Programmer’s Guide

Lab 2 Group BEERZ

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**2/23/2011**

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# Introduction

This document contains a summary of the implementation of the “Wi-11 Machine” assembler. This guide will cover all of the components that make up and are used in the execution of the assembler.

# Assembler Overview

When the assembler runs, the entry point is in the class entitled **Main**, which is implemented in the **Assembler** package in the **Main.java** file. **Main** is responsible for accepting and handling command line arguments, creating the object file and generating a program listing. **Main** uses the **Assembler** and **Program** classes in order to complete the tasks of creating the object file and listing.

## Directory Structure

The assembler’s files are in a parent directory named “cse-560-beerz,” that contains one subfolder named Assembler. The following files are in the Assembler directory:

* **Main.java**
  + Contains the implementation of the **Main** class, which controls the creation of the object file and program listing, as well as handling all of the I/O with the end user in the form of command line arguments and error and usage out to the console.
* **Assembler.java**
  + Contains the implementation of the **Assembler** class that takes a given assembly source file and assembles it into an instance of a **Program** class.
* **Program.java**
  + Implements the **Program** class, which is used to represent the assembled program in memory and provides the method for rendering the program into binary form.
* **Instruction.java**
  + Each instance of the **Instruction** class represents a single “Wi-11” assembly code machine instruction.
* **InstructionDefinition.java**
  + The **InstructionDefinition** class is used by the **Assembler** to turn the source code into the binary representation once an assembly instruction has been matched with the proper definition.
* **LiteralTable.java**
* **Operand.java**
* **OperandDefinition.java**
* **Symbol.java**
* **SymbolTable.java**

The Assembler folder contains the subfolder “/tests” that contains the test assembly files that were used in the testing of the Assembler

The Assembler folder also contains the subfolder “/docs” that contains the User’s Guide, Programmer’s Guide and the Testing Plan. Contained within the “/docs” directory is another subfolder “/Meeting Minutes” that contains the minutes for each design meeting that took place.

## Design Conventions

Across the files in our implementation, several design conventions were followed. These include the capitalization of class names, like **Main** or **InstructionDefinition**, lower-case names for packages and variables, and mixed-case names for method titles like “getSource”.

## Module Inter-Relationships

# Data Structures

There are several important data structures that are used by the assembler in the creation of the object file and the listing file. The following is a listing of the data structure, the file it appears in, the usage of the data structure, its implementation, and its invariant.

* Object: “Instruction” defined by Instruction.java
  + Represents an individual “Wi-11 Machine” instruction
  + Implemented as an **InstructionDefinition,** an array of **Operand**’s and two strings defining the name and the source of the **Instruction**
  + Invariant: the **Instruction** must be a properly formed “Wi-11 Machine” instruction
* Object: “InstructionDefinition” defined by InstructionDefinition.java
  + Represents a certain type of assembly instruction
  + Implemented as a **String** representing the instruction name, an array of **int** that represent the binary values of the final binary code, an array of **OperandDefinition**’s, and an **int** representing the size of the instruction
  + Invariant: the provided **Instruction** must be a properly form “Wi-11 Machine” instruction
* Object: “LiteralTable” defined by LiteralTable.java
  + Represents a table of literals accumulated during the first assembler pass
  + Implemented as a **HashMap<Integer, Integer>();**
  + Invariant: each literal in the table must have a unique address
* Object: “Operand” defined by Operand.java
  + Represents a value (a **Symbol**, register id, literal, or immediate value) to be used by an **Instruction**
  + Implemented as an **OperandDefinition**, a **String**, and an **OperandType**
  + Invariant: An **Operand** must be a valid **Symbol**, register, literal or immediate value
* Object: “OperandDefinition” defined by OperandDefinition.java
  + Represents the acceptable values of **Operand**’s defined for the “Wi-11 Machine”
  + Implemented as an array of **OperandType**
  + Invariant: the **Operand** must be a valid **OperandType**
* Object: “OperandType” defined by OperandType.java
  + Represents the operand types available in the “Wi-11 Machine”
  + Implemented as an enumeration of valid operand types
* Object: “Symbol” defined by Symbol.java
  + Represents the name/value pair of a defined symbol
  + Implemented as **String** and an **int** as well as a **boolean** that determines whether or not the **Symbol** is relocatable or not
* Object: “SymbolTable” defined by SymbolTable.java
  + Represents the internal mappings of names to **Symbols**
  + Implemented as a **HashMap<String, Symbol>();**
  + Invariant: Only unique **Symbols** can be entered into the **SymbolTable**

# Component Descriptions

This section provides a detailed description of both the client- and implementation-side view of every component used in the program, with the exception of the testing package of components.

## Client-Side

* **Main**
  + Description: The **Main** component is the entry point into the assembler program. It accepts the command line arguments from the user, such as, the file containing the source code, the specified object output file, and an option to generate a listing.
* **Program**
  + Description: The **Program** component holds the in-memory representation of the assembly program. The **Program** can then be rendered into its binary representation.
* **Assembler**
  + Description: The **Assembler** component

## Implementer-Side

### Main

### Assembler

### ByteOperations

* Description: A utility class that is used to obtain specific bits in a given hexadecimal number.
* **ByteOperations Methods:**
* Method: parseHex
  + Description: This method converts a hex number represented in a String to an integer value.
  + Parameters: **String** hex
  + Ensures: hex is a valid hexadecimal number representation.
  + Returns: an integer value representing the input hex value.
* Method: extractValue
  + Description: This method extracts bit values from a given integer.
  + Parameters: **int** value, **int** start, **int** end
  + Requires: start < end
  + Returns: an integer value representing the extracted bits.
* Method: getHex
  + Description: This method gets a string representation of a given integer value.
  + Parameters: **int** value, **int** numCharacters
  + Ensures: All but the least significant hex digits specified by numCharacters are removed.
  + Returns: a string representation of the integer value in hexadecimal form.
* Method: getBit
  + Description: This method returns true if the bit in “value” at the specified right-aligned index is 1.
  + Parameters: **int** value, **int** index
  + Returns: A **boolean** value indicating if the specified bit is 1.

### Instruction

* Description: Each instance of this class represents an assembly instruction that contains a definition, a name and a collection of **Operand**s.
* State: private **InstructionDefinition** definition, private **Operand**[] operands, private **String** source, private **String** name
* **Instruction** Methods
* Method: setDefinition
  + Description: Sets the definition of this Instruction, as well as the definition of all this Instruction's Operands. Note: setOperands must be called first.
  + Parameters: InstructionDefinition definition

### InstructionDefinition

### LiteralTable

### Operand

### OperandDefinition

### OperandType

### Program

### Symbol

### SymbolTable

* Description: An instance of this class maintains a mapping between symbols and their values.
* State: private **Map**<**String, Symbol**>
* **SymbolTable** Methods
* Method: define
  + Description: Adds a given **Symbol** to this **SymbolTable**.
  + Parameters: **Symbol** symbol
  + Alters: this
  + Ensures: this = #this + symbol
* Method: define
  + Description: Defines an alias for another **Symbol**.
  + Parameters: **String** alias, **String** target
  + Alters: this
  + Ensures: this = #this + alias
* Method: hasSymbol
  + Description: Returns true if this table contains a **Symbol** that matches the given name.
  + Parameters: **String** name
  + Returns: **boolean** true if and only if name matches a **Symbol** in this
* Method: get
  + Description: Gets the **Symbol** mapped to the given name, or null if none exists in this.
  + Parameters**: String** name
  + Returns: **Symbol** corresponding to name input
* Method: size
  + Description: Gets the number of defined **Symbols** in this table.
  + Returns: **int** number of defined **Symbols**