# CS 1181
# Week Seven

Reese Hatfield

# Generics and Types

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# Aside: Queues + Priority Queues

- You will need this for project

- Queue<Type> q = new ArrayDeque<>();
- Queue<Type> q = new LinkedList<>();

- PriorityQueue<> pq = new PriorityQueue<>

# What is a type?

- Data-types
  - Primitives (int, double, etc)
  - Wrapper (Integer, Double, etc)

- CustomArrayList
  - How would you handle supporting different types?

# What is a type?

- Overloaded methods?
  - Very clunky
  - Significant code duplication

- Object class?
  - Lose type information
  - Would need to cast/check everywhere

# What is a type?

- What if we could define the datatype itself as a parameter?

- What if we could do something like:
- void doThing(parameters, return Type)

- Reuse the body of the code

# Generics

- This is what generics let us do

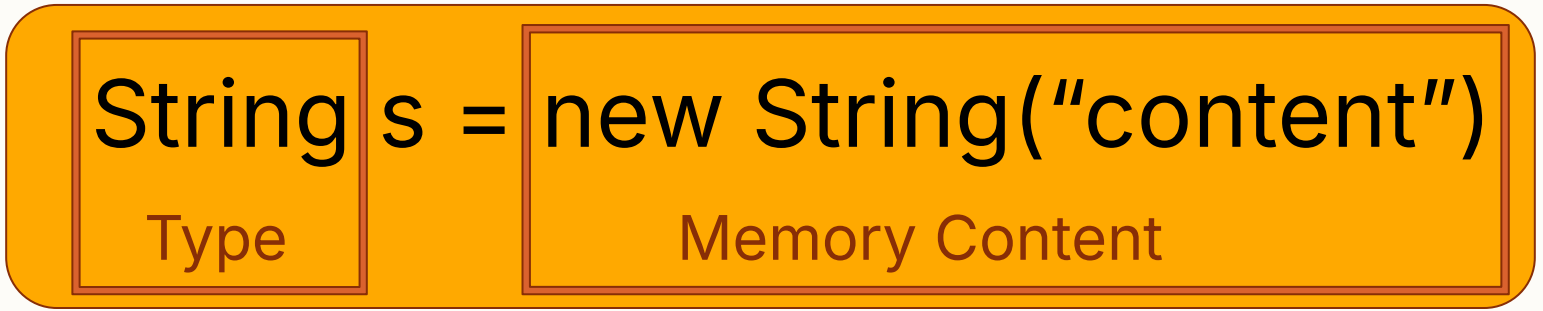
- Usually defined with <>
- You've used them already
  - ArrayList<Type>
  - Queue<Type>
  - etc.

# Generics

- Change a datatype
  - At *compile time*

- Compile time change ensures that we can't change the type later
  - Object class would not promise this

# Essence of a Type



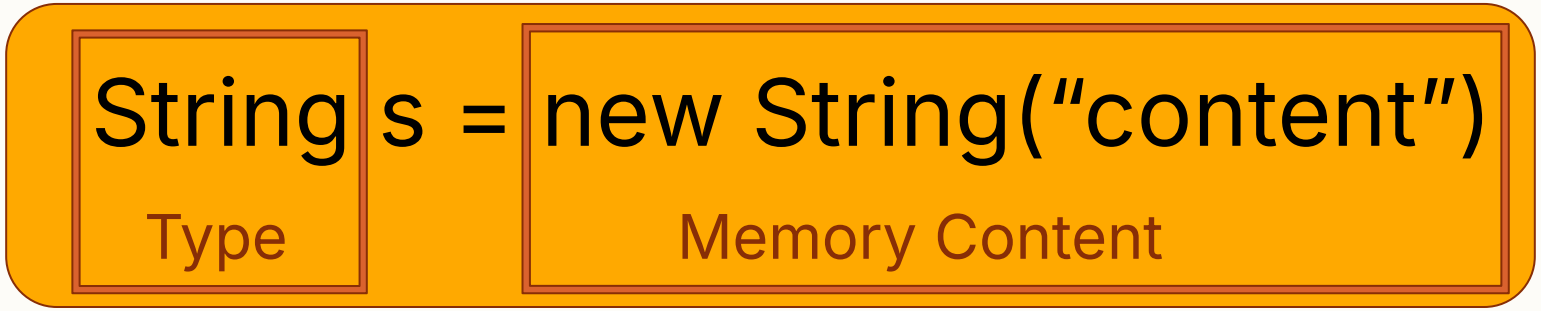
# Essence of a Type

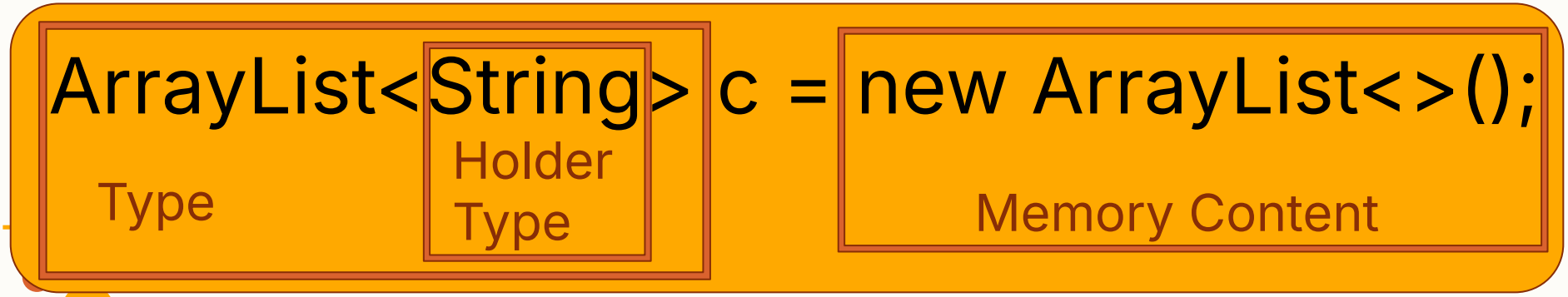
String s = new String(“content”)

Type — Memory Content

```
ArrayList<String> c = new ArrayList<>();
```

# Essence of a Type



# Generics

- Usually two places where you can define generics
  - Generic methods (rare)
  - Generic classes (common)

- public <T> void print(T item){...}
- public class Box<T> {...}

# Generics

```
public class Box<T>
```

- “T” becomes the type parameter
- T → whatever it’s defined as

```
Box<Integer> = new Box<>(5)
```

- It becomes an integer in this case

# Generics

- We can have as many of these as we want!

```
Box<Integer> = new Box<>(5)
```

```
Box<String> = new Box<>(“abc”)
```

# Generics

- “T” is common for “Type”
  - Can use whatever makes sense
- You’ll commonly see:
  - T (type)
  - K (key)
  - V (value)
  - E (element)

# Generics

- Can include more than one parameter type
- public class Thing<T1, T2>
- Let’s see that!

# Pair

- I want a class like Box, but it can hold two types
- Pair?
- I would like my pairs to only have the first be a number type

# Pair

- How can I sort something if I don't know the type ahead of time?

- I only know it once it has been created
- But Java itself *is* aware of the type
- Want to not compile if type is invalid

# Pair

- Use the *extends* keyword
- Limit the type to only types that are a subtype of what we want
- Bounded Type Parameters

- <T extends Number>
- <T extends String>

# Pair

- Extends even when using an interface
  - <T extends Comparable<T>>

- Comparable itself is an generics
- Let’s use this to make our Pair class sortable

# Pair

- Let’s use this for something more useful!
- Let’s write our own ArrayList class
- CustomArrayList<T>