Variables

Content

- What is a variable?
- Data types
- Mutability (constant vs variable)
- Scope and visibility
- Preallocation

What is a variable

- **Location** where a value is stored

Variable: a 

Address	Value
000	NULL
001	5
002	8
003	NULL

What is a variable

- **Location** where a value is stored
- Every variable has:
  - Type (statically typed languages)
  - Variable name (identifier)
  - Value

```
int a = 5;
```

Data types

Name	Shorthand	What
Integer	int	Whole numbers
Floating-point number	float	32-bit number with digits after decimal place
Double precision float	double	64-bit number with digits after decimal place
Boolean (logical in MATLAB)	bool (logical in MATLAB)	Value that's either true or false (0 or 1)
Array (1D is a vector)	~	A list of variables, depending on the language this can be further divided into lists, arrays, vectors, queues, etc.
Character	char	A single (ASCII) character
String	string or str	A list or array of characters

Typing

- Statically typing
  - Languages: C (Igor), Java, PEARL
  - Variable has one type
  - Type preassigned

```
int a = 5;
```

Typing

- Statically typing
  - Languages: C (Igor), Java, PEARL
  - Variable has one type
  - Type preassigned
- Dynamically typing
  - Languages: MATLAB, Python, R, Perl
  - Value has one type
  - Type of variable may change

```
a = 5
```

Type casting

- Explicitly converting type of a variable or value
- Only in dynamically typed languages
- Especially relevant for numerical types
- Reasons for casting:
  - Increase precision/memory
  - Reduce precision
  - Cast base type to derived type

Mutability

- Variable
  - Value dynamically assigned
  - Value may change during run-time
- Constant
  - Value assigned at initialization
  - Value cannot be changed

```
const float PI = 3.1415927;
```

Mutability

- Depending on the language more subtypes available
- Other languages don't have constant modifiers
  - Workarounds if needed
  - Use naming conventions: ALL_CAPS

```
MY_CONSTANT = 3.1415927
```

Mutability: why use constants?

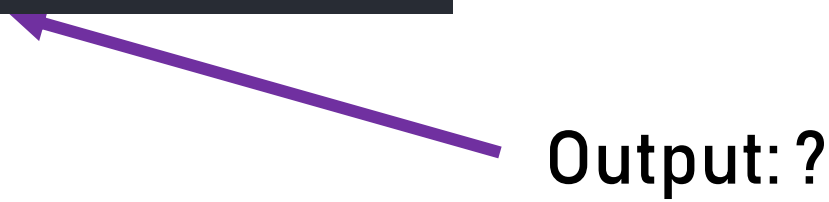
- Users are stupid!
- Reminder for yourself
- Physical constants (pi, N of Avogadro, etc)

Scope

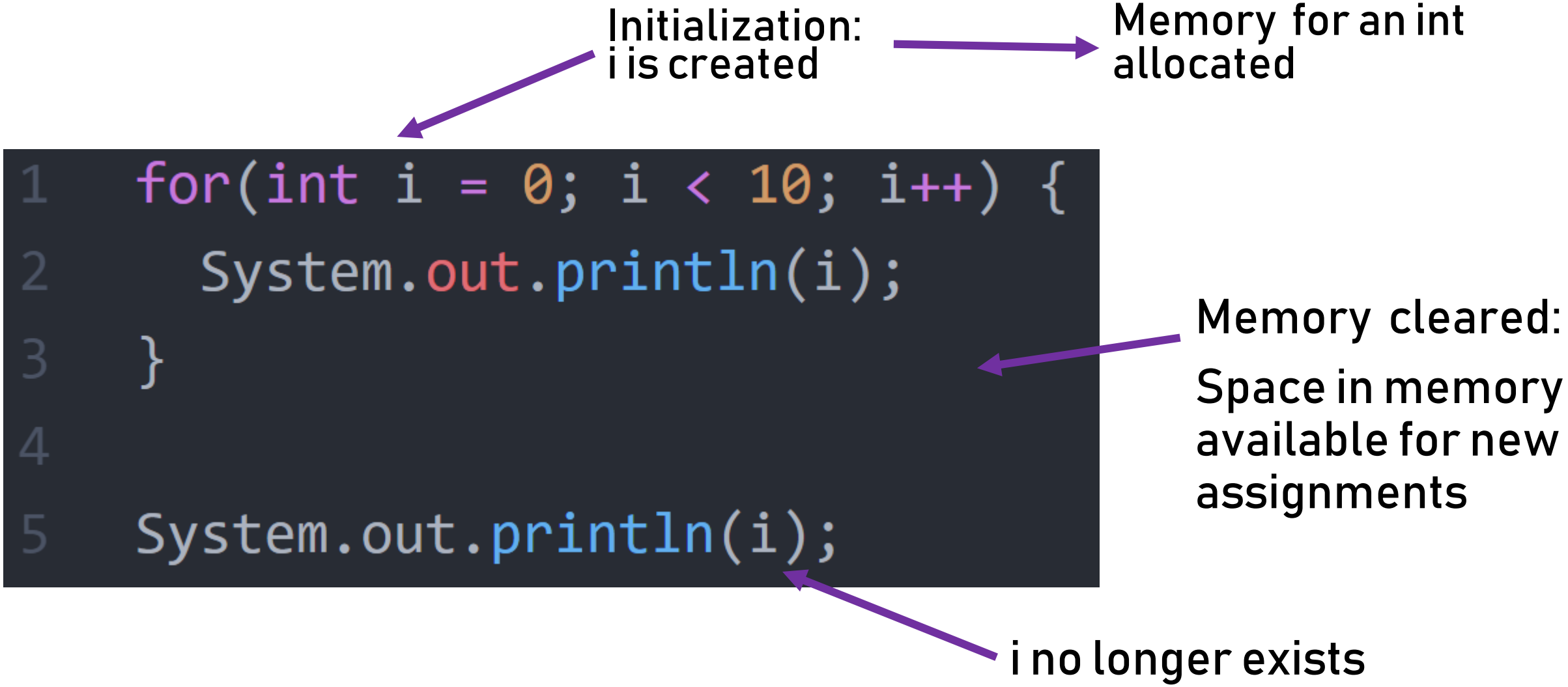
- Lifetime of a variable
- MATLAB is an exception
- Important for memory allocations

Scope

```
1   for(int i = 0; i < 10; i++) {
2       System.out.println(i);
3   }
4
5   System.out.println(i);
```



What is happening?



Function example

```
1   void main () {
2      /* local variable definition */
3      int a = 100;
4      res = myFunction(a);
5      print(res);
6      print(a);
7   }
8
9   int myFuntion(int a) {
10     a = a + 100;
11     return a;
12  }
```

Output: ?

Output: ?

Levels of scope

- Blocks (not all languages!)
- Functions
- Module/Class
- Global

Scope modifiers

- Most language allow you to make a variable global
  - Automatic if outside function
  - Only use in dire need!

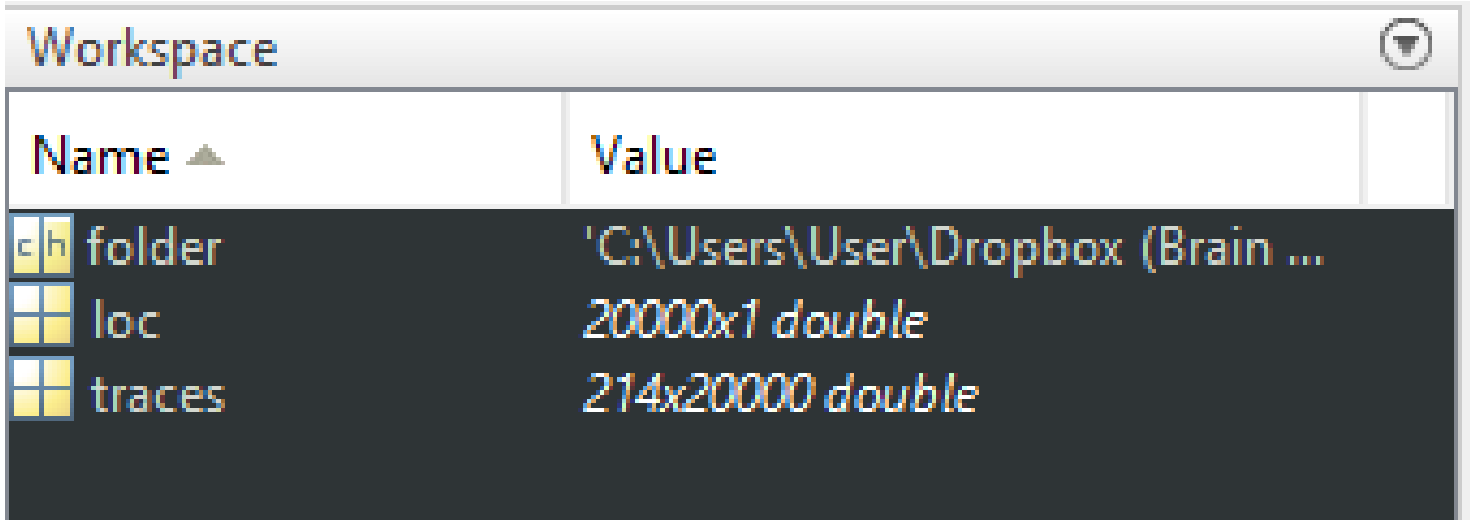
```
global i;
i = 0;

addValue(5);
disp(i)
addValue(3);
disp(i)
```

```
function addValue(v)
    global i;
    i = i + v;
end
```

MATLAB

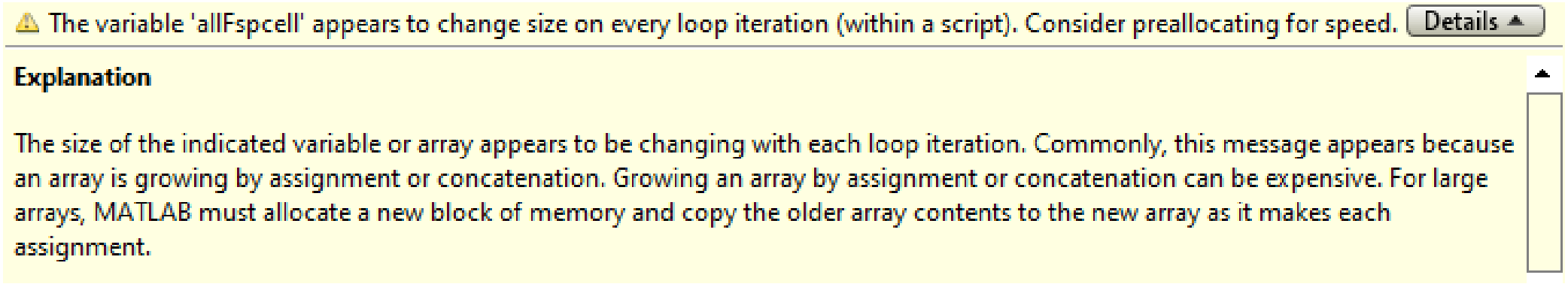
- Workspace shows scope
- Variables don't get deleted after for-loop
- Each function has it's own workspace



Variables initiated, so available in scope

A word on preallocation

- You might have gotten this error (MATLAB):



- What's going on here?

Allocation example

Allocate space for empty list (say 8 bit)

```
newArray = [];
for i = 1:10
    newArray = [newArray, i];
end
```

- Add int to the allocated space, so need 8 bits more
- Memory not always linear!

What to do?

- No problem if small array
- Preallocate the largest possible number of values

```
newArray = nan(10,1);
```

What to do?

- No problem if small array
- Preallocate the largest possible number of values
- Preallocate in chunks (i.e. every 1000 values add an extra 1000 values)

Summary

- What is a variable?
  - **Location** where a value is stored
- Data types
  - Statically vs dynamically
  - Type casting
- Mutability (constant vs variable)
  - Single value for a variable
- Scope and visibility
  - Memory allocation
  - MATLAB: use functions!
- Preallocation
  - May speed up your code