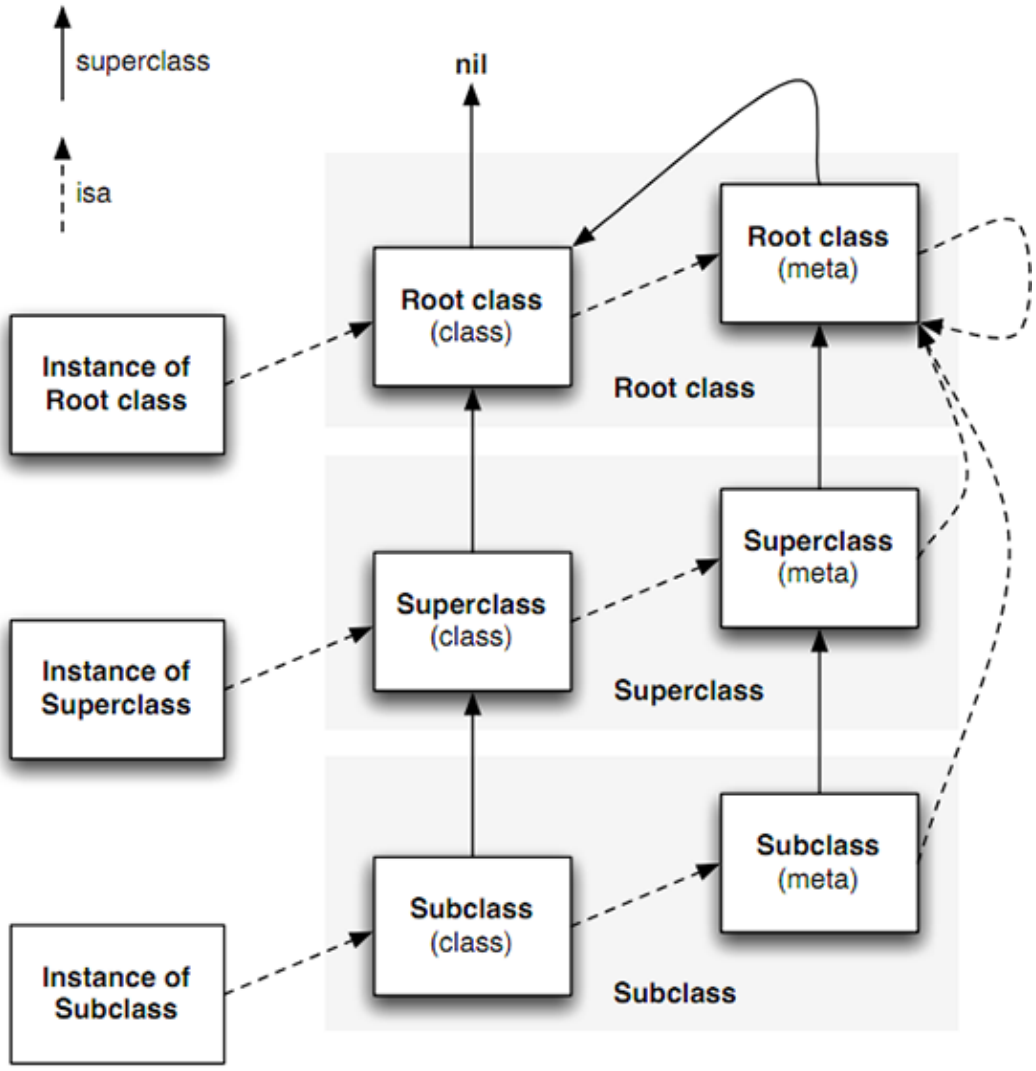
# 对象、类、元类的关系




| | |
|---|---|
| Instance | 存放 ivars 的值 |
| Class | 存放 ivars 、 instance_methods 、 properties |
| MetaClass | 存放 class_methods |

# Class

```
struct objc_class {
    Class _Nonnull isa  OBJC_ISA_AVAILABILITY;

#if !__OBJC2__
    Class _Nullable super_class                          OBJC2_UNAVAILABLE;
    const char * _Nonnull name                           OBJC2_UNAVAILABLE;
    long version                                         OBJC2_UNAVAILABLE;
    long info                                            OBJC2_UNAVAILABLE;
    long instance_size                                   OBJC2_UNAVAILABLE;
    struct objc_ivar_list * _Nullable ivars              OBJC2_UNAVAILABLE;
    struct objc_method_list * _Nullable * _Nullable methodLists                    OBJC2_UNAVAILABLE;
    struct objc_cache * _Nonnull cache                   OBJC2_UNAVAILABLE;
    struct objc_protocol_list * _Nullable protocols      OBJC2_UNAVAILABLE;
#endif

} OBJC2_UNAVAILABLE;
/* Use `Class` instead of `struct objc_class *` */
```

注意：OBJC2不可用

```
struct _class_ro_t {
        unsigned int flags;
        unsigned int instanceStart;
        unsigned int instanceSize;
        unsigned int reserved;
        const unsigned char *ivarLayout;
        const char *name;
        const struct _method_list_t *baseMethods;
        const struct _objc_protocol_list *baseProtocols;
        const struct _ivar_list_t *ivars;
        const unsigned char *weakIvarLayout;
        const struct _prop_list_t *properties;
};
```

```
struct _class_t {
        struct _class_t *isa;
        struct _class_t *superclass;
        void *cache;
        void *vtable;
        struct _class_ro_t *ro;
};
```

这才是OBJC2中Class的结构

# 样本代码分析

```objc
@interface AAA : NSObject

@property (readonly) NSString *name;
@property (class) BOOL abc;

- (void)testA;
+ (void)printA;

@end
```

```objc
@interface BBB : AAA

@property (readonly) int age;
@property (class) BOOL xyz;

- (void)testB;

+ (void)printB;

@end
```

```objc
@interface AAA ()
@property NSString *name;
@end

@implementation AAA

- (void)testA {
    self.name = @"123";
}

+ (void)printA {
    puts("AAAAAA");
}

@end
```

```objc
@interface BBB () {
    BOOL _isSelected;
}
@end

@implementation BBB

- (void)testB {
    _isSelected = !_isSelected;
}

+ (void)printB {
    puts("BBBBBB");
}

@end
```

使用clang重写：

```
clang -rewrite-objc BBB.m -o BBB.cpp
```

# 对象本质

```
struct NSObject_IMPL {
        Class isa;
};
```

```
struct AAA_IMPL {
        struct NSObject_IMPL NSObject_IVARS;
        NSString *_name;
};
```

```
struct BBB_IMPL {
        struct AAA_IMPL AAA_IVARS;
        BOOL _isSelected;
        int _age;
};
```


1. 实例对象的包含其自身对应类的ivars，以及父类的ivars，父类的父类ivars.....根父类的ivars。

   （根父类NSObject的ivars只有isa指针）

2. 实例对象除了ivar，没有别的。

# 类本质

```
static struct _class_ro_t _OBJC_CLASS_RO_$_BBB __attribute__ ((used, section
("__DATA,__objc_const"))) = {
        0, __OFFSETOFIVAR__(struct BBB, _isSelected), sizeof(struct BBB_IMPL),
        (unsigned int)0,
        0,
        "BBB",
        (const struct _method_list_t *)&_OBJC_$_INSTANCE_METHODS_BBB,
        0,
        (const struct _ivar_list_t *)&_OBJC_$_INSTANCE_VARIABLES_BBB,
        0,
        (const struct _prop_list_t *)&_OBJC_$_PROP_LIST_BBB,
};
```

```
extern "C" __declspec(dllexport) struct _class_t OBJC_CLASS_$_BBB __attribute__ ((used, section
("__DATA,__objc_data"))) = {
        0, // &OBJC_METACLASS_$_BBB,
        0, // &OBJC_CLASS_$_AAA,
        0, // (void *)&_objc_empty_cache,
        0, // unused, was (void *)&_objc_empty_vtable,
        &_OBJC_CLASS_RO_$_BBB,
};
```

1. 类包含 instance_methods、ivars、properties。

# 元类本质

```
static struct _class_ro_t _OBJC_METACLASS_RO_$_BBB __attribute__ ((used, section
("__DATA,__objc_const"))) = {
        1, sizeof(struct _class_t), sizeof(struct _class_t),
        (unsigned int)0,
        0,
        "BBB",
        (const struct _method_list_t *)&_OBJC_$_CLASS_METHODS_BBB,
        0,
        0,
        0,
        0,
};
```

```
extern "C" __declspec(dllexport) struct _class_t OBJC_METACLASS_$_BBB __attribute__ ((used,
section ("__DATA,__objc_data"))) = {
        0, // &OBJC_METACLASS_$_NSObject,
        0, // &OBJC_METACLASS_$_AAA,
        0, // (void *)&_objc_empty_cache,
        0, // unused, was (void *)&_objc_empty_vtable,
        &_OBJC_METACLASS_RO_$_BBB,
};
```

1. 元类包含 class_methods。

# property 的本质

```
struct _prop_t {
        const char *name;
        const char *attributes;
};
```

```
static struct /*_prop_list_t*/ {
        unsigned int entsize;  // sizeof(struct _prop_t)
        unsigned int count_of_properties;
        struct _prop_t prop_list[1];
} _OBJC_$_PROP_LIST_BBB __attribute__ ((used, section ("__DATA,__objc_const"))) = {
        sizeof(_prop_t),
        1,
        {{"age","Ti,R,V_age"}}
};
```

1. 属性包含名称、描述。

property的的本质是： ivar + getter + setter。

1. **没有**@synthesize、@dynamic时，编译器会自动编写 ivar、getter、setter。
2. **@synthesize**：编译器自动编写 ivar、getter、setter。
3. **@dynamic**：用户手动编写 ivar、getter、setter。

# category 的本质

```objc
@interface BBB (Cate) <NSCopying>

@property NSDate *birthday;

- (NSDate *)bornDate;

+ (void)desc;

@end
```

```objc
@implementation BBB (Cate)

- (NSDate *)birthday {
    return [NSDate date];
}

- (void)setBirthday:(NSDate *)birthday {
    NSLog(@">>> %@", birthday);
}

- (NSDate *)bornDate {
    return [NSDate date];
}

+ (void)desc {
    NSLog(@">>> %@", [self class]);
}

@end
```

```objc
struct _category_t {
        const char *name;
        struct _class_t *cls;
        const struct _method_list_t *instance_methods;
        const struct _method_list_t *class_methods;
        const struct _protocol_list_t *protocols;
        const struct _prop_list_t *properties;
};
```

```objc
static struct _category_t _OBJC_$_CATEGORY_BBB_$_Cate __attribute__ ((used, section
("__DATA,__objc_const"))) =
{
        "BBB",
        0, // &OBJC_CLASS_$_BBB,
        (const struct _method_list_t *)&_OBJC_$_CATEGORY_INSTANCE_METHODS_BBB_$_Cate,
        (const struct _method_list_t *)&_OBJC_$_CATEGORY_CLASS_METHODS_BBB_$_Cate,
        (const struct _protocol_list_t *)&_OBJC_CATEGORY_PROTOCOLS_$_BBB_$_Cate,
        (const struct _prop_list_t *)&_OBJC_$_PROP_LIST_BBB_$_Cate,
};
```

```objc
static void OBJC_CATEGORY_SETUP_$_BBB_$_Cate(void ) {
        _OBJC_$_CATEGORY_BBB_$_Cate.cls = &OBJC_CLASS_$_BBB;
}
```

1. 分类包含分类所属的类、instance_methods、class_methods、protocols、properties。
2. 分类不包含分类名称。
3. 分类中不存在ivar，所以不能添加成员变量。分类中的属性自动生成的代码只有get、set方法。

# protocol 的本质

```
@protocol Proto <NSObject>

@property int numberOfP;

- (void)reqMethod1;
+ (void)reqMethod1;

@optional
- (void)reqMethod2;
+ (void)reqMethod2;

@end
```

```
struct _protocol_t {
        void * isa;  // NULL
        const char *protocol_name;
        const struct _protocol_list_t * protocol_list; // super protocols
        const struct method_list_t *instance_methods;
        const struct method_list_t *class_methods;
        const struct method_list_t *optionalInstanceMethods;
        const struct method_list_t *optionalClassMethods;
        const struct _prop_list_t * properties;
        const unsigned int size;  // sizeof(struct _protocol_t)
        const unsigned int flags;  // = 0
        const char ** extendedMethodTypes;
};
```

```
struct _protocol_t _OBJC_PROTOCOL_Proto __attribute__ ((used)) = {
        0,
        "Proto",
        (const struct _protocol_list_t *)&_OBJC_PROTOCOL_REFS_Proto,
        (const struct method_list_t *)&_OBJC_PROTOCOL_INSTANCE_METHODS_Proto,
        (const struct method_list_t *)&_OBJC_PROTOCOL_CLASS_METHODS_Proto,
        (const struct method_list_t *)&_OBJC_PROTOCOL_OPT_INSTANCE_METHODS_Proto,
        (const struct method_list_t *)&_OBJC_PROTOCOL_OPT_CLASS_METHODS_Proto,
        (const struct _prop_list_t *)&_OBJC_PROTOCOL_PROPERTIES_Proto,
        sizeof(_protocol_t),
        0,
        (const char **)&_OBJC_PROTOCOL_METHOD_TYPES_Proto
};
```

# 方法缓存

```
struct objc_cache {
    unsigned int mask /* total = mask + 1 */                OBJC2_UNAVAILABLE;
    unsigned int occupied                                   OBJC2_UNAVAILABLE;
    Method _Nullable buckets[1]                             OBJC2_UNAVAILABLE;
};
```

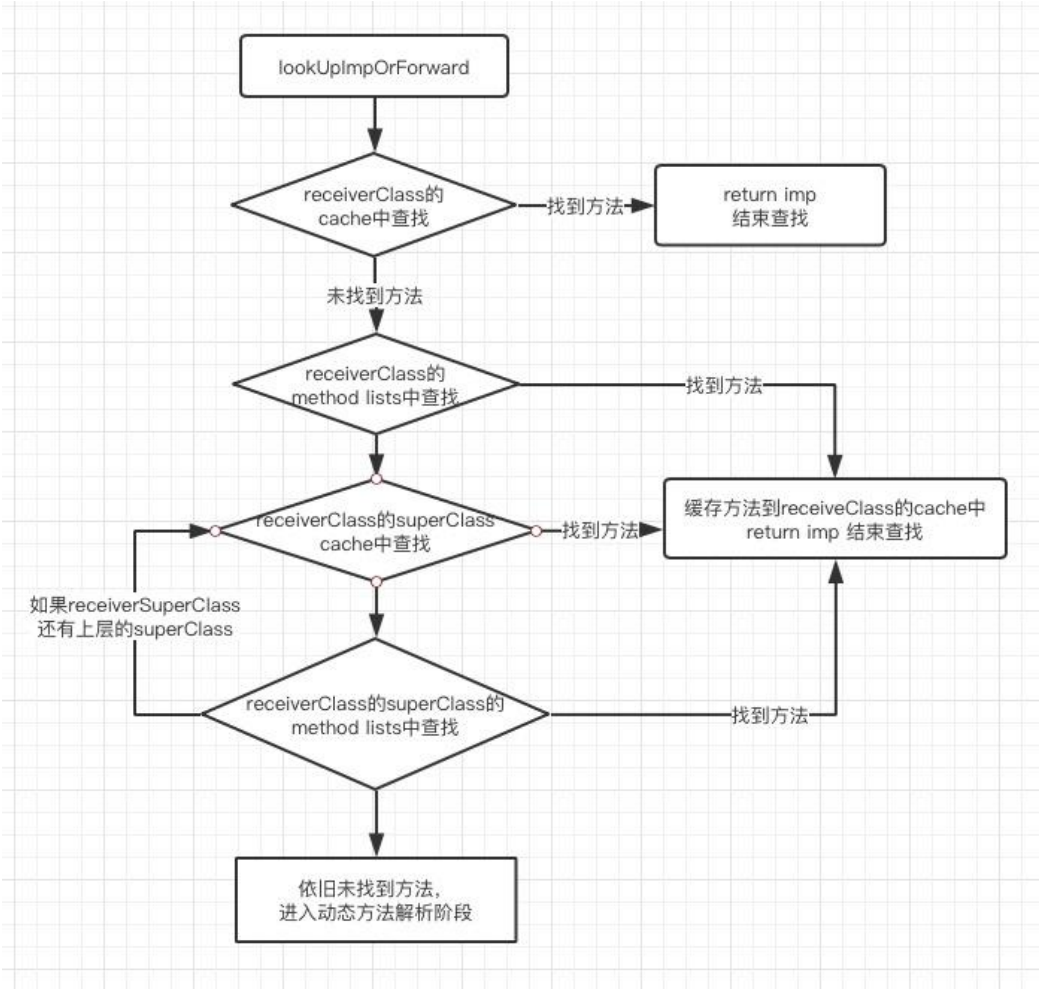
初看以为方法缓存只能缓存一个方法，但实际上是：

```
Method _Nullable buckets[mask + 1];
```

这是C99后的变长数组。

```
static void OBJC_CLASS_SETUP_$_BBB(void ) {
        OBJC_METACLASS_$_BBB.isa = &OBJC_METACLASS_$_NSObject;
        OBJC_METACLASS_$_BBB.superclass = &OBJC_METACLASS_$_AAA;
        OBJC_METACLASS_$_BBB.cache = &_objc_empty_cache;
        OBJC_CLASS_$_BBB.isa = &OBJC_METACLASS_$_BBB;
        OBJC_CLASS_$_BBB.superclass = &OBJC_CLASS_$_AAA;
        OBJC_CLASS_$_BBB.cache = &_objc_empty_cache;
}
```

注意：类、元类共用同一份缓存；也就是说，实例方法缓存、类方法缓存是同一个结构体实例。



# 消息机制

1. 消息发送
2. 动态方法解析
3. 消息转发