Introduction to Objective-C

Kevin Cathey

Introduction to Objective-C

What are object-oriented systems?

What is the Objective-C language?

What are objects?

How do you create classes in Objective-C?

acm.uiuc.edu/macwarriors/devphone

Introduction to Objective-C

What are object-oriented systems?

What is the Objective-C language?

What are objects?

How do you create classes in Objective-C?

acm.uiuc.edu/macwarriors/devphone

What is an object-oriented system?

- Has four components:

What is an object-oriented system?

- Has four components:

Component	Example in iPhone Programming

What is an object-oriented system?

- Has four components:

Component	Example in iPhone Programming
A programming language	Objective-C

What is an object-oriented system?

- Has four components:

Component	Example in iPhone Programming
A programming language	Objective-C
Library of classes and functions for common tasks	CoreFoundation, Foundation, UIKit, CoreGraphics, CoreLocation, …

What is an object-oriented system?

- Has four components:

Component	Example in iPhone Programming
A programming language	Objective-C
Library of classes and functions for common tasks	CoreFoundation, Foundation, UIKit, CoreGraphics, CoreLocation, …
Suite of developer tools	Xcode, Interface Builder, Instruments

What is an object-oriented system?

- Has four components:

Component	Example in iPhone Programming
A programming language	Objective-C
Library of classes and functions for common tasks	CoreFoundation, Foundation, UIKit, CoreGraphics, CoreLocation, …
Suite of developer tools	Xcode, Interface Builder, Instruments
Runtime system that “runs” code at runtime	Objective-C Runtime

Introduction to Objective-C

What are object-oriented systems? ✓

What is the Objective-C language?

What are objects?

How do you create classes in Objective-C?

acm.uiuc.edu/macwarriors/devphone

Objective-C Programming Language

Objective-C Programming Language

- Similarities with C

Objective-C Programming Language

- Similarities with C
  - Strict-superset of C — **everything** that works in C works in Objective-C (unlike C++).

Objective-C Programming Language

- Similarities with C
  - Strict-superset of C — **everything** that works in C works in Objective-C (unlike C++).
  - Super-set because it adds object-oriented constructs.

Objective-C Programming Language

- Similarities with C
  - Strict-superset of C — **everything** that works in C works in Objective-C (unlike C++).
  - Super-set because it adds object-oriented constructs.
  - When compiling Objective-C, largely get turned into C.

Objective-C Programming Language

- Similarities with C
  - Strict-superset of C — **everything** that works in C works in Objective-C (unlike C++).
  - Super-set because it adds object-oriented constructs.
  - When compiling Objective-C, largely get turned into C.
- Derives a lot of design and functionality from Smalltalk.

Objective-C Programming Language

- Similarities with C
  - Strict-superset of C — **everything** that works in C works in Objective-C (unlike C++).
  - Super-set because it adds object-oriented constructs.
  - When compiling Objective-C, largely get turned into C.
- Derives a lot of design and functionality from Smalltalk.
- Typing

Objective-C Programming Language

- Similarities with C
  - Strict-superset of C — **everything** that works in C works in Objective-C (unlike C++).
  - Super-set because it adds object-oriented constructs.
  - When compiling Objective-C, largely get turned into C.
- Derives a lot of design and functionality from Smalltalk.
- Typing
  - Dynamic typing for Objective-C objects (classes).

Objective-C Programming Language

- Similarities with C
  - Strict-superset of C — **everything** that works in C works in Objective-C (unlike C++).
  - Super-set because it adds object-oriented constructs.
  - When compiling Objective-C, largely get turned into C.
- Derives a lot of design and functionality from Smalltalk.
- Typing
  - Dynamic typing for Objective-C objects (classes).
  - Static typing for C scalar and pointer types.

Objective-C Programming Language

- Another improvement over C
  - #import
    - Smart #include
    - No more #ifndef and #define __MYHEADER_H__

Introduction to Objective-C

What are object-oriented systems? ✓

What is the Objective-C language? ✓

What are objects?

How do you create classes in Objective-C?

acm.uiuc.edu/macwarriors/devphone

What are (Objective-C) objects?

What are (Objective-C) objects?

- In C, we have scalar types (`int`, `long`, `struct`) and pointers to those (including `void *`).

What are (Objective-C) objects?

- In C, we have scalar types (`int`, `long`, `struct`) and pointers to those (including `void *`).
- In Objective-C, we have C types, but also a core type called an object (or instance).

Objects are an instance of some type (or class) that contain nouns (instance variables) and act with verbs (methods).

Objects

Objects

- Instance variables — the nouns.
  - Data.
  - Store some state or information pertaining to the specific instance they reside in.

Objects

- Instance variables — the nouns.
  - Data.
  - Store some state or information pertaining to the specific instance they reside in.
- Instance methods — the verbs.
  - Act on one instance's instance variables.

Objects

Instance variables & methods example

Objects

Instance variables & methods example

Jim
instance of `Person`

Objects

Instance variables & methods example

Instance variables:
- name = “Jim”
- age = 25

Jim
instance of `Person`

Objects

Instance variables & methods example

Instance variables:
- name = “Jim”
- age = 25

Instance methods:
- age()
- isOlderThan(Person p)

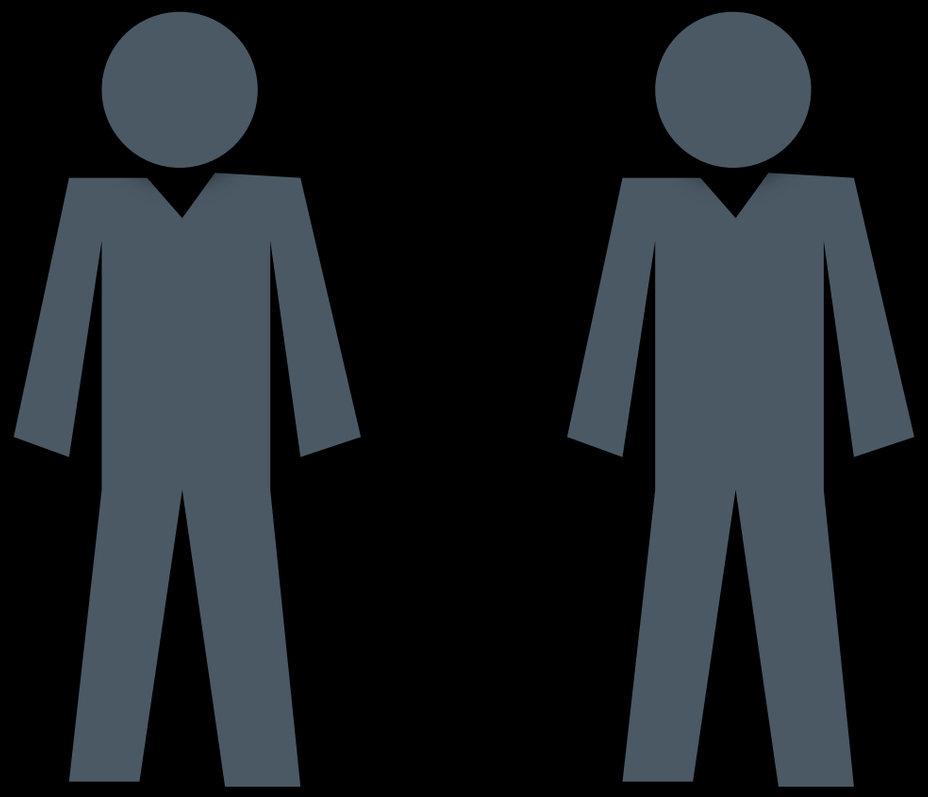
Jim
instance of `Person`

Objects

Instance variables & methods example

Instance variables:
- name = "Jim"
- age = 25

Instance methods:
- age()
- isOlderThan(Person p)



Jim
instance of `Person`

Instance variables:
- name = "Pam"
- age = 24

Instance methods:
- age()
- isOlderThan(Person p)

Pam
instance of `Person`

Objects

Instance variables & methods example

Instance variables:
- name = "Jim"
- age = 25

Instance methods:
- age()
- isOlderThan(Person p)

Jim.isOlderThan(Pam) returns true

Instance variables:
- name = "Pam"
- age = 24

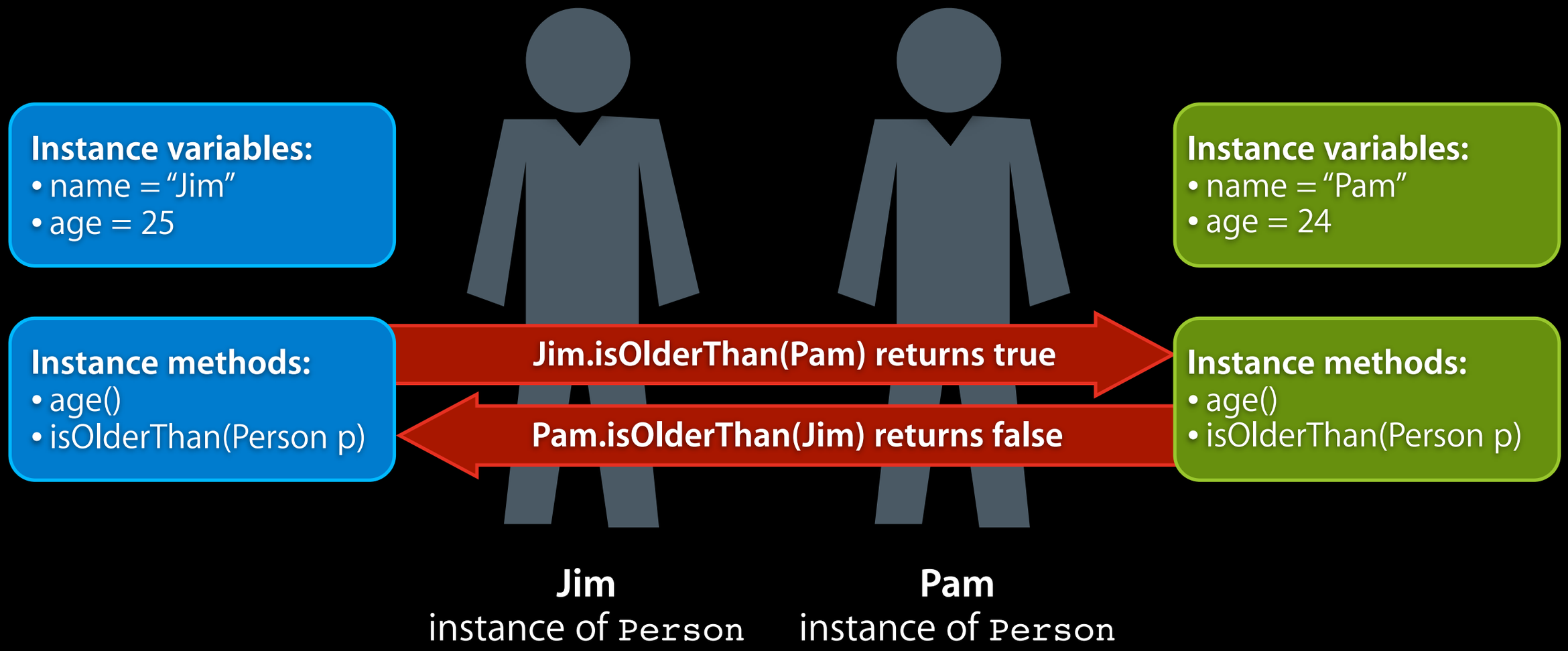
Instance methods:
- age()
- isOlderThan(Person p)

Jim
instance of `Person`

Pam
instance of `Person`

Objects

Instance variables & methods example



Special type — `id`

Special type — `id`

- Every true object (not void *) is of implicit type `id` (pronounced "id" as in "did", not "ID").

Special type — `id`

- Every true object (not void *) is of implicit type `id` (pronounced “id” as in “did”, not “ID”).
- `id` is not a class, it’s a type.

Special type — `id`

- Every true object (not void *) is of implicit type `id` (pronounced "id" as in "did", not "ID").
- `id` is not a class, it's a type.
- Typing object as `id` tells compiler: "This will eventually be some Objective-C object".

Special type — `id`

- Every true object (not void *) is of implicit type `id` (pronounced "id" as in "did", not "ID").
- `id` is not a class, it's a type.
- Typing object as `id` tells compiler: "This will eventually be some Objective-C object".
- Powerful because you can send any message to an `id` object and nothing happens till runtime.

Objects and messages

Objects and messages

- When calling instance method (or class method), not actually calling a physical address or function pointer.

Objects and messages

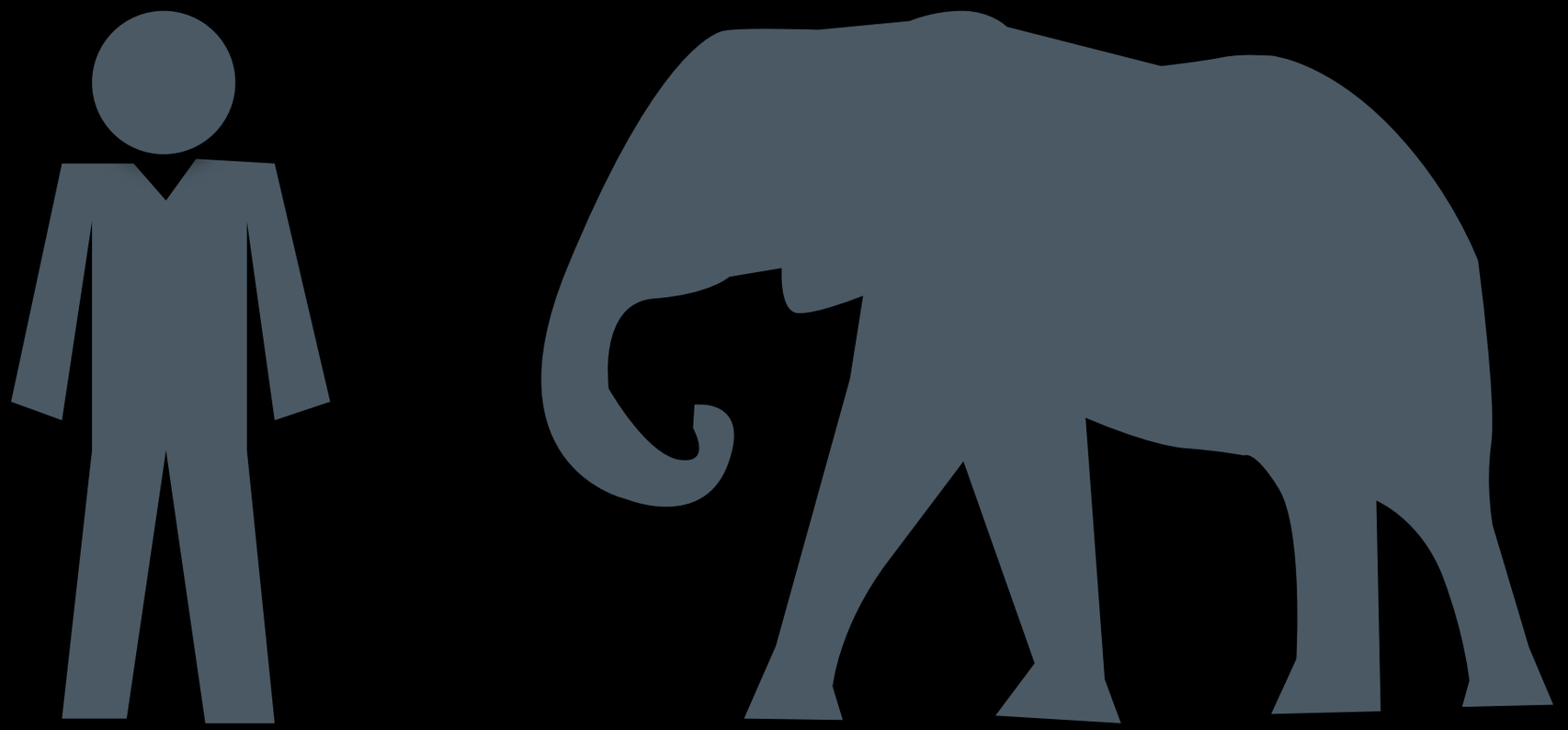
- When calling instance method (or class method), not actually calling a physical address or function pointer.
- Instead, sending object a command to execute a method by some name (called a selector).

Objects and messages

- When calling instance method (or class method), not actually calling a physical address or function pointer.
- Instead, sending object a command to execute a method by some name (called a selector).
- Basic result: dynamic binding.

Messaging

An example

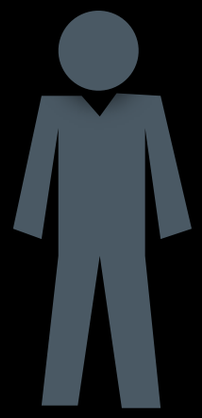


Programmer
subclass of Person

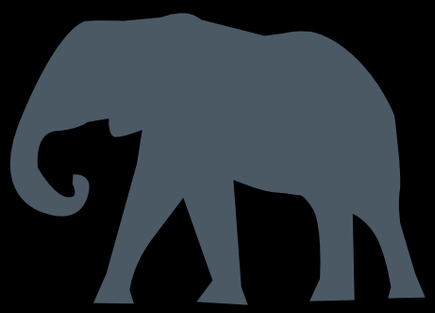
Elephant
subclass of Animal

Messaging

An example



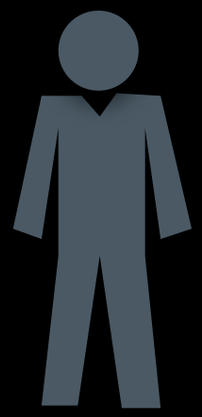
Programmer
subclass of Person



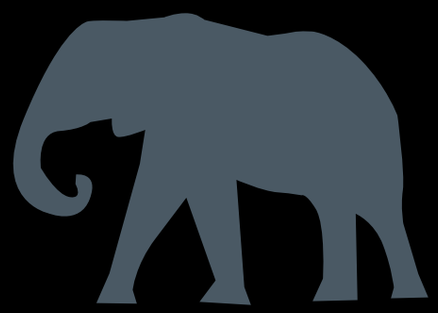
Elephant
subclass of Animal

Messaging

An example



Programmer
subclass of Person

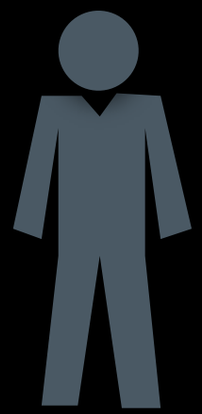


Elephant
subclass of Animal

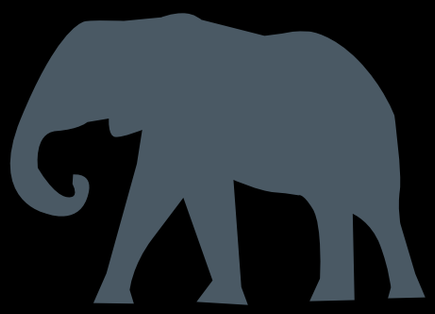
?
?
?
?
?
?
?

Messaging

An example



Programmer
subclass of Person



Elephant
subclass of Animal

?
?
?
?
?
?
?

Need to feed entire list, but don't know if entry is Programmer or Elephant.

So just send the feed message (call feed instance method) on each. Runtime then figures out who it is.

Messaging

An example

Need to feed entire list, but don't know if entry is Programmer or Elephant.

So just send the feed message (call feed instance method) on each. Runtime then figures out who it is.

Messages

- Are powerful. Make the following very easy:
  - Dynamic code loading (like plugin architectures).
  - Categories (I'll explain later)

Messages

Basic syntax

Java/C++

```
myObject.doSomething();
```

Objective-C

```
[myObject doSomething]
```

Messages

Nesting

Java/C++

```
myObject.doSomething().doSomethingElse(someArgument);
```

Objective-C

```
[[myObject doSomething] doSomethingElse:someArgument];
```

Messages

Multiple Parameters

Java/C++

```
myObject.doThisWithThatAndThat(argument1, argument2);
```

Objective-C

```
[myObject doThisWithThat:argument1 andThat:argument2];
```

Messages

Multiple Parameters

Java/C++

```
myObject.doThisWithThatAndThat(argument1, argument2);
```

Objective-C

```
[myObject doThisWithThat:argument1 andThat:argument2];
```

Messages

Sending to nil

Java

```
MyClass instance = null;
instance.doSomething(); // throws NullPointerException
```

Objective-C

```
MyClass *instance = nil; // use nil instead of NULL
[instance doSomething]; // just does nothing
```

Objective-C — nil and return values

```
Person *person = nil;
[person age]; // returns 0
[person name]; // returns nil
```

Selectors

- A **selector** describes a message, based upon its name.
- Many arguments in frameworks like Foundation and UIKit take selectors.

To create a selector directly:

```
SEL mySelector = @selector(myMethod:);
```

To create a selector from a string:

```
SEL mySelector = NSSelectorFromString(@”myMethod:”);
```

Selectors

- A **selector** describes a message, based upon its name.
- Many arguments in frameworks like Foundation and UIKit take selectors.

To create a selector directly:

```
SEL mySelector = @selector(myMethod:);
```

Preferred if possible

To create a selector from a string:

```
SEL mySelector = NSSelectorFromString(@”myMethod:”);
```

Introduction to Objective-C

What are object-oriented systems? ✓

What is the Objective-C language? ✓

What are objects? ✓

How do you create classes in Objective-C?

acm.uiuc.edu/macwarriors/devphone

Interface versus Implementation

Interface versus Implementation

- Two parts to creating a class (unlike Java).

Interface versus Implementation

- Two parts to creating a class (unlike Java).
- **Interface**
  - Tell what capabilities a class has.
  - Declare the class, it's superclass, instance variables, and methods.
  - Lives (usually) in header file (.h).

Interface versus Implementation

- Two parts to creating a class (unlike Java).
- **Interface**
  - Tell what capabilities a class has.
  - Declare the class, it's superclass, instance variables, and methods.
  - Lives (usually) in header file (.h).
- **Implementation**
  - The code behind the methods.
  - Lives (always) in implementation files (.m).

Interface

Interface

- What goes in the interface

Interface

- What goes in the interface
  - Superclass

Interface

- What goes in the interface
  - Superclass
  - Instance variables

Interface

- What goes in the interface
  - Superclass
  - Instance variables
  - Instance methods

Interface

- What goes in the interface
  - Superclass
  - Instance variables
  - Instance methods
  - Properties (we'll get to these)

Interface

- What goes in the interface
  - Superclass
  - Instance variables
  - Instance methods
  - Properties (we'll get to these)
  - Protocols (we'll get to these)

Essential types

Essential types

- **NSUInteger** & **NSInteger**
  - Use instead of `int`, `long`, `unsigned`, etc.
  - For architecture independence.

Essential types

- **NSUInteger** & **NSInteger**
  - Use instead of `int`, `long`, `unsigned`, etc.
  - For architecture independence.
- **NSString**
  - Wrapper for C-string.
  - Easiest way to create them is `@"myString"`.

Essential types

- **NSUInteger** & **NSInteger**
  - Use instead of `int`, `long`, `unsigned`, etc.
  - For architecture independence.
- **NSString**
  - Wrapper for C-string.
  - Easiest way to create them is `@"myString"`.
- **BOOL**
  - Objective-C boolean (implemented as 8-bit unsigned char).
  - Valid values are `YES` and `NO`.

Interface

Example

Name of class

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}

- (id)initWithName:(NSString *)name andAge:(NSUInteger)age;
- (BOOL)isPersonOlder:(Person *)otherPerson;

@end
```

Interface

Example

Superclass

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}

- (id)initWithName:(NSString *)name andAge:(NSUInteger)age;
- (BOOL)isPersonOlder:(Person *)otherPerson;

@end
```

Interface

Example

Instance variables

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}

- (id)initWithName:(NSString *)name andAge:(NSUInteger)age;
- (BOOL)isPersonOlder:(Person *)otherPerson;

@end
```

Interface

Example

Instance methods

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}

- (id)initWithName:(NSString *)name andAge:(NSUInteger)age;
- (BOOL)isPersonOlder:(Person *)otherPerson;

@end
```

Interface

Example

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}

- (id)initWithName:(NSString *)name andAge:(NSUInteger)age;
- (BOOL)isPersonOlder:(Person *)otherPerson;

@end
```

"-" specifies instance method
"+" specifies class method

Interface

Example

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}

- (id)initWithName:(NSString *)name andAge:(NSUInteger)age;
- (BOOL)isPersonOlder:(Person *)otherPerson;

@end
```

Method return value

Implementation

Example

In Person.m:

```
@implementation

- (id)initWithName:(NSString *)name andAge:(unsigned)age {
    return ...;
}

- (BOOL)isPersonOlder:(Person *)otherPerson {
    return ...;
}

@end
```

Instantiating a class

- First, call `alloc` class method to allocate actual memory.
- Next, call an initializer (`init`, `initWith`…).

Instantiating a class

- First, call `alloc` class method to allocate actual memory.
- Next, call an initializer (`init`, `initWith`…).

Allocating an instance of the Person class:

```
Person *person = [[Person alloc] init];
```

Instantiating a class

- First, call `alloc` class method to allocate actual memory.
- Next, call an initializer (`init`, `initWith`…).

Allocating an instance of the Person class:

```
Person *person = [[Person alloc] init];
```

Using different initializers:

```
NSString *person = [[Person alloc] init];
NSArray *array = [[NSArray alloc] initWithObject:person];
```

Properties

- You should never allow clients to access instance variables directly.

Properties

- You should never allow clients to access instance variables directly.

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}

@end
```

Properties

- You should never allow clients to access instance variables directly.

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}

@end
```

In a client using the Person class:

```
Person *jim = ...; // created Person
NSLog(@"%@ is %u years old.", jim->name, jim->age);
jim->age = 30;
```

Properties

- You should never allow clients to access instance variables directly.

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}

@end
```

In a client using the Person class:

```
Person *jim = ...; // created Person
NSLog(@"%@ is %u years old.", jim->name, jim->age);
jim->age = 30;
```

Properties

- Create getters and setters instead.

Properties

- Create getters and setters instead.

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}
- (NSString *)name;
- (void)setName:(NSString *)newName;
- (unsigned)age;
- (void)setAge:(NSUInteger)age;
@end
```

Properties

- Create getters and setters instead.

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}
- (NSString *)name;
- (void)setName:(NSString *)newName;
- (unsigned)age;
- (void)setAge:(NSUInteger)age;
@end
```

In a client using the Person class:

```
Person *jim = ...; // created Person
NSLog(@"%@ is %u years old.", [jim name], [jim age]);
[jim setAge:30];
```

Properties

- Create getters and setters instead.

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}
- (NSString *)name;
- (void)setName:(NSString *)newName;
- (unsigned)age;
- (void)setAge:(NSUInteger)age;
@end
```

In a client using the Person class:

```
Person *jim = ...; // created Person
NSLog(@"%@ is %u years old.", [jim name], [jim age]);
[jim setAge:30];
```

Properties

- If you have lots of instance variables to give access to, declaring *and* implementing all the methods is a pain.
- Objective-C properties "write" the methods for you.

Properties

- If you have lots of instance variables to give access to, declaring *and* implementing all the methods is a pain.
- Objective-C properties "write" the methods for you.
- Parts to properties

Properties

- If you have lots of instance variables to give access to, declaring *and* implementing all the methods is a pain.
- Objective-C properties "write" the methods for you.
- Parts to properties
  - Property declaration with name, type, and modifiers.

Properties

- If you have lots of instance variables to give access to, declaring *and* implementing all the methods is a pain.
- Objective-C properties "write" the methods for you.
- Parts to properties
  - Property declaration with name, type, and modifiers.
  - Instance variables with same name.

Properties

- If you have lots of instance variables to give access to, declaring *and* implementing all the methods is a pain.
- Objective-C properties "write" the methods for you.
- Parts to properties
  - Property declaration with name, type, and modifiers.
  - Instance variables with same name.
  - Property synthesization in implementation.

Properties

Properties

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}
@property(nonatomic, copy) NSString *name;
@property(nonatomic, assign) NSUInteger age;
@end
```

Properties

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}
@property(nonatomic, copy) NSString *name;
@property(nonatomic, assign) NSUInteger age;
@end
```

In a client using the Person class:

```
Person *jim = ...; // created Person
NSLog(@"%@ is %u years old.", [jim name], [jim age]);
[jim setAge:30];
```

Properties

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}
@property(nonatomic, copy) NSString *name;
@property(nonatomic, assign) NSUInteger age;
@end
```

In Person.m

```
@implementation
@synthesize name, age;
@end // we are leaking name/age, but ignore that for now.
```

In a client using the Person class:

```
Person *jim = ...; // created Person
NSLog(@"%@ is %u years old.", [jim name], [jim age]);
[jim setAge:30];
```

Properties

In Person.h:

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}
@property(nonatomic, copy) NSString *name;
@property(nonatomic, assign) NSUInteger age;
@end
```

In Person.m

```
@implementation
@synthesize name, age;
@end // we are leaking name/age, but ignore that for now.
```

In a client using the Person class:

```
Person *jim = ...; // created Person
NSLog(@"%@ is %u years old.", [jim name], [jim age]);
[jim setAge:30];
```

Properties

- Unwritten mandatory rule:

Never use “get” some property (e.g. getName)!

Properties

- Unwritten mandatory rule:

Never use “get” some property (e.g. getName)!

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}
- (NSString *)getName;
@end
```

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}
- (NSString *)name;
@end
```

Properties

- Unwritten mandatory rule:

Never use “get” some property (e.g. getName)!

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}
- (NSString *)getName;
@end
```

Incorrect

```
@interface Person : NSObject {
    NSString * name;
    NSUInteger age;
}
- (NSString *)name;
@end
```

Correct

Properties

- More in Advanced Objective-C talk.

Categories

- Allow you to extend classes — even if they are precompiled.
- This is extremely powerful!

Categories

Example

In some header or implementation file:

```
@interface Person (MyCategory)
- (void)someExtraMethod;
@end
```

Name of class

Categories

Example

In some header or implementation file:

```
@interface Person (MyCategory)
- (void)someExtraMethod;
@end
```

Name of category

Categories

Example

In some header or implementation file:

```
@interface Person (MyCategory)
- (void)someExtraMethod;
@end
```

Instance (or class) methods

Categories

Example

In some header or implementation file:

```
@interface Person (MyCategory)
- (void)someExtraMethod;
@end
```

In some implementation file:

```
@implementation Person (MyCategory)
- (void)someExtraMethod {
    ...; // do something
}
@end
```

Categories

- But why?
  - This will be covered in the Advanced Objective-C talk.

Protocols

- A set of methods a class is promised to implement.
- Similar to interfaces in Java.

Protocols

- A set of methods a class is promised to implement.
- Similar to interfaces in Java.
- Real-life example:
  - Instead of C++ copy constructor, there is NSCopying protocol.
  - Classes adopting NSCopying protocol implement copyWithZone method.
  - When object is copied, if class adopts NSCopying, then send object copyWithZone message.

Protocols

NSCopying example

Put all protocols

In Person.h:

```
@interface Person : NSObject <NSCopying> {
    NSString * name;
    NSUInteger age;
}

- (id)initWithName:(NSString *)name andAge:(NSUInteger)age;
- (BOOL)isPersonOlder:(Person *)otherPerson;

@end
```

Protocols

NSCopying example

In Person.m:

```
@implementation

- (id)copyWithZone:(NSZone *)zone {
    return ...;
}

@end
```

Protocols

Forcing compiler to check protocol for an object:

```
- (void)setCopyingCompliantObject:(id<NSCopying>)anObject;
```

Demo

Introduction to Objective-C

- What are object-oriented systems? ✓
- What is the Objective-C language? ✓
- What are objects? ✓
- How do you create classes in Objective-C? ✓

acm.uiuc.edu/macwarriors/devphone

Introduction to Objective-C

- What are object-oriented systems? ✓
- What is the Objective-C language? ✓
- What are objects? ✓
- How do you create classes in Objective-C? ✓

acm.uiuc.edu/macwarriors/devphone

Q&A

About These Slides

If you need to reference the content of this presentation, these slides will be posted on our website, listed below:

acm.uiuc.edu/macwarriors/devphone

macwarriors

macwarriors