arrow Keys to Control a Ball

```
float x = 200, y = 200;
float step = 10;

void keyPressed() {
  if (key == CODED) {
    if (keyCode == LEFT) {
      x = x - step;
    }
    if (keyCode == RIGHT) {
      x = x + step;
    }
    if (keyCode == UP) {
      y = y - step;
    }
    if (keyCode == DOWN) {
      y = y + step;
    }
  }
}
```



More on Conditionals

Conditionals – if-else-if Statement

```
if (condition) {
  doSomething();
} else if (condition2) {
  doSomethingElse();
} else {
  doYetSomethingElse();
}
```

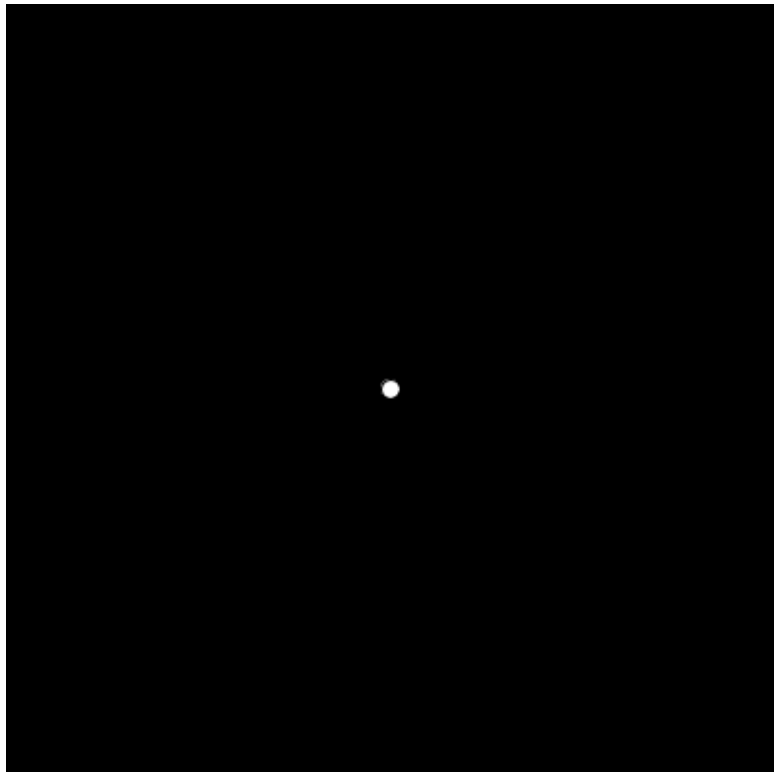
Conditionals – if-else-if Statement

```
if (condition) {
  doSomething();
} else if (condition2) {
  doSomethingElse();
} else {
  doYetSomethingElse();
}
```

```
if (condition) {
  doSomething();
} else {
  if (condition2) {
    doSomethingElse();
  } else {
    doYetSomethingElse();
  }
}
```

🧐 **Exercise**: Use the Arrow Keys to Control a Ball

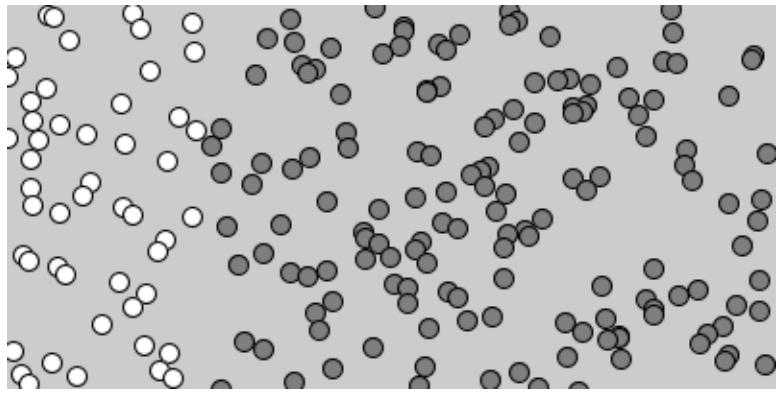
```
float x = 200;
float y = 200;
float step = 10;

void keyPressed() {
  if (key == CODED) {
    if (keyCode == LEFT) {
      x = x - step;
    } else if (keyCode == RIGHT) {
      x = x + step;
    } else if (keyCode == UP) {
      y = y - step;
    } else if (keyCode == DOWN) {
      y = y + step;
    }
  }
}
```



else if versus if

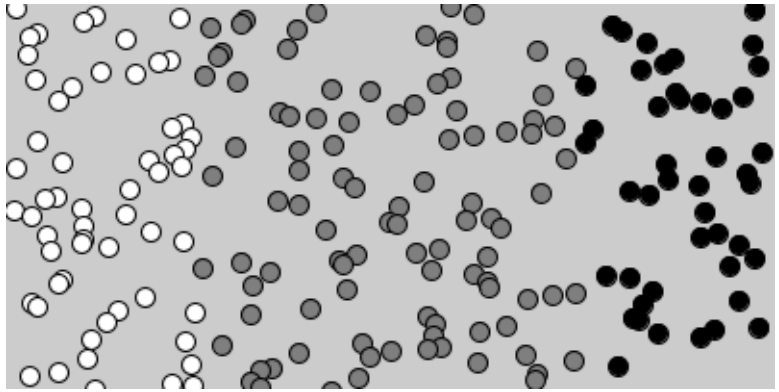
```
if (mouseX > 300) {
  fill(0);
}
if (mouseX < 100) {
  fill(255);
} else {
  fill(127);
}
```

mouseX ≥ 100



```
if (mouseX > 300) {
  fill(0);
} else if (mouseX < 100) {
  fill(255);
} else {
  fill(127);
}
```

100 ≤ mouseX ≤ 300



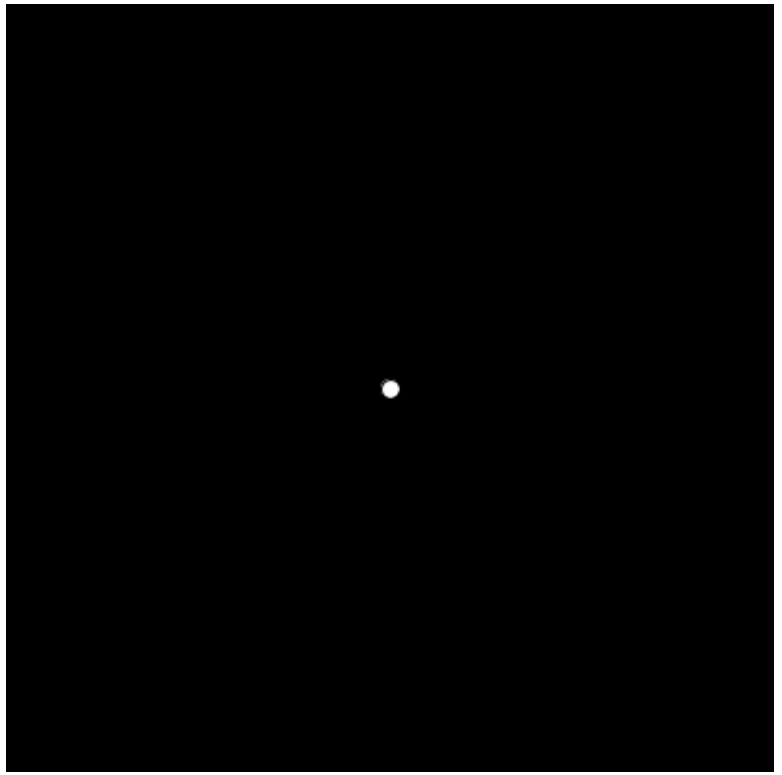
`switch` Statement

```
switch(expression) {
  case value1:
    doSomething();
    break;

  case value2:
    doSomethingElse();
    break;

  case value3:
    doYetSomethingElse();
    break;
}
```

🧐 **Exercise**: Rewrite it using `switch`

```
float x = 200;
float y = 200;
float step = 10;

void keyPressed() {
  if (key == CODED) {
    if (keyCode == LEFT) {
      x = x - step;
    } else if (keyCode == RIGHT) {
      x = x + step;
    } else if (keyCode == UP) {
      y = y - step;
    } else if (keyCode == DOWN) {
      y = y + step;
    }
  }
}
```

```
switch(expression) {
  case value1:
    doSomething();
    break;

  case value2:
    doSomethingElse();
    break;

  case value3:
    doYetSomethingElse();
    break;
}
```



switch Statement

```
if (keyCode == LEFT) {
  x = x - step;
} else if (keyCode == RIGHT) {
  x = x + step;
} else if (keyCode == UP) {
  y = y - step;
} else if (keyCode == DOWN) {
  y = y + step;
}
```

```
switch(keyCode) {
  case LEFT:
    x = x - step;
    break;

  case RIGHT:
    x = x + step;
    break;

  case UP:
    y = y - step;
    break;

  case DOWN:
    y = y + step;
    break;
}
```

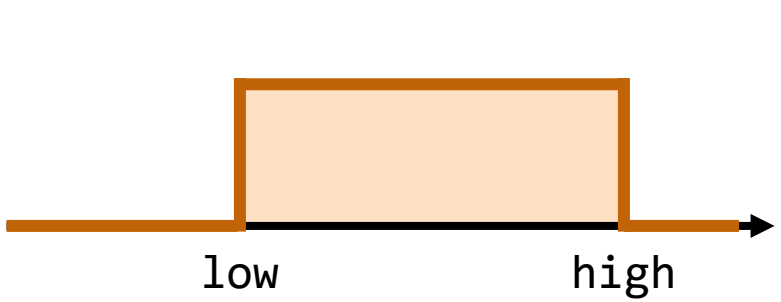
Combining Multiple Conditions in `switch`

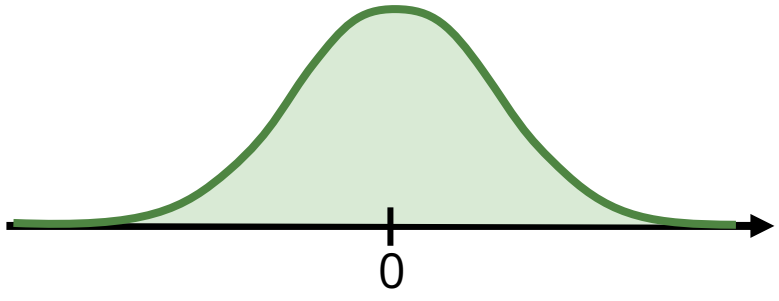
```
switch(expression) {
  case value1:
  case value2:
  case value3:
    doSomethingElse();
    break;

  case value4:
    doYetSomethingElse();
    break;
}
```

Randomness

Randomness

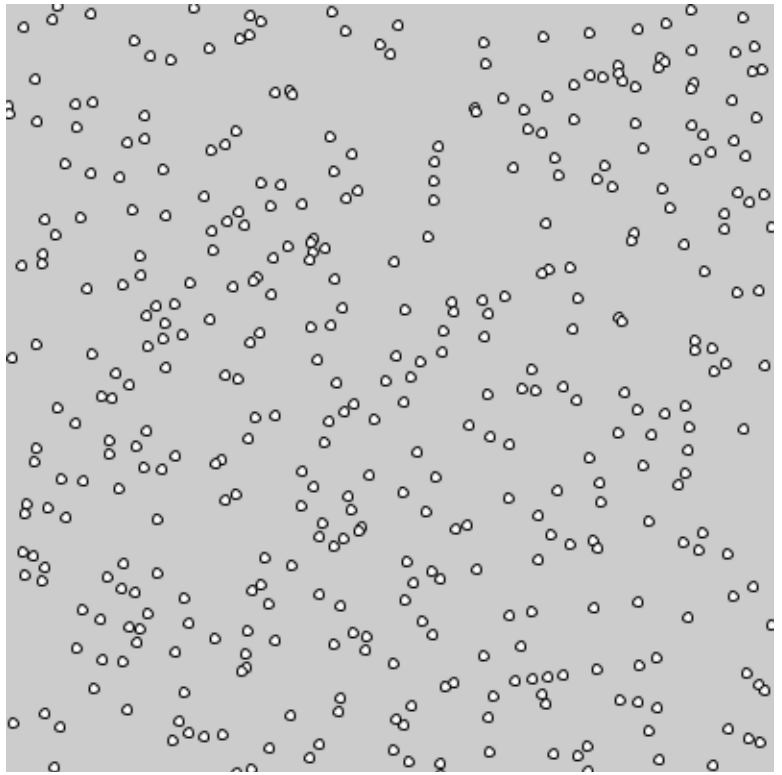
- **`random`**`(high)` Generate a random number in $U[0, high]$
- **`random`**`(low, high)` Generate a random number in $U[low, high]$
- **`randomGaussian`**`()` Generate a random number in $N[0, 1]$





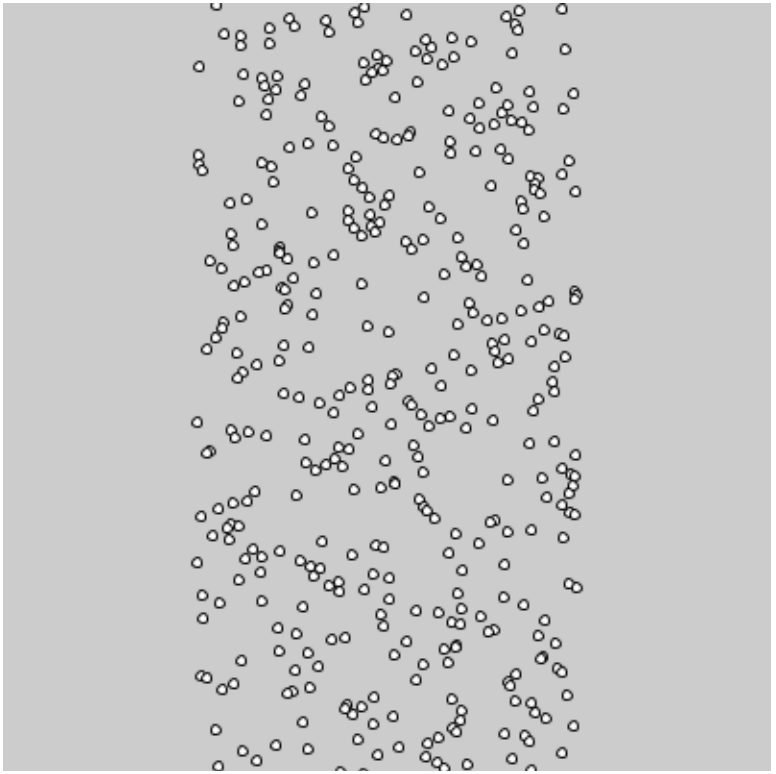
Generating Random Numbers with `random()`

```
float x, y;

void setup() {
  // Create a 400x400 canvas
  size(400, 400);
}

void draw() {
  // Generate a random number
  x = random(400);

  // Gradually increase the y-position
  y = y + 1;

  // Draw a circle
  circle(x, y, 5);
}
```

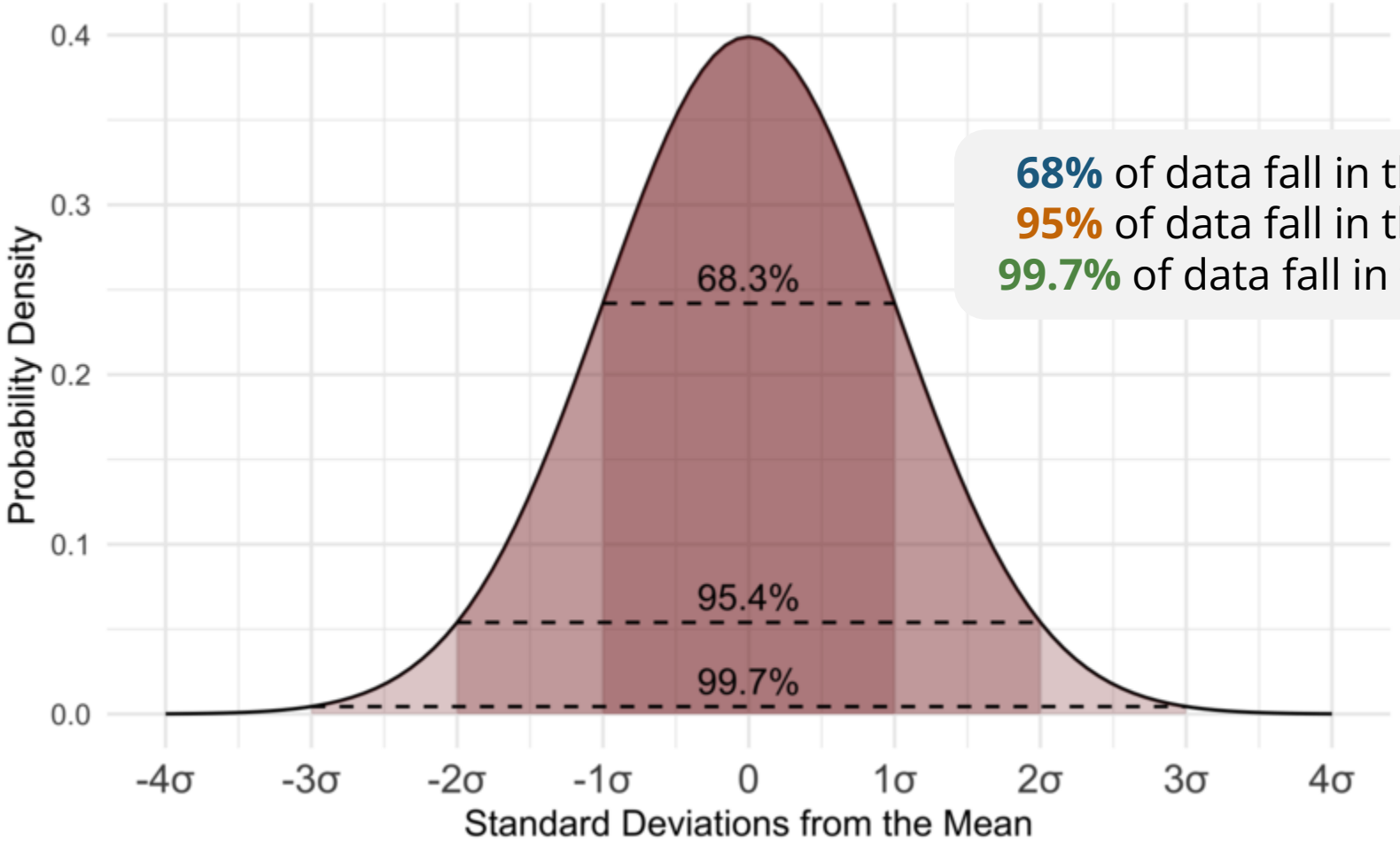


Generating Random Numbers with `random()`

```
float x, y;

void setup() {
  // Create a 400x400 canvas
  size(400, 400);
}

void draw() {
  // Generate a random number
  x = random(100, 300);

  // Gradually increase the y-position
  y = y + 1;

  // Draw a circle
  circle(x, y, 5);
}
```



Gaussian Distribution & the 68–95–99.7 Rule



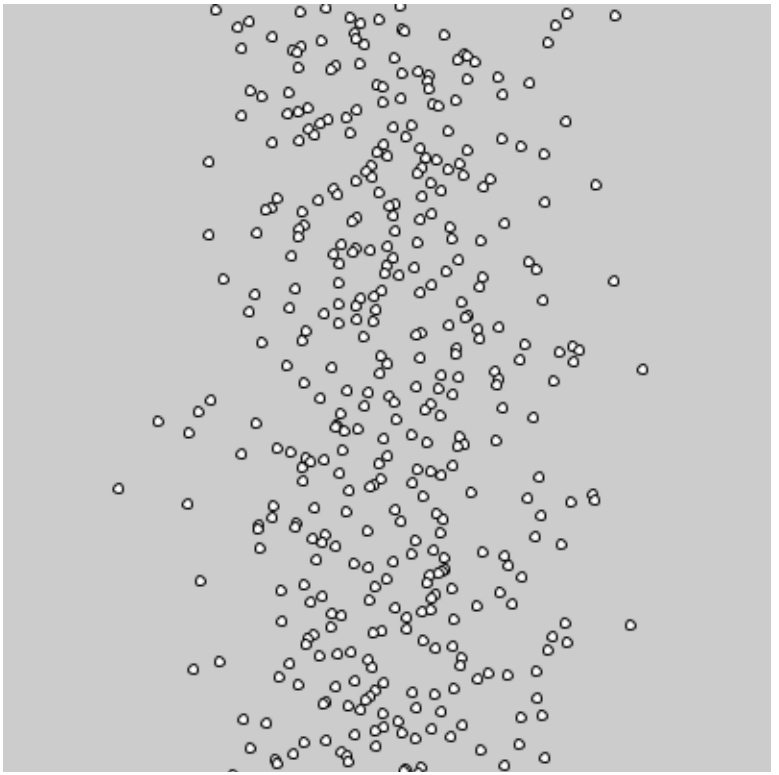
68% of data fall in the **±1σ** range
95% of data fall in the **±2σ** range
99.7% of data fall in the **±3σ** range

Random Numbers with `randomGaussian()`

```
float x, y;

void setup() {
  // Create a 400x400 canvas
  size(400, 400);
}

void draw() {
  // Generate a random number
  x = randomGaussian() * 50 + 200;

  // Gradually increase the y-position
  y = y + 1;

  // Draw a circle
  circle(x, y, 5);
}
```

$\sigma = 50$

Centered at 200

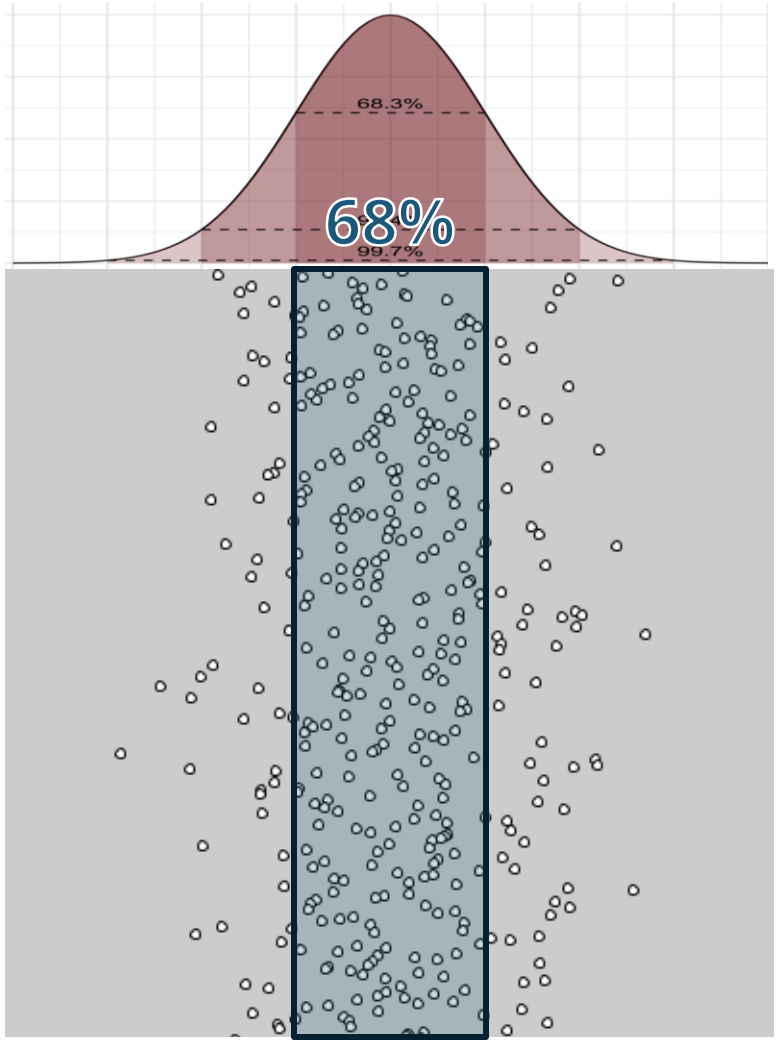


The 68–95–99.7 Rule

Standard deviation

```
x = randomGaussian() * 50 + 200;
```

Mean

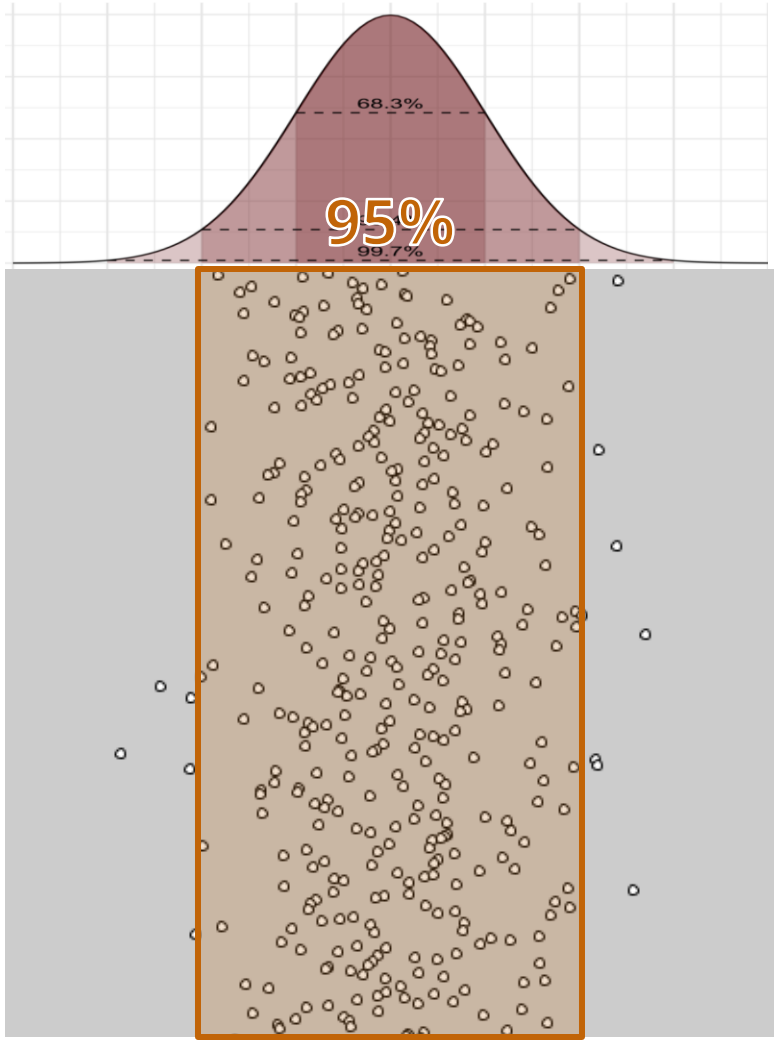


The 68–95–99.7 Rule

Standard deviation

```
x = randomGaussian() * 50 + 200;
```

Mean

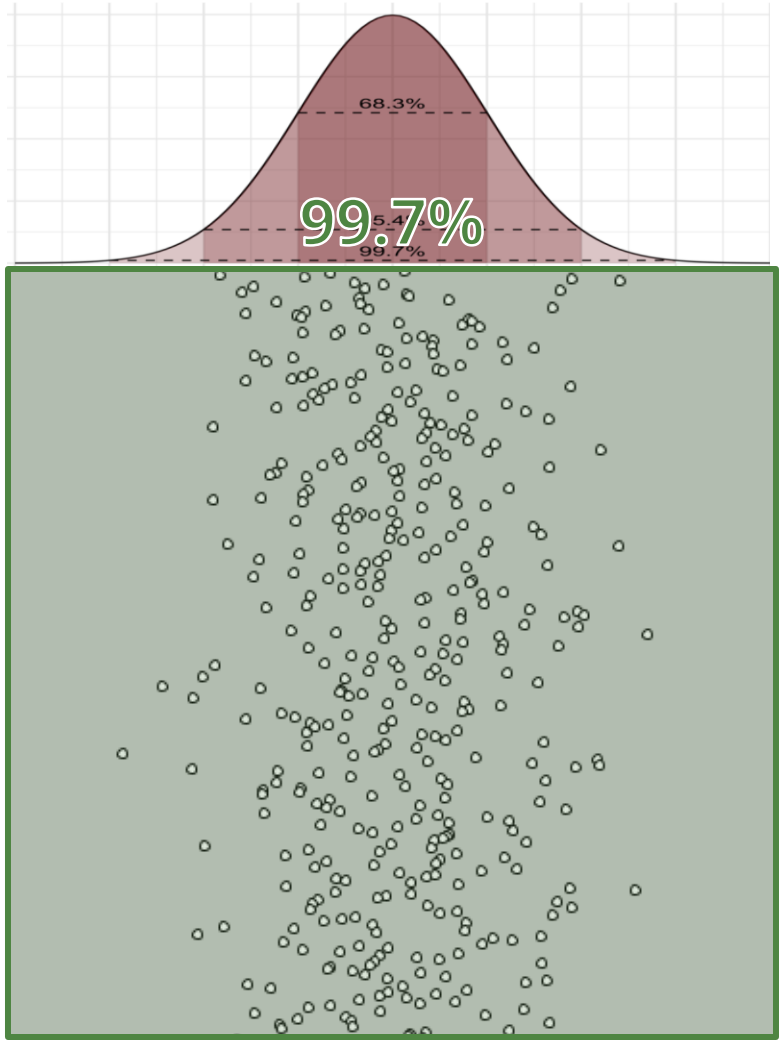


The 68–95–99.7 Rule

Standard deviation

```
x = randomGaussian() * 50 + 200;
```

Mean

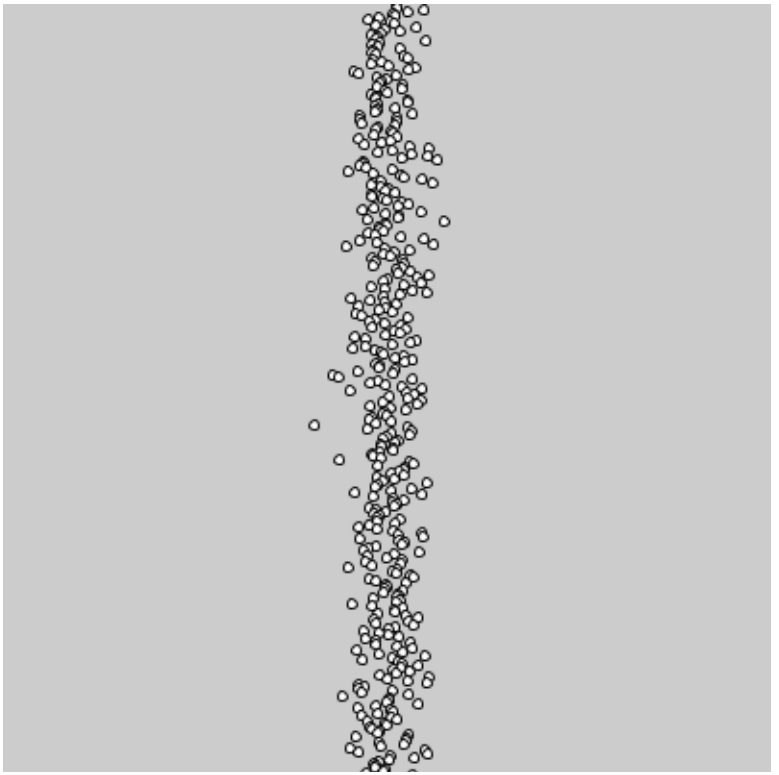


Random Numbers with `randomGaussian()`

```
float x, y;

void setup() {
  // Create a 400x400 canvas
  size(400, 400);
}

void draw() {
  // Generate a random number
  x = randomGaussian() * 10 + 200;

  // Gradually increase the y-position
  y = y + 1;

  // Draw a circle
  circle(x, y, 5);
}
```

$\sigma = 10$

Centered at 200

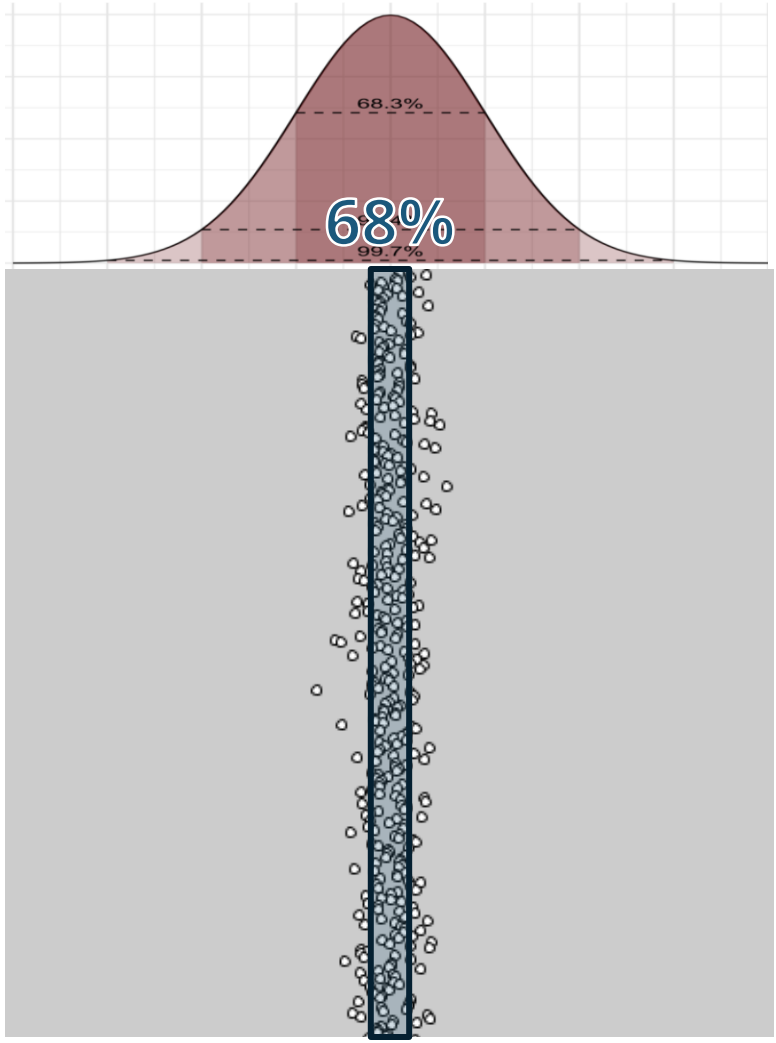


The 68–95–99.7 Rule

Standard deviation

```
x = randomGaussian() * 10 + 200;
```

Mean

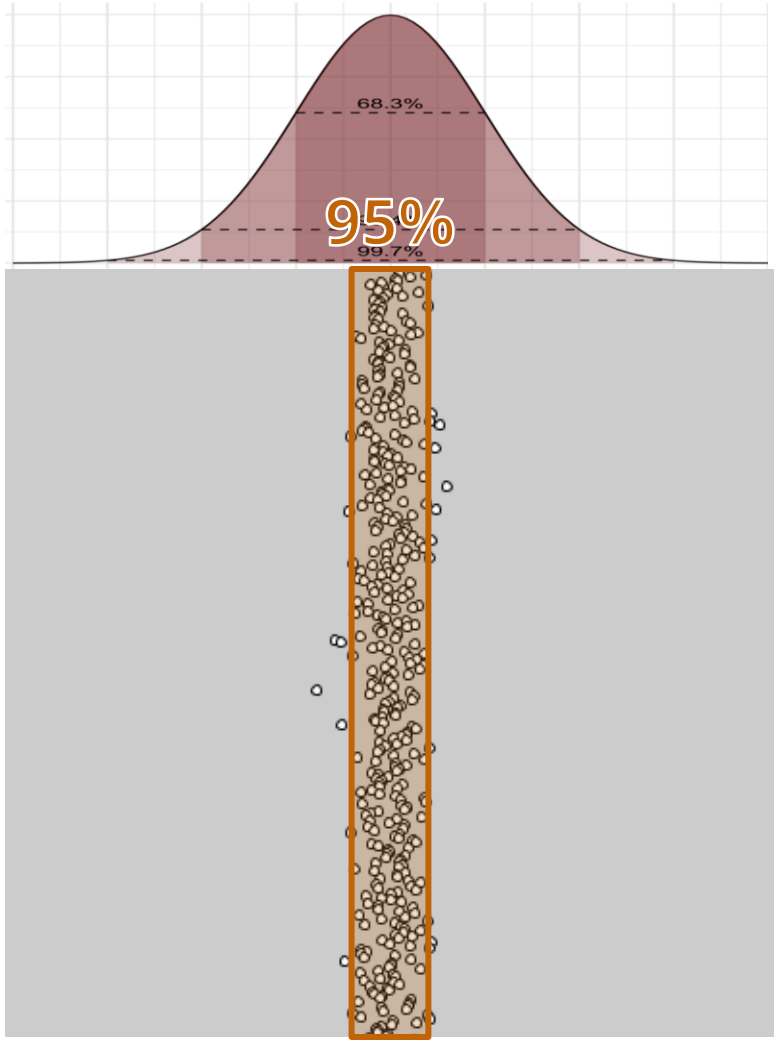


The 68–95–99.7 Rule

Standard deviation

```
x = randomGaussian() * 10 + 200;
```

Mean

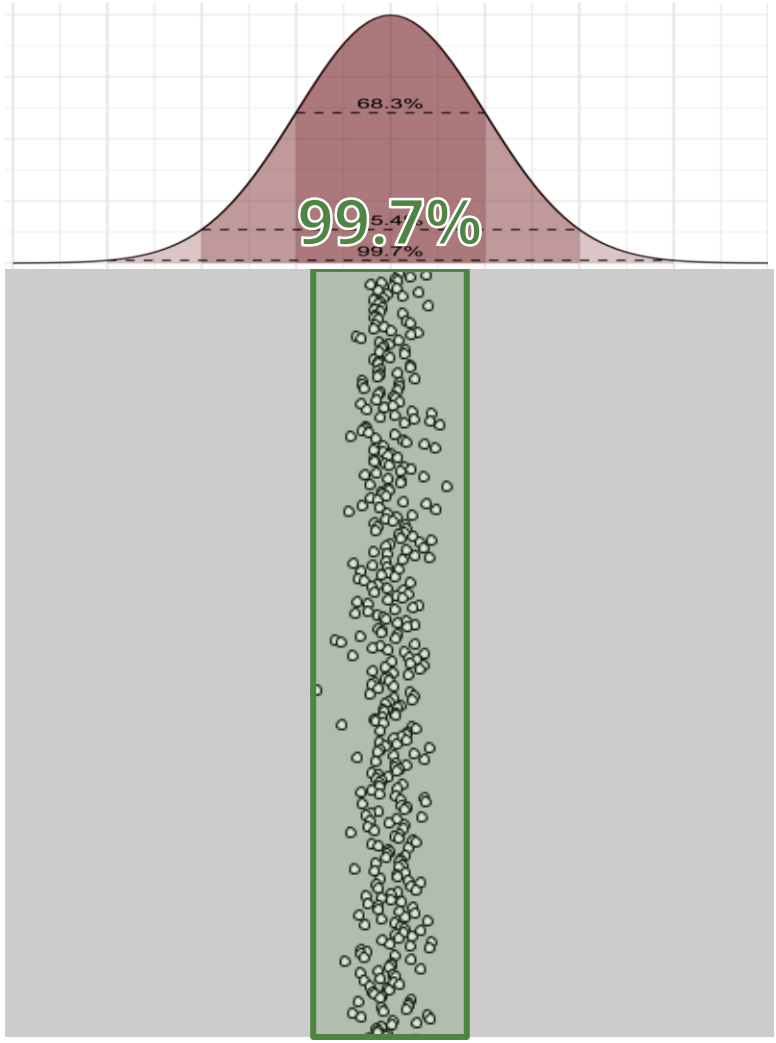


The 68–95–99.7 Rule

Standard deviation

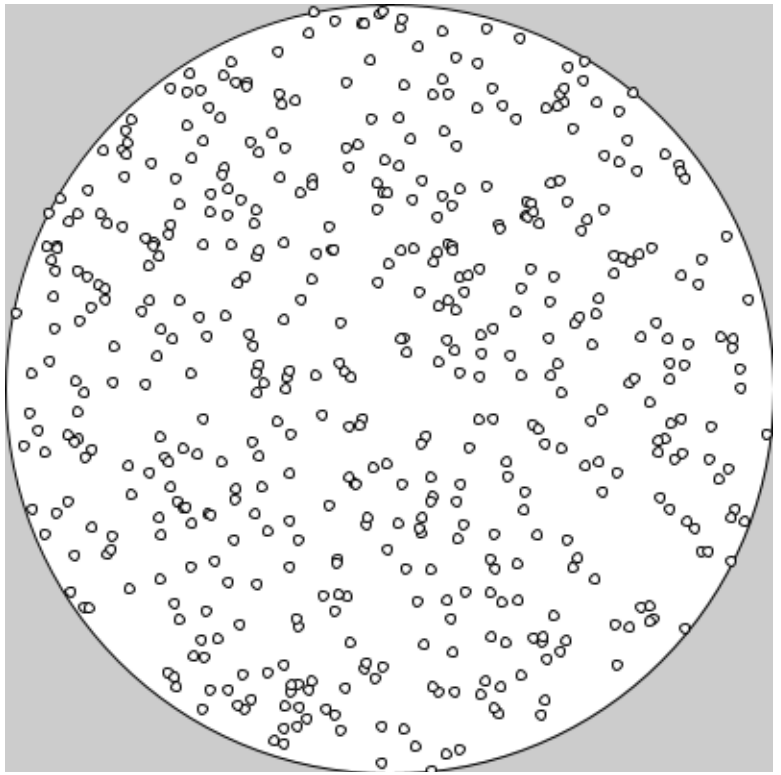
```
x = randomGaussian() * 10 + 200;
```

Mean



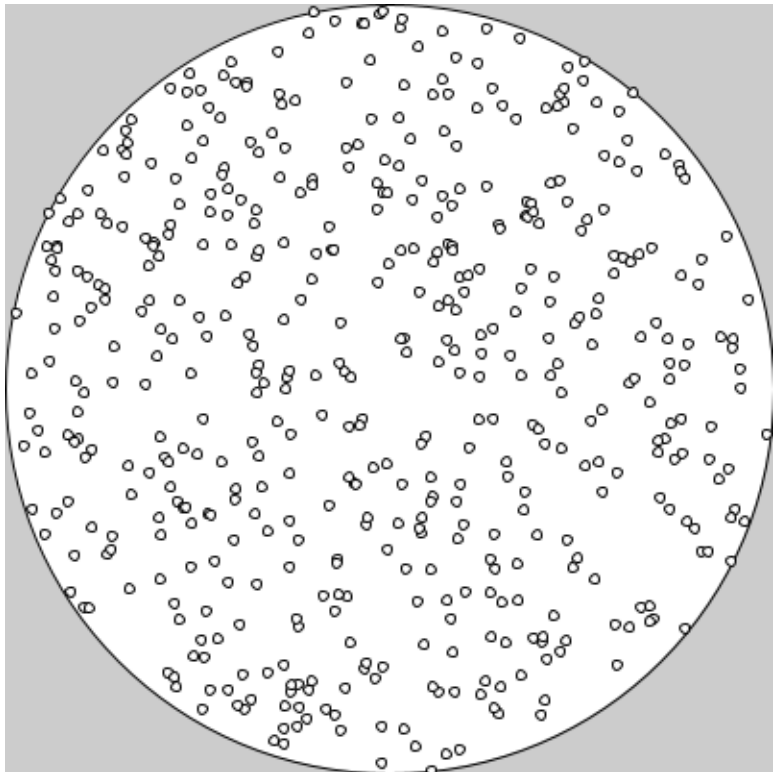
🧐 **Exercise**: Random Points in a Circle

- How to randomly **sample a point in a circle**?
- **Strategy 1: Rejection Sampling**
  - Sample randomly and **keep only those fall in the circle**



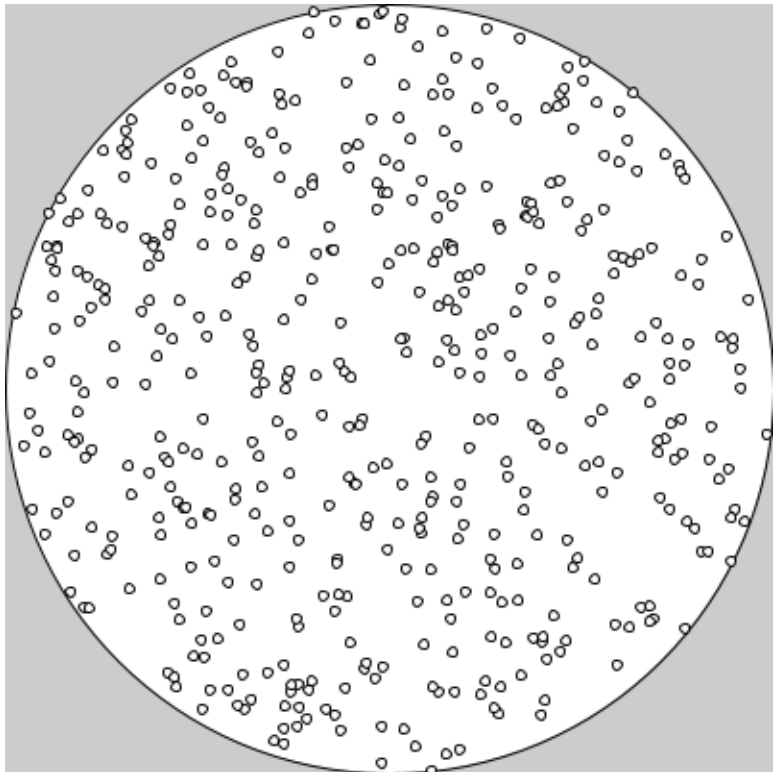
🧐 **Exercise**: Rejection Sampling

```
// Calculate the x- and y-positions
x = random(400);
y = random(400);

// Check if the point lies in the circle
if (dist(200, 200, x, y) < 200) {
  // Draw a circle
  circle(x, y, 5);
}
```

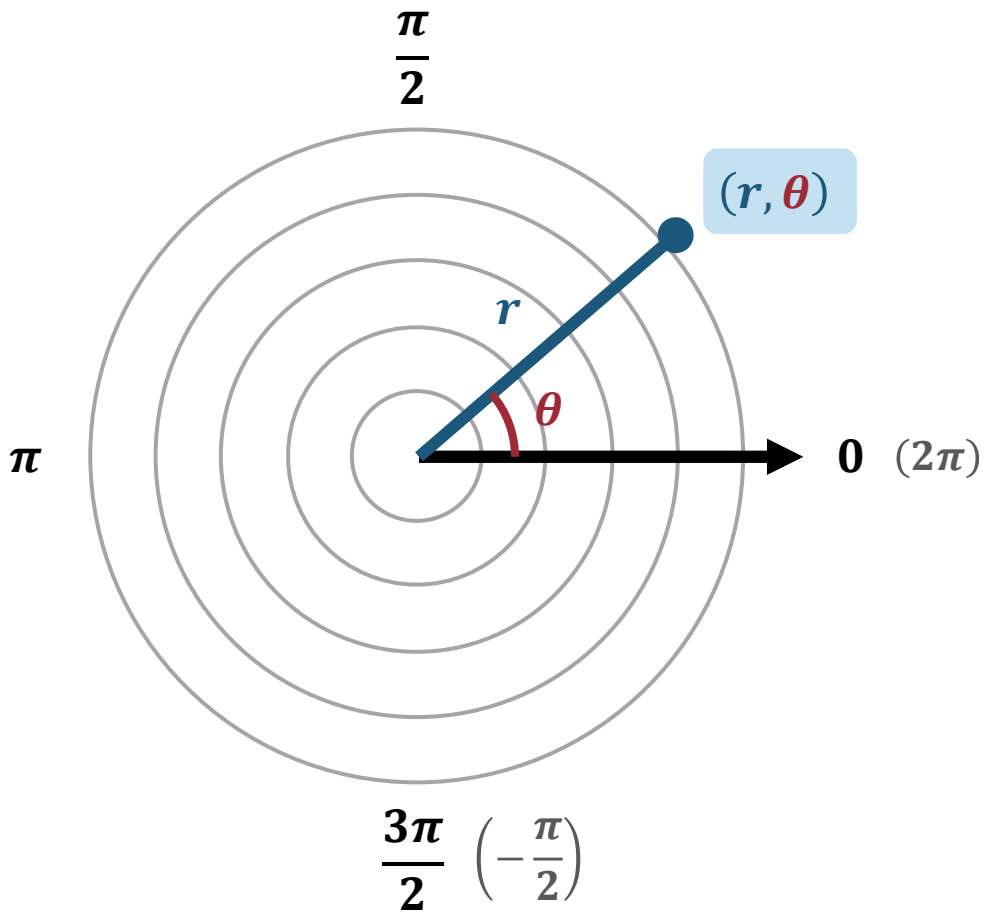


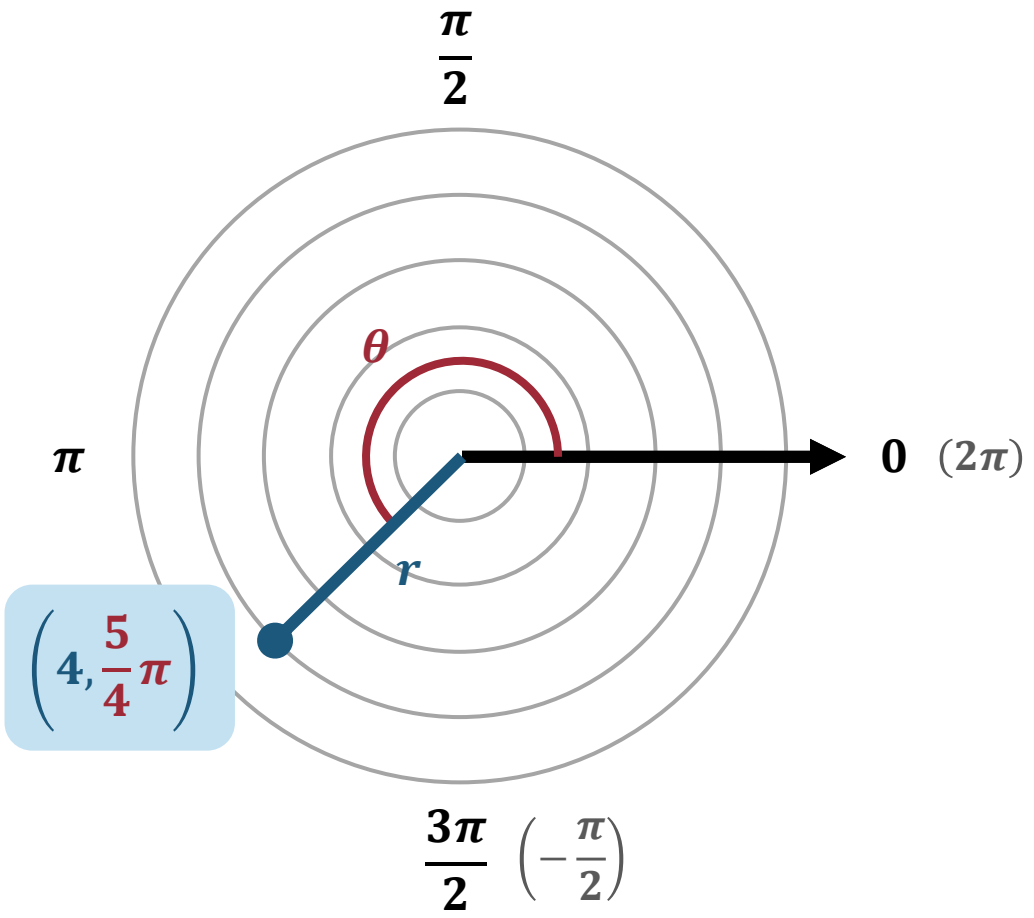
🧐 **Exercise**: Random Points in a Circle

- How to randomly **sample a point in a circle**?
- Strategy 1: Rejection Sampling
  - Sample randomly and **keep only those fall in the circle**
- **Strategy 2: Polar Coordinate Sampling**
  - Sample points that **always fall in the circle**

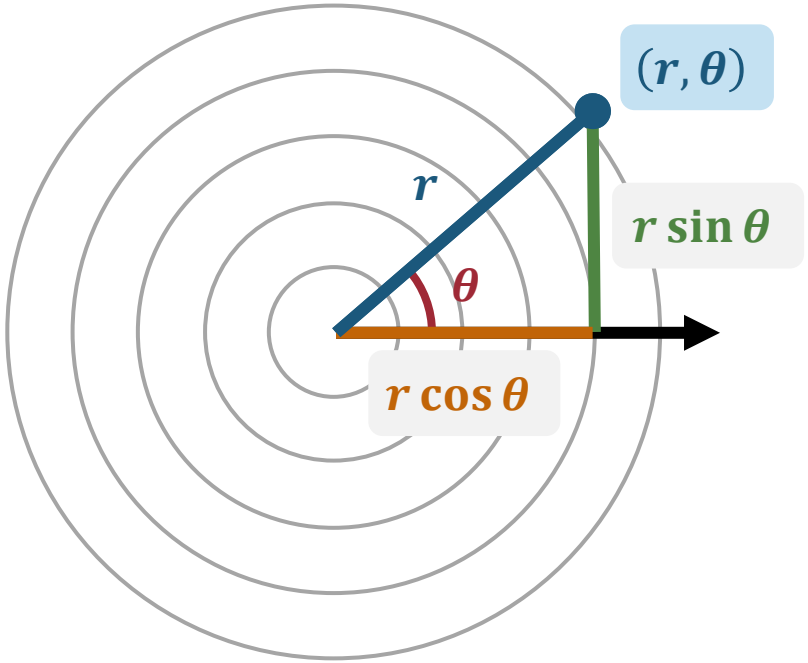


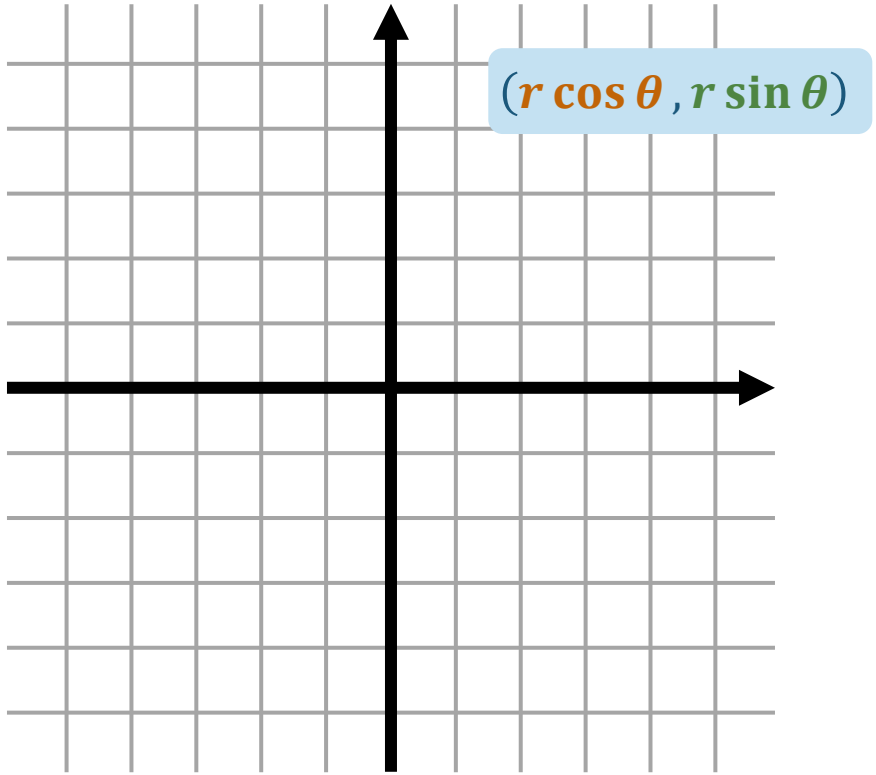
Polar Coordinate





Polar-to-Cartesian Conversion

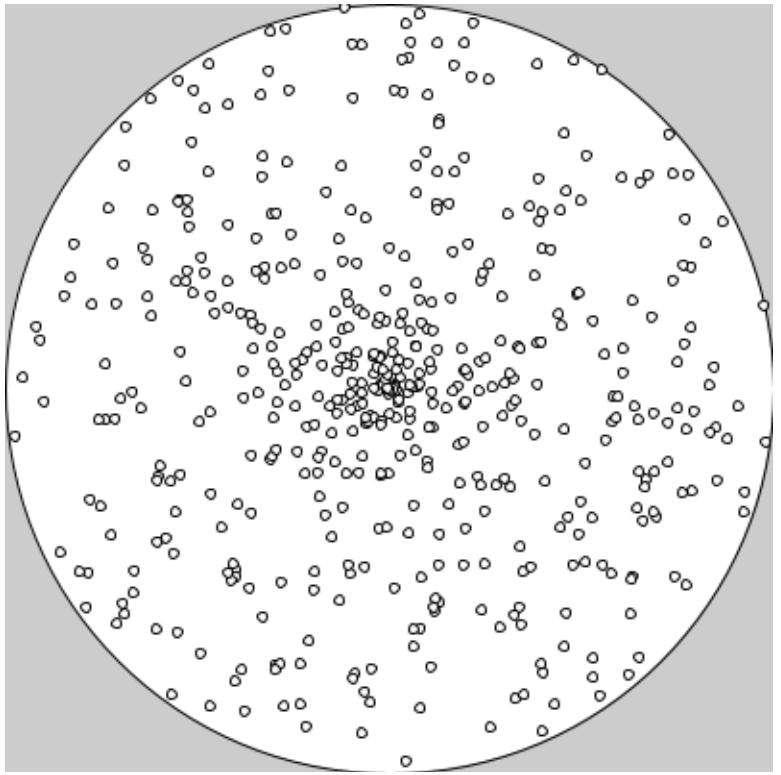




$$(r, \theta) \rightarrow (r \cos \theta , r \sin \theta)$$

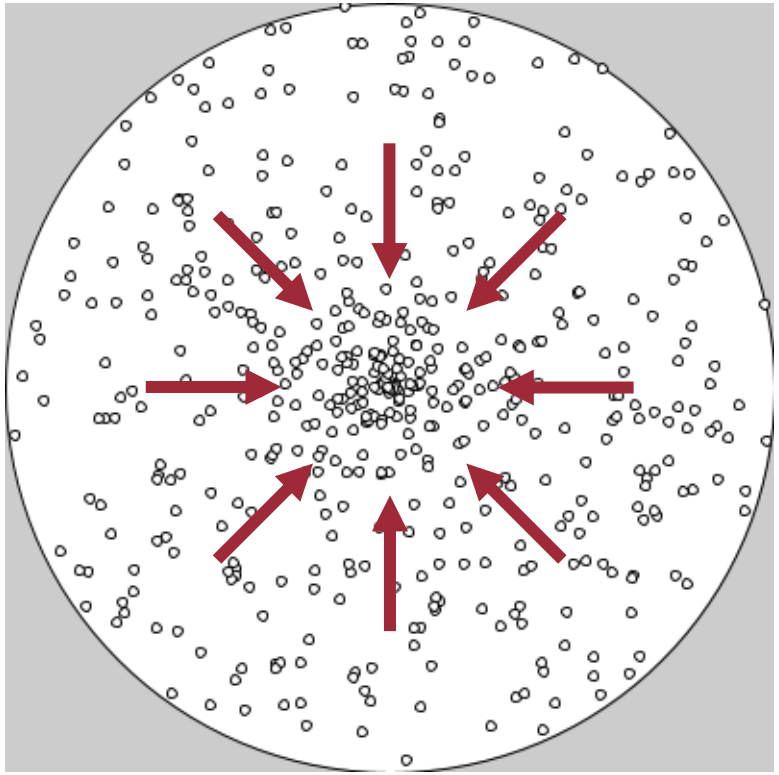
🧐 **Exercise**: Polar Coordinate Sampling

```
// Generate a random radius and angle
r = random(200);
theta = random(0, TWO_PI);

// Calculate the x- and y-positions
x = 200 + r * cos(theta);
y = 200 + r * sin(theta);

// Draw a circle
circle(x, y, 5);
```

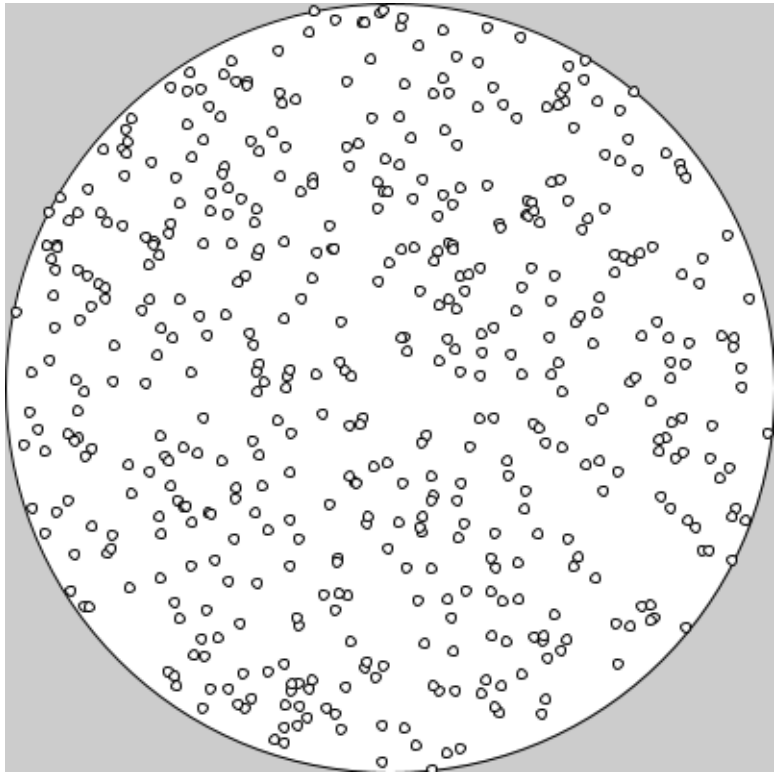


Naïve Approach vs Rejection Sampling

Naïve Approach

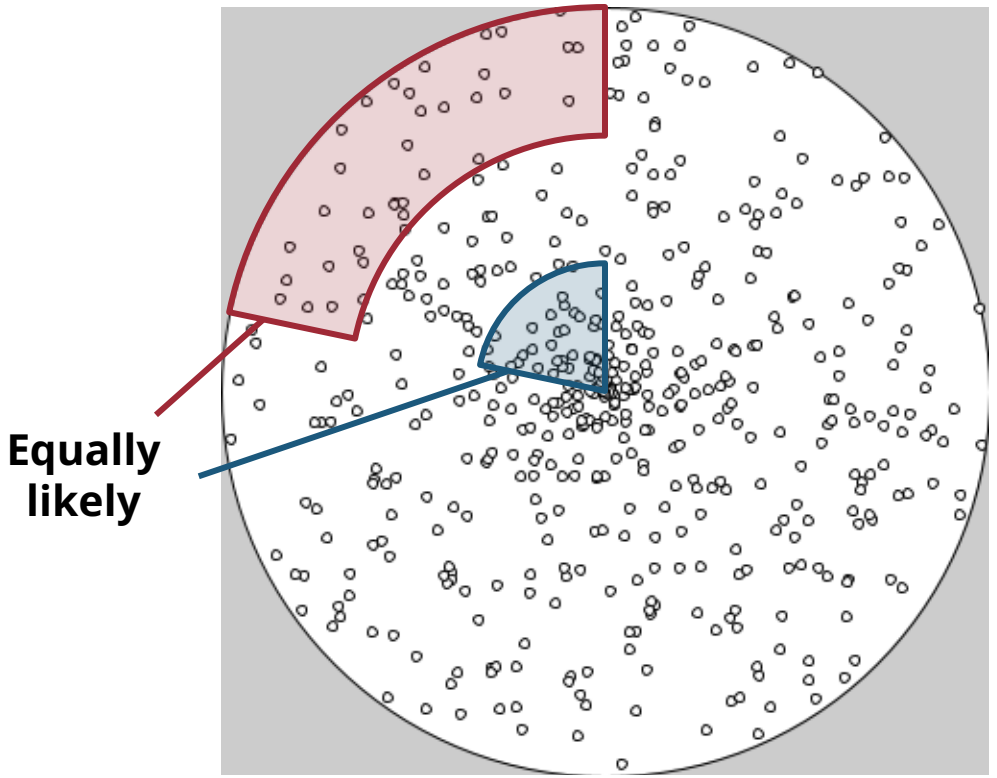


Rejection Sampling



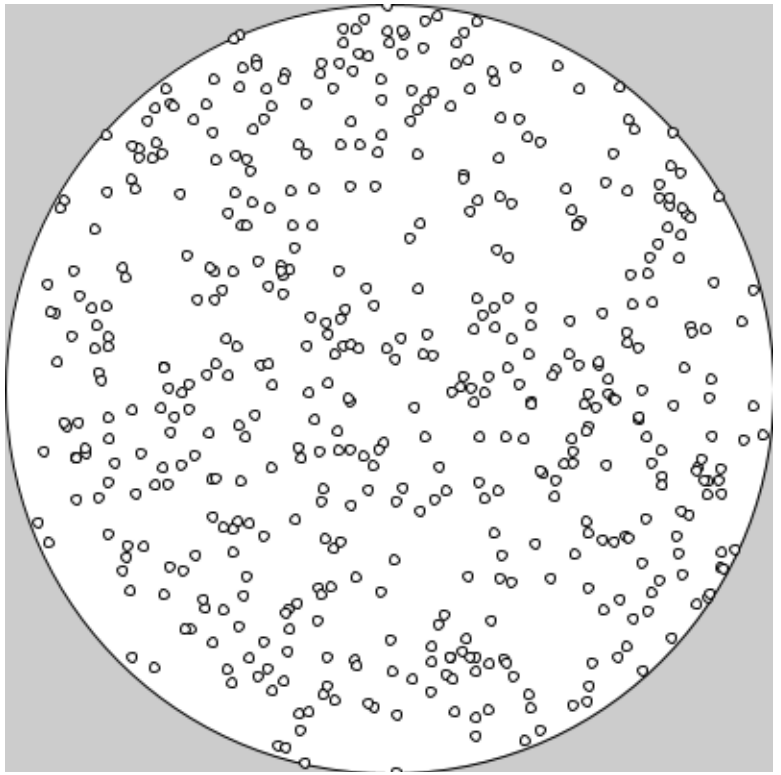
🧐 **Exercise**: Polar Coordinate Sampling

```
// Generate a random radius and angle
r = random(200);
theta = random(0, TWO_PI);

// Calculate the x- and y-positions
x = 200 + r * cos(theta);
y = 200 + r * sin(theta);

// Draw a circle
circle(x, y, 5);
```



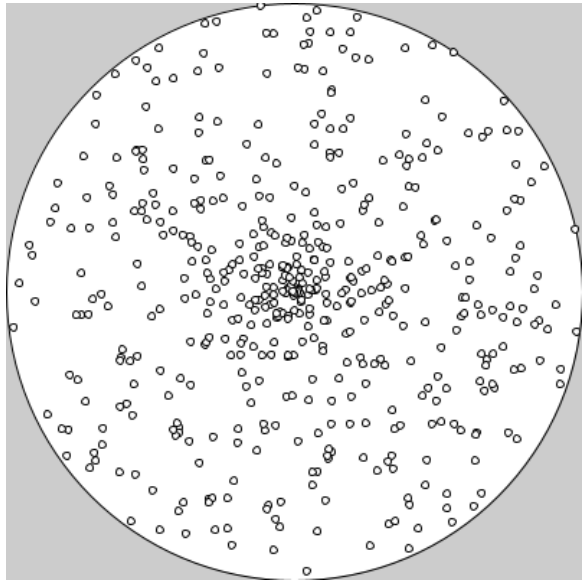
🧐 **Exercise**: Inversion Transform Sampling

```
// Generate a random radius and angle
r = 200 * sqrt(random(1));
theta = random(0, TWO_PI);

// Calculate the x- and y-positions
x = 200 + r * cos(theta);
y = 200 + r * sin(theta);

// Draw a circle
circle(x, y, 5);
```



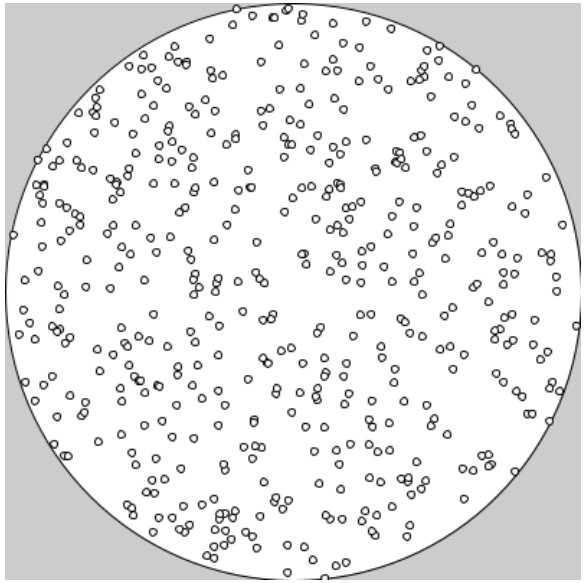
Three Approaches

Naïve Approach



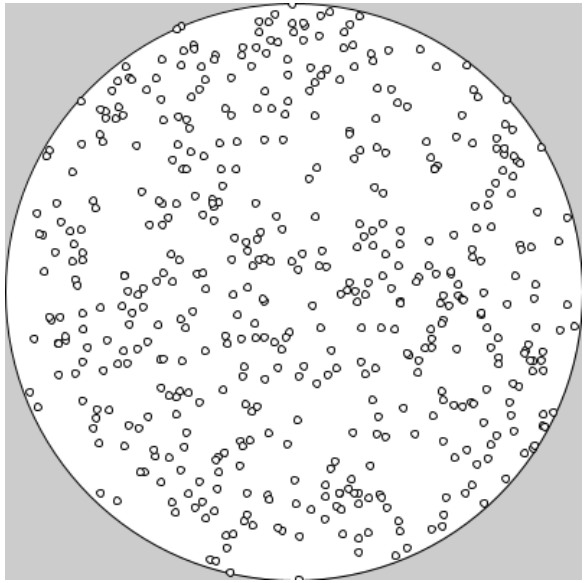
Not uniformly sampled
(denser near the center)

Rejection Sampling



Does not always produce a point at each step

Inverse Transform Sampling



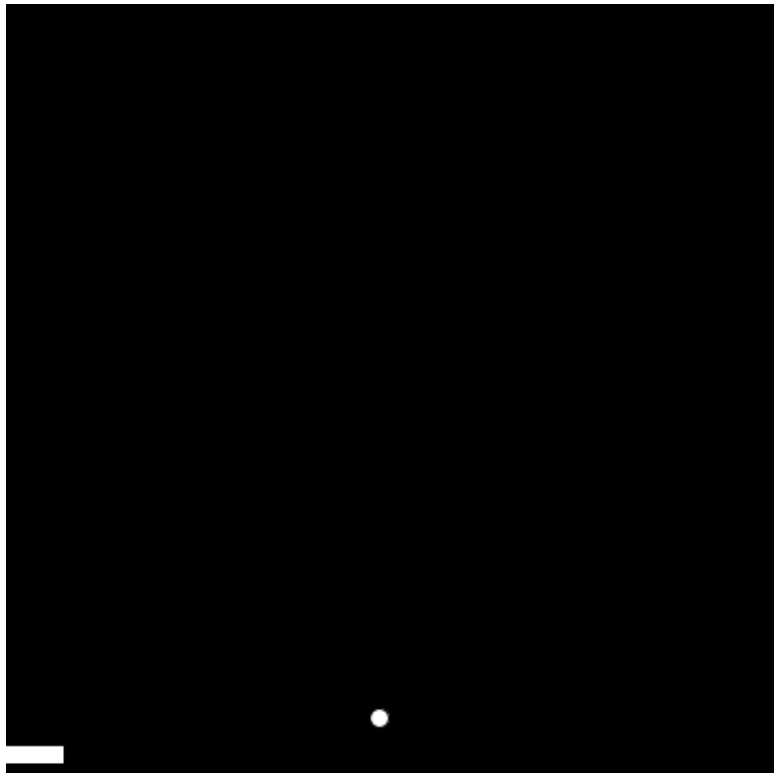
Require some math
(not always tractable)

`randomSeed()`: Controlling the Randomness

- What if I want **the same random numbers every time**?
- `random()` is not truly random, but ***random enough*** for most use cases
  - Technically, we call these algorithms *pseudorandom* algorithms
- Pseudorandom algorithms take a **random seed** as input
  - The random seed determines the sequence of random numbers it generates
  - If you set the random seed to a fixed number, you'll get the exact same sequence of random numbers when calling `random()` and `randomGaussian()`
  - Use **`randomSeed(seed)`** to set the random seed
    - Any integer works: **`randomSeed(0)`** or **`randomSeed(1000)`** or **`randomSeed(1024)`**

🔥 **HW 2**: Paddle Ball Game

- Instructions will be sent by **emails** and released on the **course website**
- Features
  - Use the mouse to control the paddle bar
  - Show “GAME OVER!” when the paddle bar does not catch the ball
  - Click the mouse to restart the game
    - You’ll implement an `init()` function that will be called when the game starts or restarts



Shooting the Ball to a Random Direction

```
speedX = speed * random(0, 1);
speedY = speed * random(0, 1);
```

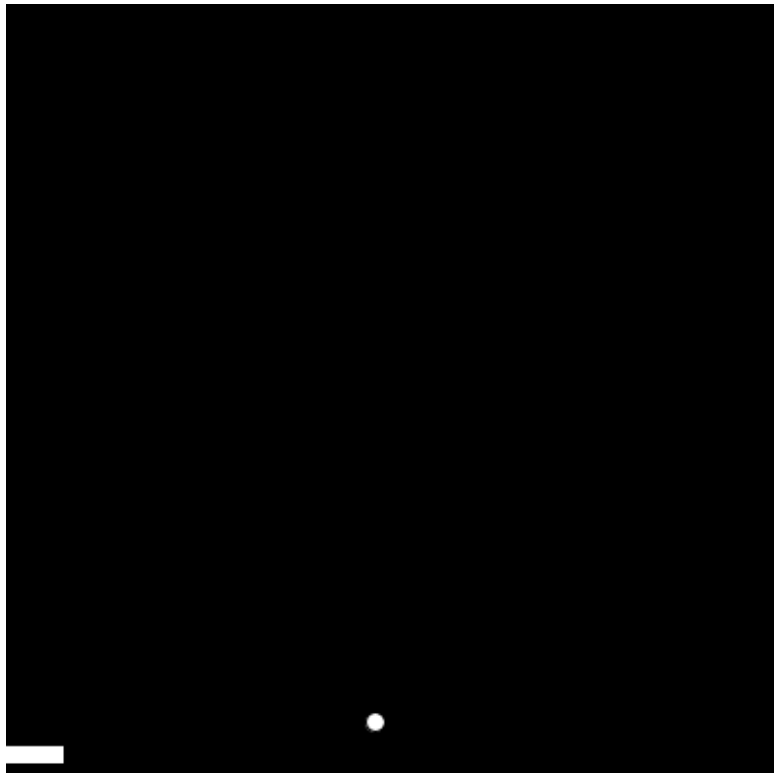
```
a = random(0, 1);
speedX = speed * a;
speedY = speed * sqrt(1 - a * a);
```

```
theta = random(0, TWO_PI);
speedX = speed * cos(theta);
speedY = speed * sin(theta);
```

🔥 **HW 2**: Sticky & Shrinking Paddle Ball Game

- To make the game more fun and challenging
- **Shrink the paddle bar size** after each catch
  - Until the bar reaches a reasonable minimum width
- Apply **stickiness between the paddle and ball**
  - A fixed ratio of the bar velocity will be added to the ball
  - Use `pmouseX` and `mouseX` to calculate the paddle velocity

The value of `mouseX` in the previous frame



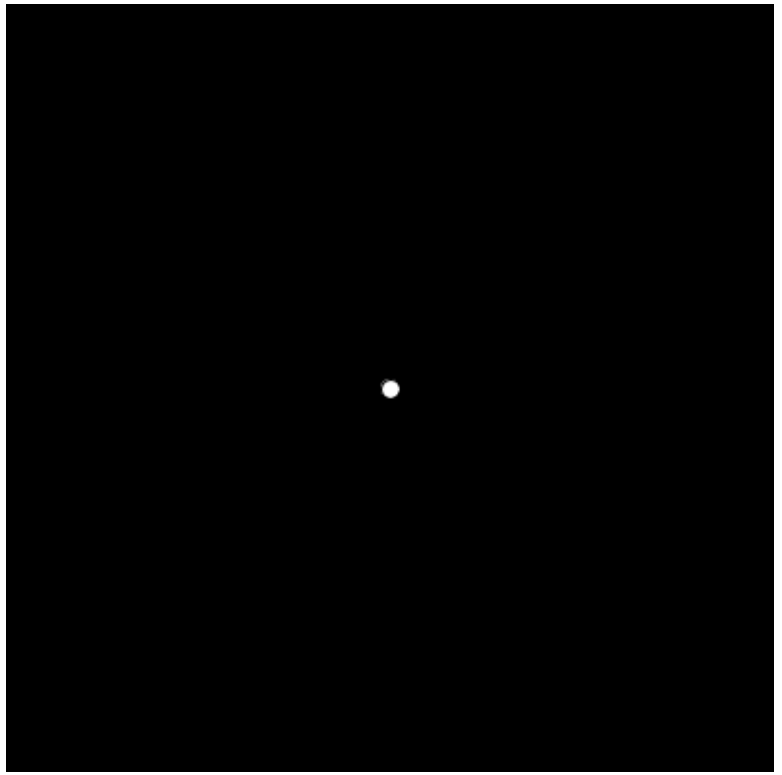
Recap

Built-in Keyboard Functions

Function	Called when
`keyPressed()`	a key is *pressed*
`keyReleased()`	a key is *released*
`keyTyped()`	a key is *clicked* (called repeatedly if held down)

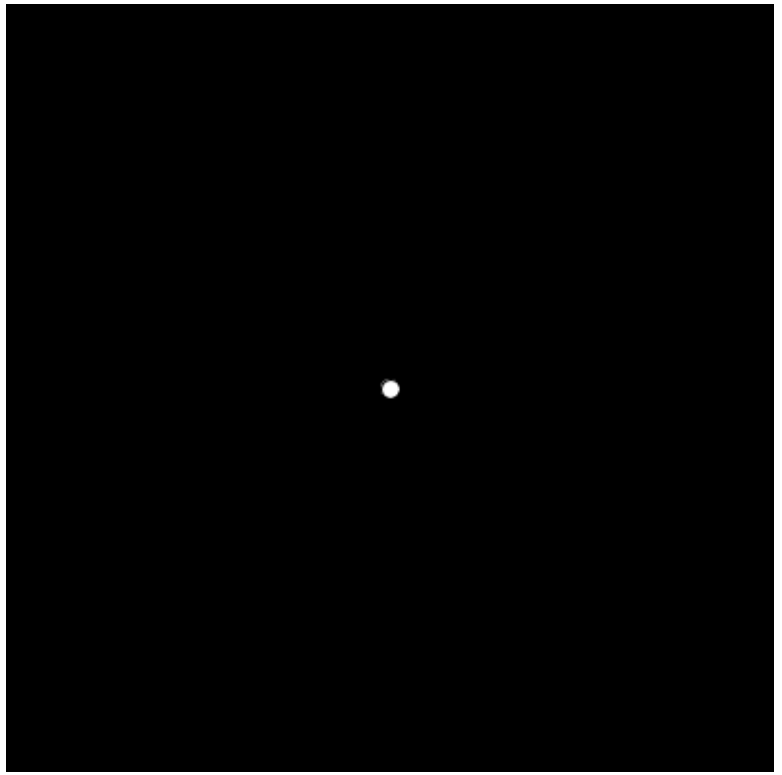
🧐 **Exercise**: Use the Arrow Keys to Control a Ball

```
float x = 200, y = 200;
float step = 10;

void keyPressed() {
  if (key == CODED) {
    if (keyCode == LEFT) {
      x = x - step;
    }
    if (keyCode == RIGHT) {
      x = x + step;
    }
    if (keyCode == UP) {
      y = y - step;
    }
    if (keyCode == DOWN) {
      y = y + step;
    }
  }
}
```



🧐 **Exercise**: Use the Arrow Keys to Control a Ball

```
float x = 200;
float y = 200;
float step = 10;

void keyPressed() {
  if (key == CODED) {
    if (keyCode == LEFT) {
      x = x - step;
    } else if (keyCode == RIGHT) {
      x = x + step;
    } else if (keyCode == UP) {
      y = y - step;
    } else if (keyCode == DOWN) {
      y = y + step;
    }
  }
}
```



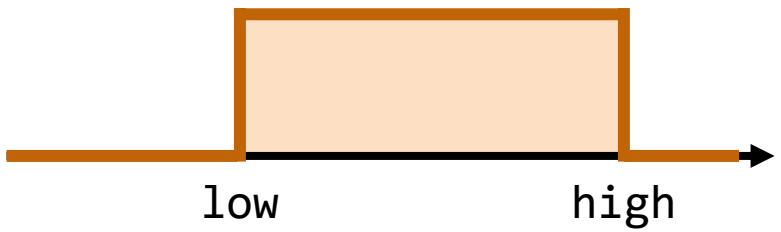
`switch` Statement

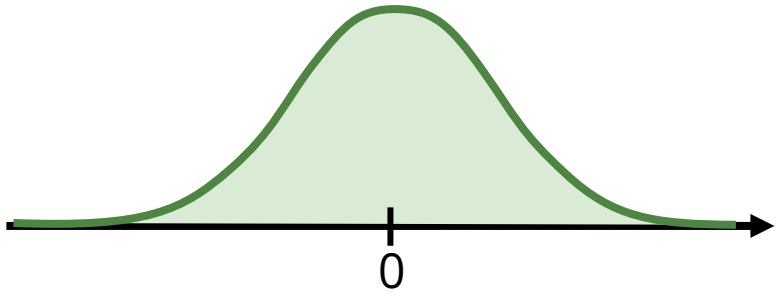
```
if (keyCode == LEFT) {
  x = x - step;
} else if (keyCode == RIGHT) {
  x = x + step;
} else if (keyCode == UP) {
  y = y - step;
} else if (keyCode == DOWN) {
  y = y + step;
}
```

```
switch(keyCode) {
  case LEFT:
    x = x - step;
    break;

  case RIGHT:
    x = x + step;
    break;

  case UP:
    y = y - step;
    break;

  case DOWN:
    y = y + step;
    break;
}
```

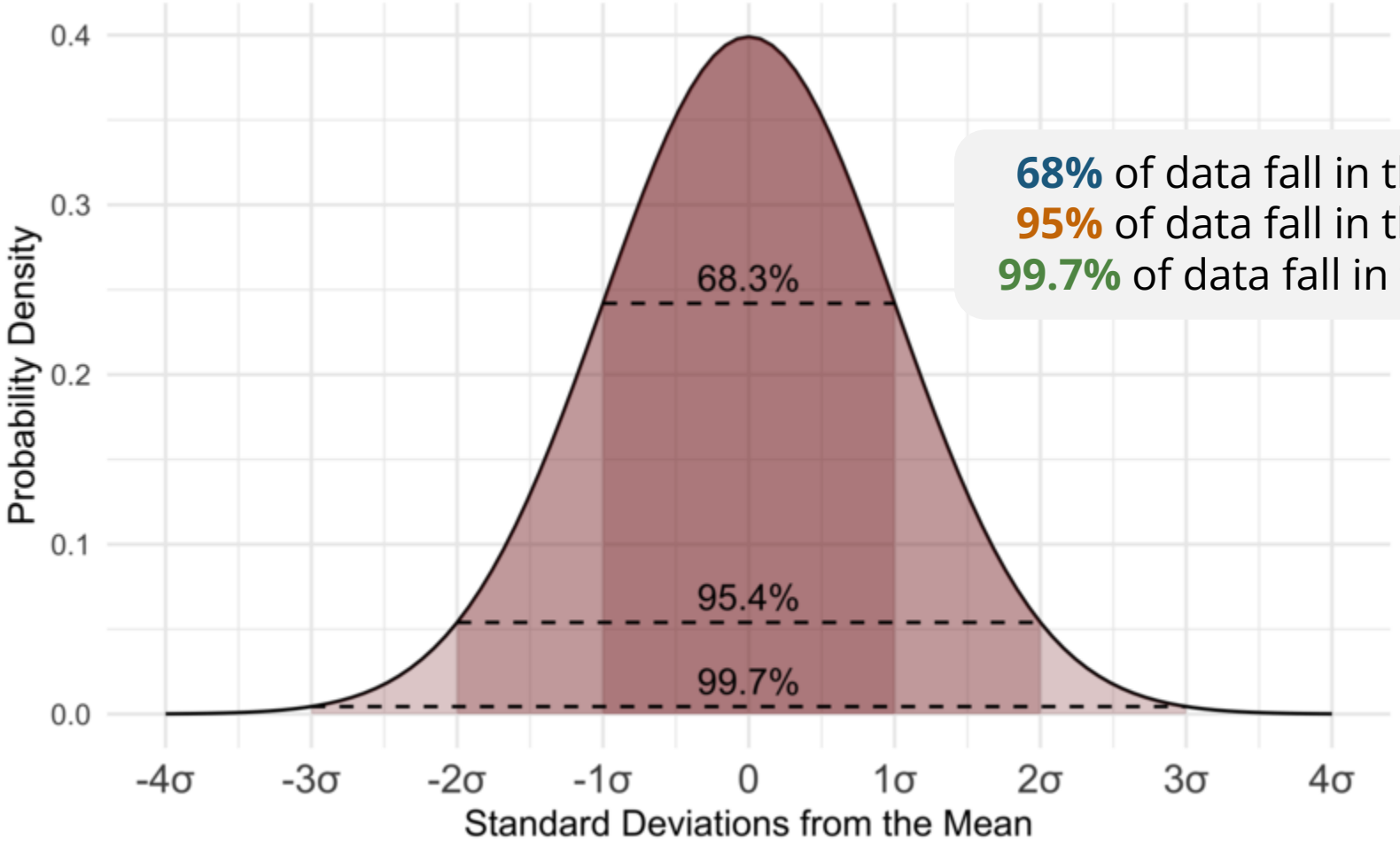
Randomness

- **`random`**`(high)` Generate a random number in $U[0, high]$
- **`random`**`(low, high)` Generate a random number in $U[low, high]$
- **`randomGaussian`**`()` Generate a random number in $N[0, 1]$





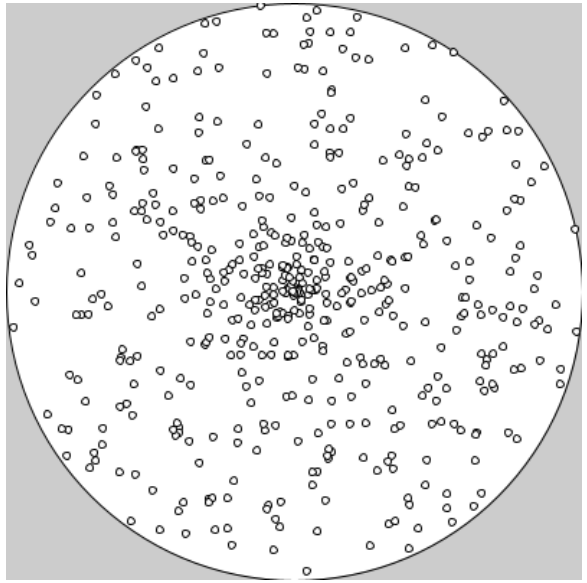
Gaussian Distribution & the 68–95–99.7 Rule



68% of data fall in the **±1σ** range
95% of data fall in the **±2σ** range
99.7% of data fall in the **±3σ** range

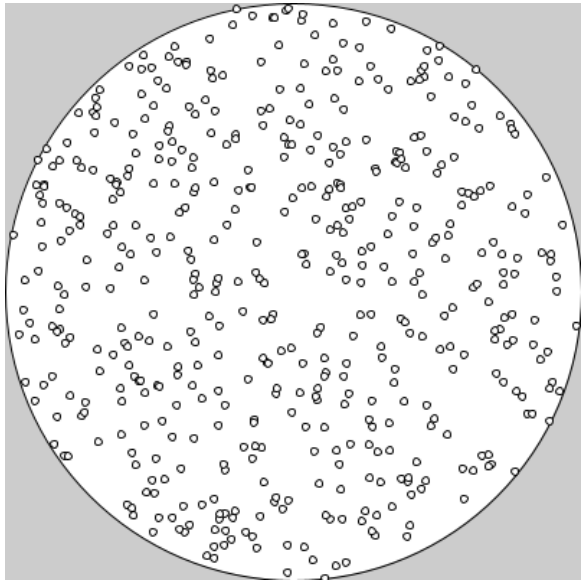
Three Approaches

Naïve Approach



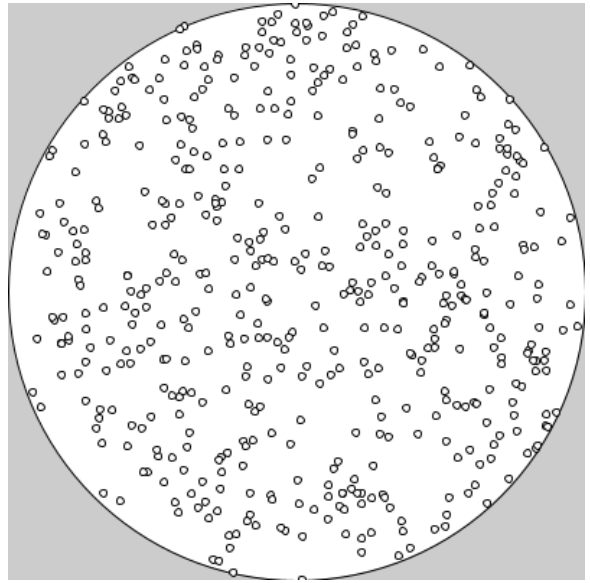
Not uniformly sampled
(denser near the center)

Rejection Sampling



Does not always produce a point at each step

Inverse Transform Sampling



Require some math
(not always tractable)

Next Lecture

Loops