Announcement

- **Start Final Project Pitches on Wednesday**
  - Presentation slides dues by Tuesday at 11:59 PM
  - Email slides to cse438ta@gmail.com

Final Project Proposal Presentations and Updates

- **We will start the final project presentations on Wednesday November 8th in class and continue them on Monday**
- **Each group will have 5 minutes to present their app**
- **Due to the large size of this course, some groups may not be able to present**
- **If someone from your group is not here to present your project you will receive a 0 that portion of the project**

Today's Topic - Object Lifecycle

- Creating objects
- Memory management
- Destroying objects

Object Creation

- Two step process
  - allocate memory to store the object
  - initialize object state

+alloc

- Class method that knows how much memory is needed

-init

- Instance method to set initial values, perform other setup

Create = Allocate + Initialize

```
Person *student = nil;

student = [[Person alloc] init];
```

Or

```
Person *student = nil;
student = [Person alloc];
student = [student init];
```


Implementing your own -init method

```
#import "Person.h“

@implementation Person

-(id)init {
  // allow superclass to initialize its state first
   self = [super init];
  if (self != nil) {
            age = 0;
            name = @“Bob”;

     // do other initialization...
  }
  return self;
}

@end
```

Multiple init methods

- Classes may define multiple init methods

```
- (id)init;
- (id)initWithName:(NSString *)name;
- (id)initWithName:(NSString *)name age:(int)age;
```

- Less specific ones typically call more specific with default values
  - Designated Initializers

```
- (id)init { return [self initWithName:@"Bob"];
 }
- (id)initWithName:(NSString *)name {
  return [self initWithName:name age:0];
 }
```


Finishing Up With an Object

```
Person *person = nil;

person = [[Person alloc] init];

[person setName:@"Alan Cannistraro"];
[person setAge:29];
[person setWishfulThinking:YES];

[person castBallot];

// What do we do with person when we're done?
```

Two flavors of Memory Management

- **Automatic Reference Counting (ARC)**
  - Full support starting in iOS 5
- **Manual Reference Counting**
  - Original Objective C design
- **Choose one or the other**
  - Do not attempt to use both in the same .m file

Why learn both methods?

- **Many of the tutorials and examples on the web were created pre-ARC**
- **A solid understanding of manual reference counting makes ARC easier to understand**
- **Xcode can run into problems with migrating existing code to use ARC**

(Manual) Memory Management

	Allocation	Destruction
C	malloc	free
Objective-C	alloc	dealloc

- **Calls must be balanced**
  - Otherwise your program may leak or crash
- **However, you'll never call -dealloc directly**
  - One exception, we'll see in a bit...

(Manual) Reference Counting

- **Every object has a retain count**
  - Defined on NSObject
  - As long as retain count is > 0, object is alive and valid

- **+alloc and -copy create objects with retain count == 1**
- **-retain increments retain count**
- **-release decrements retain count**

- **When retain count reaches 0, object is destroyed**
- **-dealloc method invoked automatically**
  - One-way street, once you're in -dealloc there's no turning back

Balanced Calls

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

[person setName:@“John Smith”];
[person setAge:29];
[person setWishfulThinking:YES];

[person castBallot];

// When we’re done with person, release it
[person release];  // person will be destroyed here
```


Reference counting in action

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

- Retain count begins at 1 with +alloc

```
[person retain];
```

- Retain count increases to 2 with –retain

```
[person release];
```

- Retain count decreases to 1 with –release

```
[person release];
```

- Retain count decreases to 0, -dealloc automatically called

Messaging deallocated objects

```
Person *person = [[Person alloc] init];
// ...
[person release]; // Object is deallocated

[person doSomething]; // Crash!
```


Messaging deallocated objects

```
Person *person = [[Person alloc] init];
// ...
[person release]; // Object is deallocated

person=nil;

[person doSomething]; // No effect
```

Implementing a -dealloc method

```
#import "Person.h“

@implementation Person

- (void)dealloc {
  // Do any cleanup that’s necessary
  // ...

  // when we’re done, call super to clean us up
  [super dealloc];
}
@end
```


Object Lifecycle Recap

- Objects begin with a retain count of 1
- Increase and decrease with -retain and –release
- When retain count reaches 0, object deallocated automatically
- You *never* call dealloc explicitly in your code
  - Exception is calling -[super dealloc]
  - You only deal with alloc, copy, retain, release

Object Ownership

```
#import <Foundation/Foundation.h>

@Interface Person : NSObject
{
  // instance variables
  NSString *name;    //Person class "owns" the name
  int age;
}

// method declarations
-(NSString *)name;
-(void)setName:(NSString *)value;

-(int)age;
-(void)setAge:(int)age;

-(BOOL)canLegallyVote;
-(void)castBallot;

@end
```


Object Ownership

```
#import "Person.h"
@implementation Person

- (NSString *)name {
  return name;
}

- (void)setName:(NSString *)newName {
   if (name != newName) {
      [name release];
      name = [newName retain];
      // name's retain count has been bumped up by 1
   }
}

@end
```

Object Ownership

```
#import "Person.h“
@implementation Person

- (NSString *)name {
  return name;
}

- (void)setName:(NSString *)newName {
   if (name != newName) {
      [name release];
      name = [newName copy];
      // name has a retain count of 1, we own it
   }
}

@end
```


Releasing Instance Variables

```
#import "Person.h“
@implementation Person

- (void)dealloc{
    //Do any cleanup that’s necessary
    [name release];

    // when we’re done, call super to clean us up
    [super dealloc];
}

@end
```

Autorelease

Returning a newly created object

```
-(NSString *)fullName {
  NSString *result;

  result = [[NSString alloc] initWithFormat:@"%@ %@",
    firstName, lastName];

  return result;
}
```

- Wrong: result is leaked!

Returning a newly created object

```
-(NSString *)fullName {
  NSString *result;

  result = [[NSString alloc] initWithFormat:@"%@ %@",
    firstName, lastName];

  [result release];
  return result;
}
```

- Wrong: result is released too early!
- Uncertain what method returns

Returning a newly created object

```
-(NSString *)fullName {
  NSString *result;

  result = [[NSString alloc] initWithFormat:@"%@ %@",
    firstName, lastName];

  [result autorelease];
  return result;
}
```

- Just right: result is released, but not right away!
- Caller gets valid object and could retain if needed

Autoreleasing Objects

- Calling -autorelease flags an object to be sent release at some point in the future
- Let's you fulfill your retain/release obligations while allowing an object some additional time to live
- Makes it much more convenient to manage memory
- Very useful in methods which return a newly created object

Method Names & Autorelease

- Methods whose names includes **alloc** or **copy** return a retained object that the caller needs to release

```
NSMutableString *string = [[NSMutableString alloc] init];

// We are responsible for calling -release or –autorelease
[string autorelease];
```

- All other methods return autoreleased objects

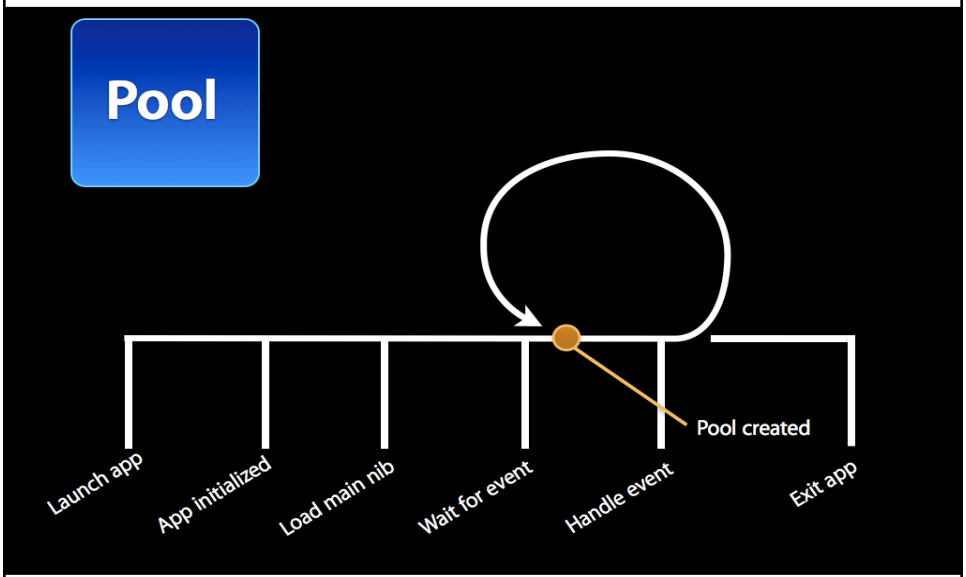
```
NSMutableString *string = [NSMutableString string];

// The method name doesn't indicate that we need to release it
// So don't- we're cool!
```

- This is a convention
  - follow it in methods you define

How does -autorelease work?

- **Object is added to current autorelease pool**
- **Autorelease pools track objects scheduled to be released**
  - When the pool itself is released, it sends -release to all its objects
- **UIKit automatically wraps a pool around every event dispatch**

Autorelease Pools (from cs193p slides)



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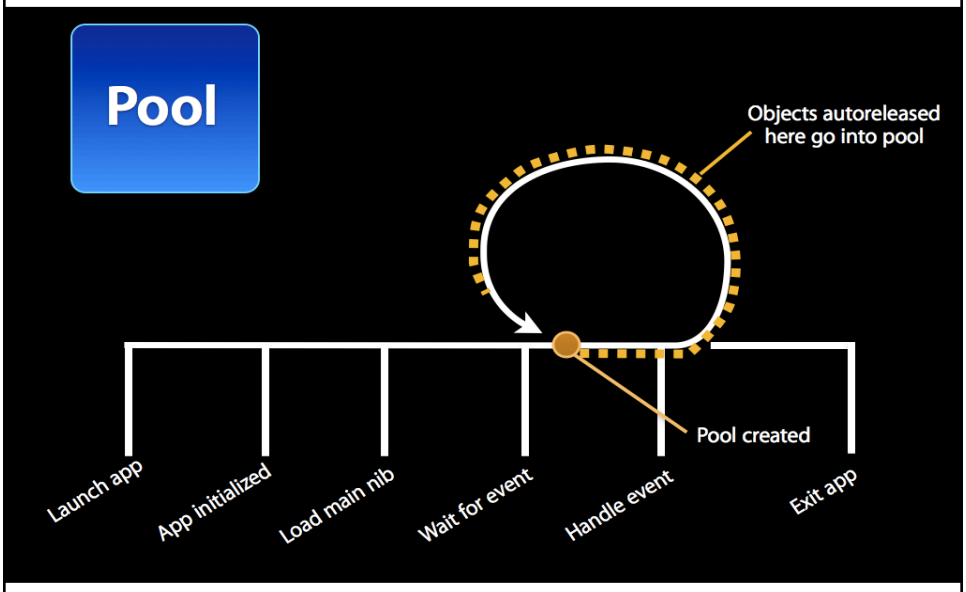

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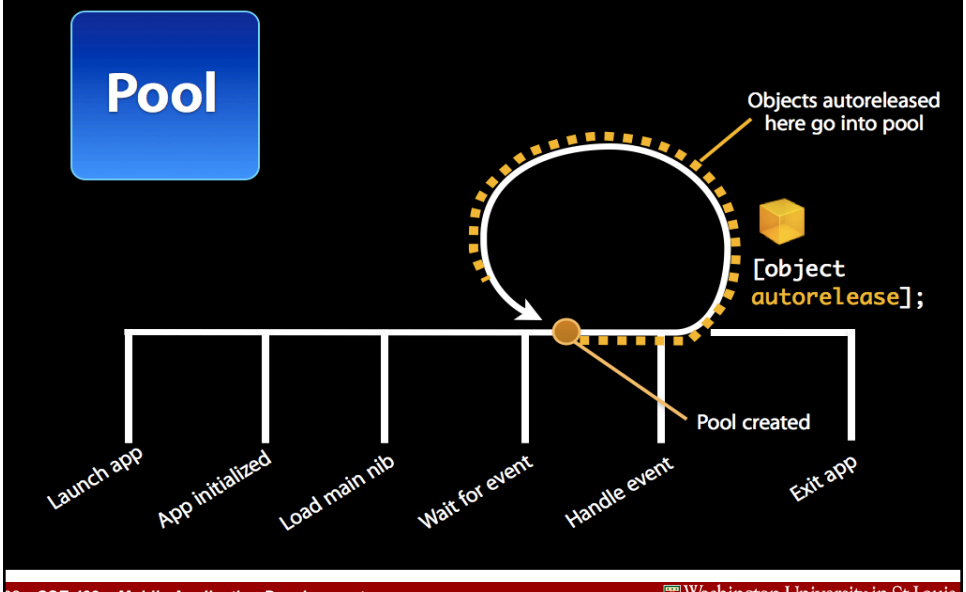
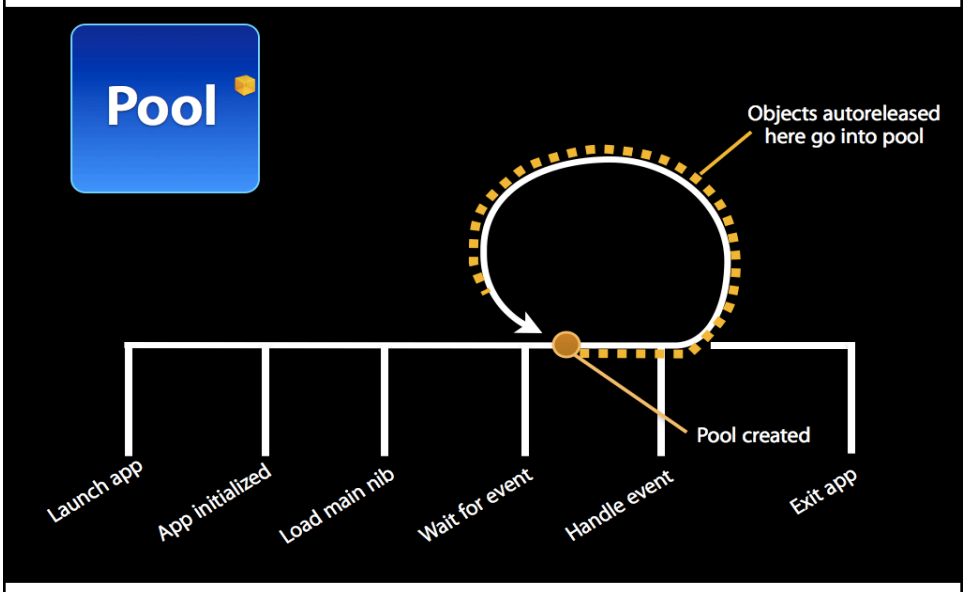


Autorelease Pools (from cs193p slides)



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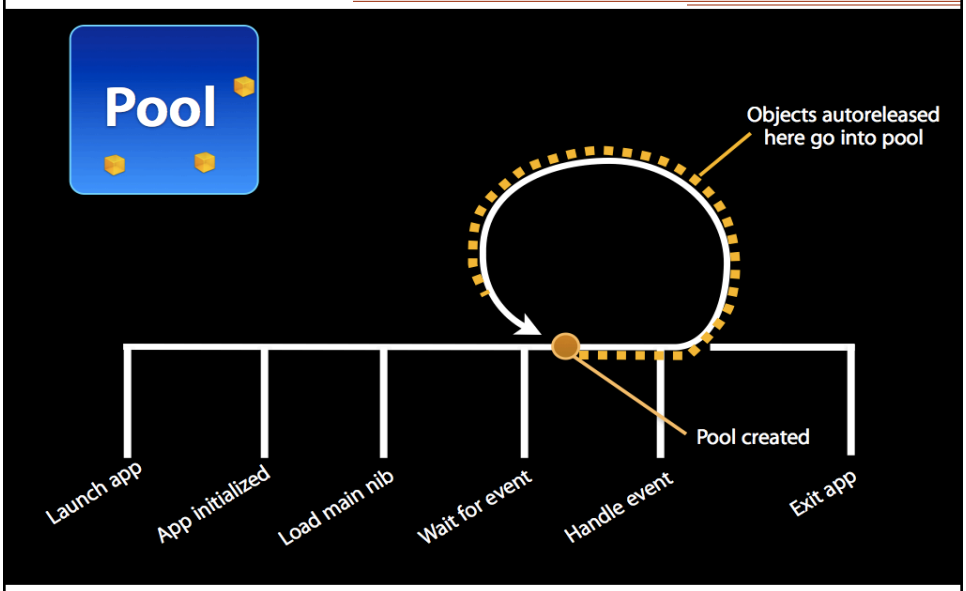

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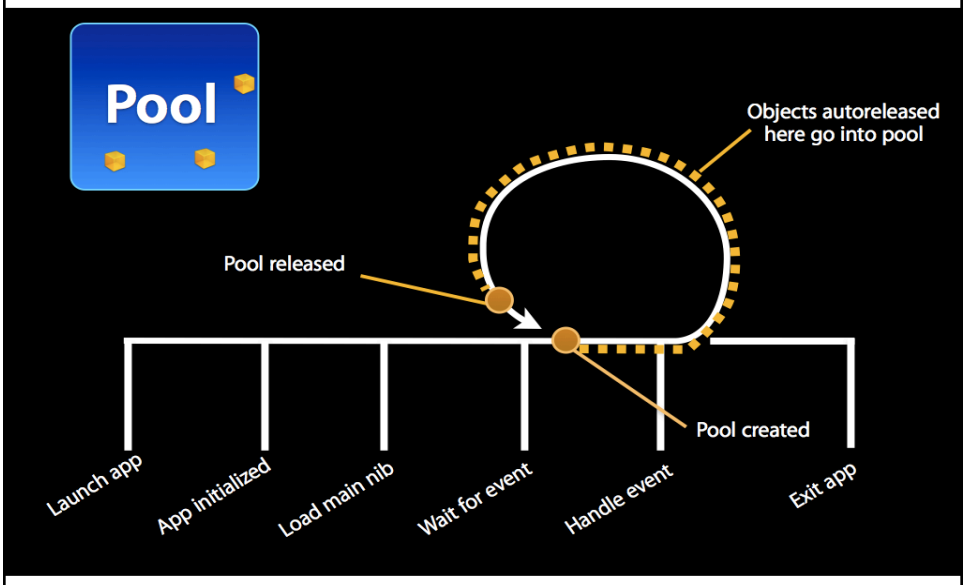

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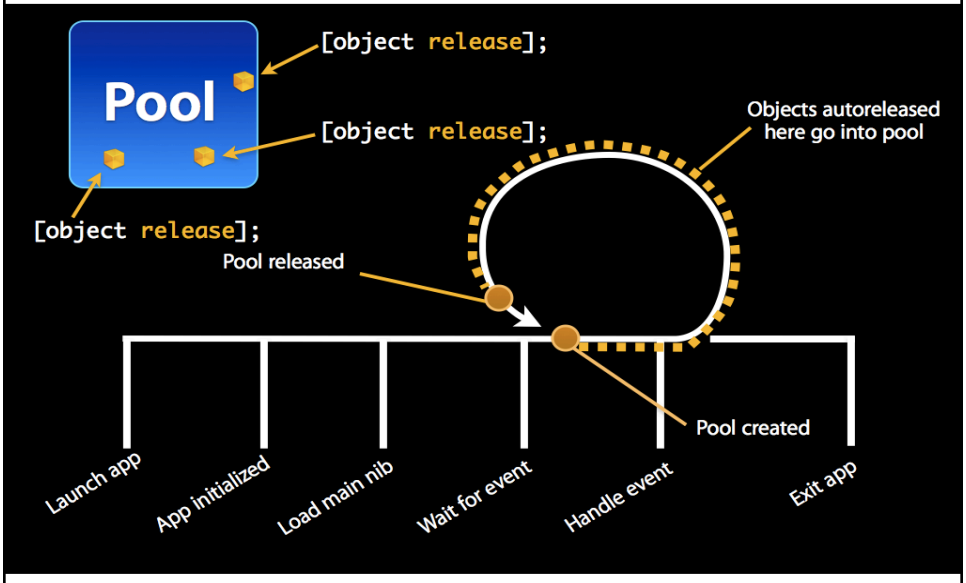

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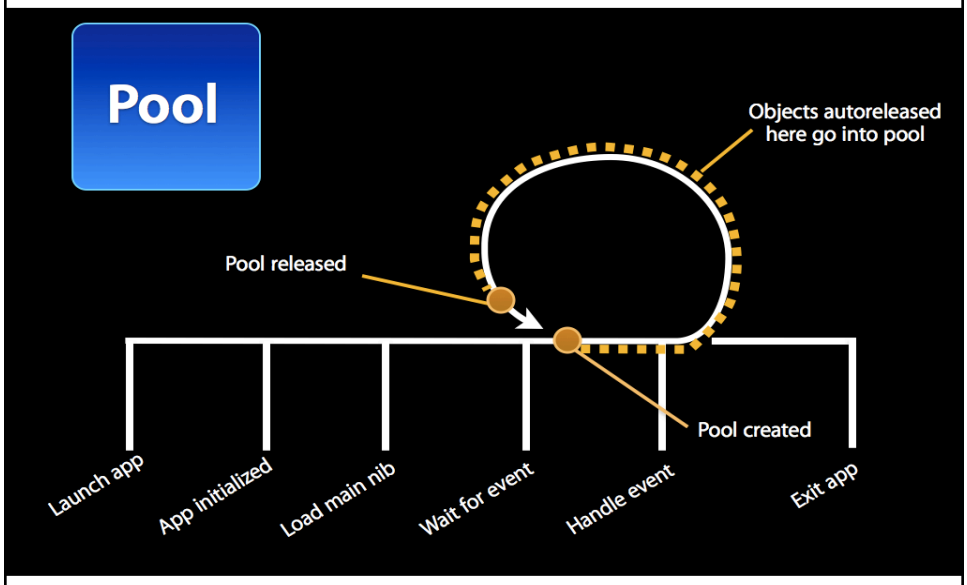


Hanging Onto an Autoreleased Object

- **Many methods return autoreleased objects**
  - Remember the naming conventions...
  - They're hanging out in the pool and will get released later
- **If you need to hold onto those objects you need to retain them**
  - Bumps up the retain count before the release happens

```
name = [NSMutableString string];

// We want to name to remain valid!
[name retain];
// ...
// Eventually, we'll release it (maybe in our -dealloc?)
[name release];
```

Side Note: Garbage Collection

- Autorelease is not garbage collection
- Objective-C on iPhone OS (iOS) does not have garbage collection

Automatic Reference Counting (ARC)

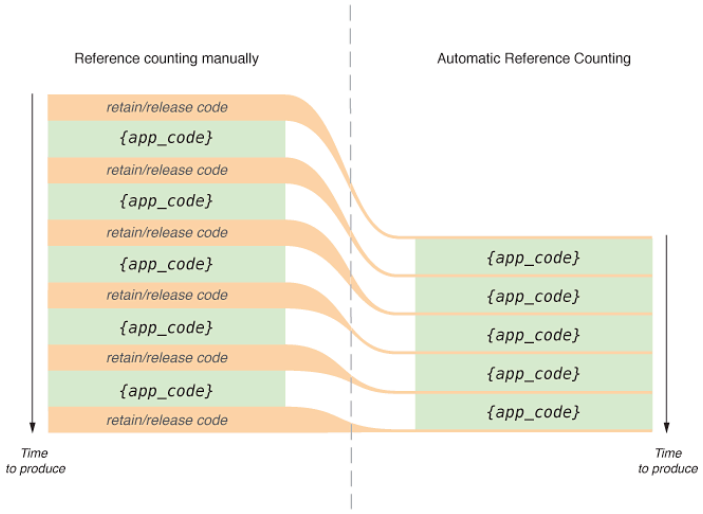
Automatic Reference Counting (ARC)

- **The new and "improved" way to manage memory**
  - All objects are either strong or weak
- **Strong**
  - Keep me around until I no longer need this memory
- **Weak**
  - Keep me around as long as some other object needs this memory

Automatic Reference Counting

- **By default all objects allocated when using ARC are strong**
  - NSNumber *myNumber = [NSNumber alloc] init];
- **Weak references are often used when pointing to objects on a storyboard**
  - UIButton, UILabel, UIImage
    - These objects are already instantiated when the storyboard loads
    - We just want a pointer to them while they are alive

Automatic Retain/Release



Properties

- **Provide access to object attributes**
- **Shortcut to implementing getter/setter methods**
- **Also allow you to specify:**
  - read-only versus read-write access
  - memory management policy

Defining Properties

```
#import<Foundation/Foundation.h>
@interface Person : NSObject
{
// instance variables
   NSString *name;
   int age;
}

// method declarations
-(NSString *)name;
-(void)setName:(NSString *)value;
-(int)age;
-(void)setAge:(int)age;
-(BOOL)canLegallyVote;

-(void)castBallot;
@end
```


Defining Properties

```
#import<Foundation/Foundation.h>
@interface Person : NSObject
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   NSString *name;
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// method declarations
-(NSString *)name;
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```

Defining Properties

```
#import<Foundation/Foundation.h>
@interface Person : NSObject
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// instance variables
   NSString *name;
   int age;
}

// method declarations
-(NSString *)name;
-(void)setName:(NSString *)value;
-(int)age;
-(void)setAge:(int)age;
-(BOOL)canLegallyVote;

-(void)castBallot;
@end
```


Defining Properties

```
#import<Foundation/Foundation.h>
@interface Person : NSObject
{
// instance variables
   NSString *name;
   int age;
}

// property declarations
@property int age;
@property (copy) NSString  *name;
@property (readonly) BOOL canLegallyVote;

-(void)castBallot;
@end
```

Synthesizing Properties

```
@implementation Person

-(int)age {
 return age;
}

-(void)setAge:(int)value {
  age = value;
}

-(NSString *)name {
  return name;
}

-(void)setName:(NSString *)value {
   if (value != name) {
      [value release];
      name = [value copy];
   }

- (BOOL)canLegallyVote { …
```


Synthesizing Properties

```
@implementation Person

-(int)age {
 return age;
}

-(void)setAge:(int)value {
  age = value;
}

-(NSString *)name {
  return name;
}

-(void)setName:(NSString *)value {
   if (value != name) {
      [value release];
      name = [value copy];
   }

- (BOOL)canLegallyVote { …
```

Synthesizing Properties

```
@implementation Person

-(int)age {
  return age;
 }

-(void)setAge:(int)value {
   age = value;
 }

-(NSString *)name {
   return name;
 }

-(void)setName:(NSString *)value {
    if (value != name) {
        [value release];
        name = [value copy];
    }

- (BOOL)canLegallyVote { ...
```


Synthesizing Properties

```
@implementation Person

@synthesize age;
@synthesize name;
-    (BOOL)canLegallyVote {
   return (age > 17);
}

@end
```

iOS Property Attributes

- Use strong and weak instead of retain and assign

```
@property (retain) NSString *name; // retain called
@property (strong) NSString *name;// new way


@property (assign) NSString *name; // pointer assignment
@property (weak) NSString *name; //new way
```


Property Names vs. Instance Variables

- Property name can be different than instance variable

```
@interface Person : NSObject {
  int numberOfYearsOld;
}

@property int age;

@end


@implementation Person

@synthesize age = numberOfYearsOld;

@end
```

Properties

- Mix and match synthesized and implemented properties

```
@implementation Person

@synthesize age;
@synthesize name;

(void)setAge:(int)value {
    age = value;
}
@end
```

- Setter method explicitly implemented
- Getter method still synthesized

Properties In Practice

- Newer APIs use @property
- Older APIs use getter/setter methods
- Properties used heavily throughout UIKit APIs
  - Not so much with Foundation APIs
- You can use either approach
  - Properties mean writing less code, but "magic" can sometimes be non-obvious

Further Reading

- **Objective-C 2.0 Programming Language**
  - "Defining a Class"
  - "Declared Properties"
- **Memory Management Programming Guide for Cocoa**

Objective C and Swift