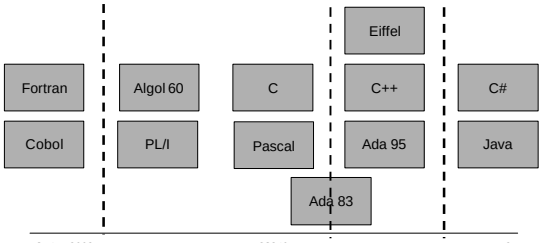
What's New In C#

C# Genealogy



C# And .Net

- Languages like C# are not isolated entities
- They interoperate in two ways:
  - By being part of a system written in more than one language
  - By accessing services and operating on a distributed environment
- Requires support from run time:
  - .Net and the Common Language Runtime

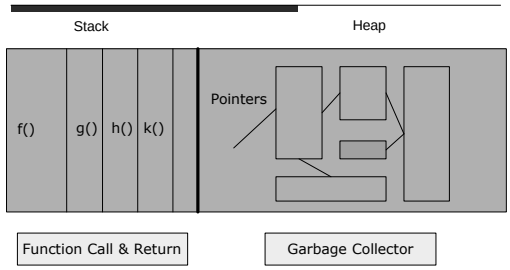
The Simple Stuff

- Most of C# is *pretty* similar to languages you are used to:
  - Declarations
  - Expressions
  - Assignment and control statements
- Other elements are *quite* similar:
  - Classes
  - Functions

Major Topics To Discuss

- Memory system and pointers
- Execution time environment
- Threads
- Exceptions
- Type system
- Identifier scope system
- Interfaces

Memory Layout



C# Memory Management

- Static vs. dynamic
- Dynamic storage—stack and heap
- Stack (Dynamic):
  - Managed algorithmically by implementation of function calls
- Heap (Dynamic)
  - Mostly managed by system
  - Provision for management by programmer

C# Memory Management

- Allocation using *new*
- Deallocation by *Garbage Collection*
- Garbage collection:
  - Track objects that are accessible
  - Free storage associated with objects that are inaccessible
  - Garbage collector is a system provided service that runs periodically
  - Deals with fragmentation

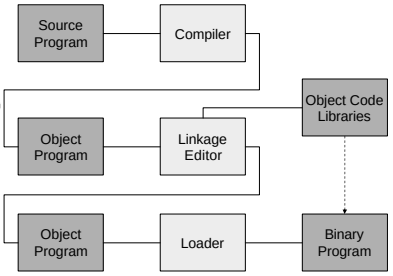
Garbage Collector Pros & Cons

- Pros:
  - Programmer does not have to implement
  - Memory management done right
- Cons:
  - No guarantee when it runs, hence no control
  - Takes processor resources
  - Does not delete storage if it is still reachable even if you don't want it…
  - Memory leaks ***can*** (and ***do***) still occur

Some Specifics of C#

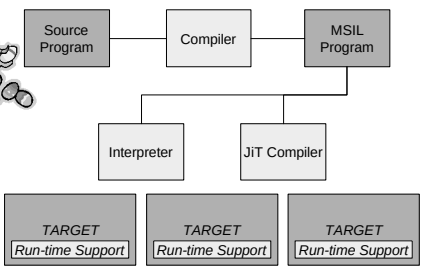
- Object destruction via *Object.Finalize:*
  - Inherited from *Object* type
  - Override to destroy object as desired
- Garbage collector available via *GC* class:
  - Runs via separate thread
  - Various methods available for access
- Pointers—yes, they are provided:
  - Syntax like C++, code marked *unsafe*
  - Objects managed by GC or user—*pinned*

Traditional Compilation



Machine Instructions For *Specific* Target

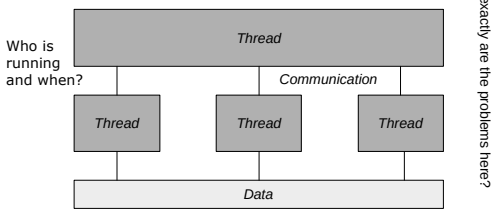
More Flexible Compilation



Machine Instructions For *Multiple* Targets

Concurrency

- Threads vs. processes/tasks
- C# supports *threads*



C# Threads

- *System.Threading* namespace
- Facilities include:
  - Thread creation, destruction
  - Child thread management, e.g. *join()*
  - Thread scheduling, priority, timing
- Synchronization:
  - Monitors
  - Semphores (mutex class)
  - Lock—serialization of statement block

Exceptions

- Why do we need exceptions?
- How should they be made available in programming languages?
- What benefits do they provide?
- What problems could they cause for us?

One Thing Is For Sure…

- Exceptions are NOT for *dealing* with errors
- They are a mechanism for changing the flow of control from sequential to a branch if certain conditions exist
- They always indicate expected circumstances. Otherwise they could not possibly be generated

Exceptions in C#

- *Throw* raises an exception
- *Catch* defines a block that handles the exception
- Etc.

Type System

- Type should be consistent:
  - Predefined and user-defined
- All C# types derive from `System.Object`
- Single rooted hierarchy
- Provides four standard methods:
  - bool Equals
  - int GetHashCode
  - Type GetType
  - String ToString

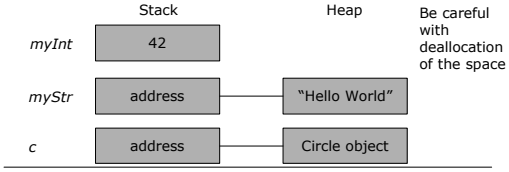
These don't necessarily mean what you think

Types Of Types

- Value types and reference types
- Value types:
  - Program variables have a value
  - Space allocated on stack
- Reference types:
  - Program variable is just a reference
  - Allocated space on stack
  - Reference is a "type-safe" pointer
  - Data space allocated on heap

Value vs. Reference

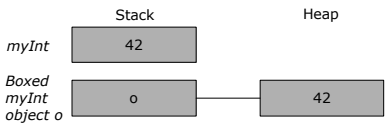
- Note the "special" status of primitive types
-
```
System.Int32  myInt = 42;
System.String myStr = "Hello World";
Circle c;
c = new Circle(...);
```



Be careful with deallocation of the space

Boxing And Unboxing

- Conversion between value variable and reference variable
-
```
System.Int32  myInt = 42;
object        o     = myInt;
int           ymInt = (int)o;
```



The Role Of A Type System

- What do we need from a type system?
  - The ability to create new "things" that are more useful (usually more abstract) than the basic machine resources
  - To allow us to build mechanical checks to stop us from hurting ourselves
- The notion of type is artificial

The Role Of A Type System

- Types across languages:
  - Consistency
  - Compatibility
- Type safety on steroids:
  - Checking for meaningful statements
  - Add "speed" to "distance"?
  - Assembly language vs. C vs Java and C# vs Ada
- Type needs to support application semantics