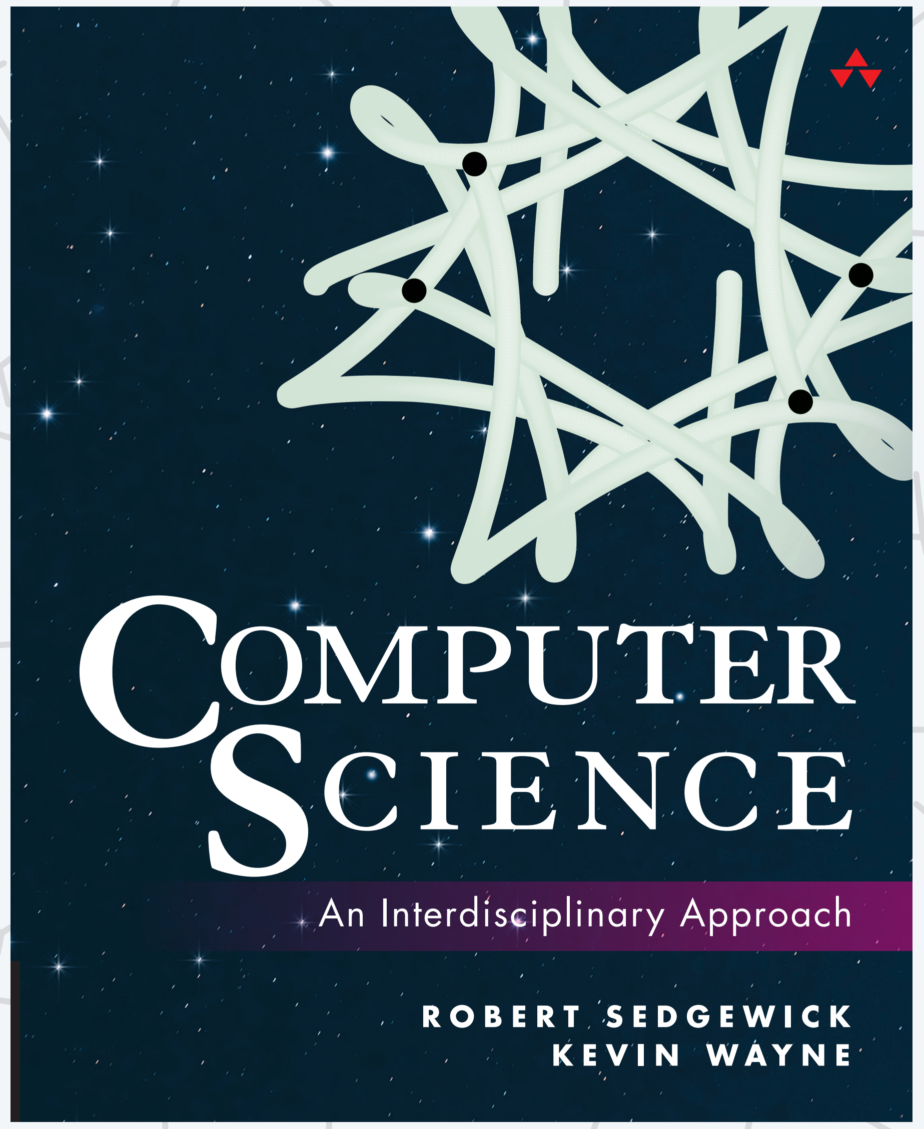

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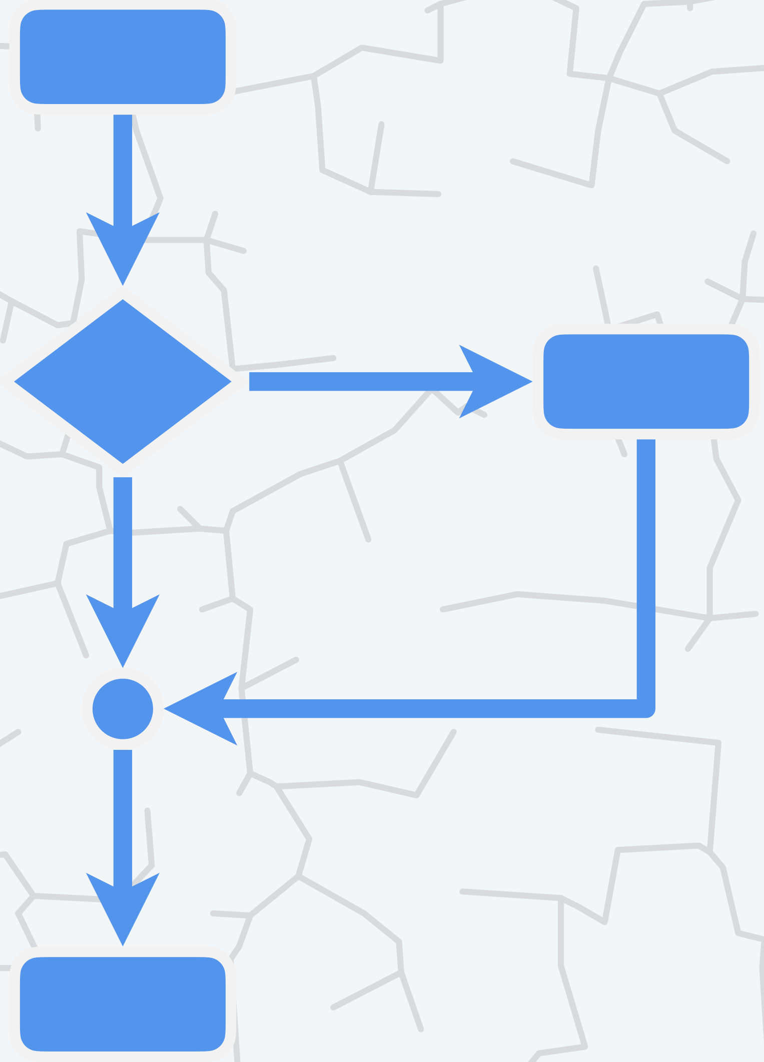
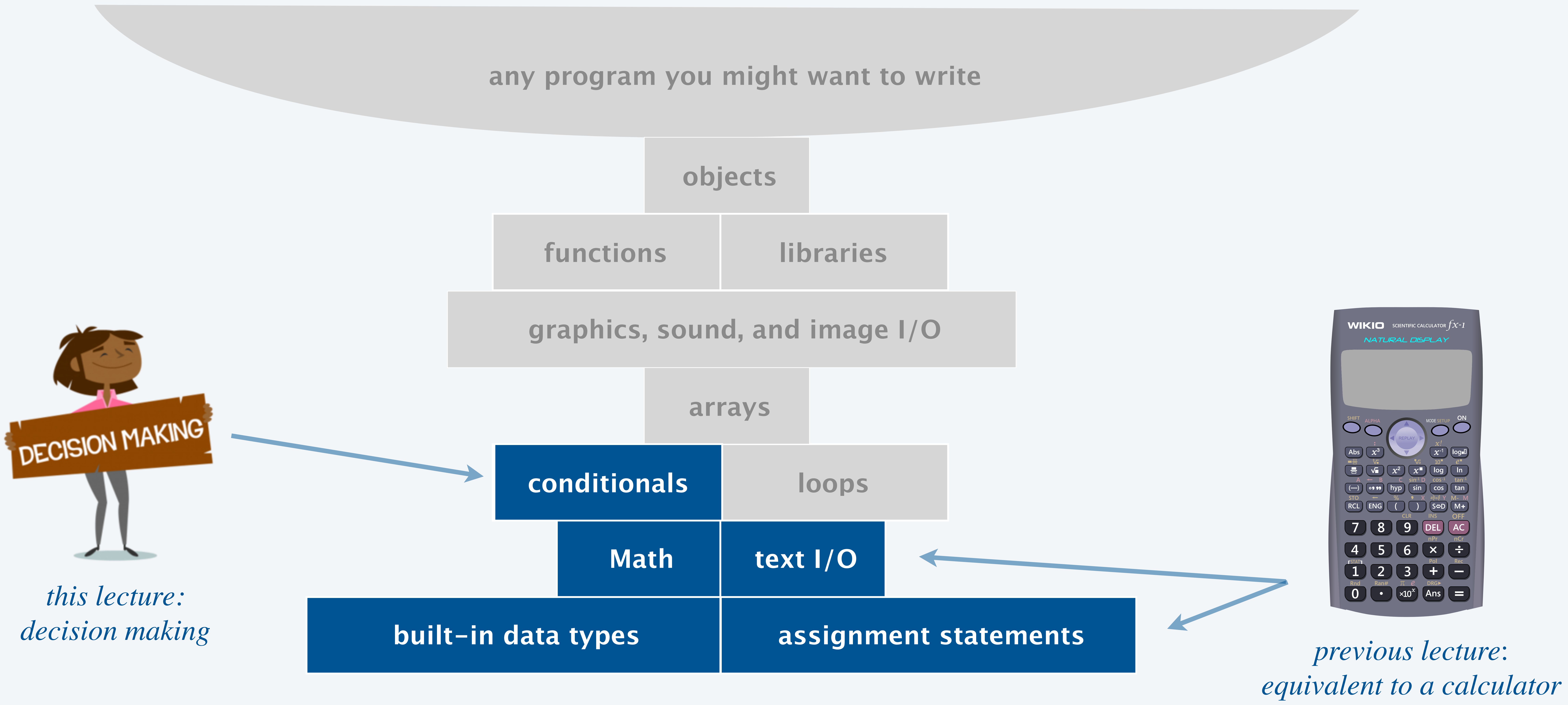
1.3 CONDITIONALS

- *if statements*
- *if–else statements*
- *nested conditionals*
- *year-to-speech*



Basic building blocks for programming

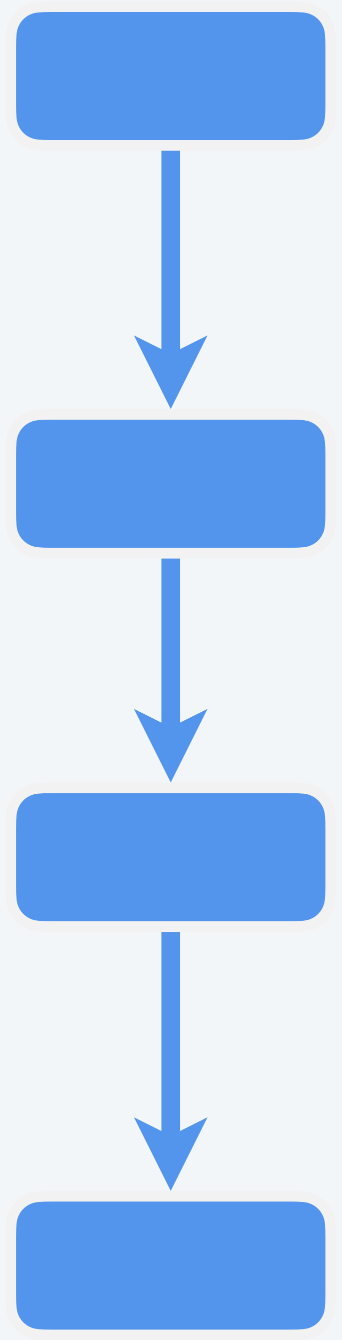


any program you might want to write
objects
functions
libraries
graphics, sound, and image I/O
arrays
conditionals
loops
Math
text I/O
built-in data types
assignment statements
DECISION MAKING
this lecture: decision making
previous lecture: equivalent to a calculator

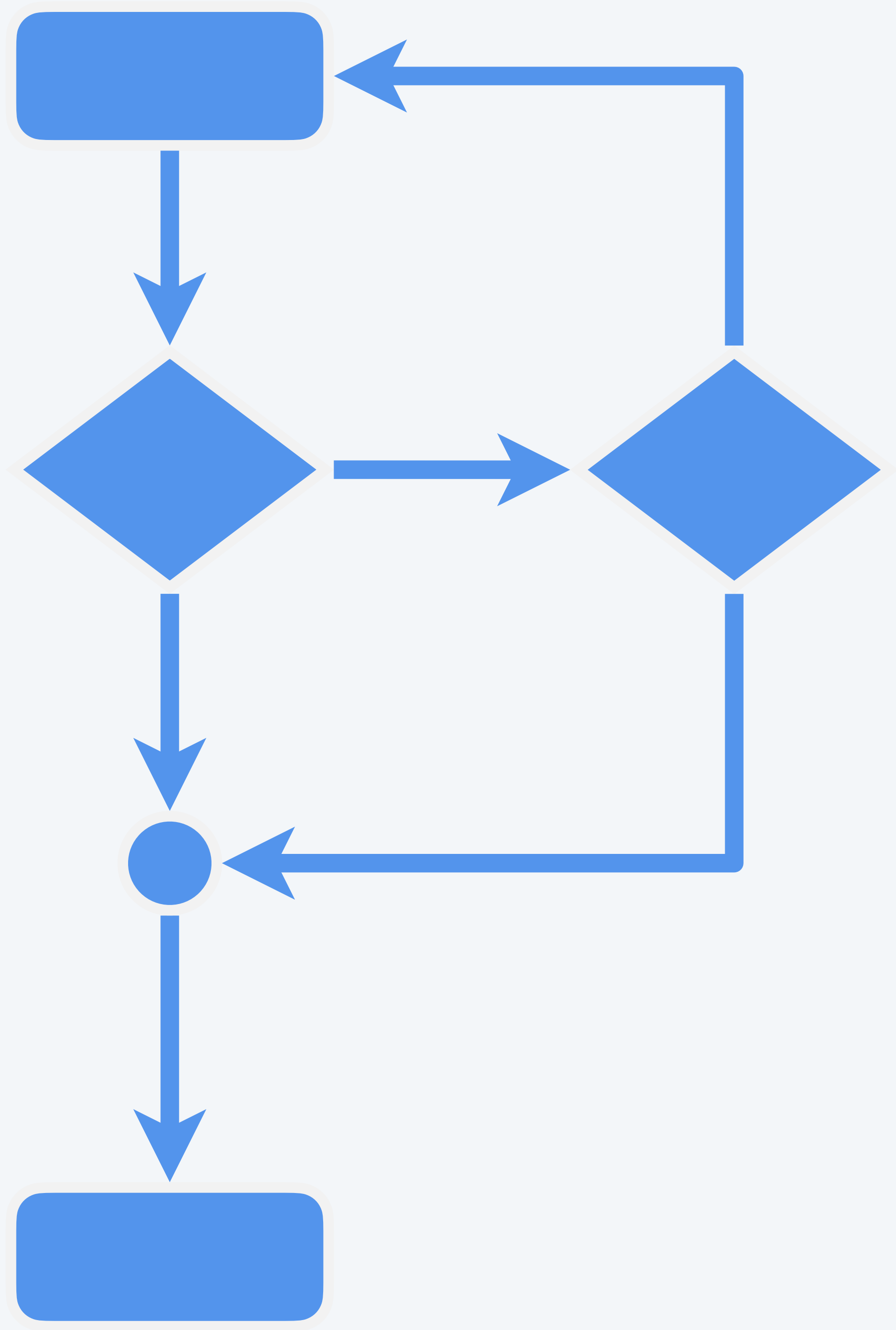
Conditionals and loops

Control flow. The sequence of statements that are actually executed in a program.

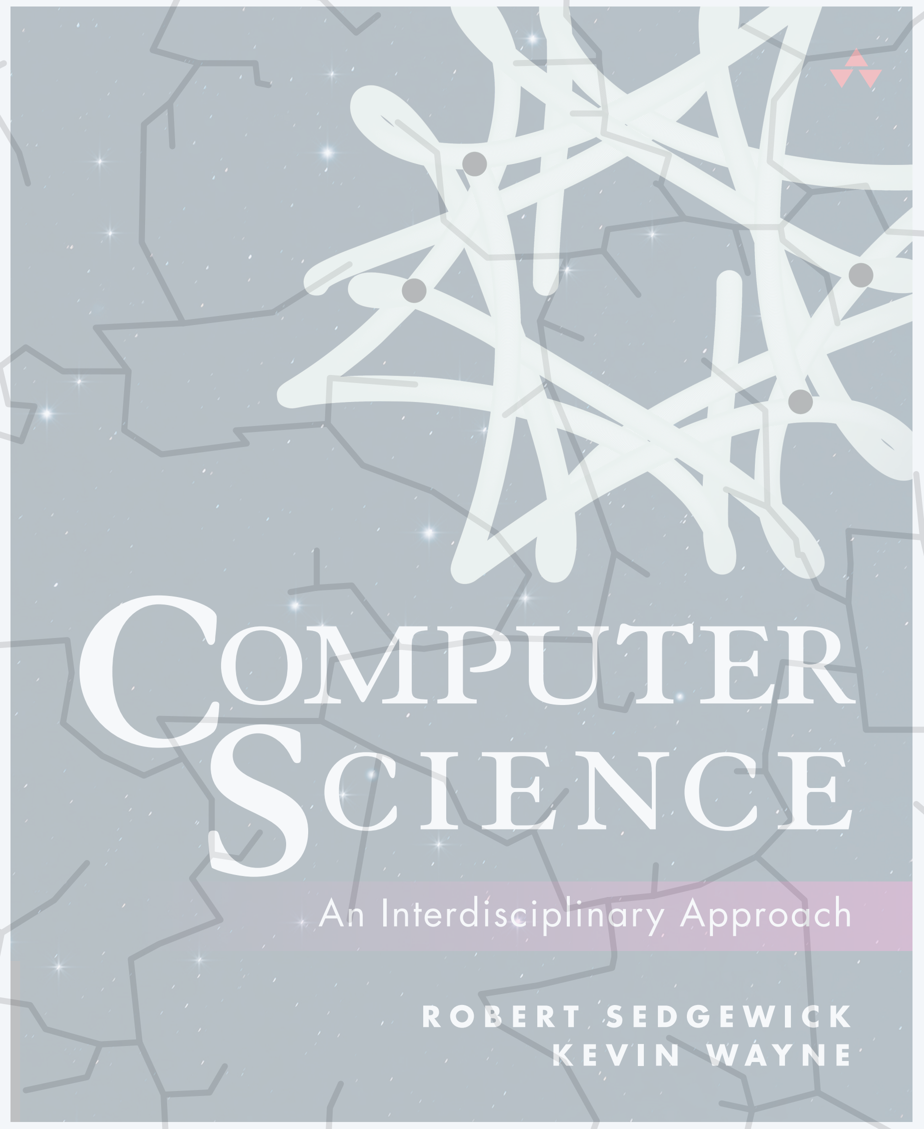
Conditionals and loops. Enable us to choreograph control flow.



straight-line control flow
(last lecture)



control flow with conditionals and loops
(this week)



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1.3 Conditionals

- *if statements*
- *if–else statements*
- *nested conditionals*
- *year-to-speech*

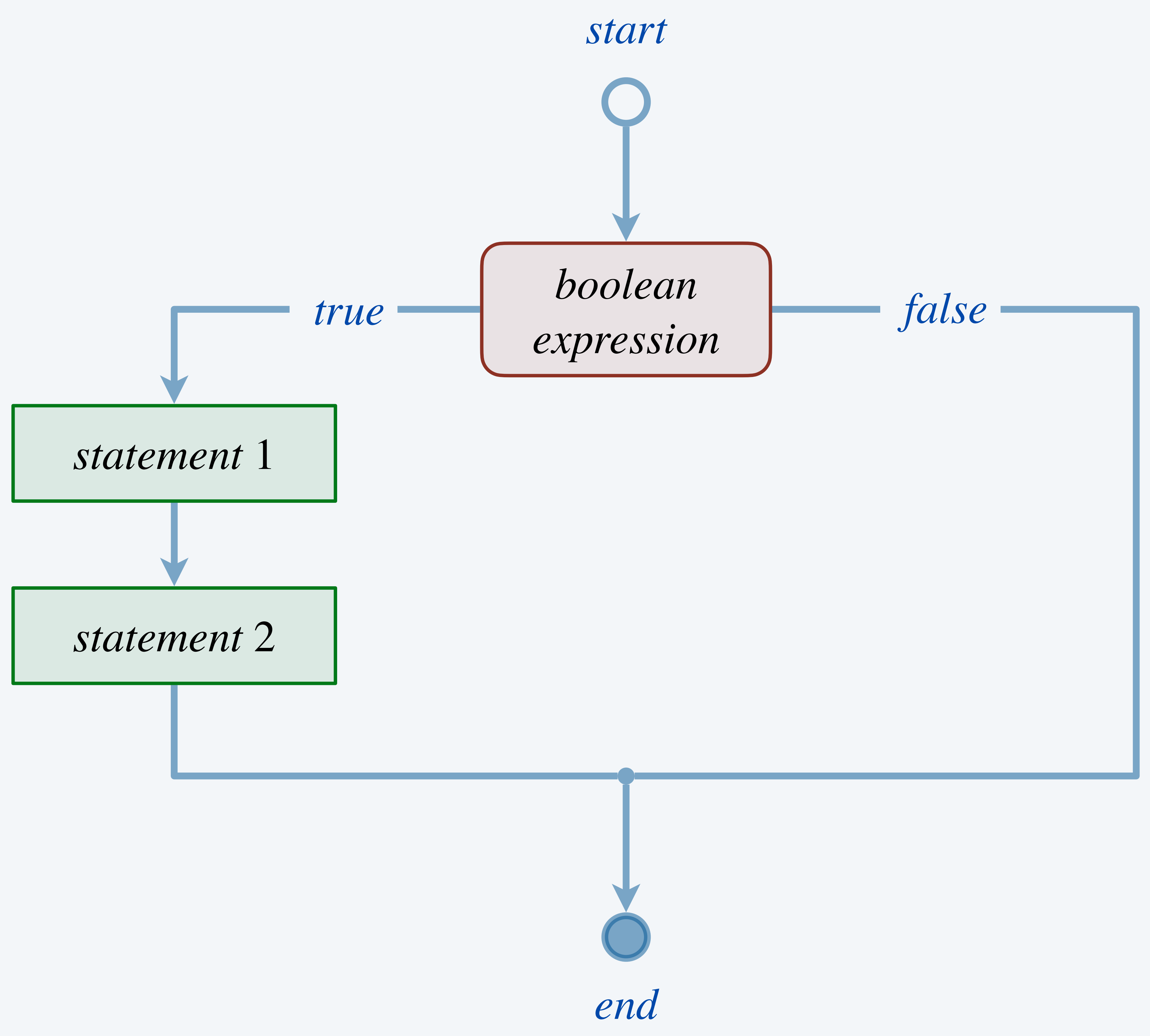
The *if* statement

Execute certain statement(s) depending on the value of a boolean expression.

- Evaluate a boolean expression.
- If true, execute statements in code block delimited by curly braces.

```
if (<boolean expression>) {
   <statement 1>
   <statement 2>
}
```

if statement template



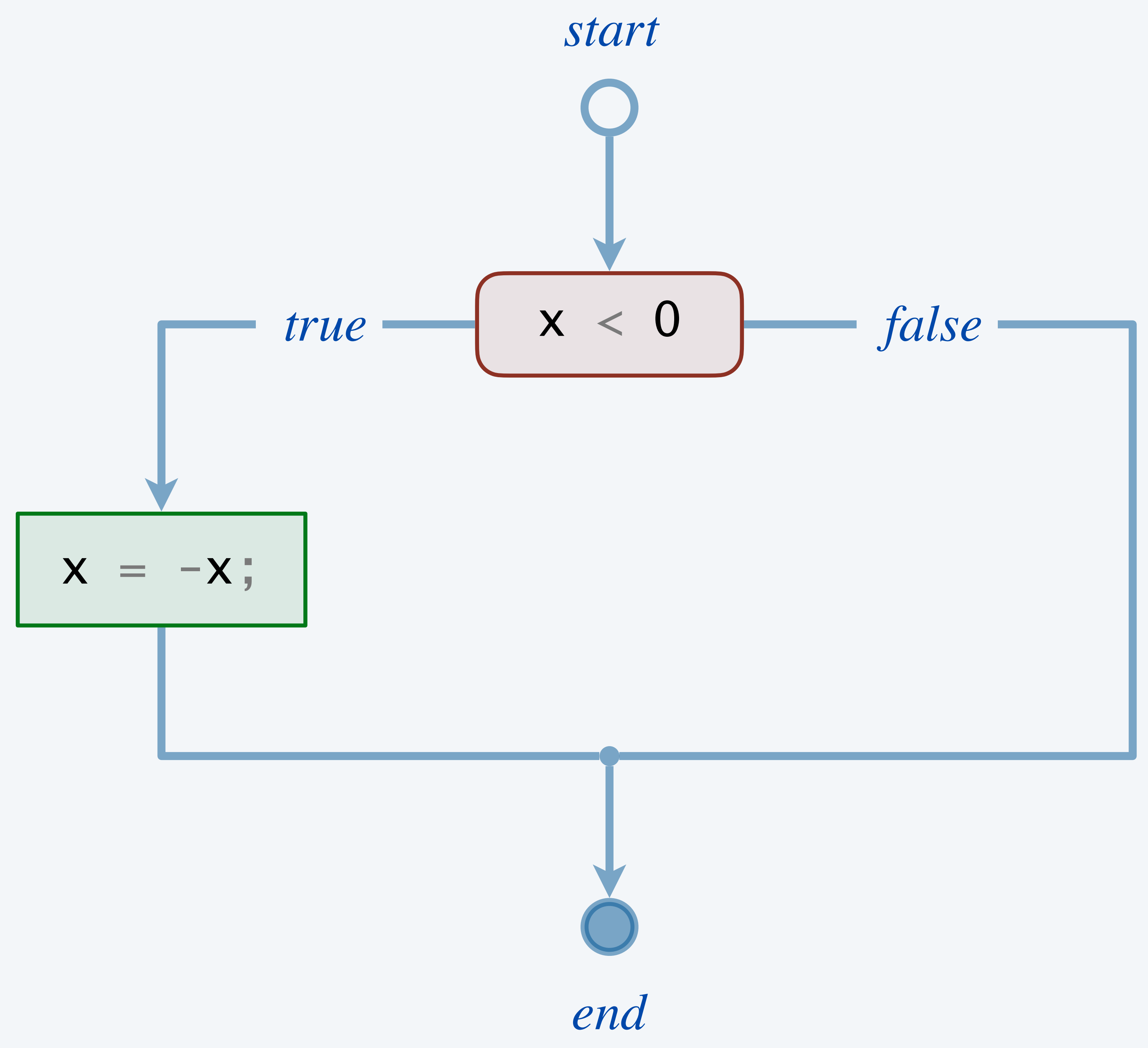
The *if* statement

Execute certain statement(s) depending on the value of a boolean expression.

- Evaluate a boolean expression.
- If true, execute statements in code block delimited by curly braces.

```
if (x < 0) {
   x = -x;
}
```

replaces x with the absolute value of x



Code blocks

A code block can contain a sequence of statements.

- Assignment statements.
- Declaration statements. ← *"local" variable accessible only within the block in which it is declared*
- Other *if* statements.
- …

```
public class TwoSort {
   public static void main(String[] args) {
      int a = Integer.parseInt(args[0]);
      int b = Integer.parseInt(args[1]);

      if (b < a) {
         int temp = a;
         a = b;
         b = temp;
      }

      System.out.println(a);
      System.out.println(b);
   }
}
```

code block consists of a sequence of statements (swap values in a *and* b*)*

```
~/cos126/conditionals> java TwoSort 1234 126
126
1234

~/cos126/conditionals> java TwoSort 126 1234
126
1234
```

More examples of *if* statements

computation	for loop

singular or plural	`String result = price + " dollar";`
	`if (price != 1) {`
	`   result += "s";`
	`}`

check if donor is ineligible to donate blood	`if ((age < 16) || (weight < 110)) {`
	`   System.out.println("ineligible");`
	`}`

time normalization	`if (minutes >= 60) {`
	`   minutes -= 60;`
	`   hours++;`
	`}`

maximum of three integers	`int max = a;`
	`if (b > max) max = b;`
	`if (c > max) max = c;`

shorthand for `result = result + "s";`

compound boolean expression

shorthand for `hours = hours + 1;`

curly braces are optional since body of each `if` *statement contains only one statement*

Conditionals: quiz 1

What is the result of compiling and executing the following program?

A. 1 1

B. 1 26

C. 26 1

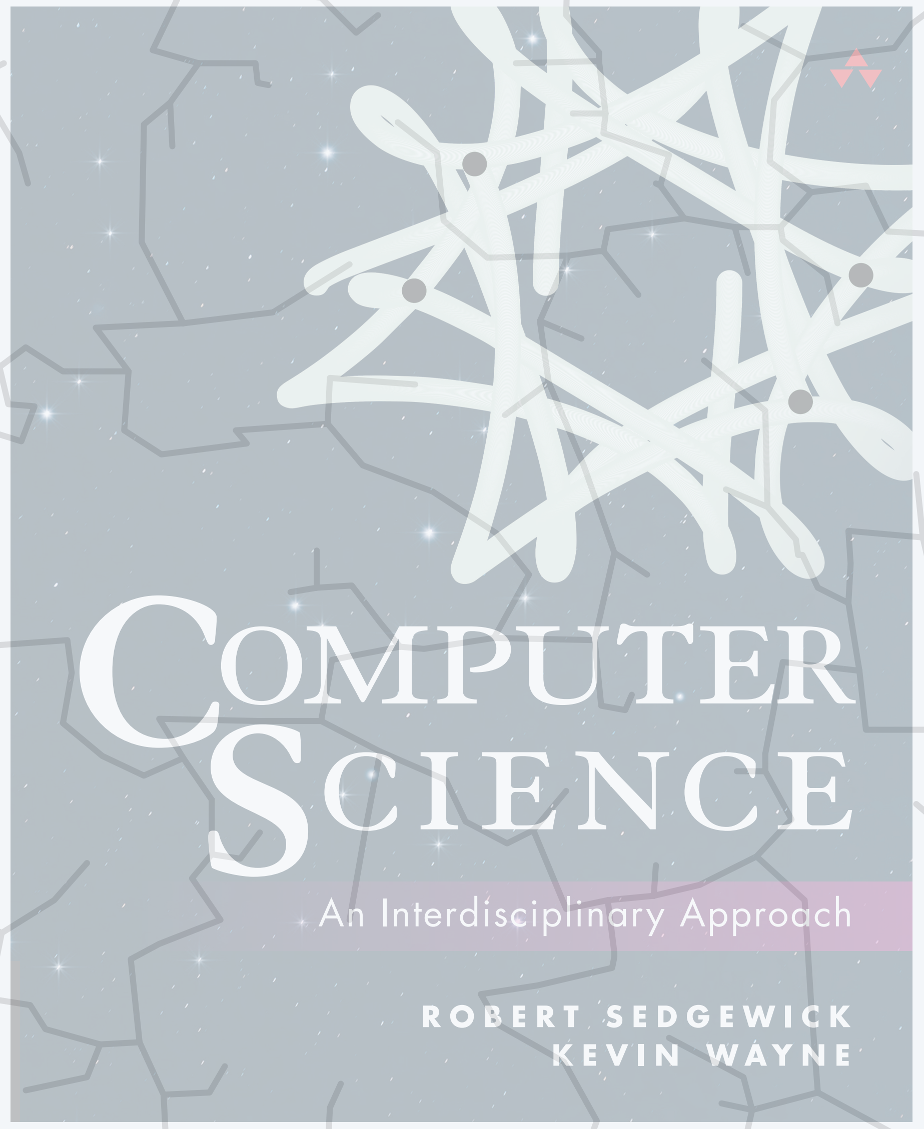
D. *Program does not compile.*

E. *Run-time error.*

```
public class Mystery1 {
   public static void main(String[] args) {
      int a = 1;
      int b = 26;
      int smallest = a;
      int largest = b;

      if (smallest > largest)
         smallest = b;
         largest = a;

      System.out.println(smallest + " " + largest);
   }
}
```



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1.3 Conditionals

- *if statements*
- *if–else statements*
- *nested conditionals*
- *year-to-speech*

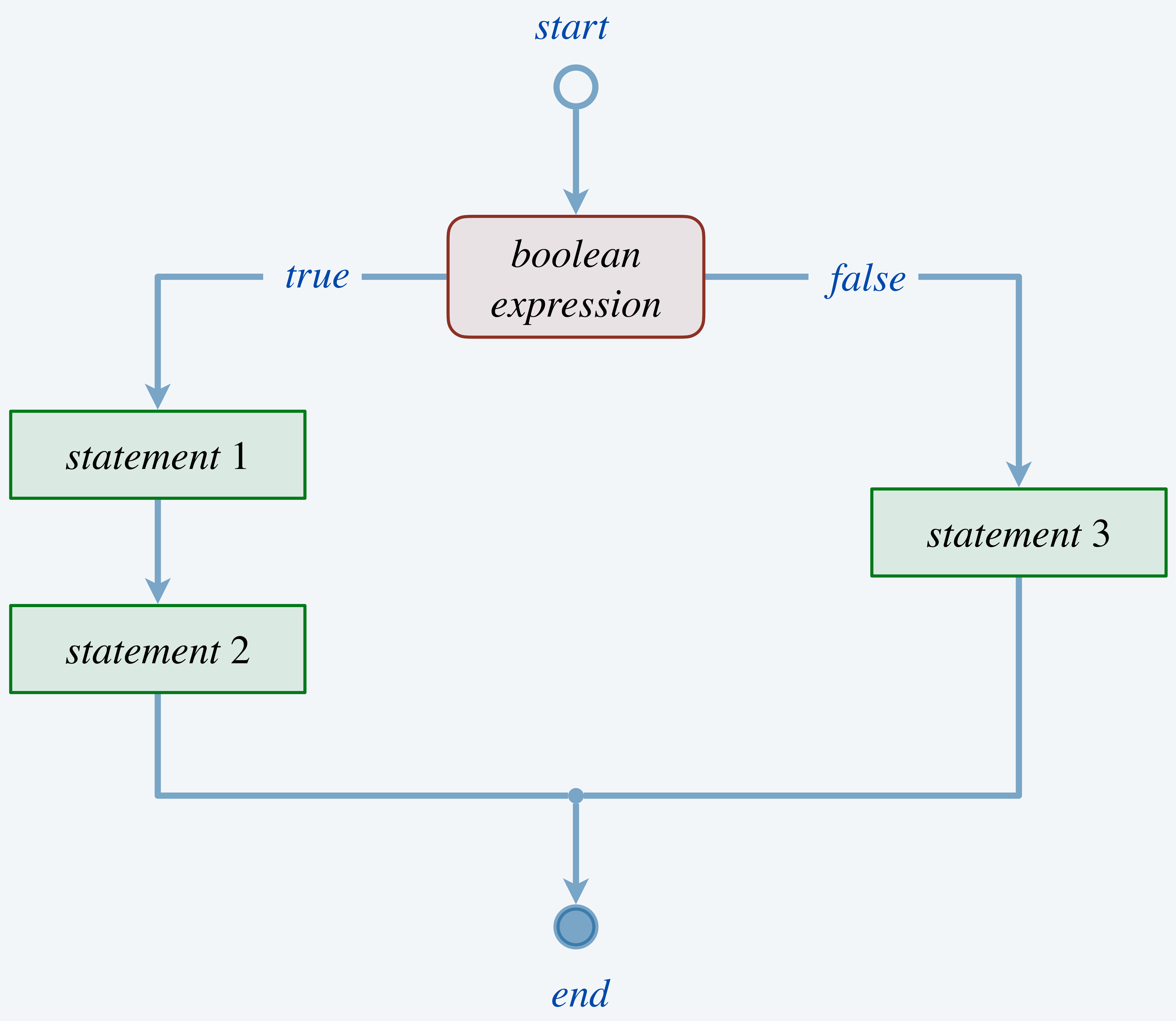
The *if-else* statement

Execute certain statements depending on the value of a boolean expression.

- Evaluate a boolean expression.
- If true, execute some statements.
- Otherwise, execute different statements. ← *the* `else` *clause*

```
if (<boolean expression>) {
   <statement 1>
   <statement 2>
}
else {
   <statement 3>
}
```

if-else statement template



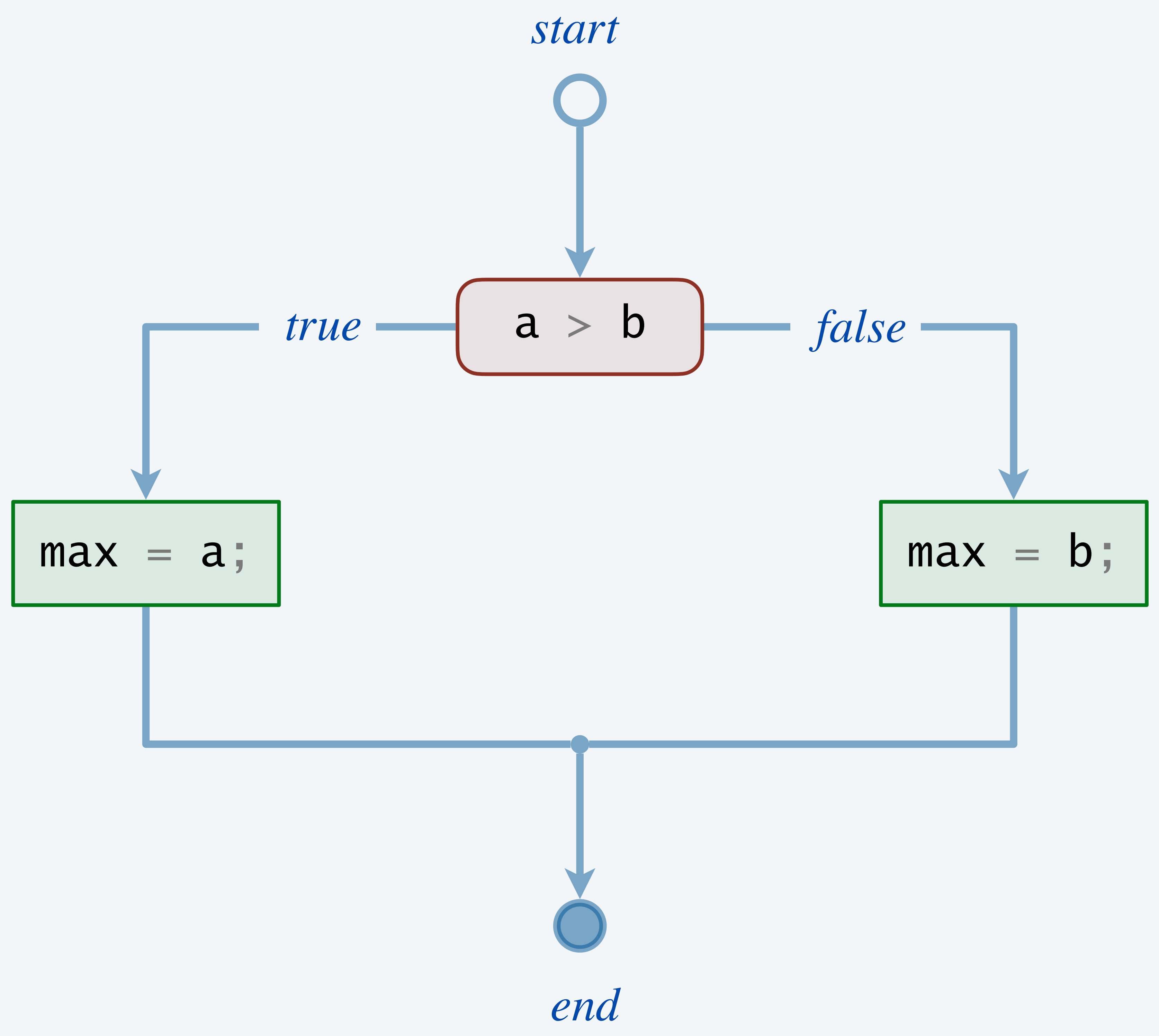
The *if-else* statement

Execute certain statements depending on the value of a boolean expression.

- Evaluate a boolean expression.
- If true, execute some statements.
- Otherwise, execute different statements. ← *the* `else` *clause*

```
int max;
if (a > b) {
   max = a;
}
else {
   max = b;
}
```

sets max to the maximum of a and b



Simulating a fair coin flip

Goal. Simulate a fair coin flip.

Recall. *Math.random*() returns a *double* value in the range $[0, 1)$.

```java
public class CoinFlip {
   public static void main(String[] args) {
      double r = Math.random();
      if (r < 0.5) {
         System.out.println("Heads");
      }
      else {
         System.out.println("Tails");
      }
   }
}
```

```
~/cos126/conditionals> java CoinFlip
Heads

~/cos126/conditionals> java CoinFlip
Tails

~/cos126/conditionals> java CoinFlip
Tails
```

More examples of *if-else* statements

computation | **if-else statement**

parity

```
String parity;
if (n % 2 == 0) parity = "even";
else            parity = "odd";
```

`if` *body consists of only one statement, so curly braces are optional*

simulating a gambler's fair bet

```
double r = Math.random();
if (r < 0.5) cash += bet;
else         cash -= bet;
```

shorthand for

```
cash = cash + bet;
cash = cash - bet;
```

integer remainder (with guard clause)

```
if (denominator == 0) {
   System.out.println("division by zero");
}
else {
   int remainder = numerator % denominator;
   System.out.println("remainder = " + remainder);
}
```

good style to include curly braces even when optional

Types of triangles

Goal. Given side lengths of a triangle, identify as equilateral, isosceles, and scalene.

```
public class Triangle {
   public static void main(String[] args) {
      int a = Integer.parseInt(args[0]);
      int b = Integer.parseInt(args[1]);
      int c = Integer.parseInt(args[2]);

      if (a == b && a == c)
         System.out.println("equilateral");

      if (a == b || a == c || b == c)
         System.out.println("isosceles");
      else
         System.out.println("scalene");

   }
}
```

assume a, b, *and* c *are the lengths of some triangle*

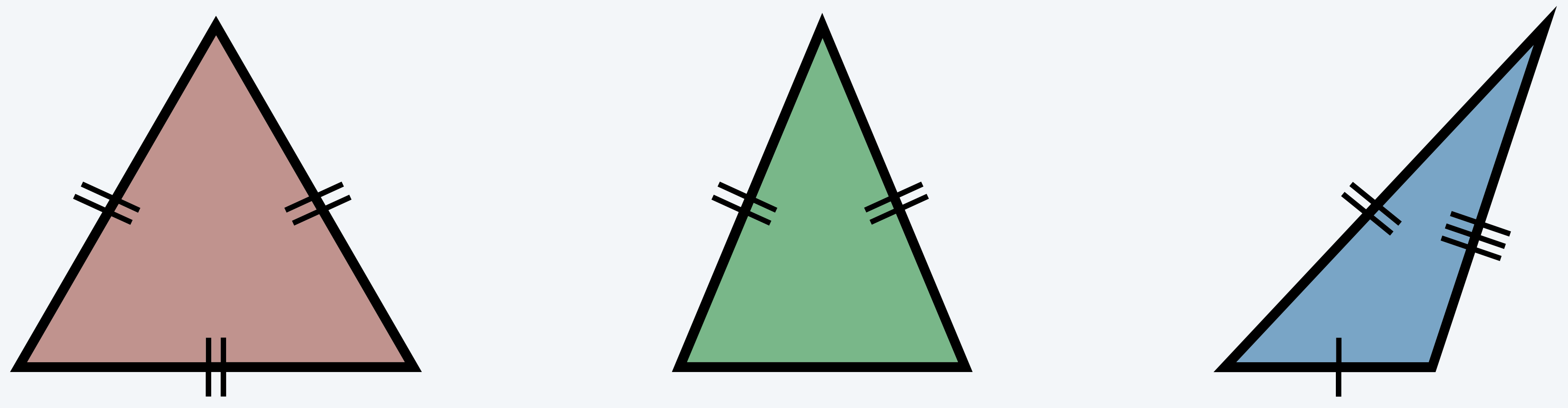
mutually exclusive

```
~/cos126/conditionals> java Triangle 3 3 4
isosceles

~/cos126/conditionals> java Triangle 4 5 6
scalene

~/cos126/conditionals> java Triangle 7 7 7
equilateral
isosceles
```

both if *statements get executed*



Conditionals: quiz 2

What does the following code fragment print?

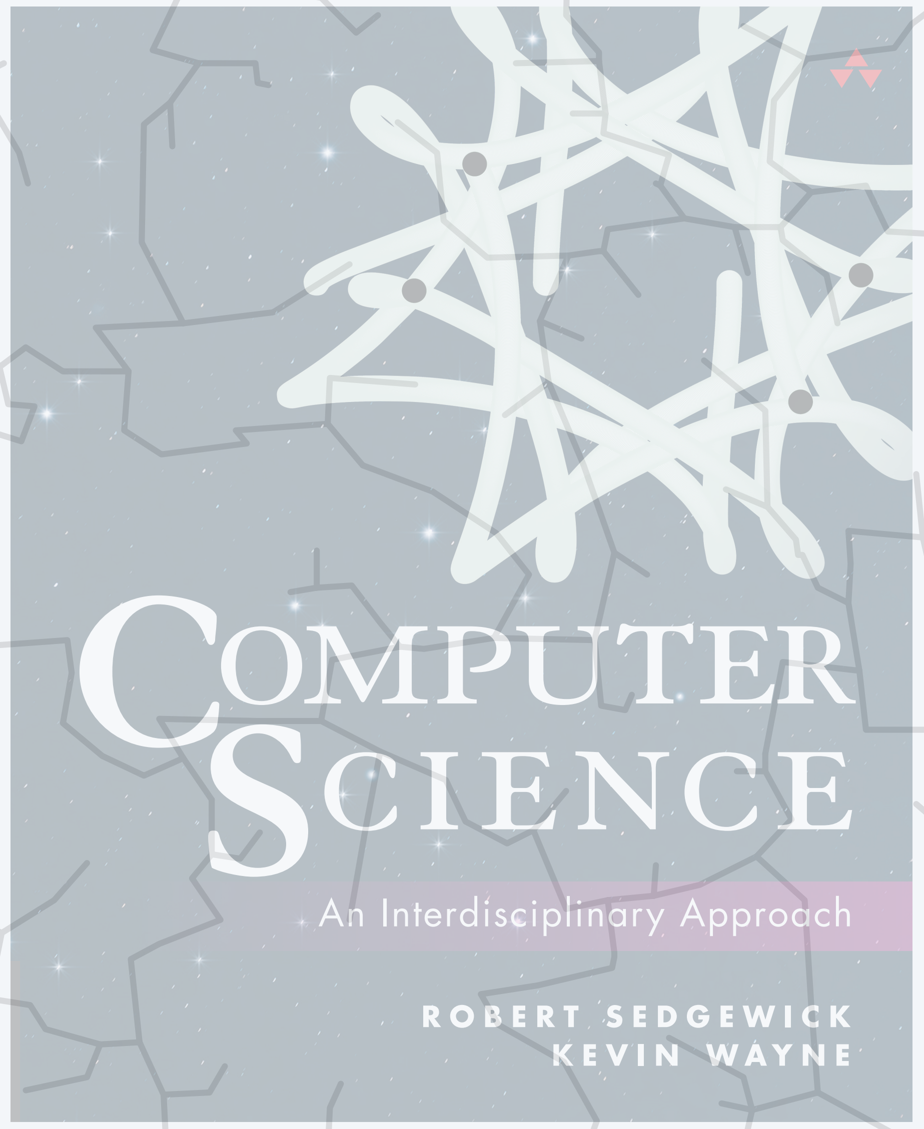
```
int x = -123;
boolean isPositive = (x > 0);
if (isPositive = true) System.out.println("positive");
else                   System.out.println("not positive");
```

A. `"positive"`

B. *nothing*

C. *compile-time error*

D. *run-time exception*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1.3 Conditionals

- *if statements*
- *if-else statements*
- *nested conditionals*
- *year-to-speech*

Nesting conditionals: rock, paper, scissors

Three-way selection. Rock, paper, scissors.

```
public class RockPaperScissors {
   public static void main(String[] args) {
      int r = (int) (Math.random() * 3);

      if (r == 0) {
         System.out.println("Rock");
      }
      else {
         if (r == 1) {
            System.out.println("Paper");
         }
         else {
            System.out.println("Scissors");
         }
      }
   }
}
```

0, 1, or 2

`if-else` *statement nested within the* `else` *clause of an* `if` *statement*

```
~/cos126/conditionals> java RockPaperScissors
Rock

~/cos126/conditionals> java RockPaperScissors
Scissors
```

Nesting conditionals: marginal tax rate

Multiway selection. Given income, calculate marginal tax rate.

income	rate
0 – $47,450	22%
$47,450 – $114,649	25%
$114,650 – $174,699	28%
$174,700 – $311,949	33%
$311,950 +	35%

```
public class TaxRate {
   public static void main(String[] args) {
      int income = Integer.parseInt(args[0]);
      double rate;

      if (income < 47450) rate = 0.22;
      else {
         if (income < 114650) rate = 0.25;
         else {
            if (income < 174700) rate = 0.28;
            else {
               if (income < 311950) rate = 0.33;
               else                 rate = 0.35;
            }
         }
      }

      System.out.println(rate);
   }
}
```

`if` statement nested within an `if` statement

`if` statement nested within an `if` statement within an `if` statement

`if` statement nested within an `if` statement within an `if` statement within an `if` statement

```
~/cos126/conditionals> java TaxRate 100000
0.25
```

Multiway selection shorthand

Note. Curly braces not needed here since each body consists of a single (compound) statement.

```
public class TaxRate {
   public static void main(String[] args) {
      int income = Integer.parseInt(args[0]);
      double rate;

      if      (income <  47450)  rate = 0.22;
      else if (income < 114650)  rate = 0.25;
      else if (income < 174700)  rate = 0.28;
      else if (income < 311950)  rate = 0.33;
      else                       rate = 0.35;

      System.out.println(rate);
   }
}
```

5 mutually exclusive alternatives

income	rate
0 – $47,450	22%
$47,450 – $114,649	25%
$114,650 – $174,699	28%
$174,700 – $311,949	33%
$311,950 +	35%

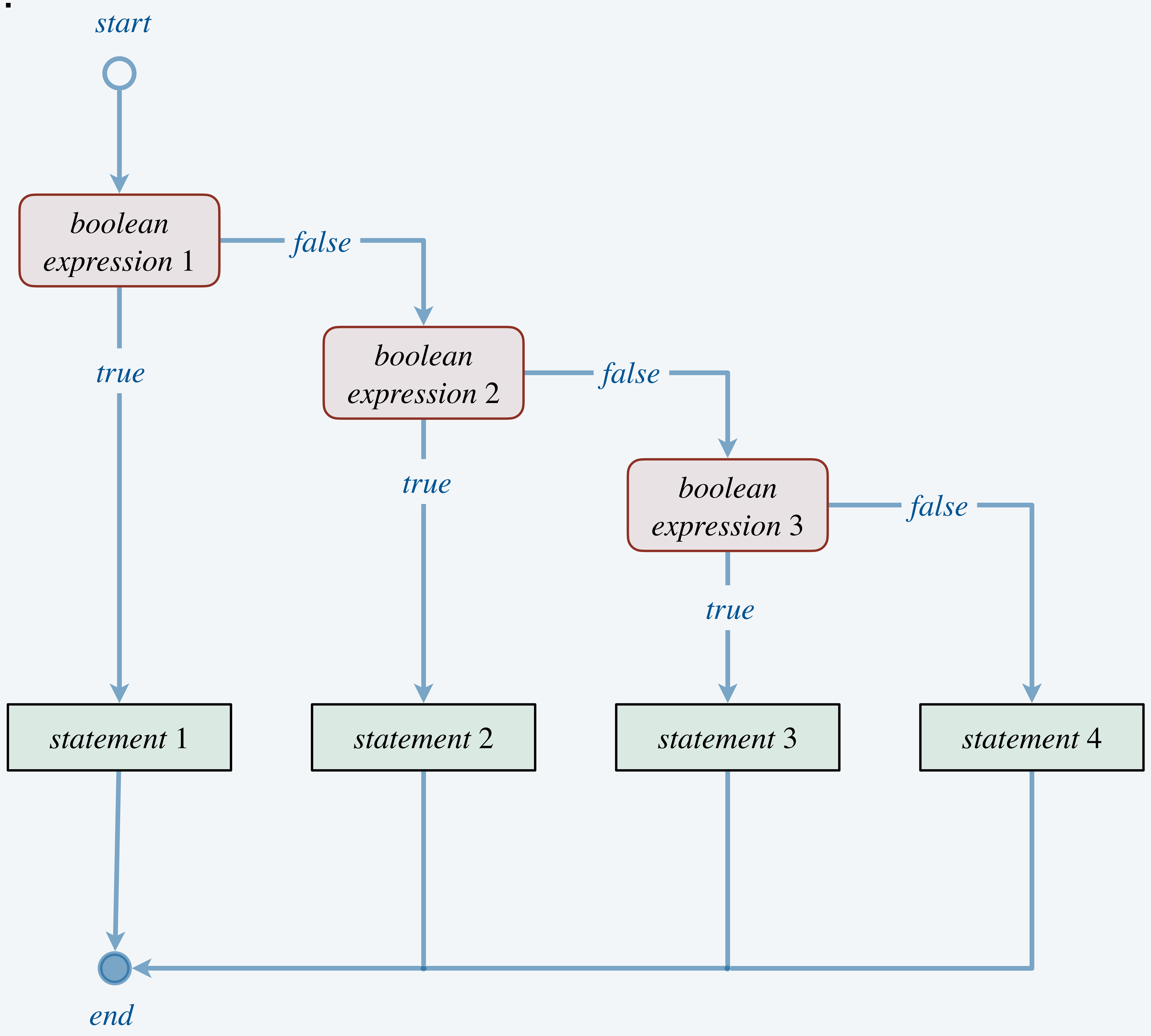
```
~/cos126/conditionals> java TaxRate 100000
0.25
```

A ladder of nested *if-else* statements

Multiway selection. Mutually exclusive alternatives.

```
if (<boolean expression 1>) {
   <statement 1>
}
else if (<boolean expression 2>) {
   <statement 2>
}
else if (<boolean expression 3>) {
   <statement 3>
}
else {
   <statement 4>
}
```

if-else ladder template



More examples of multiway selection

computation	nested if-else statements

Reynold's number
(ratio of inertial to viscous forces)
	`if (reynolds <= 2000.0) {`
	`   System.out.println("laminar flow");`
	`}`
	`else if (reynolds >= 3500.0) {`
	`   System.out.println("turbulent flow");`
	`}`
	`else {`
	`   System.out.println("transitional flow");`
	`}`

sign function
$sign(x) = \begin{cases} -1 & \text{if } x < 0 \\ 0 & \text{if } x = 0 \\ +1 & \text{if } x > 0 \end{cases}$
	`double sign;`
	`if      (x == 0.0) sign =  0.0;`
	`else if (x <  0.0) sign = -1.0;`
	`else if (x >  0.0) sign = +1.0;`
	`else               sign = Double.NaN;`

3 mutually exclusive alternatives

4 mutually exclusive alternatives

Conditionals: quiz 4

What will the following code fragment print if income in 100000?

A. 0.22

B. 0.25

C. 0.28

D. 0.33

E. 0.35

```
double rate = 0.35;
if (income <  47450) rate = 0.22;
if (income < 114650) rate = 0.25;
if (income < 174700) rate = 0.28;
if (income < 311950) rate = 0.33;
System.out.println(rate);
```

Nested *if* statements

Design principle. Avoid unnecessary/gratuitous nesting of *if* statements.

```
if (r == 0) {
   if (g == 0) {
      if (b == 0) {
         System.out.println("black");
      }
   }
}
```

bad design (gratuitous nesting)

```
if (r == 0 && g == 0 && b == 0) {
   System.out.println("black");
}
```

easier to read and debug

Dangling *else* problem

Dangling *else*. Syntactic ambiguity that can arise with nested *if-else* statements.

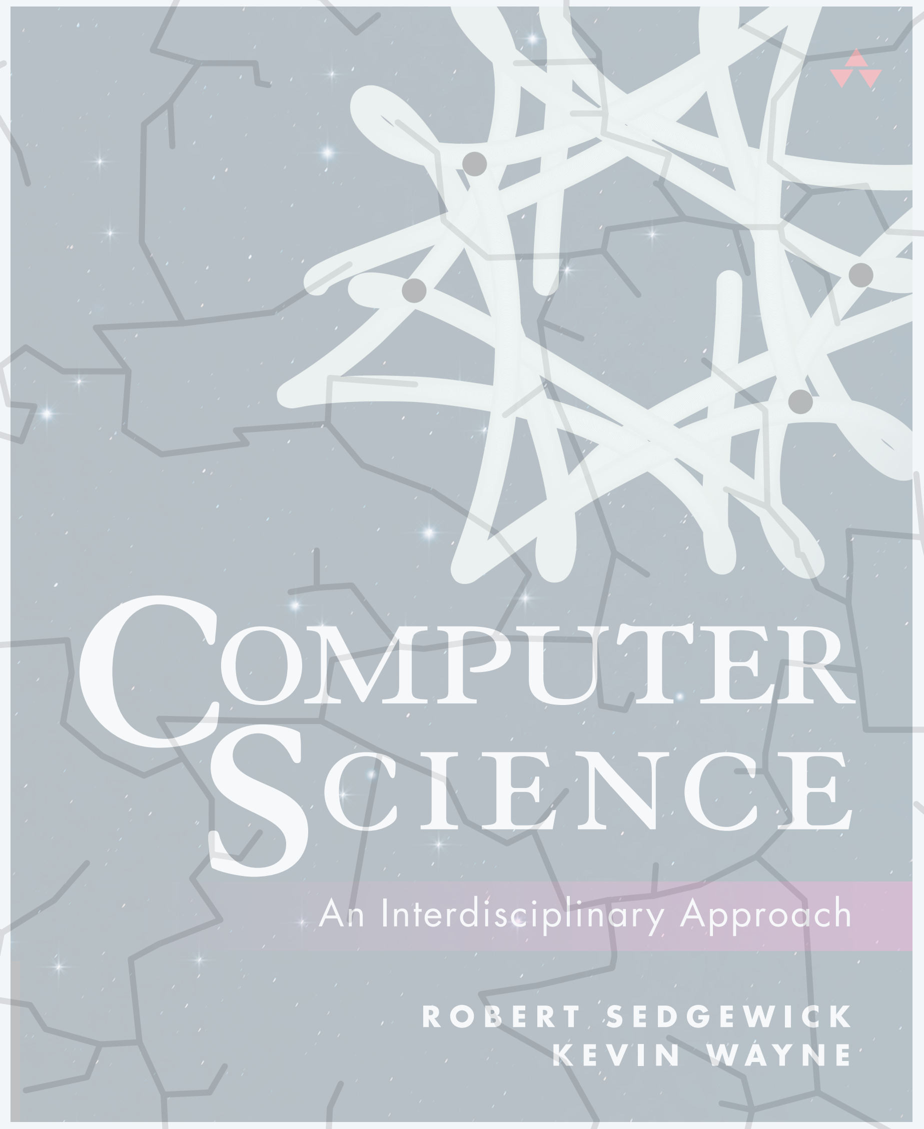
```
if (temperature >= 0)
   if (temperature >= 100) System.out.println("boiling");
else System.out.println("freezing");
```

$\leftarrow$ *prints "freezing" if temperature is 50*

which if statement is associated with the else clause?

Java rule. An *else* clause belongs to the innermost *if* to which it might possibly belong.

Design principle. Use curly braces for clarity.



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1.3 Conditionals

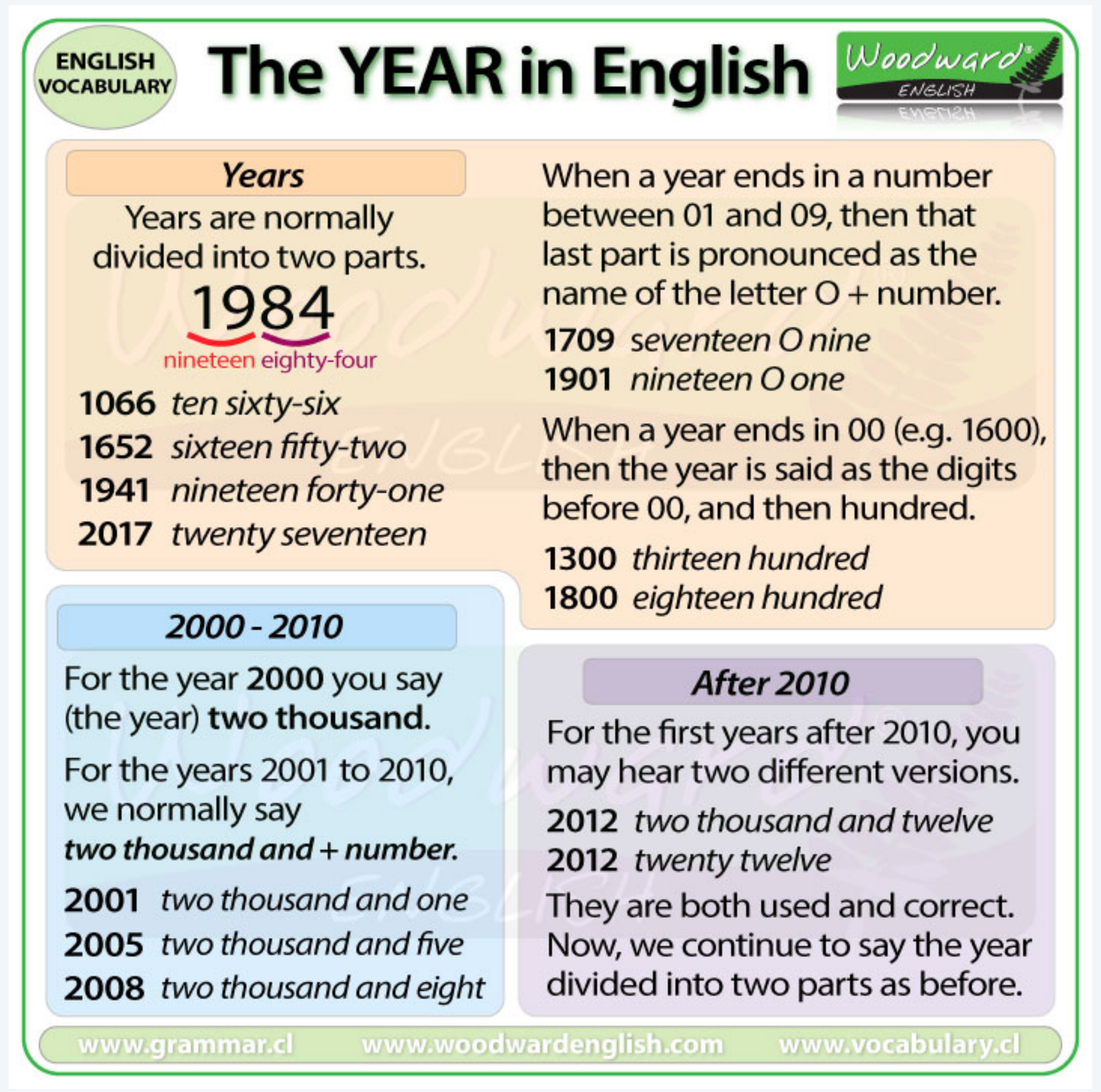
- *if statements*
- *if–else statements*
- *nested conditionals*
- *year-to-speech*

Text-to-speech year

Rules for speaking a year (1–9999) in English.

- Break up year into first–two and last–two digits; say each two–digit number.
- Special cases:
  - year ends in 000: say *thousand* for last three digits
  - year ends in 00 (but not 000): say *hundred* for last two digits
  - year ends in 01 to 09: say *oh* followed by single digit
  - year begins with 00: skip first two digits

year	spoken
2024	*twenty twenty-four*
1776	*seventeen seventy-six*
2000	*two thousand*
1700	*seventeen hundred*
1901	*nineteen oh one*
0026	*twenty-six*
12345	*invalid year*


ENGLISH VOCABULARY

The YEAR in English

Woodward ENGLISH

Years

Years are normally divided into two parts.

1984
nineteen eighty-four

1066 *ten sixty-six*
1652 *sixteen fifty-two*
1941 *nineteen forty-one*
2017 *twenty seventeen*

When a year ends in a number between 01 and 09, then that last part is pronounced as the name of the letter O + number.

1709 *seventeen O nine*
1901 *nineteen O one*

When a year ends in 00 (e.g. 1600), then the year is said as the digits before 00, and then hundred.

1300 *thirteen hundred*
1800 *eighteen hundred*

2000 - 2010

For the year **2000** you say (the year) **two thousand**.

For the years 2001 to 2010, we normally say ***two thousand and + number.***

2001 *two thousand and one*
2005 *two thousand and five*
2008 *two thousand and eight*

After 2010

For the first years after 2010, you may hear two different versions.

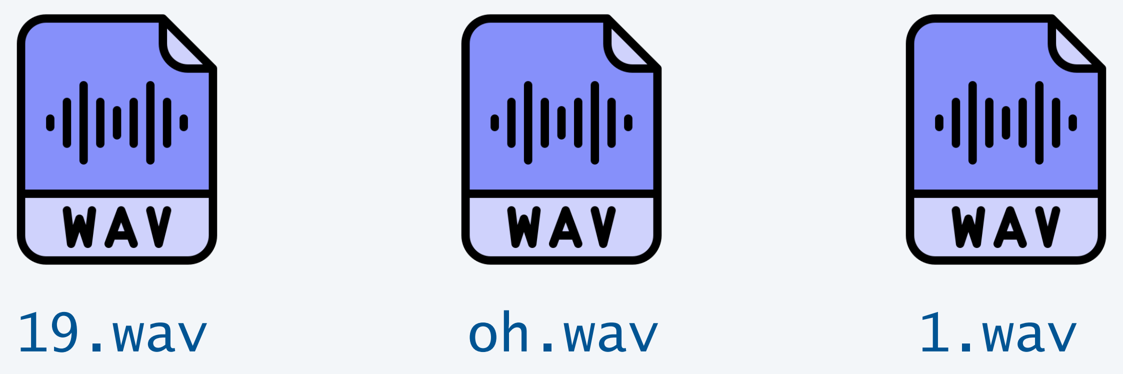
2012 *two thousand and twelve*
2012 *twenty twelve*

They are both used and correct. Now, we continue to say the year divided into two parts as before.

www.grammar.cl www.woodwardenglish.com www.vocabulary.cl

Text-to-speech approach

Domain-specific synthesis. Concatenate pre-recorded words to form desired output.



speaking the year 1901

word	WAV file
1–99	`1.wav`, `2.wav`, `3.wav`, …
hundred	`hundred.wav`
thousand	`thousand.wav`
oh	`oh.wav`

vocabulary

Applications.

- Talking clocks.
- Train schedule announcements.
- Interactive telephone voice response systems.

Note. Limited to words in vocabulary.

Live coding

```
public class SayYear {
   public static void main(String[] args) {
      int year = Integer.parseInt(args[0]);
      int firstTwoDigits = year / 100;
      int lastTwoDigits  = year % 100;

      if (year % 1000 == 0) {
         int firstDigit = year / 1000;
         StdAudio.play(firstDigit + ".wav");
         StdAudio.play("thousand.wav");
      }

      else {
         if (firstTwoDigits > 0)
            StdAudio.play(firstTwoDigits + ".wav");

         if (lastTwoDigits == 0)
            StdAudio.play("hundred.wav");

         else {
            if (lastTwoDigits < 10)
               StdAudio.play("oh.wav");

            StdAudio.play(lastTwoDigits + ".wav");
         }
      }
   }
}
```

assumes year is between 1 and 9999

parse first and last two digits of year

special case for years ending in 000

say first two digits (unless 00)

special case for years ending in 00 (but not 000)

special case for years ending in 01 to 09

say last two digits

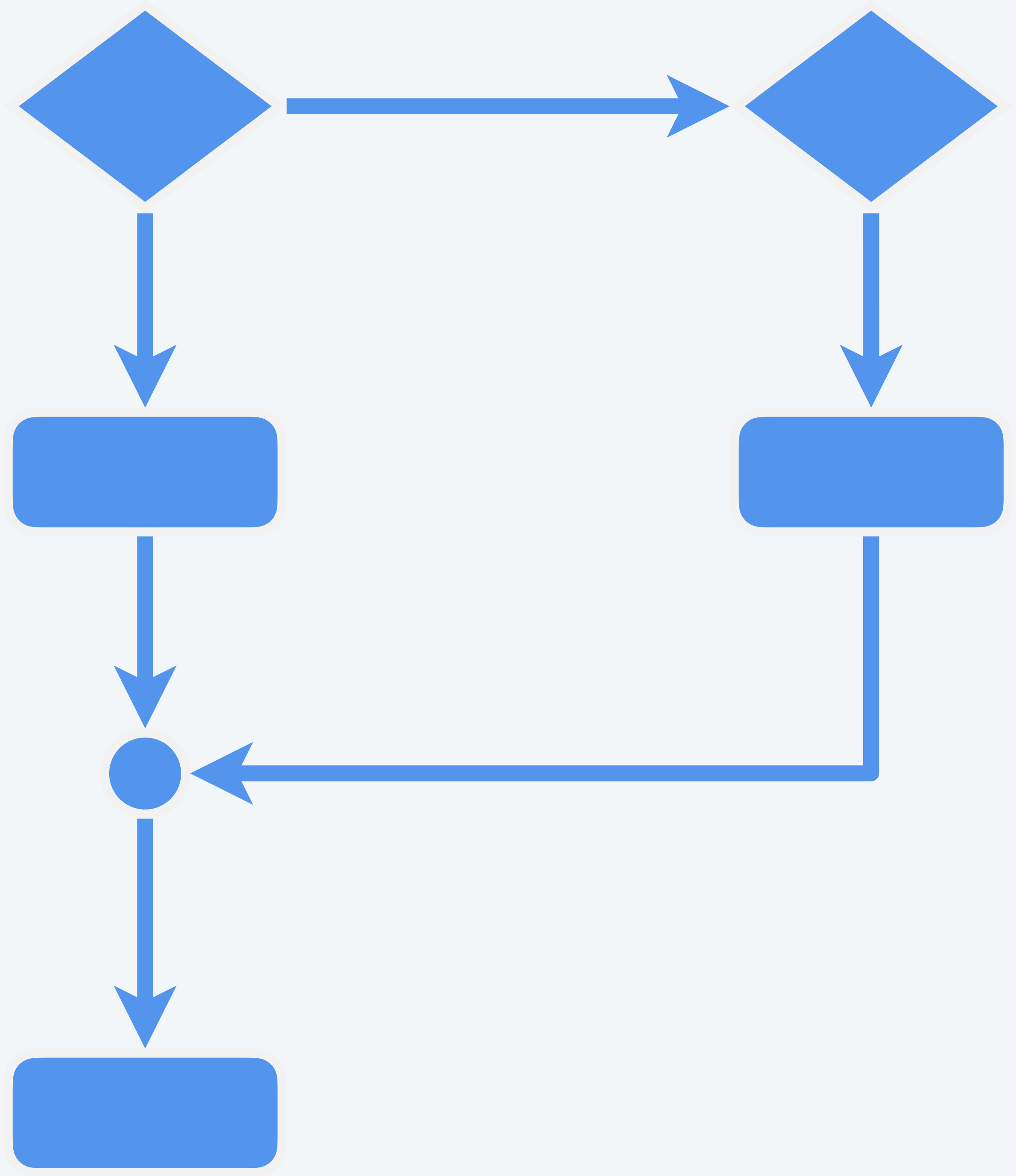
Testing

Principle. Supply inputs that activate all possible execution paths through program. ← *so that all code gets tested*

```
~/cos126/conditionals> java-introcs SayYear 2024   ←—— typical case
🔊  [speaks "twenty twenty-four"]

~/cos126/conditionals> java-introcs SayYear 1776   ←—— typical case
🔊  [speaks "seventeen seventy-six"]

~/cos126/conditionals> java-introcs SayYear 2000   ←—— year ends in 01 to 09
🔊  [speaks "two thousand"]

~/cos126/conditionals> java-introcs SayYear 1700   ←—— year ends in 000
🔊  [speaks "seventeen hundred"]

~/cos126/conditionals> java-introcs SayYear 1901   ←—— year ends in 00 (but not 000)
🔊  [speaks "nineteen oh one"]

~/cos126/conditionals> java-introcs SayYear 26     ←—— year begins with 00
🔊  [speaks "twenty-six"]
```

Summary

One-way selection.	The *`if`* statement.
Binary selection.	The *`if-else`* statement.
Multiway selection.	Ladder of nested *`if-else`* statements.



control flow with conditionals

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