CSCI 141

Lecture 11:
More turtles, `for` loops and the `range` function

Special Announcements from Merril Hunt-Paez

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AWC Website: https://wwu-awc.github.io/

Contact AWC: awc.wwu@gmail.com

Contact Merril: huntpam@wwu.edu

Happenings

Tuesday, 4/30 – ACM Hackathon Presentations & Recap

– 5 pm in CF 316

Tuesday, 4/30 – AIA Presents: Intro to SQL and Databases

– 6 pm in PH 228

Wednesday, 5/1 -- Peer Lecture Series: GDB Workshop

– 5 pm in CF 162

Announcements

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- Exam is next Friday

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  - 50 minutes

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  - Closed-book; no notes

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  - 50 minutes
  - Closed-book; no notes
  - No calculators (there won’t be any hard arithmetic)

Sample Exam Questions

- Submit one sample exam question, along with its solution to Canvas by 1pm Monday
  - Worth 1% extra credit on midterm exam.
  - I will post sample questions and solutions by Monday night.
  - I will choose one question to include on the exam.
  - Canvas assignment with more detailed instructions will go up today.

Study Tips

Reading is not enough: **solve problems**.

- **Goals** slides: can you do these things? Try and see.
- **Terminology**: be able to discuss the meaning of all words that appear in blue in the slides
- **ABCD questions**: solve it before looking at the answer (if provided)
- **Demo code**: solve the same problem without without looking at my code.
- **Homework questions**: understand what you got wrong and why. Understand what you got right and why.
- **Exercises** from the eBook

Goals

- Know how to use `import` statements to get access to modules containing functions that other people have written.
- Understand how to create a Turtle object and call its methods to move it around the screen and draw simple shapes.
    - Methods: `forward, left, right, penup, pendown`
- Know the syntax and behavior of the `for` statement (`for` loop)
- Know how to use the `range` function in the header of a `for` loop.

Last time: Modules

The Python Standard Library is a collection of modules containing many more functions.

To use functions in a module, you need to import the module using an `import` statement:

```
import module
```

By convention, we put all import statements at the **top** of programs.

Last time: Modules

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To use functions in a module, you need to import the module using an `import` statement:

```
import module
```

(replace the in `this font` with the specific module name)

By convention, we put all import statements at the **top** of programs.

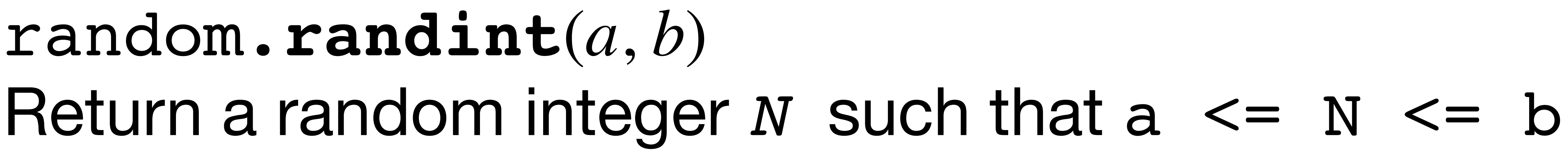
Last time: Modules

Once you've imported a module:

```
import random
```

you can call functions in that module using the following syntax:

```
random.randint(0,10)
```



`random.randint`(a, b)
Return a random integer N such that `a <= N <= b`

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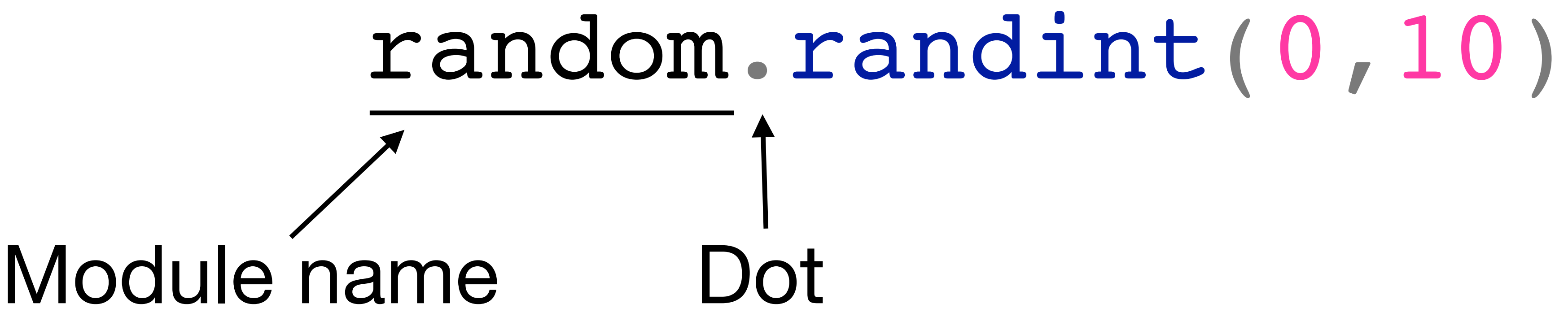

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Dot

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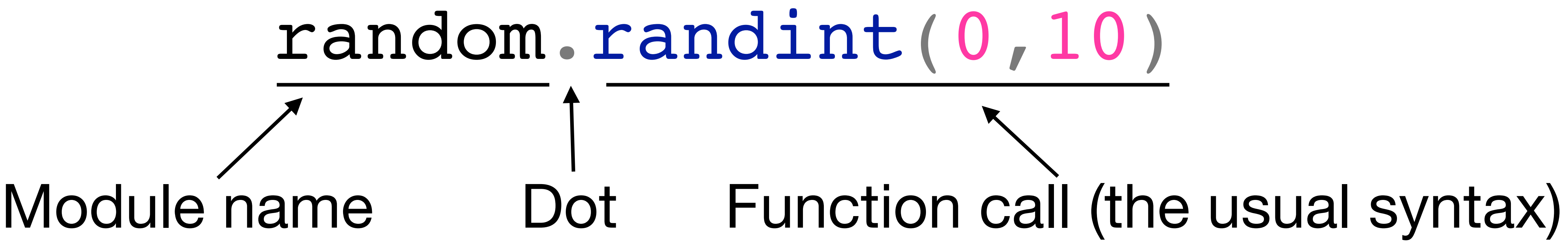


```
random.randint(0,10)
```

Module name

Dot

Function call (the usual syntax)

`random.`**`randint`**(a, b)

Return a random integer N such that `a <= N <= b`

More on import statements

Import the entire module:

```
import random
num = random.randint(1, 10)
```

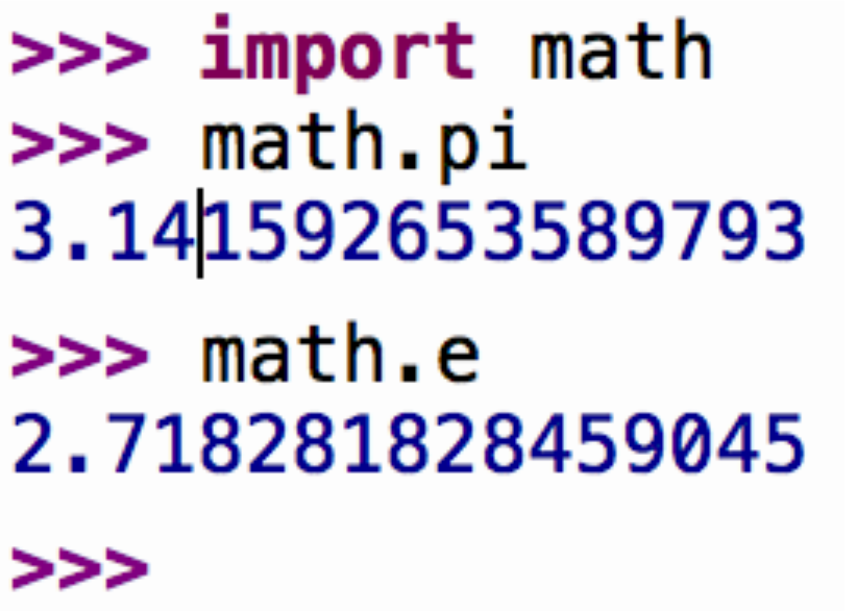
Import a specific function:

```
from math import sin
sin0 = sin(0)
```

- Don’t need module name dot notation
- Other `math` methods are not accessible:
    - `math.sqrt(4)` will throw an error
    - `math.sin(0)` will throw an error

`math` module

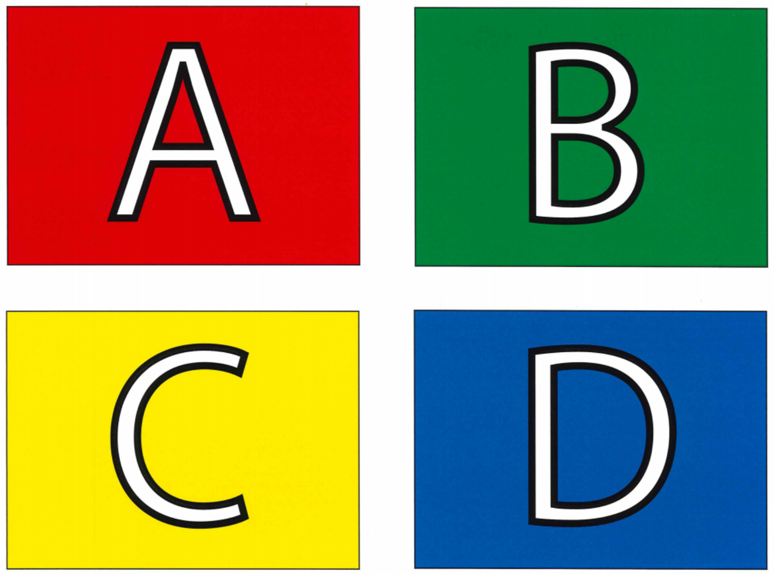
- The math module has useful stuff!
- You can read about it in the documentation.
- logarithms, trigonometry, …
- Modules can also contain values:



```
>>> import math
>>> math.pi
3.141592653589793
>>> math.e
2.718281828459045
>>>
```

import statements

Which of the following correctly computes the are of a circle with radius 4?



A

```
from math import pi
area = math.pi * 4**2
```

B

```
import math
area = math.pi * 4**2
```

C

```
from math import pi
area = (pi * 4)**2
```

D

```
import pi
area = pi * 4**2
```

import statements

Which of the following correctly computes the are of a circle with radius 4?

Only `pi` is available:
`math` is not imported.

A

```python
from math import pi
area = math.pi * 4**2
```

This works!

B

```python
import math
area = math.pi * 4**2
```

Formula is wrong!

C

```python
from math import pi
area = (pi * 4)**2
```

There is no `pi` module.

D

```python
import pi
area = pi * 4**2
```

`turtle` module

Python has Turtles!

```
import turtle
scott = turtle.Turtle()
```

turtle module

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Basic turtle methods

- forward: moves the turtle forward
- left/right: turns the turtle
- penup/pendown: turns drawing on and off

Creating and Using Objects

```python
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scott = turtle.Turtle()
```

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The `Turtle()` function starts with a capital letter.
By convention this indicates that it is a special kind of function called a constructor that creates (and returns) new objects of type `Turtle`.

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The Turtle() function returns a Turtle object, and the variable `scott` now refers to it.

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Objects can have functions associated with them, accessed via the dot notation, e.g.:

```
turtle.forward(10) # moves the turtle forward 10 units
turtle.left(90) # turns the turtle left 90 degrees
```

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```
turtle.forward(10) # moves the turtle forward 10 units
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```

What methods do Turtles have? Lots!
Check the docs: https://docs.python.org/3.3/library/turtle.html?highlight=turtle

Algorithms with Turtles

Task: Write pseudocode for an algorithm to draw a square with side length 100:

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Can we do better?

Algorithms with Turtles

Task: Write pseudocode for an algorithm to draw a square with side length 100:

```
Repeat 4 times:
    1. move forward 100
    2. turn left 90
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Demo

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- turtle_square.py: Write a loop-based program that makes a turtle and draws a square with it.

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```

We (almost) can! Using `for` loops.

The `for` statement: syntax

```
for var_name in sequence:
    codeblock
```

The for statement: syntax

for keyword

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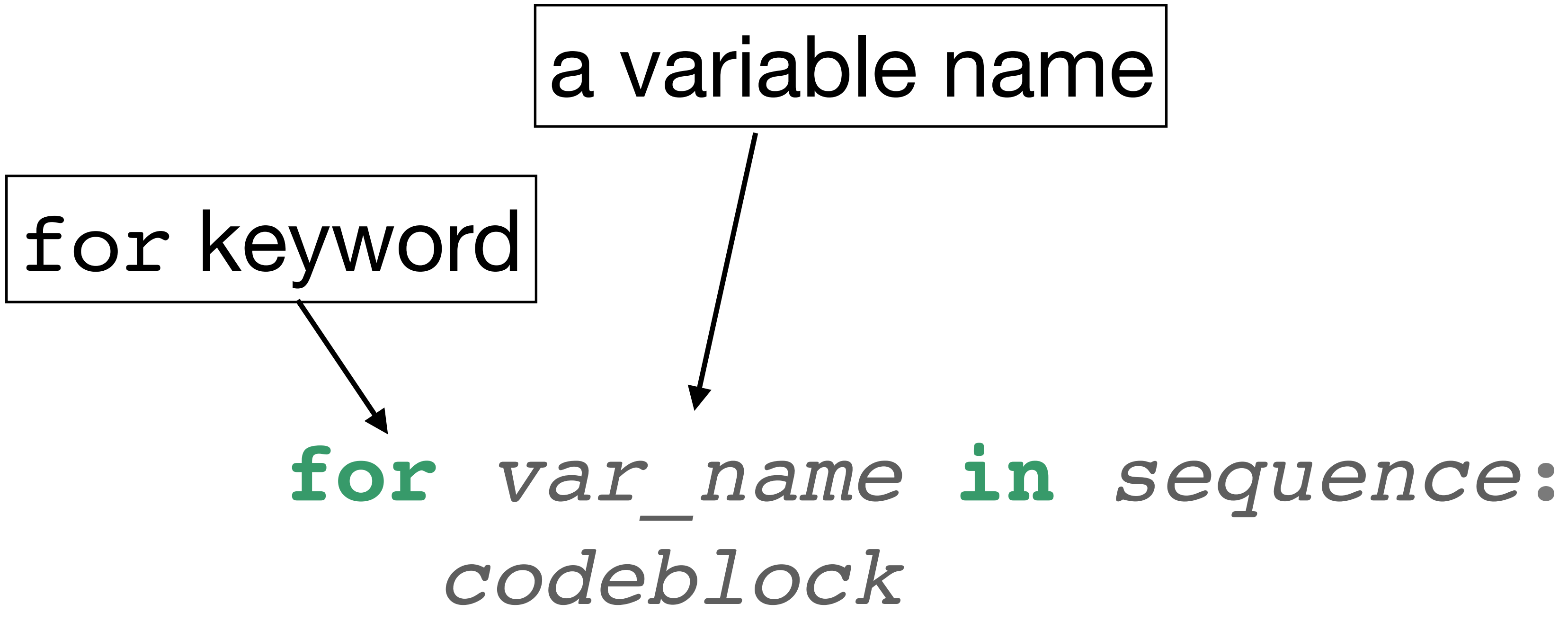

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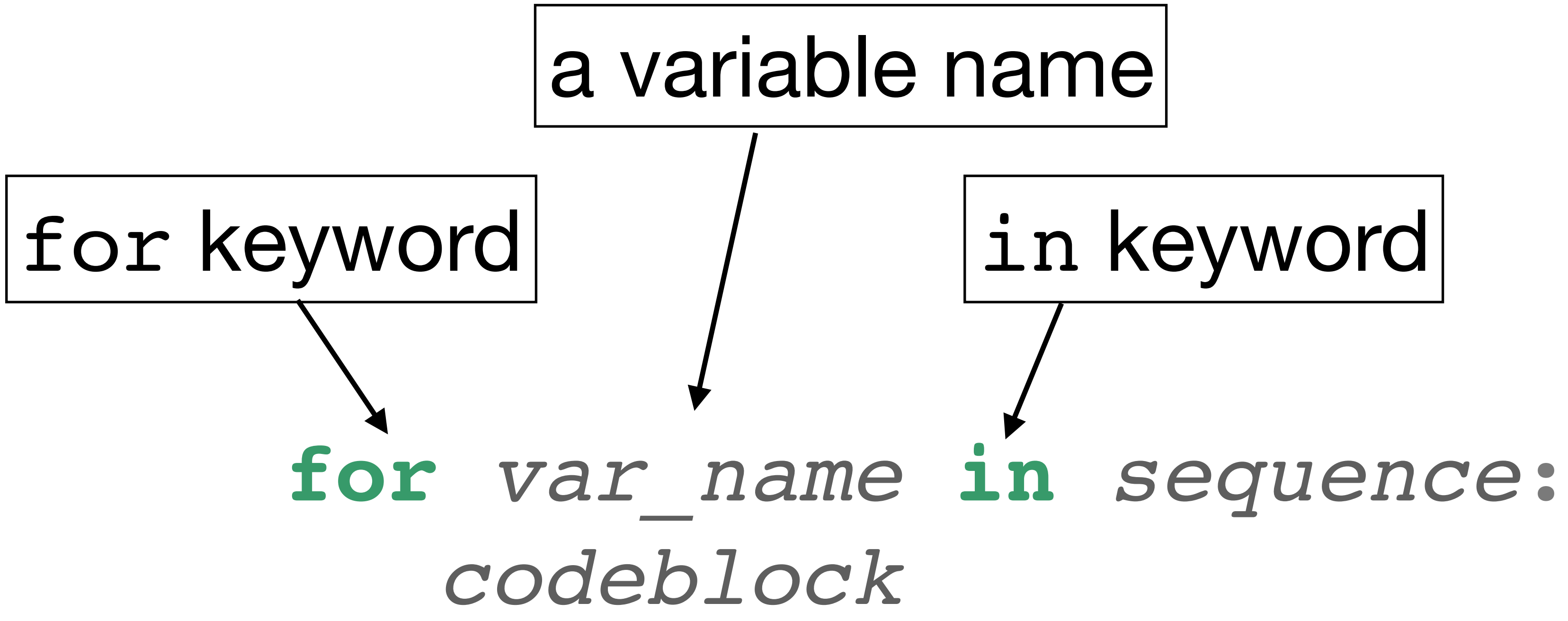

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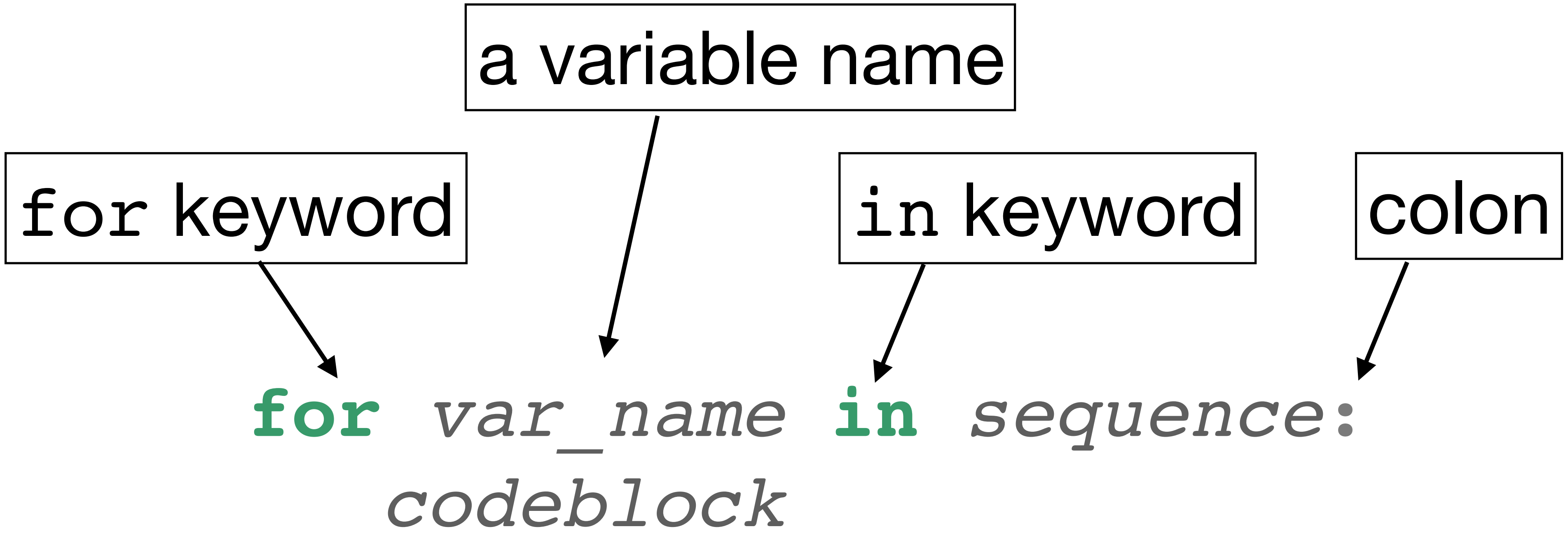

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colon

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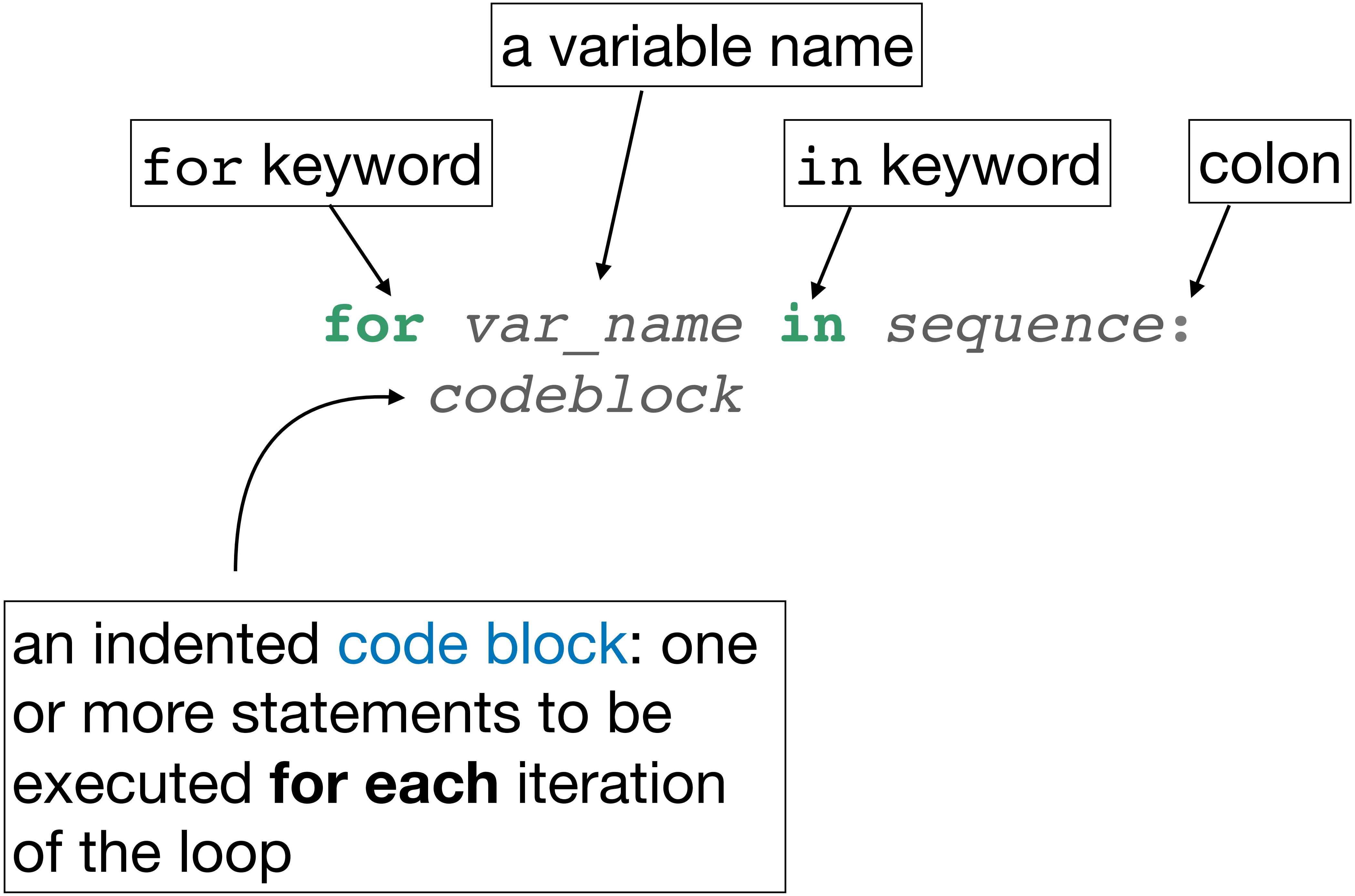

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an indented code block: one or more statements to be executed **for each** iteration of the loop

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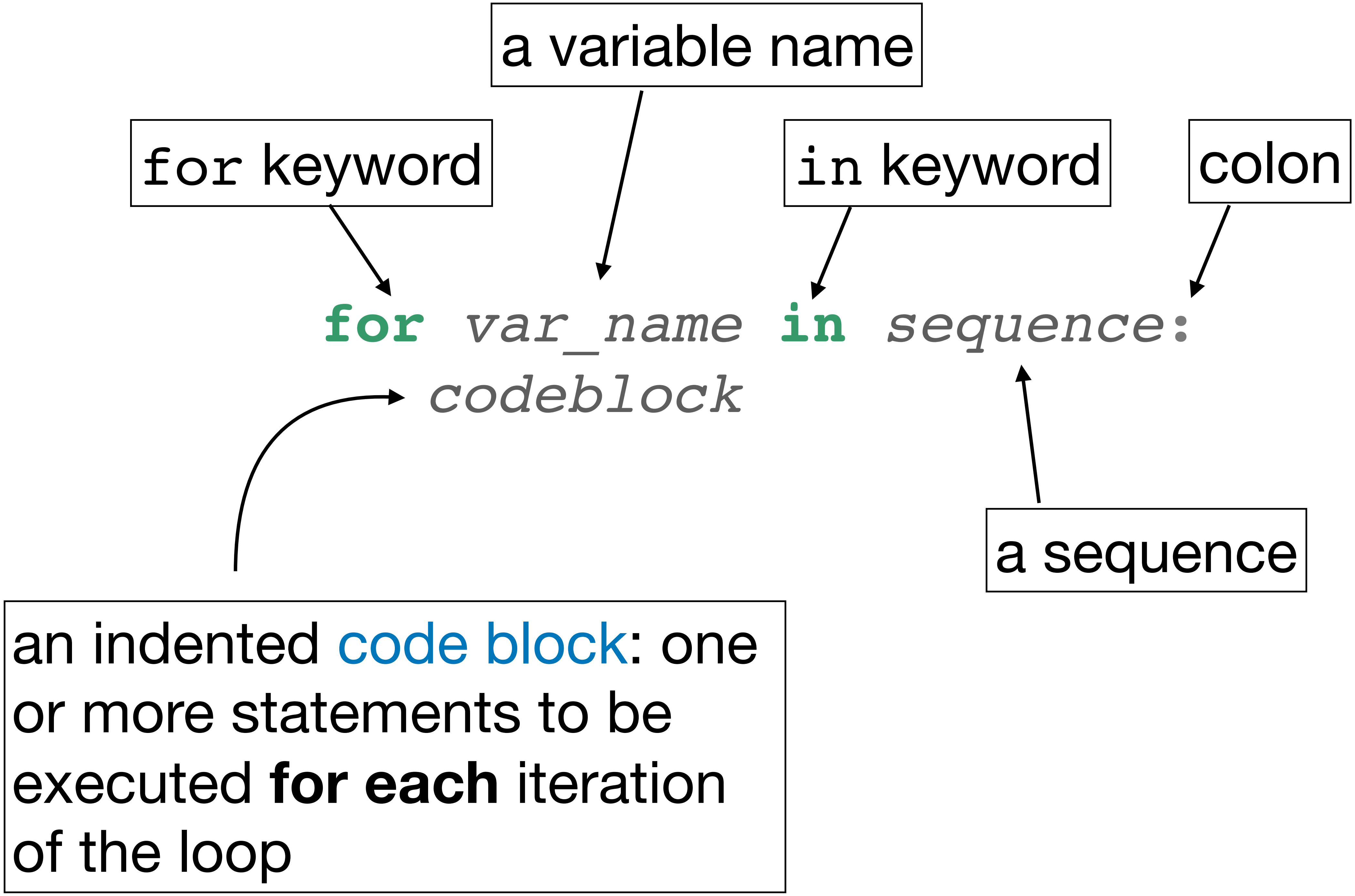

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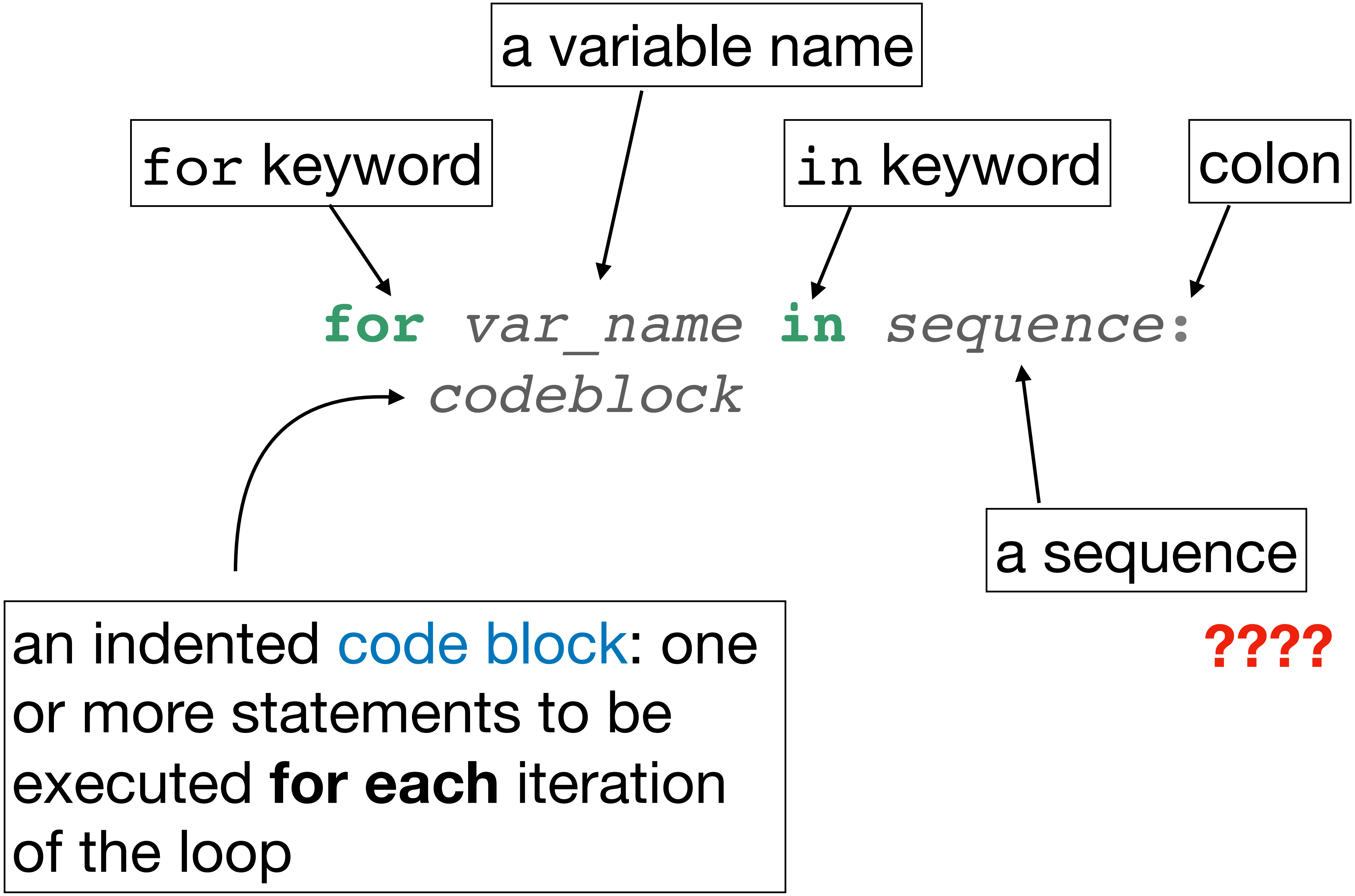

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????

Sequences in Python: Lists

```python
for color in ["red", "green", "blue"]:
    print(color)
```

This code prints:

```
red
green
blue
```

Sequences in Python: Lists

```
for color in ["red", "green", "blue"]:
    print(color)
```

This is a `list`: an ordered collection of values.
Much more on these later.

This code prints:

```
red
green
blue
```

The `for` statement: behavior

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The loop body is executed once **for each** value in the sequence (list).

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In *each* iteration, the loop variable (`color`)

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The loop body is executed once **for each** value in the sequence (list).

This code prints:

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red
green
blue
```

In *each* iteration, the loop variable (`color`) takes on a *different* value from the sequence:

The `for` statement: behavior

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for color in ["red", "green", "blue"]:
    print(color)
```

The loop body is executed once **for each** value in the sequence (list).

This code prints:

```
red
green
blue
```

In *each* iteration, the loop variable (`color`) takes on a *different* value from the sequence:

(`"red"`, then `"green"`, then `"blue"`)

The `for` statement: behavior

```
for color in ["red", "green", "blue"]:
    print(color)
```

The loop body is executed once **for each** value in the sequence (list).

This code prints:

```
red
green
blue
```

In *each* iteration, the loop variable (`color`) takes on a *different* value from the sequence:

(`"red"`, then `"green"`, then `"blue"`)

Notice: the loop variable gets updated **automatically** after each iteration!

Sequences in Python: Ranges

Lists are great if you have a list of things, but what about:

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Lists are great if you have a list of things, but what about:

“Do `someThing()` 10 times”? ugh.

```
for i in [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]:
    someThing()
```

Sequences in Python: Ranges

Lists are great if you have a list of things, but what about:

“Do `someThing()` 10 times”? ugh.

```
for i in [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]:
    someThing()
```

New function to the rescue: `range` makes it easy to generate lists like this.

Sequences in Python: Ranges

```python
for i in range(5):
    print(i)
```

This code prints:

```
0
1
2
3
4
```

Sequences in Python: Ranges

```
for i in range(5):
    print(i)
```

The range function returns a sequence of integers.

This code prints:

```
0
1
2
3
4
```

Sequences in Python: Ranges

```
for i in range(5):
    print(i)
```

The `range` function returns a sequence of integers.

Not technically a list, but acts like one: more on this later

This code prints:

```
0
1
2
3
4
```

Sequences in Python:
the `range` function

Sequences in Python: the range function

```
for i in range(5):
    print(i, end=“ “)
```

prints: 0 1 2 3 4

Sequences in Python: the `range` function

`range(a)`: from **0** *up to* but *not including* **a**

```
for i in range(5):
    print(i, end=“ “)
```

prints: 0 1 2 3 4

Sequences in Python: the `range` function

`range(`**`a`**`)`: from **0** *up to* but *not including* **`a`**

```
for i in range(5):
    print(i, end=“ “)
```

prints: 0 1 2 3 4

```
for i in range(2, 5):
    print(i, end=“ “)
```

prints: 2 3 4

Sequences in Python: the `range` function

`range(a)`: from **0** *up to* but *not including* **a**

```
for i in range(5):
    print(i, end=“ “)
```

prints: 0 1 2 3 4

`range(a, b)`: from **a** *up to* but *not including* **b**

```
for i in range(2, 5):
    print(i, end=“ “)
```

prints: 2 3 4

Sequences in Python: the `range` function

`range(`**`a`**`)`: from **0** *up to* but *not including* **`a`**

```
for i in range(5):
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prints: `0 1 2 3 4`

`range(`**`a, b`**`)`: from **a** *up to* but *not including* **`b`**

```
for i in range(2, 5):
    print(i, end=“ “)
```

prints: `2 3 4`

```
for i in range(1, 8, 3):
    print(i, end=“ “)
```

prints: `1, 4, 7`

Sequences in Python: the `range` function

`range(`**`a`**`)`: from **0** *up to* but *not including* **a**

```
for i in range(5):
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```

prints: 0 1 2 3 4

`range(`**`a`**`, `**`b`**`)`: from **a** *up to* but *not including* **b**

```
for i in range(2, 5):
    print(i, end=“ “)
```

prints: 2 3 4

`range(`**`a`**`, `**`b`**`, `**`c`**`)`: sequence from **a** *up to* but *not including* **b** counting in *increments* of **c**

```
for i in range(1, 8, 3):
    print(i, end=“ “)
```

prints: 1, 4, 7

Converting ranges to lists

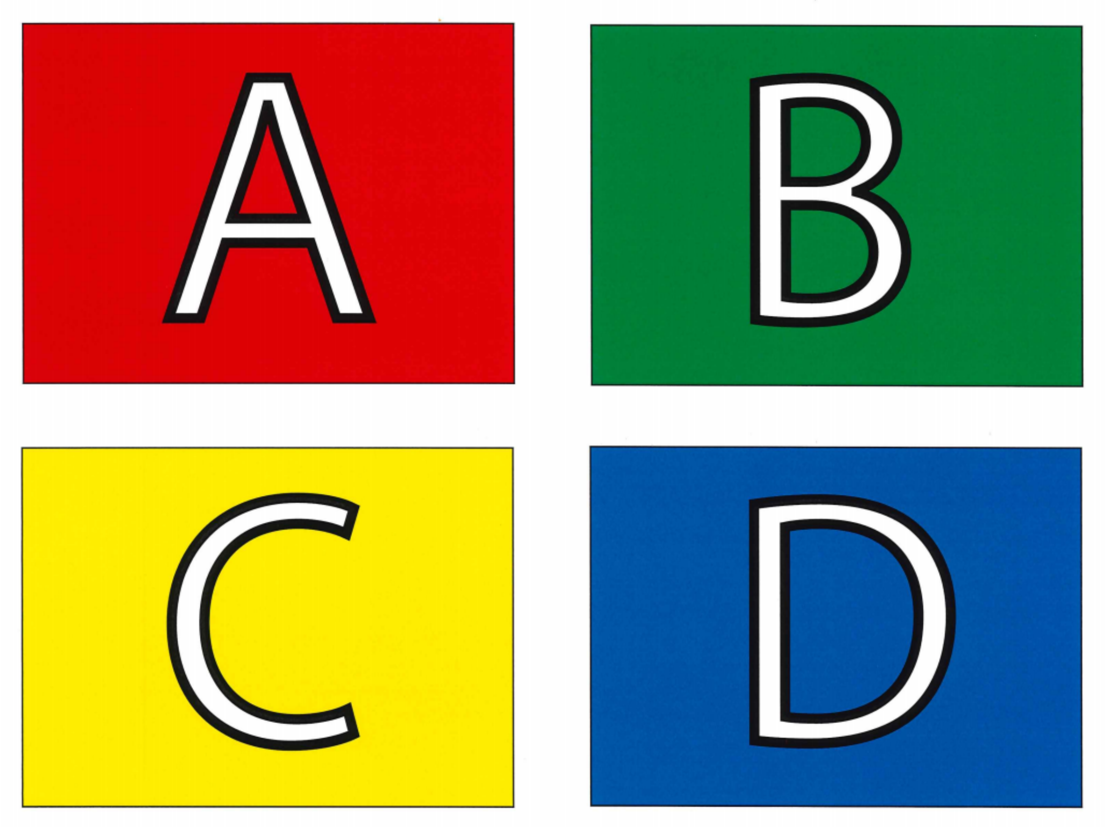
The `range` function returns a sequence of integers.

It’s not technically a list: print(range(4)) does not print `[1, 2, 3]`

To turn the range into a list (e.g., to print it), we can use the list function:

```
list(range(2, 5)) => [2, 3, 4]
```

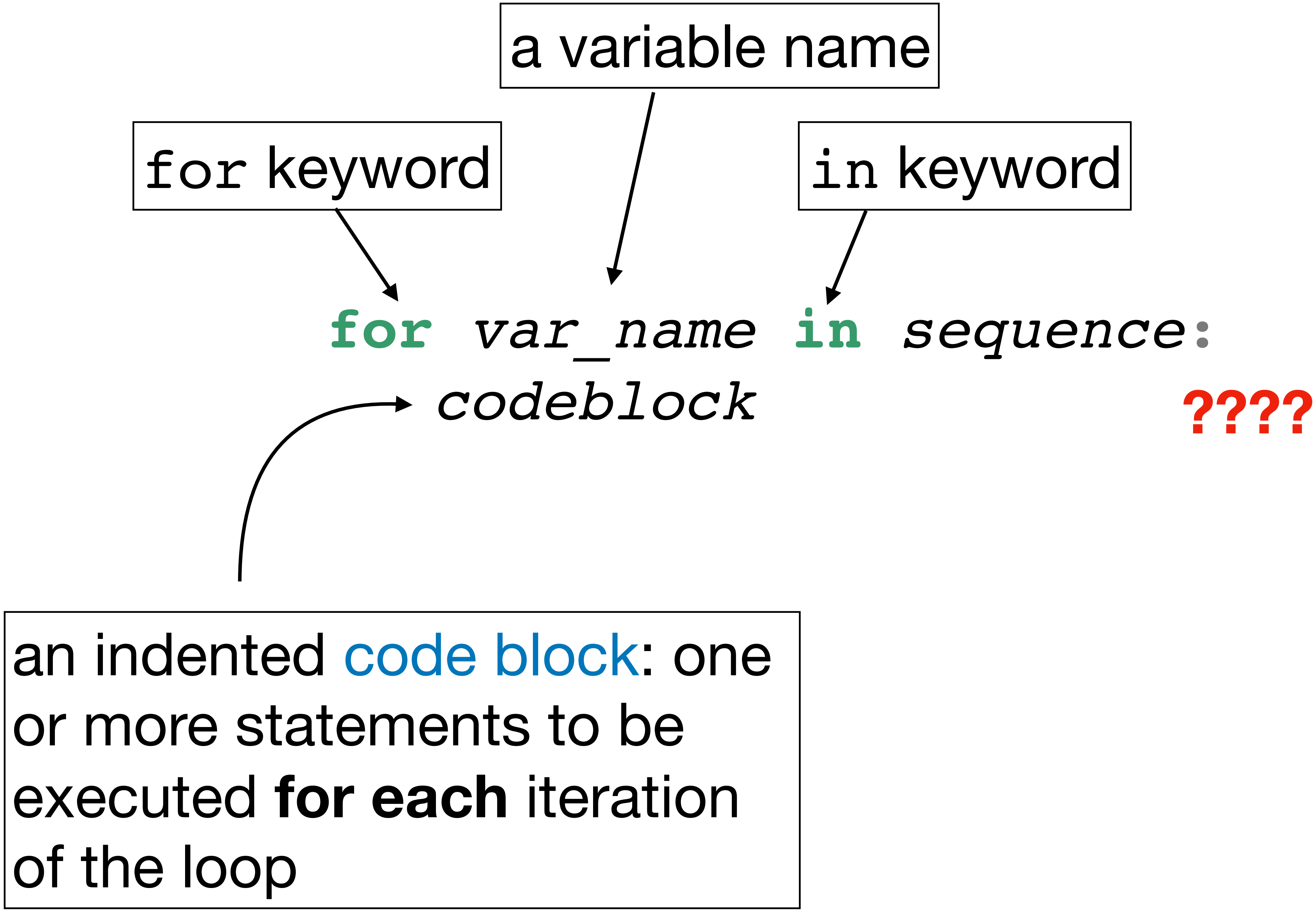
Range function: Demo



Range function: Demo

- range_demo.py

Back to `for` loops...



a variable name

`for` keyword

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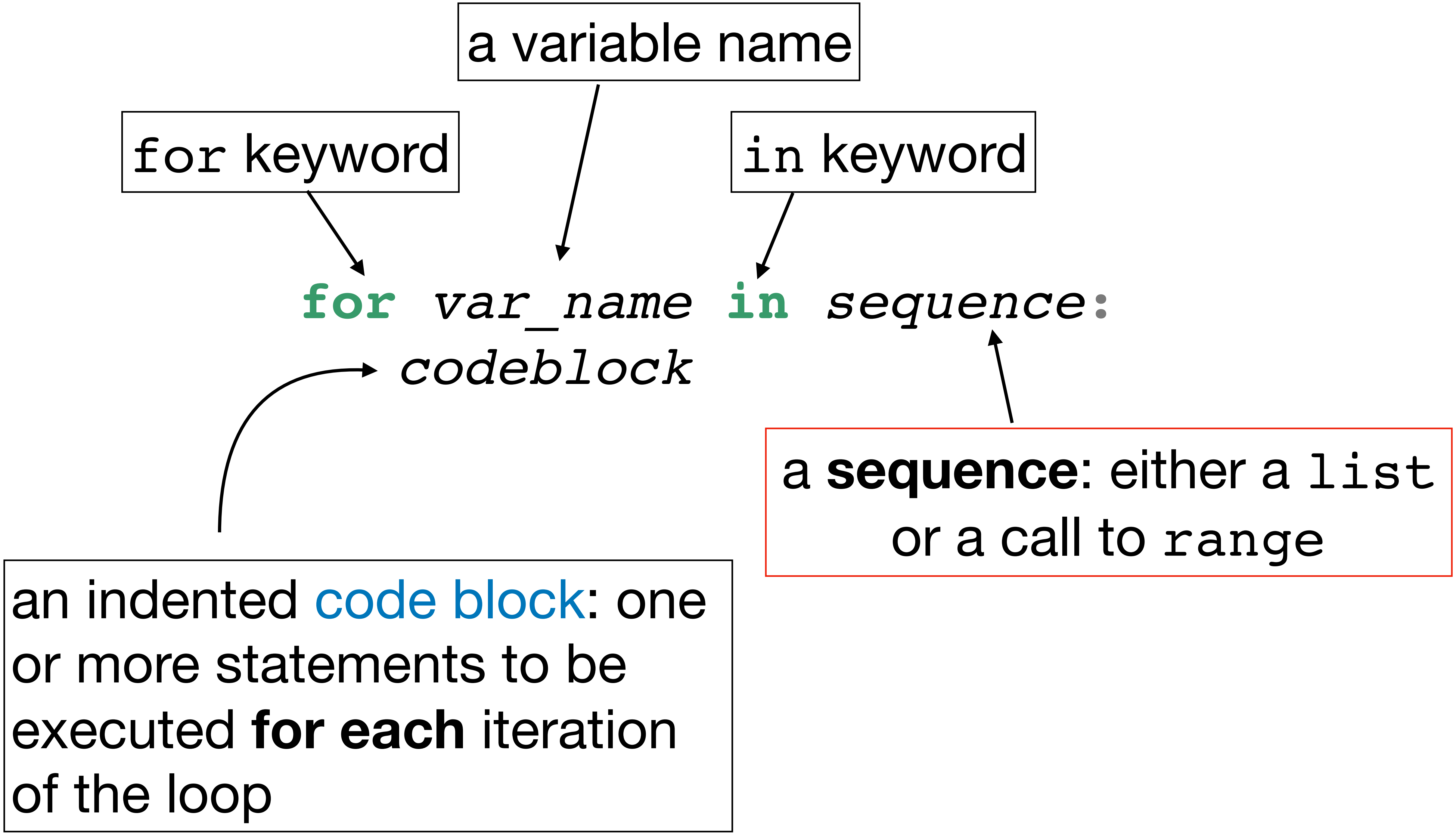
an indented code block: one or more statements to be executed **for each** iteration of the loop

Back to `for` loops...



a variable name

`for` keyword

`in` keyword

```
for var_name in sequence:
    codeblock
```

a **sequence**: either a `list` or a call to `range`

an indented code block: one or more statements to be executed **for each** iteration of the loop

Today’s Quiz

- 3 minutes

Today’s Quiz

- 3 minutes
- Working with a neighbor: do your answers agree? (2 minutes)

Demo

- turtle_square.py, revisited: let’s rewrite this with a for loop.

Generalized Squares, AKA Equilateral Polygons

Exercise 4: Write code that makes the Turtle object `scott` draw an n-sided polygon, where n and the length of each side are given by the user.

Hint: the total amount the turtle needs to turn is 360 degrees.
Code from turtle_square:

```
import turtle

scott = turtle.Turtle()
for i in range(4):
    scott.forward(100)
    scott.left(90)
```

Additional Suggested Practice Problems

1. Make a Turtle do a random walk: write a program that repeats the following 100 times:

   - Move the turtle a random distance forward.
   - Turn the turtle a random amount.

2. Re-write the dice exercise from last time using `for` loops (it's simpler this way!)