Control structures

- input()
- if-elif-else
- while-break-continue

input

- The builtin function `input(`*message*`)` prints *message*, and waits for the user provides a line of input and presses return. The line of input is returned as a `str`
- If you e.g. expect input to be an `int`, then remember to convert the input using `int()`

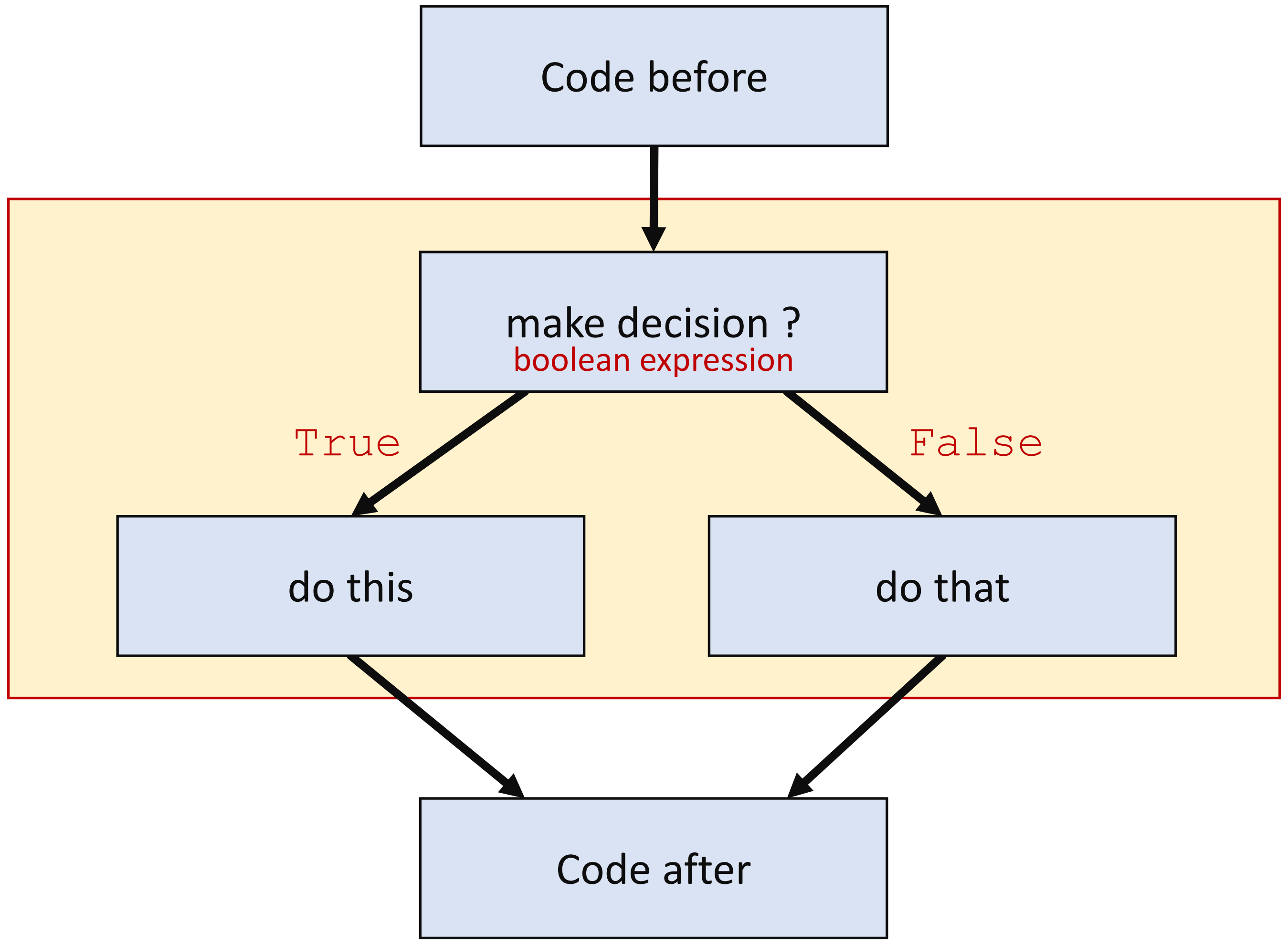
name-age.py

```
name = input('Name: ')
age = int(input('Age: '))
print(name, 'is', age, 'years old')
```

Python shell

```
> Name: Donald Duck
> Age: 84
| Donald Duck is 84 years old
```

Branching – do either this or that ?



Basic if-else

```
if boolean expression:
    code
    code
    code
else:
    code
    code
    code
```

$\left.\begin{array}{r}\text{identical}\\\text{indentation}\end{array}\right\}$ (applies to each block of *code* lines)

if-else.py

```
if x % 2 == 0:
    print('even')
else:
    print('odd')
```

Identical indentation for a sequence of lines = the same spaces/tabs should precede code

pass

- `pass` is a Python statement doing nothing. Can be used where a statement is required but you want to skip (e.g. code will be writen later)

- Example (bad example, since `else` could just be omitted):

if-else.py

```
if x % 2 == 0:
    print('even')
else:
    pass
```

if-elif-else

```
if condition:
        code
elif condition:     # zero or more “elfi“ ≡ “else if”
        code
else:     # optional
        code
```

```
if (condition) {
  code
} else if (condition) {
  code
} else {
  code
}
```

Java, C, C++ syntax

Other languages using indentation for blocking: ABC (1976), occam (1983), Miranda (1985)

if.py

```
if x == 0:
    print('zero')
```

if-else.py

```
if x % 2 == 0:
    print('even')
else:
    print('odd')
```

elif.py

```
if x < 0:
    print('negative')
elif x == 0:
    print('zero')
elif x == 1:
    print('one')
else:
    print('>= 2')
```

elif can make code nicer (less identation)

elif.py

```
if x < 0:
    print('negative')
elif x == 0:
    print('zero')
elif x == 1:
    print('one')
else:
    print('>= 2')
```

ugly-if.py

```
if x < 0:
    print('negative')
else:
    if x == 0:
        print('zero')
    else:
        if x == 1:
            print('one')
        else:
            print('>= 2')
```

Questions – What value is printed?

```
x = 1
if x == 2:
    x = x + 1
else:
    x = x + 1
    x = x + 1
x = x + 1
print(x)
```

a) 1
b) 2
c) 3
d) 4
e) 5
f) Don’t know

Nested if-statements

nested-if.py

```
if x < 0:
    print('negative')
elif x % 2 == 0:
    if x == 0:
        print('zero')
    elif x == 2:
        print('even prime number')
    else:
        print('even composite number')
else:
    if x == 1:
        print('one')
    else:
        print('some odd number')
```

Common mistake

if-if.py

```
x = int(input())
if x == 0:
    print('zero')
if x % 2 == 0:
    print('even')
```

Python shell

```
> 0
| zero
| even
```

⚠

if-elif.py

```
x = int(input())
if x == 0:
    print('zero')
elif x % 2 == 0:
    print('even')
```

Python shell

```
> 0
| zero
```

if-else *expressions*

- A very common computation is

```
if test:
    x = true-expression
else:
    x = false-expression
```

- In Python there is a shorthand for this:

```
x = true-expression if test else false-expression
```

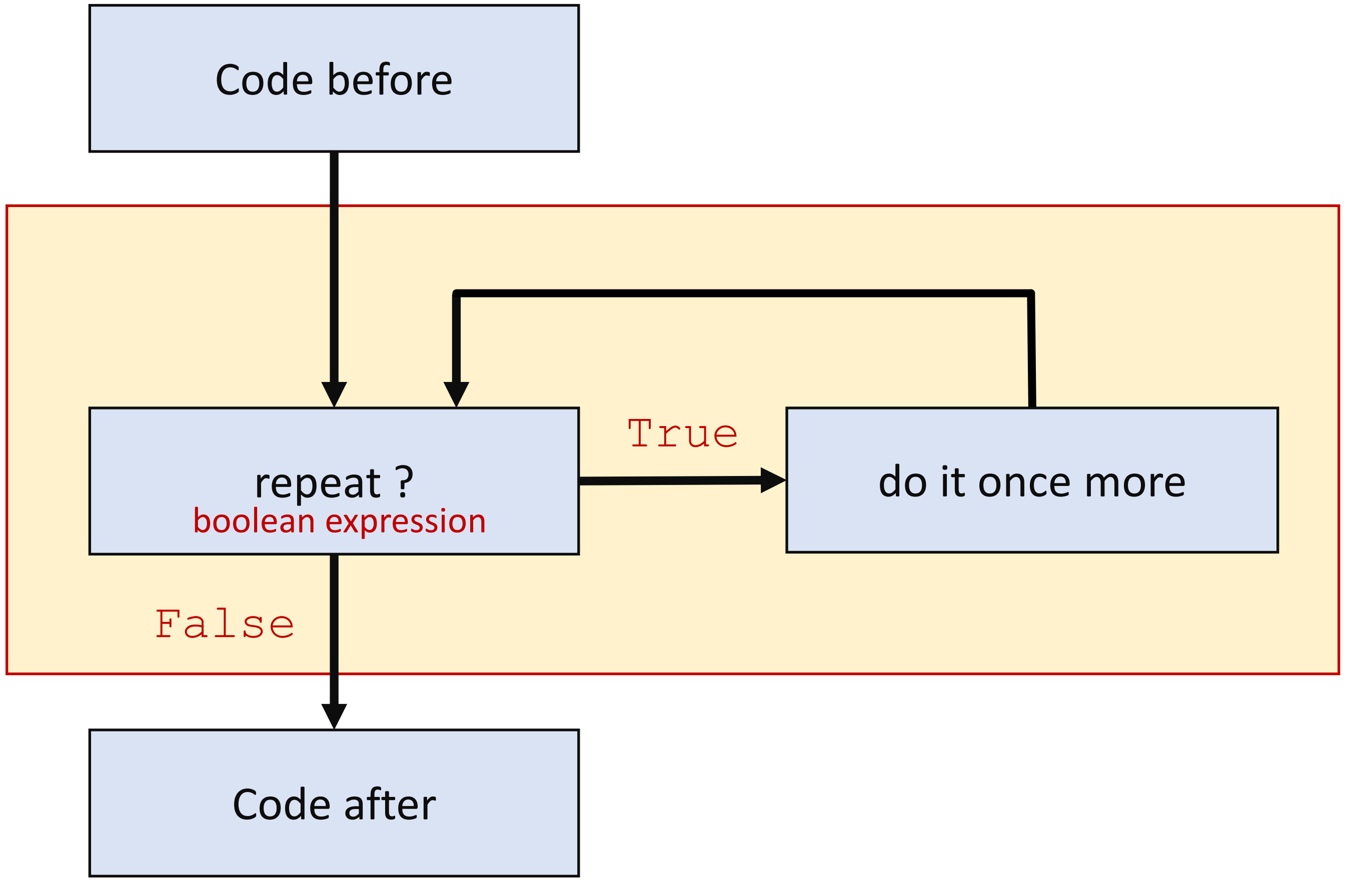
think of this as the "common case" and the "exceptional case"

(see What's New in Python 2.5 - **PEP 308: Conditional Expressions**)

- In C, C++, Java, Javascript the equivalent notation is (note the different order)

```
x = test ? true-expression : false-expression
```

Repeat until done



while-statement

```
while condition:
    code
    ...
    break  #  jump to code after while loop
    ...
    continue  #  jump to condition at the
    ...       #  beginning of while loop
```

```
while (condition) {
   code
}
```

Java, C, C++ syntax

count.py

```
x = 1
while x <= 5:
    print(x, end=' ')
    x = x + 1
print('and', x)
```

Python shell

```
| 1 2 3 4 5 and 6
```

The function `randint(a, b)` from module `random` returns a random integer from {a, a + 1,..., b – 1, b}

random-pair.py

```
from random import randint
while True:
    x = randint(1, 10)
    y = randint(1, 10)
    if abs(x - y) >= 2:
        break
    print('too close', x, y)
print(x, y)
```

Python shell

```
| too close 4 4
| too close 10 9
| 8 5
```

An exercise asks to simplify the code

Computing $\lfloor\sqrt{x}\rfloor$ using binary search

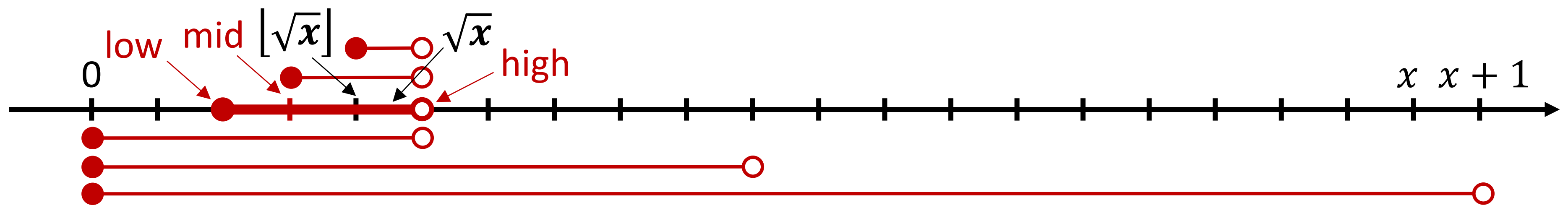
int-sqrt.py

```python
x = 20
low = 0
high = x + 1
while True:   # low <= sqrt(x) < high
    if low + 1 == high:
        break
    mid = (high + low) // 2
    if mid * mid <= x:
        low = mid
        continue
    high = mid
print(low)   # low = floor(sqrt(x))
```

Integer division

$$\left\lfloor\frac{\texttt{high}+\texttt{low}}{2}\right\rfloor$$

$$\texttt{mid} \leq \sqrt{x}$$
$$\Updownarrow$$
$$\texttt{mid}^2 \leq x$$



bisect

- **Note** Binary search on sorted lists is supported by the standard library module `bisect`
- `bisect_left` and `bisect_right` return the *insertion point* before and after, respectively, of existing occurrences of the value

binary_search_bisect.py

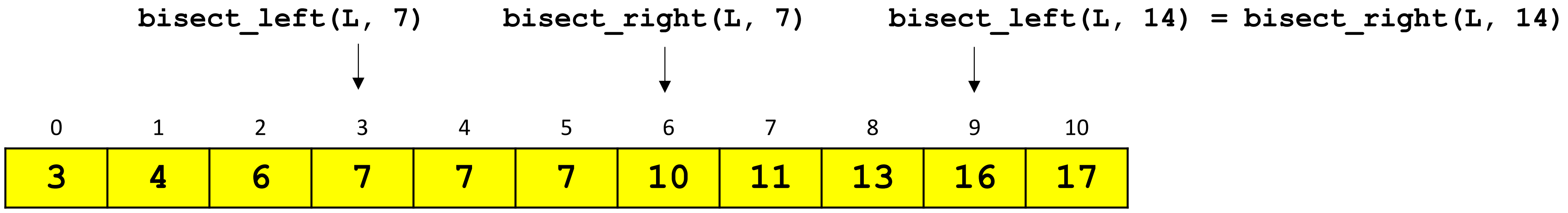
```python
from bisect import bisect_left, bisect_right

L = [3, 4, 6, 7, 7, 7, 10, 11, 13, 16, 17]

print(bisect_left(L, 7))
print(bisect_right(L, 7))
print(bisect_left(L, 14))
print(bisect_right(L, 14))
```

Python shell

```
| 3   # bisect_left(L, 7)
| 6   # bisect_right(L, 7)
| 9   # bisect_left(L, 14)
| 9   # bisect_right(L, 14)
```

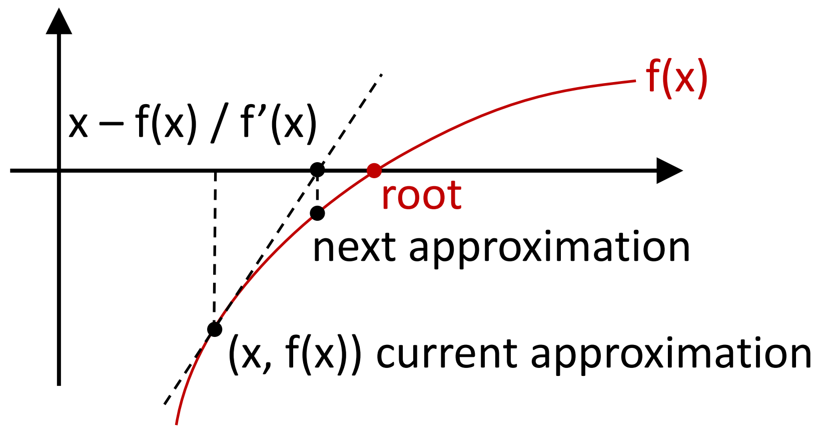


Division using the Newton-Raphson method

- **Goal:** Compute 1 / n only using +, -, and *
- $x = 1 / n \iff f(x) = n - 1 / x = 0$
- Problem reduces to finding root of f
- Newton-Raphson:

$$x := x - f(x)/f'(x) = x - (n - 1/x)/(1/x^2) = (2 - n \cdot x) \cdot x$$

since $f'(x) = 1 / x^2$ for $f(x) = n - 1 / x$



division.py

```python
n = 0.75  # n in [0.5, 1.0]
x = 1.0
last = 0.0
while last < x:
    print(x)
    last = x
    x = (2 - n * x) * x
print('Apx of 1.0 /', n, '=', x)
print('Python 1.0 /', n, '=', 1.0 / n)
```

Python shell

```
| 1.0
| 1.25
| 1.328125
| 1.3331298828125
| 1.333333330228925
| 1.3333333333333333
| Apx of 1.0 / 0.75 = 1.3333333333333333
| Python 1.0 / 0.75 = 1.3333333333333333
```

en.wikipedia.org/wiki/Newton's_method