SE 3XA3: Test Plan
Rogue Reborn

Group #6, Team Rogue++

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Table 1: **Revision History**

Date	Version	Notes
12/06/16	0.1	Initial Draft
12/06/16	0.2	Automated Tests To PlayerChar
12/06/16	0.3	Functional Requirements Evaluation
12/07/16	0.4	Introduction

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1 Introduction

1.1 Overview

The primary objective of this document is to provide a comprehensive summary of the verification process with respect to the Rogue Reborn project. Interested parties are welcome to analyze this paper as a means of evaluating the success of the final application regarding the requirements described in the SRS and tests prescribed in the Test Plan. After reviewing the document, the reader should understand the strengths and weaknesses of the Rogue Project as it relates to the expectations of the client.

1.2 Sections

A brief description of each Test Report section is provided below:

§1 Brief overview of the Test Report

§2 Functional evaluation of Rogue Reborn

§3 Non-functional evaluation of Rogue Reborn

§4 Description of relationship to original *Rogue* with respect to testing

§5 Explanation of unit testing in Rogue Reborn

§6 List of changes that were performed as a consequence of testing

§7 Tabular depiction of automated tests

§8 Justification of test files with respect to functional requirements

§9 Decomposition of modules and trace to test files

§10 Summary of code coverage metrics

2 Functional Requirements Evaluation

Overall, an evaluation of functional requirements reveals near, if not complete coverage. The tests written for the projects turned out to be quite useful, as many caught bugs or business-errors that would have otherwise gone unnoticed. Those will be discussed below. As for the rest of the functional requirements, many were mundane, general, or crucial enough to have already been satisfied earlier. Those will not be discussed, as their complete satisfaction has already been verified countless times.

The list below refers to each functional requirement by its numerical identifier, as listed in the System Requirements Specification. Please refer to the SRS document if any confusion arises.

FR.16: When performing level tests, a strange anomaly led to one test constantly failing. The test revealed that the player, in fact, did not begin at the first level. Due to an off-by-one error and slight miscommunication between developers, the current level depth the player was on was i in some places and $i+1$ in others. As soon as the test revealed this, the problem was remedied globally.

FR.19: Whenever the player uncovers a new dungeon level (including the very first level), an algorithm decides on a position in which to place the user initially. This algorithm while appearing flawless, actually had a very slight chance of placing the player in an unreachable location, surrounded by walls, doomed forever. With the automatic tests running thousands upon thousands of simulations, the bug was quickly revealed, and remedied.

FR.39: Working with C++ has its benefits, but also its drawbacks. An anomaly in the way C++ handles integers revealed a very serious bug in the code, in which player armor could reach utterly ridiculous values, rendering the player effectively invincible. By simulating every possibility of armor that can be made, this bug was caught and patched. To elaborate, the reason the bug even existed was because an unsigned integer was allowed to be reduced to a negative value, which of course means that it was not reduced to a negative number and instead went to the highest value an integer can be.

3 Non-Functional Requirements Evaluation

The following subsections evaluate the significant non-functional qualities of Rogue Reborn. To simplify notation, *NFRT i* is used to denote "Non-Functional Requirements Test *i*" from the Test Plan document. Note that the usability and playtesting surveys described in *NFRT 1* , *NFRT 2* , *NFRT 4* , *NFRT 7* , *NFRT 10* were not performed as a direct consequence of the time constraints imposed on the project (the Gantt Chart schedules this survey to be released in early January, 2017).

3.1 Usability and Aesthetics

Overall, the visual appearance of the application was well-received by the Rogue Reborn stakeholders. This was deduced through the interactions between the Rogue++ team and the *SFWRENG 3XA3* instructor staff, as well as informal conversations with other colleagues. Unfortunately, the usability survey described in *NFRT 1* will be carried out in the future, so the impressions of the general public are not yet known.

Since the usability of the original *Rogue* was relatively poor due to its seemingly-arbitrary key bindings, the Rogue Reborn application made goals to improve this area. Specifically, the application featured arrow key bindings for some of player character movements in order to accommodate a more standard and intuitive keyboard layout. However, due to the plethora of other key bindings, the Rogue++ team was *not* successful in alleviating this issue completely. A summary of the remaining non-functional test *NFRT 3* is given below.

Non-Functional Requirement Test # 3 Summary	
Description:	All strings in the Rogue Reborn source code were extracted and placed in a text file, where a developer later corrected all indicated errors that were potentially associated with a GUI output using Microsoft Word. The script that performed the string extraction is located under the `src/misc` under the name stringfinder.py.
Results:	The aforementioned script managed to located approximately 1400 strings. After manually verifying the grammatical correctness and spelling of each string in Word, it was determined that the GUI output is free of linguistic errors.

3.2 Performance

Mikhail

3.3 Robustness and Maintainability

Mikhail

3.4 Safety

Mikhail

4 Comparison to Existing Implementation

5 Unit Testing

Mikhail

6 Changes Due to Testing

Mikhail

7 Automated Testing

7.1 Automated Testing Strategy

For this project we elected not to use a 3rd party testing library. We made this decision to ease configuration/installation problems and reduce our dependencies, as we judged it would not be necessary. Instead a series of files (labeled test.foobar.cpp) in the repository hold tests, which are run by our custom test runner. These automated tests are run on command by executing the produced executable, or by the continuous integration script run whenever changes are pushed to the central repository. The results of these tests are automatically reported, resulting in a failed or successful build.

7.2 Specific System Tests

The following is a list of all system tests in the project.

7.3 Automated Testing Strategy

For this project we elected not to use a 3rd party testing library. We made this decision to ease configuration/installation problems and reduce our dependencies, as we judged it would not be necessary. Instead a series of files (labeled test.foobar.cpp) in the repository hold tests, which are run by our custom test runner. These automated tests are run on command by executing the produced executable, or by the continuous integration script run whenever changes are pushed to the central repository. The results of these tests are automatically reported, resulting in a failed or successful build.

7.4 Specific System Tests

The following is a list of all system tests in the project.

Name:	Amulet Construction
Initial State:	None
Input:	Coordinate, context value
Expected Output:	Amulet object in valid initial state

Name:	Armor Construction 1
Initial State:	None
Input:	Coordinate
Expected Output:	Armor object in valid initial state
Name:	Armor Construction 2
Initial State:	None
Input:	Coordinate, context value, type value
Expected Output:	Armor object in valid initial state
Name:	Armor Identification
Initial State:	Cursed Armor
Input:	None
Expected Output:	Verification that armor is identified
Name:	Armor Identification
Initial State:	Cursed Armor
Input:	None
Expected Output:	Verification that armor is identified
Name:	Armor Curse
Initial State:	Cursed Armor
Input:	None
Expected Output:	Verification that armor is cursed
Name:	Armor Enchantment
Initial State:	Cursed Armor
Input:	Curse level
Expected Output:	Verification that armor enchantment is correct
Name:	Armor Rating
Initial State:	Cursed Armor
Input:	None
Expected Output:	Verification that armor rating is correct
Name:	Coordinate Ordering
Initial State:	None
Input:	(0,0) coordinate and (1,1) coordinate
Expected Output:	Verification that (0,0) ¡ (1,1)
Name:	Coordinate Equality
Initial State:	None
Input:	Two (0,0) coordinates
Expected Output:	Verification that the two inputs are equal
Name:	Coordinate Inequality

Initial State:	None
Input:	(0,0) coordinate and (1,1) coordinate
Expected Output:	Verification that the two inputs are not equal
Name:	Coordinate Addition
Initial State:	None
Input:	(2,3) coordinate and (1,2) coordinate
Expected Output:	(3,5) coordinate
Name:	Coordinate Subtraction
Initial State:	None
Input:	(2,3) coordinate and (1,2) coordinate
Expected Output:	(1,1) coordinate
Name:	Feature Construction
Initial State:	None
Input:	Symbol, coordinate, visibility, color
Expected Output:	Feature object in valid initial state
Name:	Feature Symbol Check
Initial State:	Feature with given symbol
Input:	Symbol
Expected Output:	Verification that feature's symbol matches given
Name:	Feature Invisibility Check
Initial State:	Invisible feature
Input:	None
Expected Output:	Verification that feature is invisible
Name:	Feature Visibility Check
Initial State:	Visible feature
Input:	None
Expected Output:	Verification that feature is visible
Name:	Feature Location Check
Initial State:	Feature with given location
Input:	Coordinate
Expected Output:	Verification that feature's location matches given coordinate
Name:	Food Construction
Initial State:	None
Input:	Coordinate and context value
Expected Output:	Food object in valid initial state
Name:	Food Eating
Initial State:	Food and player objects

Input:	None
Expected Output:	Verification that food has increased the player's food life by an appropria
Name:	GoldPile Construction
Initial State:	None
Input:	Coordinate, gold amount value
Expected Output:	GoldPile object in valid initial state
Name:	GoldPile Quantity Check
Initial State:	GoldPile with given amount of gold
Input:	Amount of gold value
Expected Output:	Verification that gold's amount matches given amount
Name:	Item Construction 1
Initial State:	None
Input:	Symbol, coordinate, context value, item class specifier, name value, psued
Expected Output:	Item object in valid initial state
Name:	Item Construction 2
Initial State:	None
Input:	Symbol, coordinate, context value, item class specifier, name value, psued
Expected Output:	Item object in valid initial state
Name:	Name Vector Check
Initial State:	None
Input:	Vector of item names
Expected Output:	Shuffled vector of item names
Name:	Item Curse Check
Initial State:	Uncursed item
Input:	None
Expected Output:	Verification that item is uncursed
Name:	Item Curse/Effect Check 1
Initial State:	Uncursed item to which the cursed effect has been applied
Input:	None
Expected Output:	Verification that item is cursed
Name:	Item Curse/Effect Check 2
Initial State:	Cursed item whose curse effect has been removed
Input:	None
Expected Output:	Verification that item is uncursed
Name:	Item Unindentified Check
Initial State:	Identified item
Input:	None

Expected Output:	Verification that item is unidentified
Name:	Item Identified Check
Initial State:	Unidentified item
Input:	None
Expected Output:	Verification that item is identified
Name:	Item Display-Name Check 1
Initial State:	Unidentified item
Input:	Psuedoname
Expected Output:	Verification that item's display name matches psuedoname
Name:	Item Display-Name Check 2
Initial State:	Identified item
Input:	True name
Expected Output:	Verification that item's display name matches true name
Name:	ItemZone Containment Check 1
Initial State:	ItemZone with 2 items
Input:	None
Expected Output:	Verification that ItemZone contains the first item
Name:	ItemZone Containment Check 2
Initial State:	ItemZone with 2 items
Input:	None
Expected Output:	Verification that ItemZone contains the second item
Name:	ItemZone Empty Check
Initial State:	ItemZone with 2 items
Input:	None
Expected Output:	Verification that ItemZone is not empty
Name:	ItemZone Size Check
Initial State:	ItemZone with 2 items
Input:	None
Expected Output:	Verification that ItemZone's size is 2
Name:	ItemZone Keybind Check 1
Initial State:	ItemZone with 2 items
Input:	None
Expected Output:	Verification that first item is bound to 'a' key
Name:	ItemZone Keybind Check 2
Initial State:	ItemZone with 2 items
Input:	None
Expected Output:	Verification that second item is bound to 'b' key

Name:	ItemZone Contents Retrieval 1
Initial State:	ItemZone with 2 items
Input:	None
Expected Output:	Item map with exactly 1 copy of first item
Name:	ItemZone Contents Retrieval 2
Initial State:	ItemZone with 2 items
Input:	None
Expected Output:	Item map with exactly 1 copy of second item
Name:	ItemZone Removal
Initial State:	ItemZone with 2 items
Input:	Removal command
Expected Output:	ItemZone with only second item
Name:	ItemZone Keybind Persistence
Initial State:	ItemZone with first item removed
Input:	None
Expected Output:	Verification that second item is still bound to 'b'
Name:	ItemZone Weight Enforcement
Initial State:	Empty ItemZone
Input:	Attempt to add 500 pieces of armor to ItemZone
Expected Output:	ItemZone with max-weight worth of armor
Name:	Level Construction
Initial State:	None
Input:	Depth, player object
Expected Output:	Level object in valid initial state
Name:	Level Depth Check
Initial State:	Level with given depth
Input:	Depth value
Expected Output:	Verification that level's depth matches given value
Name:	Level BFSPerp Diagonal Small
Initial State:	Empty level object
Input:	Pair of coordinates diagonally adjacent
Expected Output:	Path between coordinates with expected length, utilizing taxicab moveme
Name:	Level BFSPerp Horizontal
Initial State:	Empty level object
Input:	Pair of coordinates with equal y-values
Expected Output:	Path between coordinates with expected length, utilizing taxicab moveme
Name:	Level BFSPerp Vertical

Initial State:	Empty level object
Input:	Pair of coordinates with equal x-values
Expected Output:	Path between coordinates with expected length, utilizing taxicab moveme
Name:	Level BFSDiag Horizontal
Initial State:	Empty level object
Input:	Pair of coordinates with equal y-values
Expected Output:	Path between coordinates with expected length, utilizing orthogonal move
Name:	Level BFSDiag Vertical
Initial State:	Empty level object
Input:	Pair of coordinates with equal x-values
Expected Output:	Path between coordinates with expected length, utilizing orthogonal move
Name:	Level BFSPerp Diagonal
Initial State:	Empty level object
Input:	Pair of coordinates on diagonal line
Expected Output:	Path between coordinates with expected length, utilizing taxicab moveme
Name:	Level Starting Position
Initial State:	Empty level object
Input:	None
Expected Output:	Valid starting position coordinate
Name:	Level getAdjPassable
Initial State:	Empty level object
Input:	Coordinate
Expected Output:	List of coordinates orthogonally adjacent to given coordinate
Name:	Level Path Generation
Initial State:	Player object and generated level
Input:	Series of path requests between random coordinates
Expected Output:	Valid paths between locations
Name:	Level Connectedness
Initial State:	Player object and generated level
Input:	Series of path requests between all rooms in the level
Expected Output:	Valid paths between each room
Name:	Level Staircase Check
Initial State:	Player object and generated level
Input:	None
Expected Output:	Verification that level contains a staircase
Name:	Level GoldPile Check
Initial State:	Player object and generated level

Input:	None
Expected Output:	Verification that level contains at least one goldpile
Name:	Monster Construction
Initial State:	None
Input:	Symbol, coordinate, armor value, HP value, exp value, level value, maxHI
Expected Output:	Monster object in valid initial state
Name:	Dice-Math 1
Initial State:	None
Input:	1 1-sided die
Expected Output:	Sum of values of 1
Name:	Dice-Math 2
Initial State:	None
Input:	2 1-sided die
Expected Output:	Sum of values of 2
Name:	Dice-Math 3
Initial State:	None
Input:	1 2-sided die
Expected Output:	1 ¡= Sum of values ¡= 2
Name:	Dice-Math 4
Initial State:	None
Input:	3 4-sided die
Expected Output:	3 ¡= Sum of values ¡= 12
Name:	Mob Armor Check
Initial State:	Mob object
Input:	None
Expected Output:	Verification mob armor is in valid range
Name:	Mob HP Check 1
Initial State:	Mob with given HP value
Input:	HP value
Expected Output:	Verification mob has correct HP value
Name:	Mob MaxHP Check
Initial State:	Mob with given MaxHP value
Input:	MaxHP value
Expected Output:	Verification mob has correct MaxHP value
Name:	Mob Level Check
Initial State:	Mob with given level value
Input:	Level value

Expected Output:	Verification mob has correct level value
Name:	Mob Location Check
Initial State:	Mob with given location
Input:	Coordinate
Expected Output:	Verification mob has correct location
Name:	Mob Name Check
Initial State:	Mob with given name
Input:	Name value
Expected Output:	Verification mob has correct name
Name:	Mob setMaxHP
Initial State:	Mob with default MaxHP
Input:	setMaxHP command with MaxHP value
Expected Output:	mob with given MaxHP value
Name:	Mob setcurrentHP
Initial State:	Mob with default currentHP
Input:	setCurrentHP command with currentHP value
Expected Output:	mob with given currentHP value
Name:	Mob Dead Check 1
Initial State:	Living Mob object
Input:	None
Expected Output:	Verification mob is alive
Name:	Mob HP Check 2
Initial State:	Living Mob object
Input:	Hit command for ¿¿¿ mob's current HP
Expected Output:	Verification mob has HP ¡= 0
Name:	Mob Dead Check 2
Initial State:	Dead mob object
Input:	None
Expected Output:	Verification mob is dead
Name:	Monster Construction
Initial State:	None
Input:	Symbol, coordinate
Expected Output:	Monster object in valid initial state
Name:	Monster Flag/Invisibility
Initial State:	Visible monster object
Input:	SetFlag command to make monster invisible
Expected Output:	Invisible monster object

Name:	Monster Aggrevate
Initial State:	Idling, sleeping monster object
Input:	Aggrevate command
Expected Output:	Awake, chasing monster object
Name:	Monster Damage Calculation
Initial State:	Monster object
Input:	calculateDamage command
Expected Output:	Correct amount of damage
Name:	Monster Hit Chance
Initial State:	Monster and player objects
Input:	calculateHitChange command
Expected Output:	Hit chance in valid range
Name:	Monster Armor Check
Initial State:	Monster object
Input:	None
Expected Output:	Verification that monster armor is in valid range
Name:	Invisible Monster Name Check
Initial State:	Invisible uonster object
Input:	None
Expected Output:	Verification monster has hidden name
Name:	Visible Monster Name Check
Initial State:	Invisible monster object
Input:	RemoveFlag command to make monster invisible
Expected Output:	Verification monster has real name
Name:	Monster Symbol/Level Association
Initial State:	None
Input:	Depth value
Expected Output:	Set of symbols for monsters that are valid candidates for given depth
Name:	Monster Symbol/Treasure/Level Association
Initial State:	None
Input:	Depth value
Expected Output:	Set of symbols for monsters that are valid candidates for given depth for
Name:	PlayerChar Initial Amulet Check
Initial State:	Just initialized playerchar object
Input:	None
Expected Output:	Verification the game does not believe the player has the amulet
Name:	PlayerChar Initial HP Check

Initial State:	Just initialized playerchar object
Input:	None
Expected Output:	Verification playerchar has full hp
Name:	PlayerChar Level-Up Exp
Initial State:	Playerchar object at initial level
Input:	Exp input into playerchar object
Expected Output:	Playerchar object with increased level
Name:	PlayerChar Level-Up Manual
Initial State:	Playerchar object
Input:	Level-up command
Expected Output:	Playerchar object with increased level
Name:	PlayerChar Damage
Initial State:	Playerchar object at full hp
Input:	Series of damage commands applied to playerchar object
Expected Output:	Playerchar object with less than full hp
Name:	PlayerChar UnArmed 1
Initial State:	Unarmed playerchar object
Input:	calculateDamage command
Expected Output:	0 damage value
Name:	PlayerChar Armed
Initial State:	Playerchar object armed with weapon
Input:	calculateDamage command
Expected Output:	Damage value ¿ 0
Name:	PlayerChar Stow Weapon
Initial State:	Playerchar object armed with uncursed weapon
Input:	removeWeapon command
Expected Output:	PlayerChar object unarmed
Name:	PlayerChar UnArmed 2
Initial State:	Armed playerchar object
Input:	removeWeapon command, then calculateDamage
Expected Output:	0 damage value
Name:	PlayerChar Remove Non-Armor
Initial State:	Playerchar object with no armor
Input:	removeArmor command
Expected Output:	Boolean indicating failure to remove armor
Name:	PlayerChar Remove Armor
Initial State:	Playerchar object with uncursed armor

Input:	removeArmor command
Expected Output:	Playerchar object without armor
Name:	Potion Construction 1
Initial State:	None
Input:	Coordinate
Expected Output:	Potion object in valid initial state
Name:	Potion Construction 2
Initial State:	None
Input:	Coordinate, item context value, item type specifier
Expected Output:	Potion object in valid initial state
Name:	Potion of Strength
Initial State:	Player object
Input:	Potion of strength
Expected Output:	Player with strength increased by 1
Name:	Potion of Restore Strength
Initial State:	Player object with reduced strength
Input:	Potion of restore strength
Expected Output:	Player object with pre-reduction strength
Name:	Potion of Healing
Initial State:	Player object with full hp
Input:	Potion of healing
Expected Output:	Player object with maxHP increased by 1
Name:	Potion of Extra Healing
Initial State:	Player object with full hp
Input:	Potion of extra healing
Expected Output:	Player object with maxHP increased by 2
Name:	Potion of Poison
Initial State:	Player object with strength ¿ 0
Input:	Potion of poison
Expected Output:	Player object with reduced strength
Name:	Potion of Raise Level
Initial State:	Player object with less than max level
Input:	Potion or raise level
Expected Output:	Player object with level + 1
Name:	Potion of Blindness
Initial State:	Player object without the blindness condition
Input:	Potion of blindness

Expected Output:	Player object with the blindness condition
Name:	Potion of Hallucination
Initial State:	Player object without the hallucination condition
Input:	Potion of hallucination
Expected Output:	Player object with the hallucination condition
Name:	Potion of Detect Monster
Initial State:	Player object without the detect-monsters condition
Input:	Potion of detect monsters
Expected Output:	Player object with the detect-monsters condition
Name:	Potion of Detect Object
Initial State:	Player object without the detect-objects condition
Input:	Potion of detect objects
Expected Output:	Player object with the detect-objects condition
Name:	Potion of Confusion
Initial State:	Player object without the confusion condition
Input:	Potion of confusion
Expected Output:	Player object with the confusion condition
Name:	Potion of Confusion
Initial State:	Player object without the confusion condition
Input:	Potion of confusion
Expected Output:	Player object with the confusion condition
Name:	Potion of Levitation
Initial State:	Player object without the levitation condition
Input:	Potion of levitation
Expected Output:	Player object with the levitation condition
Name:	Potion of Haste
Initial State:	Player object without the haste condition
Input:	Potion of haste
Expected Output:	Player object with the haste condition
Name:	Potion of See-Invisible
Initial State:	Player object without the invisible-sight condition
Input:	Potion of invisible
Expected Output:	Player object with the invisible-sight condition
Name:	Random Range 1
Initial State:	None
Input:	Upper and lower bounds 0,0
Expected Output:	0

Name:	Random Range 2
Initial State:	None
Input:	Upper and lower bounds 5,5
Expected Output:	5
Name:	Random Range 3
Initial State:	None
Input:	Upper and lower bounds 0,60, repeated 40 times
Expected Output:	0 ¡= result ¡= 60
Name:	Random Float
Initial State:	None
Input:	40 repeats
Expected Output:	0 ¡= result ¡= 1
Name:	Random Boolean
Initial State:	None
Input:	10 repeats
Expected Output:	Both true and false are generated
Name:	Random Percent
Initial State:	None
Input:	40 repeats
Expected Output:	0 ¡= result ¡= 100
Name:	Random Position
Initial State:	None
Input:	Two coordinates, as top-left and bottom-right of rectangle, 10 repeats
Expected Output:	Random coordinates within the bounds
Name:	Ring Construction 1
Initial State:	None
Input:	Coordinate
Expected Output:	Ring object with valid initial state
Name:	Ring Construction 2
Initial State:	None
Input:	Coordinate, item context value, type identifier
Expected Output:	Ring object with valid initial state
Name:	Ring of Stealth
Initial State:	Player object without stealth condition
Input:	Activate ring of stealth
Expected Output:	Player object with the stealth condition
Name:	Ring of Teleportation

Initial State:	Player object without random teleportation condition
Input:	Activate ring of teleportation
Expected Output:	Player object with the random teleportation condition
Name:	Ring of Regeneration
Initial State:	Player object without regeneration condition
Input:	Activate ring of regeneration
Expected Output:	Player object with the regeneration condition
Name:	Ring of Digestion
Initial State:	Player object without digestion condition
Input:	Activate ring of digestion
Expected Output:	Player object with the digestion condition
Name:	
Initial State:	
Input:	
Expected Output:	

8 Trace to Requirements

The following table maps each implemented test file to a set of functional and non-functional requirements

Table 3: **Test-Requirement Trace**

File	Related Requirement(s)
test.amulet.cpp	FR.25
test.armor.cpp	FR.29, FR.34, FR.39,
test.coord.cpp	FR.17
test.feature.cpp	FR.5, FR.13, FR.14, FR.15, FR.25, FR.31
test.food.cpp	FR.5, FR.31
test.goldpile.cpp	FR.5
test.item.cpp	FR.5, FR.13, FR.14, FR.15, FR.25, FR.30 FR.31
test.itemzone.cpp	FR.5, FR.9, FR.26
test.level.cpp	FR.16-19
test.levelgen.cpp	FR.16-19
test.main.cpp	Put everything together
test.mob.cpp	FR.37, FR.38, FR.39
test.monster.cpp	FR.35-39
test.playerchar.cpp	FR.9-15, FR.26-34, NFR.5
test.potion.cpp	FR.5, FR.13, FR.14, FR.15, FR.25, FR.31
test.ring.cpp	FR.5, FR.13, FR.14, FR.15, FR.25, FR.31
test.room.cpp	FR.17, FR.18, FR.19, FR.21
test.scroll.cpp	FR.5, FR.13, FR.14, FR.15, FR.25, FR.31
test.stairs.cpp	FR.18, FR.19
test.terrain.cpp	FR.13, FR.15, FR.18, FR.19, FR.23, FR.24
test.testable.cpp	Defines test-suite
test.testable.h	Defines test-suite
test.trap.cpp	FR.12, FR.15, FR.19, FR.20, FR.23, FR.24, FR.34
test.tunnel.cpp	FR.17, FR.19
test.uistate.cpp	FR.1-4, FR.6-10, NFR.1, NFR.3, NFR.5
test.wand.cpp	FR.5, FR.13, FR.14, FR.15, FR.25, FR.31
test.weapon.cpp	FR.5, FR.13, FR.14, FR.15, FR.25, FR.31

9 Trace to Modules

The following table re-iterates the modules of the project, along with their respective domain and module ID. The module IDs are used to refer to modules in the trace. More about the modules can be found in the Module Guide.

Table 5: **Module Hierarchy**

Level 1	**Level 2**	
Hardware-Hiding Module	BasicIO	**M1**
	Doryen	**M2**
	Input Format	**M3**
Behaviour-Hiding Module	External	**M4**
	Item	**M5**
	Level	**M6**
	LevelGen	**M7**
	MainMenu	**M8**
	Monster	**M9**
	PlayerChar	**M10**
	RipScreen	**M11**
	PlayState	**M12**
	UIState	**M13**
Software Decision Module	Coord	**M14**
	Feature	**M15**
	ItemZone	**M16**
	MasterController	**M17**
	Mob	**M18**
	Random	**M19**
	Terrain	**M20**

The following table maps test files, which implement tests, to specific modules, given by their IDs.

Table 6: **Test-Module Trace**

File	Related Module(s)
test.amulet.cpp	M7, M12, M13
test.armor.cpp	M5, M10, M18
test.coord.cpp	M2, M5, M6, M7, M14, M19
test.feature.cpp	M5, M15, M16, M10
test.food.cpp	M5, M6, M7, M10, M12
test.goldpile.cpp	M5, M6, M7, M9, M10, M15, M16
test.item.cpp	M5, M15
test.itemzone.cpp	M5, M6, M14, M15, M16
test.level.cpp	M5, M6, M9, M10, M14, M15, M19
test.levelgen.cpp	M5, M6, M9, M14, M15, M19, M20
test.main.cpp	None (Puts everything together)
test.mob.cpp	M9, M10, M12, M13, M14, M18
test.monster.cpp	M9, M14, M18
test.playerchar.cpp	M5, M6, M10, M11, M12, M13, M14, M15, M16, M17, M18
test.potion.cpp	M5, M6, M7, M9, M10, M15, M16
test.ring.cpp	M5, M6, M7, M9, M10, M15, M16
test.room.cpp	M6, M7, M14, M19
test.scroll.cpp	M5, M6, M7, M9, M10, M15, M16
test.stairs.cpp	M7, M15, M17, M20
test.terrain.cpp	M6, M7, M19, M20
test.testable.cpp	Defines test-suite
test.testable.h	Defines test-suite
test.trap.cpp	M6, M7, M10, M13, M15
test.tunnel.cpp	M6, M5, M14
test.uistate.cpp	M4, M8, M11, M12, M13, M17
test.wand.cpp	M5, M6, M7, M9, M10, M15, M16
test.weapon.cpp	M5, M6, M7, M9, M10, M15, M16

10 Code Coverage Metrics

By looking at the test-requirements matrix, and also cross-referencing the test-module trace above with the module-requirements trace given in the

Module Guide, it is possible to determine exactly which functional and non-functional requirements were satisfied with the test cases we created.

As can be expected, near **complete coverage** of both functional and non-functional requirements is achieved. Except for a few non-functional requirements, the modules and direct requirements reflected in the test cases offer a complete coverage of the requirements. Some (in particular, non-functional) requirements are nigh impossible to test using code. An example includes NFR.2: "The Rogue Reborn game shall be fun and entertaining." Whatever software exists that can determine such a thing would never pass the Turing test, and thus can be deemed an impossibility as of current technology. But while it is impossible to test with code, such a thing is easily testable with human playtesters.

Along with NFR.2, several non-functional requirements were not feasible to assert with software, but all were correctly proven by other means, most of which involved manual human labor.

To expand on the previous statements, we encountered some requirements where the achievable target was difficult to materialize, but still algorithmic and computational in nature. A prime example of this is the luminosity constraint, which ruled that no two consecutive frames may have a change in brightness greater than some defined delta. In order to properly measure this, we had to go outside of the program, and write a separate script to do the hard work. We used python to calculate the pixel-accurate luminosity of some key screenshots, and using the calculation proposed by the non-functional requirement, arrived at correct results. The results were deemed close enough to the predefined delta, which itself was based more or less on our intuition.