Programming and Problem-Solving

Functions and local variables

Dennis Komm

Repetition – Control Structures

Control Flow

Control Flow – `if`

Order of the (repeated) execution of statements

- generally from top to bottom...

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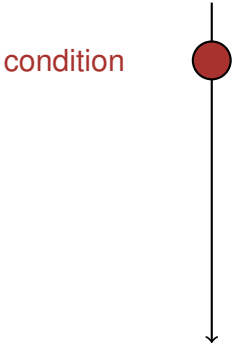


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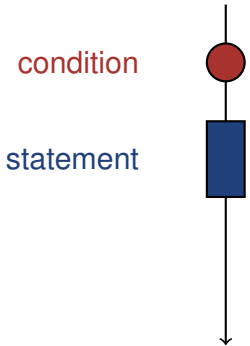


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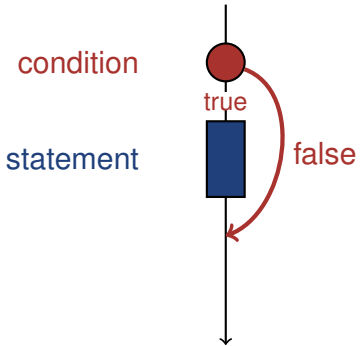


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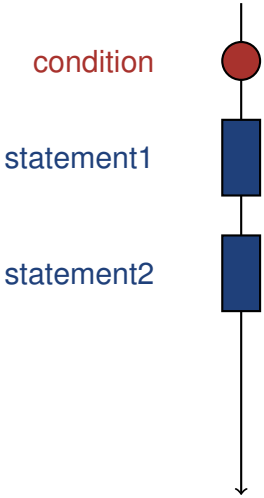
Control Flow – `if-else`

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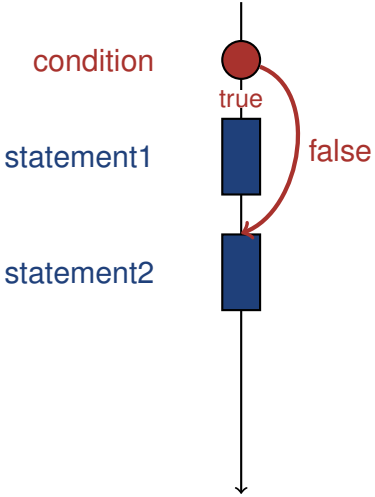


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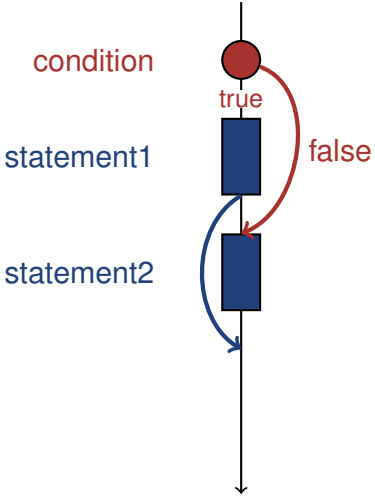


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Control Flow – `while`

`while` *condition*:
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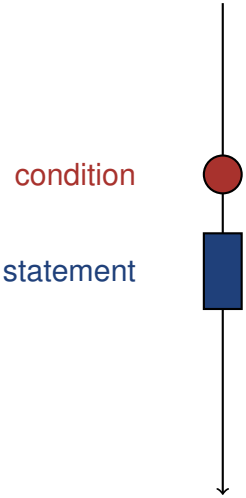

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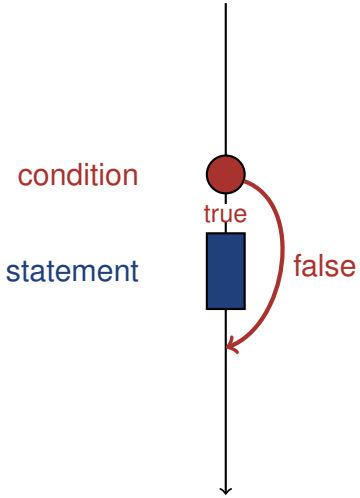

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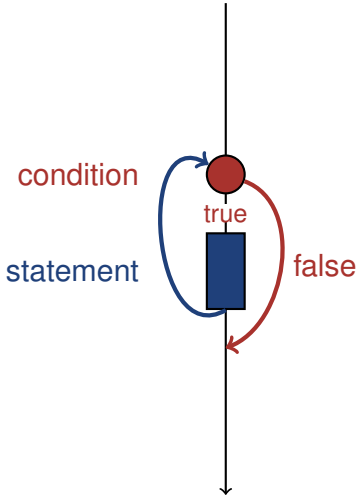

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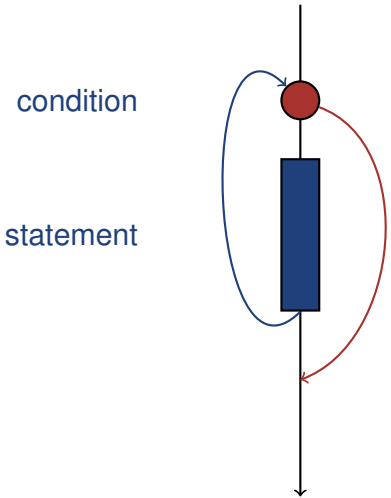

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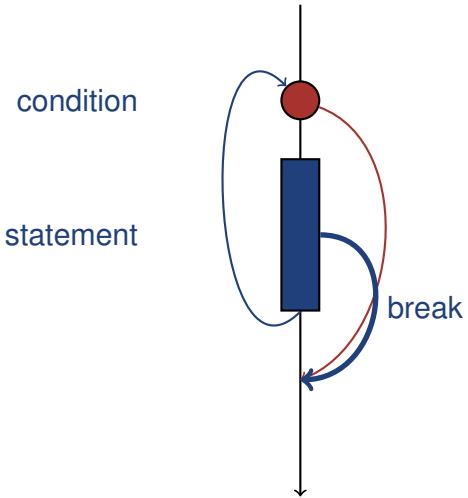

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- One algorithm per file
- Statements are processed sequentially
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def welcome():
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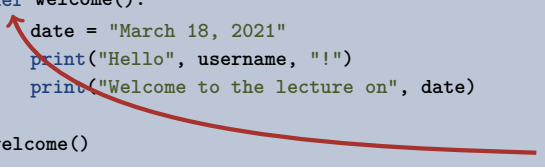

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Optional list of parameters

Analogy to Natural Languages

- Python “understands” some specific words
- These are called **keywords**: `def`, `if`, `while`, etc.
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From Merriam-Webster dictionary

re·frig·er·a·tor

A room or appliance for keeping food or other items cool

Analogy to Natural Languages

```
  def welcome():
    date = "March 18, 2021"
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```
username = input("Enter username:")
if username == "leafr" or username == "skamp" or username == "dkomm":
    welcome()
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$$f(x) = 2 \cdot x + 1$$

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- `return` without argument is used to simply end the function call

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- `b = (f(10) > 20)` assigns `b` the Boolean value `True`

Functions with Parameters

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def checkuser(givenname):
    validnames = [ "heinj", "sarstein", "spiasko", "celich", "sommerda", "fiscmanu" ]
    if givenname in validnames:
        return True
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username = input("Enter username:")

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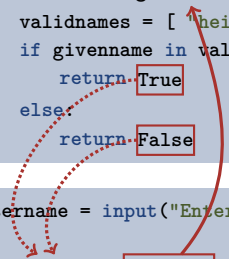

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Definition of Functions

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NameError: name 'f' is not defined
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Example – Cookie Calculator

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children = int(input("Number of children:"))
cookies = int(input("Number of cookies:"))

print("Every child receives", cookies // children, "cookies")
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children = int(input("Number of children:"))
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We want to make sure that `children` is positive and that each child gets at least one cookie

Cookie Calculator – Check Input

From this . . .

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children = int(input("Number of children:"))
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while True:
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        break
    else:
        print("Value needs to be at least 1")
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Analogously, we have to check that `cookies >= children`

Cookie Calculator – Getting Complicated

```
while True:
    children = int(input("Number of children:"))
    if children >= 1:
        break
    else:
        print("Value needs to be at least 1")

while True:
    cookies = int(input("Number of cookies:"))
    if cookies >= children:
        break
    else:
        print("Value needs to be at least", children)

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    else:
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Read and check number of children

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  - The minimum, i.e., `1` vs. `children`
- We can outsource the code fragment into a function and thus feature **reuse**
- We have to **parameterize** the different aspects

Exercise – Cookie Calculator

Write a function that

- gets two parameters `prompt` and `minimum`
- asks the user for an integer input
- returns the input using `return` if it is at least `minimum`
- otherwise asks for a new input

Use the function in the cookie calculator

Exercise – Cookie Calculator

```
def checkinput(prompt, minimum):
    while True:
        x = int(input(prompt))
        if x >= minimum:
            return x
        else:
            print("Value needs to be at least", minimum)


children = checkinput("Number of children:", 1)
cookies = checkinput("Number of cookies:", children)

print("Every child receives", cookies // cookies, "cookies")
print("Dad receives", cookies % children, "cookies")
```

Functions

Scope and Lifetime of Variables

Local Variables

Parameters of a function are only valid within this function

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def f(x):
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The same is true for variables that are defined in a function

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- Such variables (parameters) are called **local variables**
- Variables defined outside of a function are called **global variables**
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```
def f(x):
    if x < 0:
        return -100
    y = x + 1
    if y < 10:
        y += 10
    else:
        y -= 20
    return y
```

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scope of x

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Local Variables

- Such variables (parameters) are called **local variables**
- Variables defined outside of a function are called **global variables**
- Field of validity is called **scope** of the variable
- Time in which it is defined is called **lifetime** of the variable

scope of x

```
def f(x):
    if x < 0:
        return -100
    y = x + 1
    if y < 10:
        y += 10
    else:
        y -= 20
    return y
```

```
def f(x):
    if x < 0:
        return -100
    y = x + 1
    if y < 10:
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    else:
        y -= 20
    return y
```

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scope of x

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def f(x):
    if x < 0:
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    y = x + 1
    if y < 10:
        y += 10
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        y -= 20
    return y
```

scope of y

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def f(x):
    if x < 0:
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```

Global Variables

Global variables can be accessed within a function

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```
x = 1

def f():
    y = x + 1
    print(y)
    return

print(x)
f()
print(x)
```

Global Variables

Global variables can be accessed within a function

```
x = 1

def f():
    y = x + 1
    print(y)
    return

print(x)
f()
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```

Global Variables

Global variables can be accessed within a function

```
x = 1

def f():
    y = x + 1
    print(y)
    return

print(x)
f()
print(x)
```

local variable `y` gets value
which depends on global variable `x`

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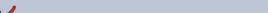
```
x = 1

def f():
    y = x + 1
    print(y)
    return

print(x)
f()
print(x)
```



output global variable `x`

Global Variables

Global variables can be accessed within a function

```
x = 1

def f():
    y = x + 1
    print(y)
    return

print(x)
f()
print(x)
```

Global Variables

Global variables can be accessed within a function

```
x = 1

def f():
    y = x + 1
    print(y)
    return

print(x)
f()
print(x)
```

output global variable `x`

output local variable `y`

output global variable `x`

Global Variables

Global variables can be accessed within a function

```
x = 1

def f():
    y = x + 1
    print(y)
    return

print(x)
f()
print(x)
```

```
x = 1

def f(y):
    z = x + y
    return z

print(x)
print(f(2))
print(x)
```

Global Variables

Global variables can be accessed within a function

```
x = 1

def f():
    y = x + 1
    print(y)
    return

print(x)
f()
print(x)
```

```
x = 1

def f(y):
    z = x + y
    return z

print(x)
print(f(2))
print(x)
```

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Global variables can be accessed within a function

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def f():
    y = x + 1
    print(y)
    return

print(x)
f()
print(x)
```

```
x = 1

def f(y):
    z = x + y
    return z

print(x)
print(f(2))
print(x)
```

Global Variables

Global variables can be accessed within a function

```
x = 1

def f():
    y = x + 1
    print(y)
    return

print(x)
f()
print(x)
```

```
x = 1

def f(y):
    z = x + y
    return z

print(x)
print(f(2))
print(x)
```

local variable z gets value that depends on global variable x and parameter y

Global Variables

Global variables can be accessed within a function

```
x = 1

def f():
    y = x + 1
    print(y)
    return

print(x)
f()
print(x)
```

```
x = 1

def f(y):
    z = x + y
    return z

print(x)
print(f(2))
print(x)
```

Global Variables

Global variables can be accessed within a function

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x = 1

def f():
    y = x + 1
    print(y)
    return

print(x)
f()
print(x)
```

```
x = 1

def f(y):
    z = x + y
    return z

print(x)
print(f(2))
print(x)
```

output global variable `x`

output local variable `z`

Global Variables

Global variables can be accessed within a function

```
x = 1

def f():
    y = x + 1
    print(y)
    return

print(x)
f()
print(x)
```

```
x = 1

def f(y):
    z = x + y
    return z

print(x)    <-- output global variable x
print(f(2)) <-- output local variable z
print(x)    <-- output global variable x
```

Local Variables

Local and global variables can have the same name

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```
x = 1

def f():
    x = 2
    return x

print(x)
print(f())
print(x)
```

Local Variables

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```
x = 1

def f():
    x = 2
    return x

print(x)
print(f())
print(x)
```

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def f():
    x = 2
    return x

print(x)
print(f())
print(x)
```

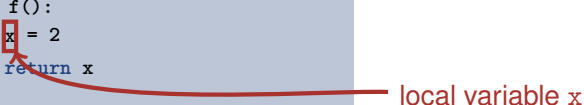

Local Variables

Local and global variables can have the same name

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```
x = 1

def f():
    x = 2
    return x

print(x)
print(f())
print(x)
```

Local Variables

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```
x = 1

def f():
    x = 2
    return x

print(x)
print(f())
print(x)
```

output global variable x

Local Variables

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```
x = 1

def f():
    x = 2
    return x

print(x)      <-- output global variable x
print(f())    <-- output local variable x
print(x)
```

Local Variables

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```
x = 1

def f():
    x = 2
    return x

print(x)      <-- output global variable x
print(f())    <-- output local variable x
print(x)      <-- output global variable x
```

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```
x = 1

def f():
    x = 2
    return x

print(x)
print(f())
print(x)
```

```
x = 1

def f(x):
    x = x + 1
    return x

print(x)
print(f(2))
print(x)
```

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    x = 2
    return x

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print(f())
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```

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def f(x):
    x = x + 1
    return x

print(x)
print(f(2))
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def f(x):
    x = x + 1
    return x

print(x)
print(f(2))
print(x)
```

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def f():
    x = 2
    return x

print(x)
print(f())
print(x)
```

```
x = 1

def f(x):
    x = x + 1
    return x

print(x)
print(f(2))
print(x)
```

parameter x gets new value that depends on its current value

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def f():
    x = 2
    return x

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print(f())
print(x)
```
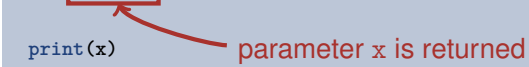

```
x = 1

def f(x):
    x = x + 1
    return x

print(x)
print(f(2))
print(x)
```



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print(f())
print(x)
```

```
x = 1

def f(x):
    x = x + 1
    return x

print(x)
print(f(2))
print(x)
```

output global variable x

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```
x = 1

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    x = 2
    return x

print(x)
print(f())
print(x)
```

```
x = 1

def f(x):
    x = x + 1
    return x

print(x)    <-- output global variable x
print(f(2)) <-- output parameter x
print(x)
```

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def f():
    x = 2
    return x

print(x)
print(f())
print(x)
```

```
x = 1

def f(x):
    x = x + 1
    return x

print(x)      <-- output global variable x
print(f(2))   <-- output parameter x
print(x)      <-- output global variable x
```

Thanks for your attention