

## ABSTRACT

### Analysis of Testing Approaches for Web Applications Based on Each Choice and Pairwise Methods

by

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April, 2016

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Time and quality are important factors when determining the proper approach for software testing. A software program can often be used in various environments (different platforms, operating systems, browsers, networks, etc.) and require thorough testing to provide high quality and reliability in different configurations. Combinatorial testing is an effective approach to testing hardware and software configurations. However, testing resources are often restricted in real practice. Because business goals require different testing methods, there is no best one-size-fits-all testing approach. For this reason, we experimentally investigated and analyzed several combinatorial approaches based on Each Choice and pairwise methods (with and without the consideration of operational profiles) through the testing of an Adviser Scheduling application located in a university web portal. Test sets with various configurations were generated according to six different combinatorial strategies. The Advanced Combinatorial Testing System (ACTS) tool, which was provided by the National Institute of Standards and Technology (NIST), was used to generate pairwise test sets automatically. The case study web application was retested for each of the proposed testing approaches, and the results were compared after taking into account the number of test cases and the corresponding detected faults. Based on this analysis, we answer

three research questions and provide recommendations for the selection of testing approaches to align with different business goals. The recommendation chosen for web applications allowed for improved quality and reduced time for software testing.



Analysis of Testing Approaches for Web Applications Based on Each Choice and Pairwise  
Methods

A Thesis

Presented To the Faculty of the Department of Computer Science

East Carolina University

In Partial Fulfillment of the Requirements for the Degree

Master of Science in Software Engineering

by

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April, 2016

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Dedicated to

My parents and sister,

For all their love and endless support

## ACKNOWLEDGEMENTS

I would like to take this opportunity to thank my thesis adviser, Dr. Sergiy Vilkomir, for his help and support while working under his supervision. He provided me with much insight on how to manage my thesis and encouraged me when the work seemed overwhelming.

I would also like to thank Dr. Tabrizi and Dr. Ding for taking time out of their schedule to serve on my thesis committee. I truly appreciate Dr. Vilkomir, Dr. Tabrizi and Dr. Ding's assistance in helping to ensure my thesis meets the requirements set by the university.

Finally, to my family and fiancé, thank you for your love and support while I completed my master's degree. Your encouragement inspired me to follow through with this degree while working full time.



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## CHAPTER 1: INTRODUCTION

### 1.1 Research Questions and Contributions

The aim of this thesis is to analyze testing approaches based on combinatorial testing methods (specifically using the Each Choice and pairwise methods). This paper wants to investigate incorporating software testing methods that align with different business goals by answering three research questions:

*(RQ1) Do combinatorial testing methods allow for a reduced amount of testing, while maintaining a high level of quality?*

*(RQ2) Do combinatorial testing methods increase the effectiveness of testing without increasing the testing effort?*

*(RQ3) What are the practical benefits of applying combinatorial testing methods to web applications (a case study analysis)?*

My contributions to this thesis:

- Formulated six different strategies based on Each Choice and pairwise testing approaches
- Aligned testing strategies with business goals
- Generated test sets for each of the six strategies
- Retested the case study application for each of the six strategies
- Analyzed the results and practicality of each strategy
- Compared the strategies and provided a recommendation for web application testing

### 1.2 Adopting a Software Testing Technique that Aligns with Business Goals

Many software testing methodologies have been introduced over the years in attempts to make the software testing process more efficient. A software program can often be used in various

environments, such as different platforms, operating systems, browsers, networks, etc., and it requires comprehensive testing for many configurations to provide high quality and reliability. One of the best approaches in this situation is combinatorial testing [1, 2], which has been confirmed to be practical and effective [3-6].

Combinatorial  $t$ -way testing requires that any combination of values of any  $t$  testing parameters or configuration items should be included in some test case. This type of testing is often used for  $t=1$  (Each Choice testing) or  $t=2$  (pairwise testing) [7, 8]. Each Choice covers all values of all parameters, but it does not consider combinations of values. Pairwise testing covers all values *and* combinations of each value with all others, i.e., it covers all pairs of values. A larger value of  $t$  increases the effectiveness of  $t$ -way testing, but this requires more test cases, obliging testers to compromise between desirable effectiveness and available testing resources.

Testing resources (time, money, and human resources) are often restricted in real practice. A company's business goal might include improving the quality or effectiveness of testing while keeping the same degree of testing or even reducing the number of test cases, while still maintaining the appropriate level of testing quality. Because different business goals require different testing approaches, there is no "best" testing approach. Sets of different approaches should be considered to select one suitable for the current situation and the specific business goals.

In real practice, some configurations are more common than others. For example, when a particular software application is accessed by many users, Internet Explorer may be used more often than Chrome, Windows 8 more often than Windows Vista, etc. This can be described using an operational profile, which is a quantitative characterization of how a system or software will be used [9]. To achieve trustworthy test results, software testing should be performed according to the operational profile, namely, the proportion of tests for different configurations should

approximately reflect the occurrences of these configurations in the software's real usage [10, 11]. However, combinatorial approaches treat all testing configurations equally. In order to reflect the operational profile, these approaches should be modified and the number of configurations extended.

### **1.3 Organization of Thesis**

In this thesis, we analyzed several combinatorial testing approaches based on Each Choice and pairwise methods, with and without consideration of an operational profile. The thesis is organized as follows: Chapter 2 provides a background on Each Choice and pairwise testing. The Adviser Scheduling application, used as a case study for applying combinatorial testing, is described in Chapter 3. Chapter 4 explains the organization of our investigation, detailed information on test configurations that were generated according to different combinatorial testing methods, and the application of proposed testing approaches. Chapter 5 provides experimental testing results of these configurations and analyzes the effectiveness of the proposed approaches. The conclusions and recommendation are presented in Chapter 6.

## CHAPTER 2: BACKGROUND AND RELATED WORK

### 2.1 The Each Choice and Pairwise Methods of Combinatorial Testing

Combinatorial testing is a black-box testing technique, which is a method of software testing that examines the functionality of an application without the tester knowing the internal workings of the item being tested. According to Brcic and Kalpic, the goal of combinatorial testing is to detect faults caused by parameter interactions, thereby also covering interaction between system components [12]. Bryce et al. believes that the idea behind combinatorial testing is that many of the errors found in software can be introduced by the interaction of two or more parameters, known as interaction failures [13]. Kuhn, Kacker and Lei introduced the idea of the *Interaction Rule* which states: “Most failures are induced by single factor faults or by the joint combinatorial effect (interaction) of two factors, with progressively fewer failures induced by interactions between three or more factors” [14]. While combinatorial testing can apply to t-way interactions, the focus of this research will be based on 1 and 2-way interactions, also known as Each Choice and pairwise testing respectively.

Consider an application that has four test parameters with three configurations each:

- Browser: IE, Chrome, Firefox
- Resolution: 640 x 480, 800 x 600, 1024 x 768
- Access Level: Guest, Member, Administrator
- Operating System: Windows 7, Windows 8, Windows 10

There are three browsers, resolutions, access levels, and operating systems. Of all the users who access the application, many will access the application in a different way. Exhaustively testing all combinations of each parameter would require 81 configurations (3 configurations, 4 parameters:  $3^4 = 81$ ). Instead of exhaustively testing all 81 configurations, pairwise testing could be used. Using this method would allow all individual pairs of interactions to be tested in just 9 configurations. The



pairwise combinatorial test set is shown in Table 1. This test set covers all pairwise combinations between parameters and configurations.

Browser	Resolution	Access Level	Operating System
Internet Explorer	640 x 480	Guest	Windows 7
Internet Explorer	800 x 600	Member	Windows 8
Internet Explorer	1024 x 768	Administrator	Windows 10
Chrome	640 x 480	Administrator	Windows 8
Chrome	800 x 600	Guest	Windows 10
Chrome	1024 x 768	Member	Windows 7
Firefox	640 x 480	Member	Windows 10
Firefox	800 x 600	Administrator	Windows 7
Firefox	1024 x 768	Guest	Windows 8

Table 1: A Pairwise Combinatorial Test Set

Alternatively, the Each Choice testing method could be used, which would cover each value of every parameter once. The Each Choice test set, shown in Table 2, can further reduce the number of configurations to 3.

Browser	Resolution	Access Level	Operating System
Internet Explorer	640 x 480	Guest	Windows 7
Chrome	800 x 600	Member	Windows 8
Firefox	1024 x 768	Administrator	Windows 10

Table 2: An Each Choice Test Set

## 2.2 Strengths of Pairwise and Each Choice Testing

### Reduced Cost in Testing

The testing phase of software development requires a significant amount of time and resources. According to Hartman, estimations have shown that the testing phase can consume at least half the cost of developing a new software product [15]. Although testing costs money, the repercussions of not thoroughly testing software can cost an organization even more. As discussed

earlier, pairwise testing can reduce the number of required test configurations from 81 to 9. Suppose a software tester averages 3 test configurations per hour and makes \$20.00 per hour. Without using pairwise testing, it would cost the employer \$540.00, but using pairwise testing it would only cost the employer \$60.00. This drastically reduces the cost of testing. Each Choice testing can further reduce the number of required test configurations from 9 to 3, as shown in Table 2. Using the same software testing cost example above, the Each Choice method can cut the cost of testing to \$20.00.

### Increased Test Execution Efficiency

Studies have shown that more than twice as many defects are found per tester hour when using pairwise testing as compared to manual test case selection. In a study performed by Kuhn, Kacker, Lei and Hunter, the summary of testing results for 10 projects that compared pairwise and manual testing showed that 2.4 times as many defects were found per hour when using pairwise testing as opposed to manual testing [2]. This increased efficiency in test execution has many benefits. It is now realized that an organization can cut the costs of software testing, while at the same time finding at least twice as many defects per test hour.

### Better Quality

In the same study performed by Kuhn et al., the test results for 10 projects showed a 13% higher rate of total defects found compared to manual test case selection [2]. The rate of defects found per test hour were more drastic than the total defects found when comparing the pairwise and manual test results. Even though the results are not as drastic, the pairwise test rate is still more favorable than the manual test rate. When considering the overall improved defect rate, along with the improved defect rate per test hour, and the reduced time and cost of testing, the idea of implementing the pairwise testing method seems preferable.

### Increased Configuration Coverage

As discussed in the Introduction, a software program often requires comprehensive testing for many configurations to provide high quality and reliability. The strategy of the Each Choice testing method is “to include each value of each parameter in at least one test case” [8]. The pairwise testing method covers all pairs of values. Both the Each Choice and pairwise methods systematically cover configuration values to aid in thorough testing. Using a random testing technique would not as easily demonstrate that a program has been tested thoroughly and is ready for its release.

### Quicker Production Deploys

Advances in technology have brought about rapid changes in software. Companies compete for the best software products while customers cannot wait to get their hands on the newest product releases. Drastic reduction in the number of required tests for pairwise and Each Choice testing allows software testers to complete the test sets faster and move on to the next project. Having the ability to deploy software to production quicker than the competition could also be a strength for the company as it could lead to increased sales and profits.

## **2.3 Weaknesses of Pairwise and Each Choice Testing**

### Fewest Faults Detected in a Comparative Evaluation

Grindal, Offutt and Andler presented results of five combination strategies in a comparative evaluation. The five strategies included Each Choice, Orthogonal Arrays, Heuristic Pairwise, All Values and Base Choice. Of the evaluated strategies, Each Choice found the smallest amount of faults. Further, the results of their analysis showed that “the performance of Each Choice is unpredictable in terms of which faults will be detected” [8]. However, these results would not necessarily hold true in other testing evaluations.

### Taking a Combinatorial Testing Shortcut

Pairwise testing is a Combinatorial testing method that covers all pairs of parameter values as a configuration. Combinatorial testing can also cover all 3-way or 4-way testing combinations, but would require a much larger test set. According to Bach and Schroeder, “Pairwise testing is an economical alternative to testing all possible combinations of a set of variables. The pairwise approach is popular because it generates small test sets that are relatively easy to manage and execute” [16].

## CHAPTER 3: CASE STUDY – ADVISER SCHEDULING APPLICATION

### **3.1 Description of the Adviser Scheduling Application**

Many universities use a web portal to provide students, faculty, and staff with access to valuable data and applications within one location. Access to a portal is usually granted with university credentials. These credentials validate the access the user should have. For instance, when an employee logs into a portal, he or she may have access to applications such as Pay History and Workplace Training. However, when a student logs in, he or she would not get access to those applications. Instead, other applications would be available such as GPA Calculator, Grade History, and Course Schedule. Frequently, applications are available to multiple user types, but each user is granted a different level of access based on need. For example, an employee user type could view announcements in an application, but an administrator could add, edit, and delete the announcements. Each application within a portal is customized to fit the needs of all users having access to the application.

Before each application within a portal is released to its users, it must be tested thoroughly to ensure that it works for all user types. Testing configurations should be created to include user access testing, along with other parameters such as browser, operating system, etc. Testing multiple configurations can ensure that the application is ready for all users who will access the application in different ways. This case study reviews the original testing process for an Adviser Scheduling application in a university web portal, and proposes and implements practical combinatorial testing approaches.

The Adviser Scheduling application is used for advising processes specified by an Academic Advising Collaborative. The application has four main functions: scheduling, accepting appointments, viewing academic information, and processing appointment outcomes. The

scheduling feature and processing appointment outcomes feature is accessible by all users of the application. The accepting appointments and viewing academic information features are available only to advisers.

There are three different user permission groups in the Adviser Scheduling application: administrator, faculty, and delegate. Each group is given limited access to the application based on the permission group they have been assigned. For users to access the Adviser Scheduling application, they must first log into the university portal. Once they have done so, using their university credentials, they can find the Adviser Scheduling application in the portal's Tools section.

The application's interface allows advisers to manage and perform routine tasks with ease. After opening the application, the adviser will see their calendar, the advisee roster, and outstanding actions. The outstanding actions list contains appointment requests created either by delegates within the Adviser Scheduling application or by students using the student scheduler application (which is a separate entity from the Adviser Scheduling application). When an adviser accepts or rejects an appointment displayed in their Outstanding Actions list, the calendar and advisee roster is updated accordingly. After accepting an appointment, the calendar immediately displays the appointment in its allotted time slot. At the same time, the advisee roster adds the student for the newly created appointment to the top of the roster. If rejected, the appointment is removed from the Outstanding Actions list and is not added to the calendar. Figure 1 displays a portion of an adviser's calendar with student appointments.

12pm	UNAVAILABLE	UNAVAILABLE	UNAVAILABLE
	[Redacted] - Class Registration	[Redacted] - Change Major	[Redacted] - Class Registration
1pm	[Redacted] - Class Registration	[Redacted] - Other	
	[Redacted] - Other		[Redacted] - Class Registration
2pm	[Redacted] - Class Registration		[Redacted] - Class Registration
	[Redacted] - Change Major		[Redacted] - Change Major
3pm	UNAVAILABLE	UNAVAILABLE	UNAVAILABLE
		[Redacted] - Other	[Redacted] - Class Registration

Figure 1: Adviser Scheduling Application – Redacted for Confidentiality

### 3.2 Description of the Test Cases

The Adviser Scheduling application consists of 21 test cases in total. Each user type (Faculty, Administrator, and Delegate) has varied access to the application. Faculty users (advisers) have access to all 21 test cases. Administrators have access to 10 test cases and Delegates have access to 12 test cases. Table 3 displays the application’s 21 test cases and what user types have access to each test case.

	User Type	Test Case
1	F, A	Opt in to Adviser Scheduling Application
2	F, A	Set Available Times
3	F, D	Create Appointment
4	F, D	Edit Appointment
5	F, D	Delete Appointment
6	F	Accept Student Appointment
7	F	Reject Student Appointment
8	F	Accept all Student Appointments

9	F, D	Update Appointment Outcome
10	F	View Advisee Appointment Information on Advisee Screen
11	F	View Advisee Grades and Test Scores on Advisee Screen
12	F	Access Degree Information from Advisee Screen
13	F, A, D	View other Adviser Calendars in your Group
14	F, A, D	View group Announcements
15	F, A, D	View Advisee Roster
16	F, A, D	Search Advisee Roster
17	F, D	Create Appointment with Non-Advisee
18	F, A, D	See Non-Advisee Appointments in Roster
19	F, A, D	View Calendar of Appointments and Unavailable Times in Week Format
20	F, A, D	View Calendar of Appointments and Unavailable Times in Month Format
21	F, A	Opt out of Adviser Scheduling Application

Table 3: *Test Cases and Corresponding User Access*

### 3.3 The Original Testing Phase

When originally testing the Adviser Scheduling application, one test set consisting of 11 configurations of parameters was used, with a total of 121 tests completed for the application's 21 test cases. The configuration parameters and their values included:

- Browser: IE, Chrome
- User type: Faculty, Administrator, Delegate
- Operating System: Windows 7, OS X
- Network: On Campus–Secured, On Campus–Unsecured, Off Campus

These configurations were determined by the testing time allotted as the project's deadline approached, along with tester knowledge of the portal and experience of the types of bugs normally found. The original testing procedure was found to be adequate and thorough; however, there were not enough resources to provide mobile testing. Table 4 shows the configurations of the parameters listed above that were used in testing and the number of tests completed for each configuration.



Config	Browser	User Type	Operating System	Network	Tests
1	IE	Faculty	Windows 7	On Campus–Secured	21
2	IE	Admin	Windows 7	On Campus–Secured	10
3	IE	Delegate	Windows 7	On Campus–Secured	12
4	IE	Faculty	Windows 7	On Campus–Unsecured	7
5	IE	Faculty	Windows 7	Off Campus	7
6	Chrome	Faculty	Windows 7	On Campus–Secured	21
7	Chrome	Admin	Windows 7	On Campus–Secured	10
8	Chrome	Delegate	Windows 7	On Campus–Secured	12
9	Chrome	Faculty	OS X	On Campus–Secured	7
10	Chrome	Faculty	OS X	On Campus–Unsecured	7
11	Chrome	Faculty	OS X	Off Campus	7

Table 4: *Original Testing Configurations and Number of Tests Completed*

### 3.4 The Operational Profile

According to the data collected by an Academic Technologies team, 42 percent of users access the Adviser Scheduling application with Internet Explorer. Faculty are the only user type to have access to all 21 of the application’s test cases, while the other user types perform auxiliary functions, making the faculty user type the most common. Due to the fact that the standard operating system provided to university faculty is Windows 7 connected to the on-campus secured network, they are most commonly used to access the application. In addition, the data collected by the Academic Technologies team suggested that 16 percent of user traffic comes from mobile devices; however, that percentage has risen and will continue to rise due to mobile device and tablet popularity and convenience. When testing with the Each Choice and pairwise testing methods, the operational profile data can be considered while determining the test sets as a way of tailoring the test sets to the user majority.

## CHAPTER 4: SUGGESTED APPROACHES

### 4.1 Testing Approaches and Organization of the Investigation

Our experimental investigation included retesting the Adviser Scheduling application using six combinatorial approaches based on Each Choice and pairwise testing. This application, used as a case study and described in the previous section, has already been deployed and tested in depth but without using combinatorial approaches. The first version of this application, which contained all the bugs found and removed in the original testing phase, was retested. Our results were compared to the original test results, taking into account the number of test cases and the corresponding bugs found for each combinatorial approach. Our goal was to find an approach comparable in size to the number of original test cases while providing greater effectiveness in fault detection.

We investigated the following six approaches:

- Each Choice
- Each Choice with consideration of the operational profile
- Each Choice with additional parameters
- Pairwise
- Pairwise with consideration of the operational profile
- Pairwise with additional parameters

The “pure” Each Choice and pairwise approaches used the same configuration parameters and their values as the initial testing. However, Each Choice required significantly fewer test cases. Pairwise required approximately the same number of test cases as the initial testing but provided much better coverage of parameter value combinations. Taking into consideration the operational profile, we suggested using the same method for Each Choice and pairwise. Usually, the precise reflection of operational profiles requires using probabilistic models and a large number of test

cases [12], but this was not possible for practical testing in our case study. An approximate approach to consider operational profiles has been suggested by Kuhn et al. [1, pp. 61-64] by adding additional values of parameters. We suggested another simple approximate method of adding one or two additional test cases into the test sets with the most frequently used parameter values. This made the distribution of values in test sets closer to the real operational profile.

Because combinatorial approaches require a small number of tests, it was possible to add additional configuration parameters and still have a comparable number of test cases compared to those in the original testing. In turn, new parameters allowed testing new configurations that were not tested originally. Detailed analysis of the generated test cases (Chapter 4) and the results of testing for different approaches (Chapter 5) allowed for the provision of practical recommendations for the selection of testing approaches to align with different business goals.

## **4.2 Application of the Testing Approaches**

The two methods being explored through re-testing of the Adviser Scheduling application are Each Choice testing and pairwise testing, both with and without consideration of the application's operational profile. The Each Choice testing method provides test sets that allow for a significant reduction in the amount of testing while retaining or improving the testing quality. The pairwise testing method provides test set sizes similar to or slightly larger than the original testing approach.

With both the Each Choice and pairwise testing methods, variations can be made to the test sets to tailor the methods to testing needs. Three sets of testing approaches were used for both methods to test the Adviser Scheduling application. For each testing method, at least one approach aims to reduce the number of required test configurations, one takes the application's operational profile into consideration, and one aims to increase the test coverage and number of detected bugs.

### 4.3 Each Choice Testing Approaches

Three test sets (Tables 5-7) were created using the Each Choice testing method. The goal of the results from these tables is to maintain testing quality while significantly reducing the number of required tests.

Each Choice Test Set 1: This Each Choice testing table includes the application's original testing parameters shown in Table 5. The table covers every parameter tested originally at least once using three configurations.

Config	Browser	User Type	Operating System	Network	Tests
1	IE	Faculty	Windows 7	On Campus–Secured	21
2	Chrome	Admin	OS X	On Campus–Unsecured	10
3	IE	Delegate	Windows 7	Off Campus	12

Table 5: *Each Choice Test Set 1*

Each Choice Test Set 2: With the resources provided by the Academic Technologies team, the operational profile of the Adviser Scheduling application was determined and considered when testing with the Each Choice and pairwise testing methods. The data in Table 6 include the most common parameter values based on the operational profile. This extra configuration was added to Test Set 1 to consider the application's operational profile, making Test Set 2 consist of four configurations.

Config	Browser	User Type	Operating System	Network	Tests
4	IE	Faculty	Windows 7	On Campus –Unsecured	21

Table 6: *Each Choice Test Set 2*

Each Choice Test Set 3: This Each Choice testing table introduces a new parameter and values and consists of five configurations (see Table 7). The aim of this test set is to reduce the

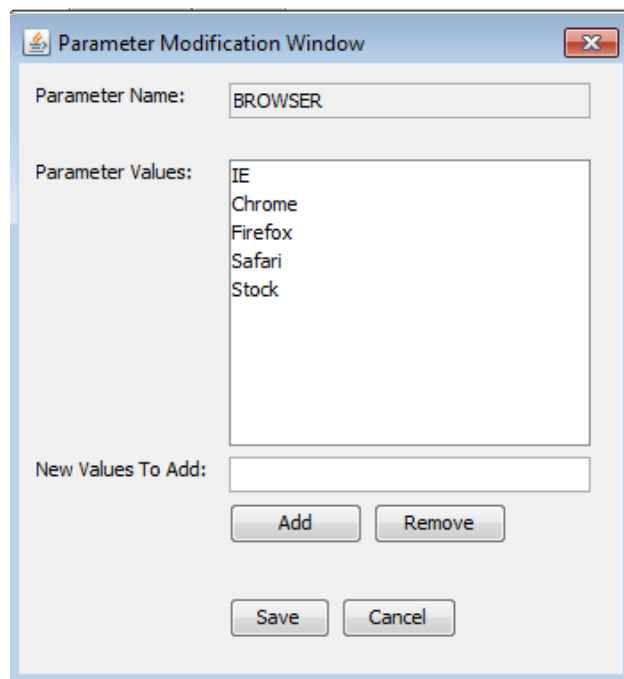
number of required tests while increasing the number of bugs found by testing mobile devices, which were not a part of the application’s original test range.

Config	Browser	User Type	Operating System	Network	Mobile	Tests
1	IE	Faculty	Windows 7	On Campus–Secured	No	21
2	Chrome	Admin	Windows 10	On Campus–Unsecured	No	10
3	Firefox	Delegate	OS X	Off Campus	No	12
4	Safari	Faculty	iOS	On Campus–Secured	Yes	21
5	Stock	Admin	Android	On Campus–Unsecured	Yes	21

Table 7: Each Choice Test Set 3

#### 4.4 Pairwise Testing Approaches

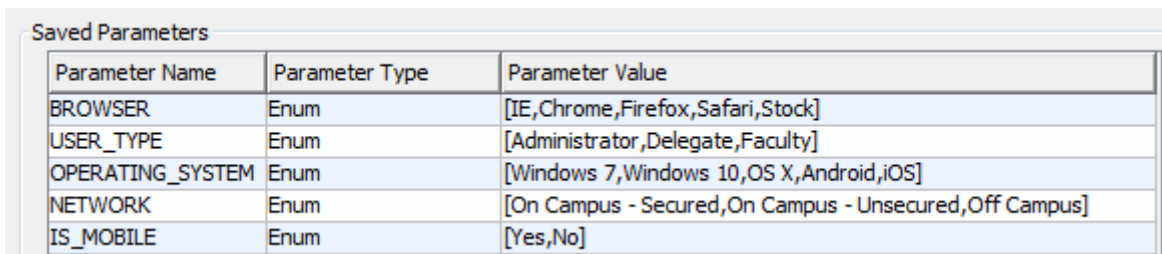
To generate the test sets used for pairwise testing in this case study, the Advanced Combinatorial Testing System (ACTS) tool was used. Provided by the National Institute of Standards and Technology, ACTS is a free tool that assists users in generating  $t$ -way combinatorial test sets. Prior to using the ACTS tool, the user must identify the parameters that will be used in testing, along with their values and associated constraints. The tool eliminates any combinations



that violate constraints between parameters as they were configured while creating the system, and then it allows the user to build and view the test set.

Figure 2: *Building the Parameters*

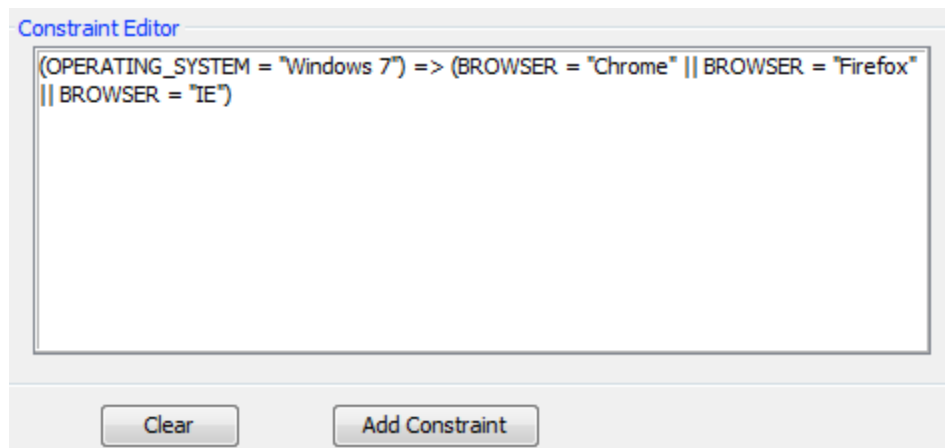
Figure 2 depicts one of the steps taken to generate the parameters used in Pairwise Test Set 3 provided in Section 4.5. Each parameter is given a name, the associated parameter values are entered and the parameter is saved. This process is completed for each parameter that is needed for the test set. Once all the parameters are created, they can be previewed before building the test set. Figure 3 previews the parameters and values for Pairwise Test Set 3 before the test set was built.



Parameter Name	Parameter Type	Parameter Value
BROWSER	Enum	[IE,Chrome,Firefox,Safari,Stock]
USER_TYPE	Enum	[Administrator,Delegate,Faculty]
OPERATING_SYSTEM	Enum	[Windows 7,Windows 10,OS X,Android,iOS]
NETWORK	Enum	[On Campus - Secured,On Campus - Unsecured,Off Campus]
IS_MOBILE	Enum	[Yes,No]

Figure 3: *Previewing the Parameters*

After entering the parameters, constraints need to be added so that invalid test scenarios can be avoided. For instance, avoiding having a test using a Windows 7 computer and the Android



Stock browser available on Android tablets. Figure 4 shows a constraint being entered to restrict the browser type to Chrome, Firefox or Safari when using a Windows 7 operating system.

Figure 4: *Entering a Constraint*

Similarly to creating parameters, when finished entering constraints, you can preview your list of constraints before building the test set. The full list of constraints for Pairwise Test Set 3 is shown in Figure 5. Once these constraints were reviewed, the test set was generated.

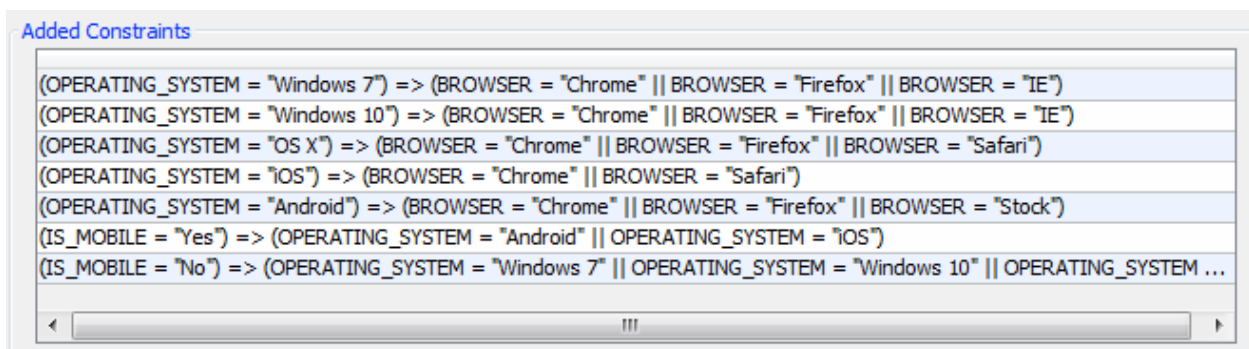


Figure 5: *Previewing the Constraints*

The more parameters and constraints there are, the more beneficial the ACTS tool becomes. Manually writing the test sets for systems with numerous parameters and constraints would be very time consuming. A t-way test set generation from 1-6 is another large benefit of the ACTS tool. To expand on this, the tool can create test sets for base-choice testing (also called 1-way testing), which creates a test set for every 1 parameter combination, up to 6-way testing, which creates a test set for every 6 parameter combinations.

Once the parameters and constraints have been added, the test set can be generated. Figure 6 represents Pairwise Test Set 3, which is discussed in detail later in this section. This test set covers all pairwise testing combinations for browser, user type, operating system, network, and mobile devices and neglects all the invalid combinations ruled out by the constraints.

	BROWSER	USER_TYPE	OPERATING_SYSTEM	NETWORK	IS_MOBILE
1	IE	Delegate	Windows 7	On Campus - Unsecured	No
2	IE	Faculty	Windows 10	Off Campus	No
3	Chrome	Administrator	Windows 7	On Campus - Secured	No
4	Chrome	Delegate	Windows 10	On Campus - Unsecured	No
5	Chrome	Faculty	OS X	Off Campus	No
6	Chrome	Administrator	Android	On Campus - Unsecured	Yes
7	Chrome	Delegate	iOS	On Campus - Secured	Yes
8	Firefox	Faculty	Windows 7	Off Campus	No
9	Firefox	Administrator	Windows 10	On Campus - Secured	No
10	Firefox	Delegate	OS X	On Campus - Unsecured	No
11	Firefox	Faculty	Android	On Campus - Secured	Yes
12	Safari	Administrator	OS X	Off Campus	No
13	Safari	Faculty	iOS	On Campus - Unsecured	Yes
14	Stock	Delegate	Android	Off Campus	Yes
15	Safari	Administrator	iOS	Off Campus	Yes
16	IE	Administrator	Windows 7	On Campus - Secured	No
17	Stock	Administrator	Android	On Campus - Unsecured	Yes
18	Safari	Delegate	OS X	On Campus - Secured	No
19	Stock	Faculty	Android	On Campus - Secured	Yes

Figure 6: *Pairwise Test Set 3 Generated with the ACTS Tool*

For the Adviser Scheduling application case study, the ACTS tool was used to create pairwise (2-way) test sets for the application’s 21 test cases. Three test sets were created using the ACTS tool.

Pairwise Test Set 1: This test set includes the parameters used in the original testing phase to show that less testing could be performed with a much higher level of coverage. This test set includes nine configurations of the original testing parameters, shown in Table 8, which is two configurations fewer than used originally.

Config	Browser	User Type	Operating System	Network	Test
1	Chrome	Faculty	OS X	Off Campus	21
2	IE	Faculty	Windows 7	On Campus–Secured	21
3	Chrome	Faculty	Windows 7	On Campus–Unsecured	21
4	IE	Admin	Windows 7	Off Campus	10
5	Chrome	Admin	OS X	On Campus–Secured	10
6	IE	Admin	Windows 7	On Campus–Unsecured	10
7	Chrome	Delegate	OS X	Off Campus	12
8	IE	Delegate	Windows 7	On Campus–Secured	12
9	Chrome	Delegate	OS X	On Campus–Unsecured	12

Table 8: *Pairwise Test Set 1*

Pairwise Test Set 2: The second test set includes the parameters used in the original testing phase, the same nine configurations as in Test Set 1, and an additional two configurations that are derived from the operational profile. These additional two configurations are shown in Table 9.



Config	Browser	User Type	Operating System	Network	Tests
10	IE	Faculty	Windows 7	On Campus–Unsecured	21
11	IE	Faculty	Windows 7	Off Campus	21

Table 9: *Pairwise Test Set 2*

Pairwise Test Set 3: The third test set introduces more parameters and parameter values to broaden the testing scope with the intent to find new bugs. This test set includes 19 configurations, listed in Table 10, based on five parameters. The new parameter introduced in this set is “Mobile” with values “Yes” and “No.” Several new parameter values were added for parameters “Browser” and “Operating System.”

Config	Browser	User Type	Operating System	Network	Mobile	Tests
1	IE	Admin	Windows 7	On Campus–Unsecured	No	10
2	IE	Delegate	Windows 10	Off Campus	No	12
3	Chrome	Faculty	Windows 7	On Campus–Secured	No	21
4	Chrome	Admin	Windows 10	On Campus–Unsecured	No	10
5	Chrome	Delegate	OS X	Off Campus	No	12
6	Chrome	Faculty	Android	On Campus–Unsecured	Yes	21
7	Chrome	Admin	iOS	On Campus–Secured	Yes	10
8	Firefox	Delegate	Windows 7	Off Campus	No	12
9	Firefox	Faculty	Windows 10	On Campus–Secured	No	21
10	Firefox	Admin	OS X	On Campus–Unsecured	No	10
11	Firefox	Delegate	Android	On Campus–Secured	Yes	12
12	Safari	Faculty	OS X	Off Campus	No	21
13	Safari	Delegate	iOS	On Campus–Unsecured	Yes	10
14	Stock	Admin	Android	Off Campus	Yes	12
15	Safari	Faculty	iOS	Off Campus	Yes	21
16	IE	Faculty	Windows 7	On Campus–Secured	No	21
17	Stock	Faculty	Android	On Campus–Unsecured	Yes	21
18	Safari	Admin	OS X	On Campus–Secured	No	10
19	Stock	Delegate	Android	On Campus–Secured	Yes	12

Table 10: *Pairwise Test Set 3*

## CHAPTER 5: RESULTS OF THE INVESTIGATION

Figure 7 and Table 11 display the results of the investigation, comparing the number of tests completed for each test set with the number of bugs found. In addition, Table 11 compares the number of parameters and their values and the number of configurations tested per test set.

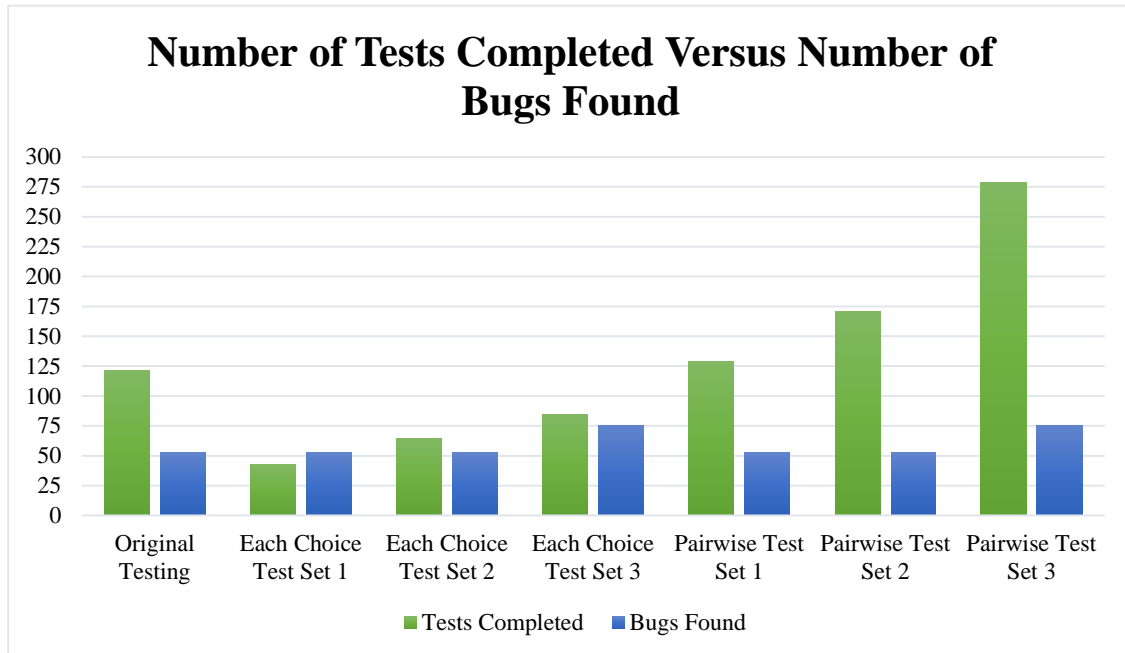


Figure 7: Comparison of the Number of Tests Completed to Number of Bugs Found

	Test Sets	Parameters	Parameter Values	Config. per Test Set	Tests	Bugs
1	Original Test	4	10	11	121	53
2	Each Choice Test Set 1	4	10	3	43	53
3	Each Choice Test Set 2	4	10	4	64	53
4	Each Choice Test Set 3	5	16	5	85	75
5	Pairwise Test Set 1	4	10	9	129	53
6	Pairwise Test Set 2	4	10	11	171	53
7	Pairwise Test Set 3	5	16	19	279	75

Table 11: Number of Parameters and Configurations for Each Testing Method

A total of 43 tests were performed while testing Each Choice Test Set 1. This test set provided the same quality of testing as the original procedure, while reducing the number of tests from 121 to 43, essentially cutting the number of tests by 65%. While testing Each Choice Test Set 2, 64 tests were performed that detected the same 53 bugs found during the original testing. Each Choice Test Set 2 consisted of 21 more test cases than Each Choice Test Set 1 to include consideration of the operational profile. Each Choice Test Set 3 consisted of 85 tests. This test set introduced testing coverage for mobile devices. A total of 75 bugs were found during testing. These bugs consisted of the same 53 bugs detected during the original testing of the Adviser Scheduling application, in addition to 22 new bugs that were specific to mobile devices and mobile browsers. Tables 12-14 display the bugs found by test case for Each Choice Test Sets 1-3.

Pairwise Test Set 1 consisted of 129 tests. This test set provided the same quality of testing as the original procedure. However, it required slightly more test cases but fewer test configurations. The amount of testing was approximately the same as it was for original testing, but the provided level of coverage was much better. While testing Pairwise Test Set 2, 171 tests were performed that detected the same 53 bugs as found during the application's original testing. Pairwise Test Set 2 consisted of 42 more test cases than Pairwise Test Set 1 to include consideration of the operational profile. Pairwise Test Set 3 consisted of 279 tests to include testing coverage for mobile devices. A total of 75 bugs were found during testing, as with Each Choice Test Set 3. Each Choice Test Set 3 provided the same quality of testing as Pairwise Test Set 3, while reducing the number of tests from 279 to 85. While in our case study pairwise testing did not demonstrate additional benefits when compared with Each Choice, in other situations pairwise could be considered as the most effective and promising approach. Tables 15-17 display the bugs found by test case for Pairwise Test Sets 1-3.

## Each Choice Test Set 1

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### Test Case 1: Opt in to Adviser Scheduling application (F, A)

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	0	
IE	Delegate	Windows 7	Off Campus	N/A	

### Test Case 2: Set Available Times (F, A)

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	3	8, 35, 36
Chrome	Admin	OS X	On Campus - Unsecured	3	8, 35, 36
IE	Delegate	Windows 7	Off Campus	N/A	

### Test Case 3: Create Appointment (F, D)

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52

### Test Case 4: Edit Appointment (F, D)

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	5	3, 20, 21, 40, 41
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	5	3, 20, 21, 40, 41

**Test Case 5: Delete Appointment (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	1	15
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	1	15

**Test Case 6: Accept Student Appointment (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	2	4, 19
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	N/A	

**Test Case 7: Reject Student Appointment (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	1	19
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	N/A	

**Test Case 8: Accept All Student Appointments (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	2	4, 19
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	N/A	

**Test Case 9: Update Appointment Outcome (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	7	4, 9, 11, 14, 18, 19, 23
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	7	4, 9, 11, 14, 18, 19, 23

**Test Case 10: View Advisee Appointment Information on Advisee Screen (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	9	7, 17, 21, 28, 38, 43, 46, 49, 51
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	N/A	

**Test Case 11: View Advisee Grades and Test Scores on Advisee Screen (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	N/A	

**Test Case 12: Access Student Degree Information from Advisee Screen (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	N/A	

**Test Case 13: View Other Adviser Calendars in Your Group (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	0	
IE	Delegate	Windows 7	Off Campus	0	

**Test Case 14: View Group Announcements (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	0	
IE	Delegate	Windows 7	Off Campus	0	

**Test Case 15: View Advisee Roster (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	5	11, 22, 32, 43, 48
Chrome	Admin	OS X	On Campus - Unsecured	4	11, 22, 32, 43
IE	Delegate	Windows 7	Off Campus	5	11, 22, 32, 43, 48

**Test Case 16: Search Advisee Roster (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	2	25, 53
Chrome	Admin	OS X	On Campus - Unsecured	1	25
IE	Delegate	Windows 7	Off Campus	2	25, 53

**Test Case 17: Create Appointment with Non-Advisee (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	0	

**Test Case 18: See Non-Advisee Appointments in Roster (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	1	22
Chrome	Admin	OS X	On Campus - Unsecured	1	22
IE	Delegate	Windows 7	Off Campus	1	22

**Test Case 19: View Calendar of Appointments and Unavailable Times in Week Format (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Admin	OS X	On Campus - Unsecured	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
IE	Delegate	Windows 7	Off Campus	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50

**Test Case 20: View Calendar of Appointments and Unavailable Times in Month Format (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Admin	OS X	On Campus - Unsecured	8	6, 13, 14, 16, 19, 35, 42, 45
IE	Delegate	Windows 7	Off Campus	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50

**Test Case 21: Opt Out of Adviser Scheduling Application (F, A)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	0	
IE	Delegate	Windows 7	Off Campus	N/A	

Table 12: *Each Choice Test Results by Test Case*



## Each Choice Test Set 2

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### Test Case 1: Opt in to Adviser Scheduling application (F, A)

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	0	
IE	Delegate	Windows 7	Off Campus	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	0	

### Test Case 2: Set Available Times (F, A)

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	3	8, 35, 36
Chrome	Admin	OS X	On Campus - Unsecured	3	8, 35, 36
IE	Delegate	Windows 7	Off Campus	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	3	8, 35, 36

### Test Case 3: Create Appointment (F, D)

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
IE	Faculty	Windows 7	On Campus - Unsecured	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52

**Test Case 4: Edit Appointment (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	5	3, 20, 21, 40, 41
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	5	3, 20, 21, 40, 41
IE	Faculty	Windows 7	On Campus - Unsecured	5	3, 20, 21, 40, 41

**Test Case 5: Delete Appointment (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	1	15
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	1	15
IE	Faculty	Windows 7	On Campus - Unsecured	1	15

**Test Case 6: Accept Student Appointment (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	2	4, 19
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	2	4, 19

**Test Case 7: Reject Student Appointment (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	1	19
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	1	19

**Test Case 8: Accept All Student Appointments (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	2	4, 19
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	2	4, 19

**Test Case 9: Update Appointment Outcome (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	7	4, 9, 11, 14, 18, 19, 23
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	7	4, 9, 11, 14, 18, 19, 23
IE	Faculty	Windows 7	On Campus - Unsecured	7	4, 9, 11, 14, 18, 19, 23

**Test Case 10: View Advisee Appointment Information on Advisee Screen (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	9	7, 17, 21, 28, 38, 43, 46, 49, 51
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	9	7, 17, 21, 28, 38, 43, 46, 49, 51

**Test Case 11: View Advisee Grades and Test Scores on Advisee Screen (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	0	

**Test Case 12: Access Student Degree Information from Advisee Screen (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	0	

**Test Case 13: View Other Adviser Calendars in Your Group (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	0	
IE	Delegate	Windows 7	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Unsecured	0	

**Test Case 14: View Group Announcements (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	0	
IE	Delegate	Windows 7	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Unsecured	0	

**Test Case 15: View Advisee Roster (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	5	11, 22, 32, 43, 48
Chrome	Admin	OS X	On Campus - Unsecured	4	11, 22, 32, 43
IE	Delegate	Windows 7	Off Campus	5	11, 22, 32, 43, 48
IE	Faculty	Windows 7	On Campus - Unsecured	5	11, 22, 32, 43, 48

**Test Case 16: Search Advisee Roster (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	2	25, 53
Chrome	Admin	OS X	On Campus - Unsecured	1	25
IE	Delegate	Windows 7	Off Campus	2	25, 53
IE	Faculty	Windows 7	On Campus - Unsecured	2	25, 53

**Test Case 17: Create Appointment with Non-Advisee (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	N/A	
IE	Delegate	Windows 7	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Unsecured	0	

**Test Case 18: See Non-Advisee Appointments in Roster (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	1	22
Chrome	Admin	OS X	On Campus - Unsecured	1	22
IE	Delegate	Windows 7	Off Campus	1	22
IE	Faculty	Windows 7	On Campus - Unsecured	1	22

**Test Case 19: View Calendar of Appointments and Unavailable Times in Week Format (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Admin	OS X	On Campus - Unsecured	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
IE	Delegate	Windows 7	Off Campus	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
IE	Faculty	Windows 7	On Campus - Unsecured	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50

**Test Case 20: View Calendar of Appointments and Unavailable Times in Month Format (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Admin	OS X	On Campus - Unsecured	8	6, 13, 14, 16, 19, 35, 42, 45
IE	Delegate	Windows 7	Off Campus	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
IE	Faculty	Windows 7	On Campus - Unsecured	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50

**Test Case 21: Opt Out of Adviser Scheduling Application (F, A)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Admin	OS X	On Campus - Unsecured	0	
IE	Delegate	Windows 7	Off Campus	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	0	

Table 13: Each Choice Test Results by Test Case – Considering Operational Profile

## Each Choice Test Set 3

### Test Case 1: Opt in to Adviser Scheduling application (F, A)

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	0	
Firefox	Delegate	OS X	Off Campus	No	N/A	
Safari	Faculty	iOS	On Campus - Secured	Yes	0	
Stock	Admin	Android	On Campus - Unsecured	Yes	0	

### Test Case 2: Set Available Times (F, A)

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	3	8, 35, 36
Chrome	Admin	Windows 10	On Campus - Unsecured	No	3	8, 35, 36
Firefox	Delegate	OS X	Off Campus	No	N/A	
Safari	Faculty	iOS	On Campus - Secured	Yes	3	8, 35, 36
Stock	Admin	Android	On Campus - Unsecured	Yes	3	8, 35, 36

### Test Case 3: Create Appointment (F, D)

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Firefox	Delegate	OS X	Off Campus	No	19	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47
Safari	Faculty	iOS	On Campus - Secured	Yes	23	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 57, 58, 59, 63

Stock	Admin	Android	On Campus - Unsecured	Yes	23	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 57, 58, 59, 63
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#### Test Case 4: Edit Appointment (F, D)

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	5	3, 20, 21, 40, 41
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Firefox	Delegate	OS X	Off Campus	No	5	3, 20, 21, 40, 41
Safari	Faculty	iOS	On Campus - Secured	Yes	7	3, 20, 21, 40, 41, 56, 63
Stock	Admin	Android	On Campus - Unsecured	Yes	7	3, 20, 21, 40, 41, 56, 63

#### Test Case 5: Delete Appointment (F, D)

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	1	15
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Firefox	Delegate	OS X	Off Campus	No	1	15
Safari	Faculty	iOS	On Campus - Secured	Yes	2	15, 56
Stock	Admin	Android	On Campus - Unsecured	Yes	2	15, 56

#### Test Case 6: Accept Student Appointment (F)

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	2	4, 19
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Firefox	Delegate	OS X	Off Campus	No	N/A	
Safari	Faculty	iOS	On Campus - Secured	Yes	4	4, 19, 61, 62
Stock	Admin	Android	On Campus - Unsecured	Yes	4	4, 19, 61, 62



**Test Case 7: Reject Student Appointment (F)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	1	19
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Firefox	Delegate	OS X	Off Campus	No	N/A	
Safari	Faculty	iOS	On Campus - Secured	Yes	3	19, 61, 62
Stock	Admin	Android	On Campus - Unsecured	Yes	3	19, 61, 62

**Test Case 8: Accept All Student Appointments (F)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	2	4, 19
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Firefox	Delegate	OS X	Off Campus	No	N/A	
Safari	Faculty	iOS	On Campus - Secured	Yes	2	4, 19
Stock	Admin	Android	On Campus - Unsecured	Yes	2	4, 19

**Test Case 9: Update Appointment Outcome (F, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	7	4, 9, 11, 14, 18, 19, 23
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Firefox	Delegate	OS X	Off Campus	No	7	4, 9, 11, 14, 18, 19, 23
Safari	Faculty	iOS	On Campus - Secured	Yes	7	4, 9, 11, 14, 18, 19, 23
Stock	Admin	Android	On Campus - Unsecured	Yes	7	4, 9, 11, 14, 18, 19, 23

**Test Case 10: View Advisee Appointment Information on Advisee Screen (F)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	9	7, 17, 21, 28, 38, 43, 46, 49, 51
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Firefox	Delegate	OS X	Off Campus	No	N/A	
Safari	Faculty	iOS	On Campus - Secured	Yes	8	7, 17, 21, 28, 38, 43, 46, 65
Stock	Admin	Android	On Campus - Unsecured	Yes	8	7, 17, 21, 28, 38, 43, 46, 65

**Test Case 11: View Advisee Grades and Test Scores on Advisee Screen (F)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Firefox	Delegate	OS X	Off Campus	No	N/A	
Safari	Faculty	iOS	On Campus - Secured	Yes	2	65, 66
Stock	Admin	Android	On Campus - Unsecured	Yes	2	65, 66

**Test Case 12: Access Student Degree Information from Advisee Screen (F)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Firefox	Delegate	OS X	Off Campus	No	N/A	
Safari	Faculty	iOS	On Campus - Secured	Yes	0	
Stock	Admin	Android	On Campus - Unsecured	Yes	0	

**Test Case 13: View Other Adviser Calendars in Your Group (F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	0	
Firefox	Delegate	OS X	Off Campus	No	0	
Safari	Faculty	iOS	On Campus - Secured	Yes	0	
Stock	Admin	Android	On Campus - Unsecured	Yes	1	74

**Test Case 14: View Group Announcements (F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	0	
Firefox	Delegate	OS X	Off Campus	No	0	
Safari	Faculty	iOS	On Campus - Secured	Yes	0	
Stock	Admin	Android	On Campus - Unsecured	Yes	0	

**Test Case 15: View Advisee Roster (F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	5	11, 22, 32, 43, 48
Chrome	Admin	Windows 10	On Campus - Unsecured	No	4	11, 22, 32, 43
Firefox	Delegate	OS X	Off Campus	No	4	11, 22, 32, 43
Safari	Faculty	iOS	On Campus - Secured	Yes	6	11, 22, 32, 43, 67, 70
Stock	Admin	Android	On Campus - Unsecured	Yes	7	11, 22, 32, 43, 67, 71, 73

**Test Case 16: Search Advisee Roster (F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	2	25, 53
Chrome	Admin	Windows 10	On Campus - Unsecured	No	1	25
Firefox	Delegate	OS X	Off Campus	No	1	25
Safari	Faculty	iOS	On Campus - Secured	Yes	4	25, 55, 68, 69
Stock	Admin	Android	On Campus - Unsecured	Yes	5	25, 55, 68, 69, 75

**Test Case 17: Create Appointment with Non-Advisee (F, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Firefox	Delegate	OS X	Off Campus	No	0	
Safari	Faculty	iOS	On Campus - Secured	Yes	0	
Stock	Admin	Android	On Campus - Unsecured	Yes	0	

**Test Case 18: See Non-Advisee Appointments in Roster (F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	1	22
Chrome	Admin	Windows 10	On Campus - Unsecured	No	1	22
Firefox	Delegate	OS X	Off Campus	No	1	22
Safari	Faculty	iOS	On Campus - Secured	Yes	1	22
Stock	Admin	Android	On Campus - Unsecured	Yes	1	22

**Test Case 19: View Calendar of Appointments and Unavailable Times in Week Format (F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Admin	Windows 10	On Campus - Unsecured	No	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
Firefox	Delegate	OS X	Off Campus	No	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
Safari	Faculty	iOS	On Campus - Secured	Yes	13	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 60, 64, 70
Stock	Admin	Android	On Campus - Unsecured	Yes	14	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 60, 64, 71, 72

**Test Case 20: View Calendar of Appointments and Unavailable Times in Month Format (F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Admin	Windows 10	On Campus - Unsecured	No	8	6, 13, 14, 16, 19, 35, 42, 45
Firefox	Delegate	OS X	Off Campus	No	8	6, 13, 14, 16, 19, 35, 42, 45
Safari	Faculty	iOS	On Campus - Secured	Yes	11	6, 13, 14, 16, 19, 35, 42, 45, 60, 64, 70
Stock	Admin	Android	On Campus - Unsecured	Yes	12	6, 13, 14, 16, 19, 35, 42, 45, 60, 64, 71, 72

**Test Case 21: Opt Out of Adviser Scheduling Application (F, A)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	0	
Firefox	Delegate	OS X	Off Campus	No	N/A	
Safari	Faculty	iOS	On Campus - Secured	Yes	0	
Stock	Admin	Android	On Campus - Unsecured	Yes	0	

Table 14: Each Choice Test Results by Test Case – Considering Mobile

## Pairwise Test Set 1

### Test Case 1: Opt in to Adviser Scheduling application (F, A)

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	0	
Chrome	Admin	OS X	On Campus - Secured	0	
IE	Admin	Windows 7	On Campus - Unsecured	0	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	

### Test Case 2: Set Available Times (F, A)

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	3	8, 35, 36
IE	Faculty	Windows 7	On Campus - Secured	3	8, 35, 36
Chrome	Faculty	Windows 7	On Campus - Unsecured	3	8, 35, 36
IE	Admin	Windows 7	Off Campus	3	8, 35, 36
Chrome	Admin	OS X	On Campus - Secured	3	8, 35, 36
IE	Admin	Windows 7	On Campus - Unsecured	3	8, 35, 36
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	

**Test Case 3: Create Appointment (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	19	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47
IE	Faculty	Windows 7	On Campus - Secured	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
Chrome	Faculty	Windows 7	On Campus - Unsecured	19	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	19	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47
IE	Delegate	Windows 7	On Campus - Secured	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
Chrome	Delegate	OS X	On Campus - Unsecured	19	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47

**Test Case 4: Edit Appointment (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	5	3, 20, 21, 40, 41
IE	Faculty	Windows 7	On Campus - Secured	5	3, 20, 21, 40, 41
Chrome	Faculty	Windows 7	On Campus - Unsecured	5	3, 20, 21, 40, 41
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	5	3, 20, 21, 40, 41
IE	Delegate	Windows 7	On Campus - Secured	5	3, 20, 21, 40, 41

Chrome	Delegate	OS X	On Campus - Unsecured	5	3, 20, 21, 40, 41
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**Test Case 5: Delete Appointment (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	1	15
IE	Faculty	Windows 7	On Campus - Secured	1	15
Chrome	Faculty	Windows 7	On Campus - Unsecured	1	15
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	1	15
IE	Delegate	Windows 7	On Campus - Secured	1	15
Chrome	Delegate	OS X	On Campus - Unsecured	1	15

**Test Case 6: Accept Student Appointment (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	2	4, 19
IE	Faculty	Windows 7	On Campus - Secured	2	4, 19
Chrome	Faculty	Windows 7	On Campus - Unsecured	2	4, 19
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	



**Test Case 7: Reject Student Appointment (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	1	19
IE	Faculty	Windows 7	On Campus - Secured	1	19
Chrome	Faculty	Windows 7	On Campus - Unsecured	1	19
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	

**Test Case 8: Accept All Student Appointments (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	2	4, 19
IE	Faculty	Windows 7	On Campus - Secured	2	4, 19
Chrome	Faculty	Windows 7	On Campus - Unsecured	2	4, 19
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	

**Test Case 9: Update Appointment Outcome (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	7	4, 9, 11, 14, 18, 19, 23
IE	Faculty	Windows 7	On Campus - Secured	7	4, 9, 11, 14, 18, 19, 23
Chrome	Faculty	Windows 7	On Campus - Unsecured	7	4, 9, 11, 14, 18, 19, 23
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	7	4, 9, 11, 14, 18, 19, 23
IE	Delegate	Windows 7	On Campus - Secured	7	4, 9, 11, 14, 18, 19, 23
Chrome	Delegate	OS X	On Campus - Unsecured	7	4, 9, 11, 14, 18, 19, 23

**Test Case 10: View Advisee Appointment Information on Advisee Screen (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	7	7, 17, 21, 28, 38, 43, 46
IE	Faculty	Windows 7	On Campus - Secured	9	7, 17, 21, 28, 38, 43, 46, 49, 51
Chrome	Faculty	Windows 7	On Campus - Unsecured	7	7, 17, 21, 28, 38, 43, 46
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	

**Test Case 11: View Advisee Grades and Test Scores on Advisee Screen (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	

**Test Case 12: Access Student Degree Information from Advisee Screen (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	

**Test Case 13: View Other Adviser Calendars in Your Group (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	0	
Chrome	Admin	OS X	On Campus - Secured	0	
IE	Admin	Windows 7	On Campus - Unsecured	0	
Chrome	Delegate	OS X	Off Campus	0	
IE	Delegate	Windows 7	On Campus - Secured	0	
Chrome	Delegate	OS X	On Campus - Unsecured	0	

**Test Case 14: View Group Announcements (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	0	
Chrome	Admin	OS X	On Campus - Secured	0	
IE	Admin	Windows 7	On Campus - Unsecured	0	
Chrome	Delegate	OS X	Off Campus	0	
IE	Delegate	Windows 7	On Campus - Secured	0	
Chrome	Delegate	OS X	On Campus - Unsecured	0	

**Test Case 15: View Advisee Roster (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	4	11, 22, 32, 43
IE	Faculty	Windows 7	On Campus - Secured	5	11, 22, 32, 43, 48
Chrome	Faculty	Windows 7	On Campus - Unsecured	4	11, 22, 32, 43
IE	Admin	Windows 7	Off Campus	5	11, 22, 32, 43, 48
Chrome	Admin	OS X	On Campus - Secured	4	11, 22, 32, 43
IE	Admin	Windows 7	On Campus - Unsecured	5	11, 22, 32, 43, 48
Chrome	Delegate	OS X	Off Campus	4	11, 22, 32, 43
IE	Delegate	Windows 7	On Campus - Secured	5	11, 22, 32, 43, 48
Chrome	Delegate	OS X	On Campus - Unsecured	4	11, 22, 32, 43

**Test Case 16: Search Advisee Roster (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	1	25
IE	Faculty	Windows 7	On Campus - Secured	2	25, 53
Chrome	Faculty	Windows 7	On Campus - Unsecured	1	25
IE	Admin	Windows 7	Off Campus	2	25, 53
Chrome	Admin	OS X	On Campus - Secured	1	25
IE	Admin	Windows 7	On Campus - Unsecured	2	25, 53
Chrome	Delegate	OS X	Off Campus	1	25
IE	Delegate	Windows 7	On Campus - Secured	2	25, 53
Chrome	Delegate	OS X	On Campus - Unsecured	1	25

**Test Case 17: Create Appointment with Non-Advisee (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	0	
IE	Delegate	Windows 7	On Campus - Secured	0	
Chrome	Delegate	OS X	On Campus - Unsecured	0	

**Test Case 18: See Non-Advisee Appointments in Roster (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	1	22
IE	Faculty	Windows 7	On Campus - Secured	1	22
Chrome	Faculty	Windows 7	On Campus - Unsecured	1	22
IE	Admin	Windows 7	Off Campus	1	22
Chrome	Admin	OS X	On Campus - Secured	1	22
IE	Admin	Windows 7	On Campus - Unsecured	1	22
Chrome	Delegate	OS X	Off Campus	1	22
IE	Delegate	Windows 7	On Campus - Secured	1	22
Chrome	Delegate	OS X	On Campus - Unsecured	1	22

**Test Case 19: View Calendar of Appointments and Unavailable Times in Week Format  
(F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
IE	Faculty	Windows 7	On Campus - Secured	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Faculty	Windows 7	On Campus - Unsecured	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
IE	Admin	Windows 7	Off Campus	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Admin	OS X	On Campus - Secured	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
IE	Admin	Windows 7	On Campus - Unsecured	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Delegate	OS X	Off Campus	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
IE	Delegate	Windows 7	On Campus - Secured	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Delegate	OS X	On Campus - Unsecured	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45

**Test Case 20: View Calendar of Appointments and Unavailable Times in Month Format  
(F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	8	6, 13, 14, 16, 19, 35, 42, 45
IE	Faculty	Windows 7	On Campus - Secured	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Faculty	Windows 7	On Campus - Unsecured	8	6, 13, 14, 16, 19, 35, 42, 45
IE	Admin	Windows 7	Off Campus	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Admin	OS X	On Campus - Secured	8	6, 13, 14, 16, 19, 35, 42, 45
IE	Admin	Windows 7	On Campus - Unsecured	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Delegate	OS X	Off Campus	8	6, 13, 14, 16, 19, 35, 42, 45
IE	Delegate	Windows 7	On Campus - Secured	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Delegate	OS X	On Campus - Unsecured	8	6, 13, 14, 16, 19, 35, 42, 45

**Test Case 21: Opt Out of Adviser Scheduling Application (F, A)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	0	
Chrome	Admin	OS X	On Campus - Secured	0	
IE	Admin	Windows 7	On Campus - Unsecured	0	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	

Table 15: *Pairwise Test Results by Test Case*



## Pairwise Test Set 2

### Test Case 1: Opt in to Adviser Scheduling application (F, A)

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	0	
Chrome	Admin	OS X	On Campus - Secured	0	
IE	Admin	Windows 7	On Campus - Unsecured	0	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Faculty	Windows 7	Off Campus	0	

### Test Case 2: Set Available Times (F, A)

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	3	8, 35, 36
IE	Faculty	Windows 7	On Campus - Secured	3	8, 35, 36
Chrome	Faculty	Windows 7	On Campus - Unsecured	3	8, 35, 36
IE	Admin	Windows 7	Off Campus	3	8, 35, 36
Chrome	Admin	OS X	On Campus - Secured	3	8, 35, 36
IE	Admin	Windows 7	On Campus - Unsecured	3	8, 35, 36
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	

IE	Faculty	Windows 7	On Campus - Unsecured		8, 35, 36
IE	Faculty	Windows 7	Off Campus		8, 35, 36

### Test Case 3: Create Appointment (F, D)

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	19	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47
IE	Faculty	Windows 7	On Campus - Secured	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
Chrome	Faculty	Windows 7	On Campus - Unsecured	19	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	19	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47
IE	Delegate	Windows 7	On Campus - Secured	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
Chrome	Delegate	OS X	On Campus - Unsecured	19	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47
IE	Faculty	Windows 7	On Campus - Unsecured	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
IE	Faculty	Windows 7	Off Campus	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52

**Test Case 4: Edit Appointment (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	5	3, 20, 21, 40, 41
IE	Faculty	Windows 7	On Campus - Secured	5	3, 20, 21, 40, 41
Chrome	Faculty	Windows 7	On Campus - Unsecured	5	3, 20, 21, 40, 41
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	5	3, 20, 21, 40, 41
IE	Delegate	Windows 7	On Campus - Secured	5	3, 20, 21, 40, 41
Chrome	Delegate	OS X	On Campus - Unsecured	5	3, 20, 21, 40, 41
IE	Faculty	Windows 7	On Campus - Unsecured	5	3, 20, 21, 40, 41
IE	Faculty	Windows 7	Off Campus	5	3, 20, 21, 40, 41

**Test Case 5: Delete Appointment (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	1	15
IE	Faculty	Windows 7	On Campus - Secured	1	15
Chrome	Faculty	Windows 7	On Campus - Unsecured	1	15
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	1	15
IE	Delegate	Windows 7	On Campus - Secured	1	15
Chrome	Delegate	OS X	On Campus - Unsecured	1	15
IE	Faculty	Windows 7	On Campus - Unsecured	1	15
IE	Faculty	Windows 7	Off Campus	1	15

**Test Case 6: Accept Student Appointment (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	2	4, 19
IE	Faculty	Windows 7	On Campus - Secured	2	4, 19
Chrome	Faculty	Windows 7	On Campus - Unsecured	2	4, 19
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	2	4, 19
IE	Faculty	Windows 7	Off Campus	2	4, 19

**Test Case 7: Reject Student Appointment (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	1	19
IE	Faculty	Windows 7	On Campus - Secured	1	19
Chrome	Faculty	Windows 7	On Campus - Unsecured	1	19
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	1	19
IE	Faculty	Windows 7	Off Campus	1	19

**Test Case 8: Accept All Student Appointments (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	2	4, 19
IE	Faculty	Windows 7	On Campus - Secured	2	4, 19
Chrome	Faculty	Windows 7	On Campus - Unsecured	2	4, 19
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	2	4, 19
IE	Faculty	Windows 7	Off Campus	2	4, 19

**Test Case 9: Update Appointment Outcome (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	7	4, 9, 11, 14, 18, 19, 23
IE	Faculty	Windows 7	On Campus - Secured	7	4, 9, 11, 14, 18, 19, 23
Chrome	Faculty	Windows 7	On Campus - Unsecured	7	4, 9, 11, 14, 18, 19, 23
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	7	4, 9, 11, 14, 18, 19, 23
IE	Delegate	Windows 7	On Campus - Secured	7	4, 9, 11, 14, 18, 19, 23
Chrome	Delegate	OS X	On Campus - Unsecured	7	4, 9, 11, 14, 18, 19, 23
IE	Faculty	Windows 7	On Campus - Unsecured	7	4, 9, 11, 14, 18, 19, 23
IE	Faculty	Windows 7	Off Campus	7	4, 9, 11, 14, 18, 19, 23

**Test Case 10: View Advisee Appointment Information on Advisee Screen (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	7	7, 17, 21, 28, 38, 43, 46
IE	Faculty	Windows 7	On Campus - Secured	9	7, 17, 21, 28, 38, 43, 46, 49, 51
Chrome	Faculty	Windows 7	On Campus - Unsecured	7	7, 17, 21, 28, 38, 43, 46
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	9	7, 17, 21, 28, 38, 43, 46, 49, 51
IE	Faculty	Windows 7	Off Campus	9	7, 17, 21, 28, 38, 43, 46, 49, 51

**Test Case 11: View Advisee Grades and Test Scores on Advisee Screen (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Faculty	Windows 7	Off Campus	0	

**Test Case 12: Access Student Degree Information from Advisee Screen (F)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	N/A	
IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Faculty	Windows 7	Off Campus	0	

**Test Case 13: View Other Adviser Calendars in Your Group (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	0	
Chrome	Admin	OS X	On Campus - Secured	0	
IE	Admin	Windows 7	On Campus - Unsecured	0	
Chrome	Delegate	OS X	Off Campus	0	
IE	Delegate	Windows 7	On Campus - Secured	0	
Chrome	Delegate	OS X	On Campus - Unsecured	0	
IE	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Faculty	Windows 7	Off Campus	0	

**Test Case 14: View Group Announcements (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	0	
Chrome	Admin	OS X	On Campus - Secured	0	
IE	Admin	Windows 7	On Campus - Unsecured	0	
Chrome	Delegate	OS X	Off Campus	0	
IE	Delegate	Windows 7	On Campus - Secured	0	
Chrome	Delegate	OS X	On Campus - Unsecured	0	
IE	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Faculty	Windows 7	Off Campus	0	

**Test Case 15: View Advisee Roster (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	4	11, 22, 32, 43
IE	Faculty	Windows 7	On Campus - Secured	5	11, 22, 32, 43, 48
Chrome	Faculty	Windows 7	On Campus - Unsecured	4	11, 22, 32, 43
IE	Admin	Windows 7	Off Campus	5	11, 22, 32, 43, 48
Chrome	Admin	OS X	On Campus - Secured	4	11, 22, 32, 43
IE	Admin	Windows 7	On Campus - Unsecured	5	11, 22, 32, 43, 48
Chrome	Delegate	OS X	Off Campus	4	11, 22, 32, 43
IE	Delegate	Windows 7	On Campus - Secured	5	11, 22, 32, 43, 48
Chrome	Delegate	OS X	On Campus - Unsecured	4	11, 22, 32, 43
IE	Faculty	Windows 7	On Campus - Unsecured	5	11, 22, 32, 43, 48
IE	Faculty	Windows 7	Off Campus	5	11, 22, 32, 43, 48



**Test Case 16: Search Advisee Roster (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	1	25
IE	Faculty	Windows 7	On Campus - Secured	2	25, 53
Chrome	Faculty	Windows 7	On Campus - Unsecured	1	25
IE	Admin	Windows 7	Off Campus	2	25, 53
Chrome	Admin	OS X	On Campus - Secured	1	25
IE	Admin	Windows 7	On Campus - Unsecured	2	25, 53
Chrome	Delegate	OS X	Off Campus	1	25
IE	Delegate	Windows 7	On Campus - Secured	2	25, 53
Chrome	Delegate	OS X	On Campus - Unsecured	1	25
IE	Faculty	Windows 7	On Campus - Unsecured	2	25, 53
IE	Faculty	Windows 7	Off Campus	2	25, 53

**Test Case 17: Create Appointment with Non-Advisee (F, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	N/A	
Chrome	Admin	OS X	On Campus - Secured	N/A	
IE	Admin	Windows 7	On Campus - Unsecured	N/A	
Chrome	Delegate	OS X	Off Campus	0	
IE	Delegate	Windows 7	On Campus - Secured	0	
Chrome	Delegate	OS X	On Campus - Unsecured	0	
IE	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Faculty	Windows 7	Off Campus	0	

**Test Case 18: See Non-Advisee Appointments in Roster (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	1	22
IE	Faculty	Windows 7	On Campus - Secured	1	22
Chrome	Faculty	Windows 7	On Campus - Unsecured	1	22
IE	Admin	Windows 7	Off Campus	1	22
Chrome	Admin	OS X	On Campus - Secured	1	22
IE	Admin	Windows 7	On Campus - Unsecured	1	22
Chrome	Delegate	OS X	Off Campus	1	22
IE	Delegate	Windows 7	On Campus - Secured	1	22
Chrome	Delegate	OS X	On Campus - Unsecured	1	22
IE	Faculty	Windows 7	On Campus - Unsecured	1	22
IE	Faculty	Windows 7	Off Campus	1	22

**Test Case 19: View Calendar of Appointments and Unavailable Times in Week Format (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
IE	Faculty	Windows 7	On Campus - Secured	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Faculty	Windows 7	On Campus - Unsecured	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
IE	Admin	Windows 7	Off Campus	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Admin	OS X	On Campus - Secured	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
IE	Admin	Windows 7	On Campus - Unsecured	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Delegate	OS X	Off Campus	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
IE	Delegate	Windows 7	On Campus - Secured	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Delegate	OS X	On Campus - Unsecured	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45

IE	Faculty	Windows 7	On Campus - Unsecured	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
IE	Faculty	Windows 7	Off Campus	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50

**Test Case 20: View Calendar of Appointments and Unavailable Times in Month Format (F, A, D)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	8	6, 13, 14, 16, 19, 35, 42, 45
IE	Faculty	Windows 7	On Campus - Secured	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Faculty	Windows 7	On Campus - Unsecured	8	6, 13, 14, 16, 19, 35, 42, 45
IE	Admin	Windows 7	Off Campus	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Admin	OS X	On Campus - Secured	8	6, 13, 14, 16, 19, 35, 42, 45
IE	Admin	Windows 7	On Campus - Unsecured	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Delegate	OS X	Off Campus	8	6, 13, 14, 16, 19, 35, 42, 45
IE	Delegate	Windows 7	On Campus - Secured	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Delegate	OS X	On Campus - Unsecured	8	6, 13, 14, 16, 19, 35, 42, 45
IE	Faculty	Windows 7	On Campus - Unsecured	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
IE	Faculty	Windows 7	Off Campus	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50

**Test Case 21: Opt Out of Adviser Scheduling Application (F, A)**

Browser	User Type	Operating System	Network	# Bugs	Bug ID's
Chrome	Faculty	OS X	Off Campus	0	
IE	Faculty	Windows 7	On Campus - Secured	0	
Chrome	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Admin	Windows 7	Off Campus	0	
Chrome	Admin	OS X	On Campus - Secured	0	
IE	Admin	Windows 7	On Campus - Unsecured	0	
Chrome	Delegate	OS X	Off Campus	N/A	

IE	Delegate	Windows 7	On Campus - Secured	N/A	
Chrome	Delegate	OS X	On Campus - Unsecured	N/A	
IE	Faculty	Windows 7	On Campus - Unsecured	0	
IE	Faculty	Windows 7	Off Campus	0	

Table 16: *Pairwise Test Results by Test Case – Considering Operational Profile*

## Pairwise Test Set 3

### Test Case 1: Opt in to Adviser Scheduling application (F, A)

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	0	
IE	Delegate	Windows 10	Off Campus	No	N/A	
Chrome	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	0	
Chrome	Delegate	OS X	Off Campus	No	N/A	
Chrome	Faculty	Android	On Campus - Unsecured	Yes	0	
Chrome	Admin	iOS	On Campus - Secured	Yes	0	
Firefox	Delegate	Windows 7	Off Campus	No	N/A	
Firefox	Faculty	Windows 10	On Campus - Secured	No	0	
Firefox	Admin	OS X	On Campus - Unsecured	No	0	
Firefox	Delegate	Android	On Campus - Secured	Yes	N/A	
Safari	Faculty	OS X	Off Campus	No	0	
Safari	Delegate	iOS	On Campus - Unsecured	Yes	N/A	
Stock	Admin	Android	Off Campus	Yes	0	
Safari	Faculty	iOS	Off Campus	Yes	0	
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Stock	Faculty	Android	On Campus - Unsecured	Yes	0	
Safari	Admin	OS X	On Campus - Secured	No	0	
Stock	Delegate	Android	On Campus - Secured	Yes	N/A	

**Test Case 2: Set Available Times (F, A)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	3	8, 35, 36
IE	Delegate	Windows 10	Off Campus	No	N/A	
Chrome	Faculty	Windows 7	On Campus - Secured	No	3	8, 35, 36
Chrome	Admin	Windows 10	On Campus - Unsecured	No	3	8, 35, 36
Chrome	Delegate	OS X	Off Campus	No	N/A	
Chrome	Faculty	Android	On Campus - Unsecured	Yes	3	8, 35, 36
Chrome	Admin	iOS	On Campus - Secured	Yes	3	8, 35, 36
Firefox	Delegate	Windows 7	Off Campus	No	N/A	
Firefox	Faculty	Windows 10	On Campus - Secured	No	3	8, 35, 36
Firefox	Admin	OS X	On Campus - Unsecured	No	3	8, 35, 36
Firefox	Delegate	Android	On Campus - Secured	Yes	N/A	
Safari	Faculty	OS X	Off Campus	No	3	8, 35, 36
Safari	Delegate	iOS	On Campus - Unsecured	Yes	N/A	
Stock	Admin	Android	Off Campus	Yes	3	8, 35, 36
Safari	Faculty	iOS	Off Campus	Yes	3	8, 35, 36
IE	Faculty	Windows 7	On Campus - Secured	No	3	8, 35, 36
Stock	Faculty	Android	On Campus - Unsecured	Yes	3	8, 35, 36
Safari	Admin	OS X	On Campus - Secured	No	3	8, 35, 36
Stock	Delegate	Android	On Campus - Secured	Yes	N/A	

**Test Case 3: Create Appointment (F, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	N/A	
IE	Delegate	Windows 10	Off Campus	No	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
Chrome	Faculty	Windows 7	On Campus - Secured	No	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Chrome	Delegate	OS X	Off Campus	No	19	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47
Chrome	Faculty	Android	On Campus - Unsecured	Yes	23	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 57, 58, 59, 63
Chrome	Admin	iOS	On Campus - Secured	Yes	N/A	
Firefox	Delegate	Windows 7	Off Campus	No	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
Firefox	Faculty	Windows 10	On Campus - Secured	No	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
Firefox	Admin	OS X	On Campus - Unsecured	No	N/A	
Firefox	Delegate	Android	On Campus - Secured	Yes	23	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 57, 58, 59, 63
Safari	Faculty	OS X	Off Campus	No	19	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47
Safari	Delegate	iOS	On Campus - Unsecured	Yes	23	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 57, 58, 59, 63

Stock	Admin	Android	Off Campus	Yes	N/A	
Safari	Faculty	iOS	Off Campus	Yes	23	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 57, 58, 59, 63
IE	Faculty	Windows 7	On Campus - Secured	No	21	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 48, 52
Stock	Faculty	Android	On Campus - Unsecured	Yes	23	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 57, 58, 59, 63
Safari	Admin	OS X	On Campus - Secured	No	N/A	
Stock	Delegate	Android	On Campus - Secured	Yes	23	2, 5, 10, 12, 13, 15, 16, 20, 24, 26, 27, 29, 30, 31, 33, 37, 39, 44, 47, 57, 58, 59, 63

#### Test Case 4: Edit Appointment (F, D)

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	N/A	
IE	Delegate	Windows 10	Off Campus	No	5	3, 20, 21, 40, 41
Chrome	Faculty	Windows 7	On Campus - Secured	No	5	3, 20, 21, 40, 41
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Chrome	Delegate	OS X	Off Campus	No	5	3, 20, 21, 40, 41
Chrome	Faculty	Android	On Campus - Unsecured	Yes	7	3, 20, 21, 40, 41, 56, 63
Chrome	Admin	iOS	On Campus - Secured	Yes	N/A	
Firefox	Delegate	Windows 7	Off Campus	No	5	3, 20, 21, 40, 41
Firefox	Faculty	Windows 10	On Campus - Secured	No	5	3, 20, 21, 40, 41
Firefox	Admin	OS X	On Campus - Unsecured	No	N/A	
Firefox	Delegate	Android	On Campus - Secured	Yes	7	3, 20, 21, 40, 41, 56, 63
Safari	Faculty	OS X	Off Campus	No	5	3, 20, 21, 40, 41



Safari	Delegate	iOS	On Campus - Unsecured	Yes	7	3, 20, 21, 40, 41, 56, 63
Stock	Admin	Android	Off Campus	Yes	N/A	
Safari	Faculty	iOS	Off Campus	Yes	7	3, 20, 21, 40, 41, 56, 63
IE	Faculty	Windows 7	On Campus - Secured	No	5	3, 20, 21, 40, 41
Stock	Faculty	Android	On Campus - Unsecured	Yes	7	3, 20, 21, 40, 41, 56, 63
Safari	Admin	OS X	On Campus - Secured	No	N/A	
Stock	Delegate	Android	On Campus - Secured	Yes	7	3, 20, 21, 40, 41, 56, 63

### Test Case 5: Delete Appointment (F, D)

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	N/A	
IE	Delegate	Windows 10	Off Campus	No	1	15
Chrome	Faculty	Windows 7	On Campus - Secured	No	1	15
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Chrome	Delegate	OS X	Off Campus	No	1	15
Chrome	Faculty	Android	On Campus - Unsecured	Yes	2	15, 56
Chrome	Admin	iOS	On Campus - Secured	Yes	N/A	
Firefox	Delegate	Windows 7	Off Campus	No	1	15
Firefox	Faculty	Windows 10	On Campus - Secured	No	1	15
Firefox	Admin	OS X	On Campus - Unsecured	No	N/A	
Firefox	Delegate	Android	On Campus - Secured	Yes	2	15, 56
Safari	Faculty	OS X	Off Campus	No	1	15
Safari	Delegate	iOS	On Campus - Unsecured	Yes	2	15
Stock	Admin	Android	Off Campus	Yes	N/A	
Safari	Faculty	iOS	Off Campus	Yes	2	15, 56
IE	Faculty	Windows 7	On Campus - Secured	No	1	15

Stock	Faculty	Android	On Campus - Unsecured	Yes	2	15, 56
Safari	Admin	OS X	On Campus - Secured	No	N/A	
Stock	Delegate	Android	On Campus - Secured	Yes	2	15, 56

**Test Case 6: Accept Student Appointment (F)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	N/A	
IE	Delegate	Windows 10	Off Campus	No	N/A	
Chrome	Faculty	Windows 7	On Campus - Secured	No	2	4, 19
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Chrome	Delegate	OS X	Off Campus	No	N/A	
Chrome	Faculty	Android	On Campus - Unsecured	Yes	4	4, 19, 61, 62
Chrome	Admin	iOS	On Campus - Secured	Yes	N/A	
Firefox	Delegate	Windows 7	Off Campus	No	N/A	
Firefox	Faculty	Windows 10	On Campus - Secured	No	2	4, 19
Firefox	Admin	OS X	On Campus - Unsecured	No	N/A	
Firefox	Delegate	Android	On Campus - Secured	Yes	N/A	
Safari	Faculty	OS X	Off Campus	No	2	4, 19
Safari	Delegate	iOS	On Campus - Unsecured	Yes	N/A	
Stock	Admin	Android	Off Campus	Yes	N/A	
Safari	Faculty	iOS	Off Campus	Yes	4	4, 19, 61, 62
IE	Faculty	Windows 7	On Campus - Secured	No	2	4, 19
Stock	Faculty	Android	On Campus - Unsecured	Yes	4	4, 19, 61, 62
Safari	Admin	OS X	On Campus - Secured	No	N/A	
Stock	Delegate	Android	On Campus - Secured	Yes	N/A	

**Test Case 7: Reject Student Appointment (F)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	N/A	
IE	Delegate	Windows 10	Off Campus	No	N/A	
Chrome	Faculty	Windows 7	On Campus - Secured	No	1	19
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Chrome	Delegate	OS X	Off Campus	No	N/A	
Chrome	Faculty	Android	On Campus - Unsecured	Yes	3	19, 61, 62
Chrome	Admin	iOS	On Campus - Secured	Yes	N/A	
Firefox	Delegate	Windows 7	Off Campus	No	N/A	
Firefox	Faculty	Windows 10	On Campus - Secured	No	1	19
Firefox	Admin	OS X	On Campus - Unsecured	No	N/A	
Firefox	Delegate	Android	On Campus - Secured	Yes	N/A	
Safari	Faculty	OS X	Off Campus	No	1	19
Safari	Delegate	iOS	On Campus - Unsecured	Yes	N/A	
Stock	Admin	Android	Off Campus	Yes	N/A	
Safari	Faculty	iOS	Off Campus	Yes	3	19, 61, 62
IE	Faculty	Windows 7	On Campus - Secured	No	1	19
Stock	Faculty	Android	On Campus - Unsecured	Yes	3	19, 61, 62
Safari	Admin	OS X	On Campus - Secured	No	N/A	
Stock	Delegate	Android	On Campus - Secured	Yes	N/A	

**Test Case 8: Accept All Student Appointments (F)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	N/A	
IE	Delegate	Windows 10	Off Campus	No	N/A	
Chrome	Faculty	Windows 7	On Campus - Secured	No	2	4, 19
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Chrome	Delegate	OS X	Off Campus	No	N/A	
Chrome	Faculty	Android	On Campus - Unsecured	Yes	2	4, 19
Chrome	Admin	iOS	On Campus - Secured	Yes	N/A	
Firefox	Delegate	Windows 7	Off Campus	No	N/A	
Firefox	Faculty	Windows 10	On Campus - Secured	No	2	4, 19
Firefox	Admin	OS X	On Campus - Unsecured	No	N/A	
Firefox	Delegate	Android	On Campus - Secured	Yes	N/A	
Safari	Faculty	OS X	Off Campus	No	2	4, 19
Safari	Delegate	iOS	On Campus - Unsecured	Yes	N/A	
Stock	Admin	Android	Off Campus	Yes	N/A	
Safari	Faculty	iOS	Off Campus	Yes	2	4, 19
IE	Faculty	Windows 7	On Campus - Secured	No	2	4, 19
Stock	Faculty	Android	On Campus - Unsecured	Yes	2	4, 19
Safari	Admin	OS X	On Campus - Secured	No	N/A	
Stock	Delegate	Android	On Campus - Secured	Yes	N/A	

**Test Case 9: Update Appointment Outcome (F, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	N/A	
IE	Delegate	Windows 10	Off Campus	No	7	4, 9, 11, 14, 18, 19, 23
Chrome	Faculty	Windows 7	On Campus - Secured	No	7	4, 9, 11, 14, 18, 19, 23
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Chrome	Delegate	OS X	Off Campus	No	7	4, 9, 11, 14, 18, 19, 23
Chrome	Faculty	Android	On Campus - Unsecured	Yes	7	4, 9, 11, 14, 18, 19, 23
Chrome	Admin	iOS	On Campus - Secured	Yes	N/A	
Firefox	Delegate	Windows 7	Off Campus	No	7	4, 9, 11, 14, 18, 19, 23
Firefox	Faculty	Windows 10	On Campus - Secured	No	7	4, 9, 11, 14, 18, 19, 23
Firefox	Admin	OS X	On Campus - Unsecured	No	N/A	
Firefox	Delegate	Android	On Campus - Secured	Yes	7	4, 9, 11, 14, 18, 19, 23
Safari	Faculty	OS X	Off Campus	No	7	4, 9, 11, 14, 18, 19, 23
Safari	Delegate	iOS	On Campus - Unsecured	Yes	7	4, 9, 11, 14, 18, 19, 23
Stock	Admin	Android	Off Campus	Yes	N/A	
Safari	Faculty	iOS	Off Campus	Yes	7	4, 9, 11, 14, 18, 19, 23
IE	Faculty	Windows 7	On Campus - Secured	No	7	4, 9, 11, 14, 18, 19, 23
Stock	Faculty	Android	On Campus - Unsecured	Yes	7	4, 9, 11, 14, 18, 19, 23
Safari	Admin	OS X	On Campus - Secured	No	N/A	
Stock	Delegate	Android	On Campus - Secured	Yes	7	4, 9, 11, 14, 18, 19, 23

**Test Case 10: View Advisee Appointment Information on Advisee Screen (F)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	N/A	
IE	Delegate	Windows 10	Off Campus	No	N/A	
Chrome	Faculty	Windows 7	On Campus - Secured	No		7, 17, 21, 28, 38, 43, 46, 49, 51
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Chrome	Delegate	OS X	Off Campus	No	N/A	
Chrome	Faculty	Android	On Campus - Unsecured	Yes		7, 17, 21, 28, 38, 43, 46, 65
Chrome	Admin	iOS	On Campus - Secured	Yes	N/A	
Firefox	Delegate	Windows 7	Off Campus	No	N/A	
Firefox	Faculty	Windows 10	On Campus - Secured	No		7, 17, 21, 28, 38, 43, 46, 49, 51
Firefox	Admin	OS X	On Campus - Unsecured	No	N/A	
Firefox	Delegate	Android	On Campus - Secured	Yes	N/A	
Safari	Faculty	OS X	Off Campus	No		7, 17, 21, 28, 38, 43, 46
Safari	Delegate	iOS	On Campus - Unsecured	Yes	N/A	
Stock	Admin	Android	Off Campus	Yes	N/A	
Safari	Faculty	iOS	Off Campus	Yes		7, 17, 21, 28, 38, 43, 46, 65
IE	Faculty	Windows 7	On Campus - Secured	No		7, 17, 21, 28, 38, 43, 46, 49, 51
Stock	Faculty	Android	On Campus - Unsecured	Yes		7, 17, 21, 28, 38, 43, 46, 65
Safari	Admin	OS X	On Campus - Secured	No	N/A	
Stock	Delegate	Android	On Campus - Secured	Yes	N/A	

**Test Case 11: View Advisee Grades and Test Scores on Advisee Screen (F)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	N/A	
IE	Delegate	Windows 10	Off Campus	No	N/A	
Chrome	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Chrome	Delegate	OS X	Off Campus	No	N/A	
Chrome	Faculty	Android	On Campus - Unsecured	Yes	2	65, 66
Chrome	Admin	iOS	On Campus - Secured	Yes	N/A	
Firefox	Delegate	Windows 7	Off Campus	No	N/A	
Firefox	Faculty	Windows 10	On Campus - Secured	No	0	
Firefox	Admin	OS X	On Campus - Unsecured	No	N/A	
Firefox	Delegate	Android	On Campus - Secured	Yes	N/A	
Safari	Faculty	OS X	Off Campus	No	0	
Safari	Delegate	iOS	On Campus - Unsecured	Yes	N/A	
Stock	Admin	Android	Off Campus	Yes	N/A	
Safari	Faculty	iOS	Off Campus	Yes	2	65, 66
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Stock	Faculty	Android	On Campus - Unsecured	Yes	2	65, 66
Safari	Admin	OS X	On Campus - Secured	No	N/A	
Stock	Delegate	Android	On Campus - Secured	Yes	N/A	

**Test Case 12: Access Student Degree Information from Advisee Screen (F)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	N/A	
IE	Delegate	Windows 10	Off Campus	No	N/A	
Chrome	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Chrome	Delegate	OS X	Off Campus	No	N/A	
Chrome	Faculty	Android	On Campus - Unsecured	Yes	0	
Chrome	Admin	iOS	On Campus - Secured	Yes	N/A	
Firefox	Delegate	Windows 7	Off Campus	No	N/A	
Firefox	Faculty	Windows 10	On Campus - Secured	No	0	
Firefox	Admin	OS X	On Campus - Unsecured	No	N/A	
Firefox	Delegate	Android	On Campus - Secured	Yes	N/A	
Safari	Faculty	OS X	Off Campus	No	0	
Safari	Delegate	iOS	On Campus - Unsecured	Yes	N/A	
Stock	Admin	Android	Off Campus	Yes	N/A	
Safari	Faculty	iOS	Off Campus	Yes	0	
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Stock	Faculty	Android	On Campus - Unsecured	Yes	0	
Safari	Admin	OS X	On Campus - Secured	No	N/A	
Stock	Delegate	Android	On Campus - Secured	Yes	N/A	



**Test Case 13: View Other Adviser Calendars in Your Group (F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	0	
IE	Delegate	Windows 10	Off Campus	No	0	
Chrome	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	0	
Chrome	Delegate	OS X	Off Campus	No	0	
Chrome	Faculty	Android	On Campus - Unsecured	Yes	0	
Chrome	Admin	iOS	On Campus - Secured	Yes	0	
Firefox	Delegate	Windows 7	Off Campus	No	0	
Firefox	Faculty	Windows 10	On Campus - Secured	No	0	
Firefox	Admin	OS X	On Campus - Unsecured	No	0	
Firefox	Delegate	Android	On Campus - Secured	Yes	0	
Safari	Faculty	OS X	Off Campus	No	0	
Safari	Delegate	iOS	On Campus - Unsecured	Yes	0	
Stock	Admin	Android	Off Campus	Yes	1	74
Safari	Faculty	iOS	Off Campus	Yes	0	
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Stock	Faculty	Android	On Campus - Unsecured	Yes	1	74
Safari	Admin	OS X	On Campus - Secured	No	0	
Stock	Delegate	Android	On Campus - Secured	Yes	1	74

**Test Case 14: View Group Announcements (F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	0	
IE	Delegate	Windows 10	Off Campus	No	0	
Chrome	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	0	
Chrome	Delegate	OS X	Off Campus	No	0	
Chrome	Faculty	Android	On Campus - Unsecured	Yes	0	
Chrome	Admin	iOS	On Campus - Secured	Yes	0	
Firefox	Delegate	Windows 7	Off Campus	No	0	
Firefox	Faculty	Windows 10	On Campus - Secured	No	0	
Firefox	Admin	OS X	On Campus - Unsecured	No	0	
Firefox	Delegate	Android	On Campus - Secured	Yes	0	
Safari	Faculty	OS X	Off Campus	No	0	
Safari	Delegate	iOS	On Campus - Unsecured	Yes	0	
Stock	Admin	Android	Off Campus	Yes	0	
Safari	Faculty	iOS	Off Campus	Yes	0	
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Stock	Faculty	Android	On Campus - Unsecured	Yes	0	
Safari	Admin	OS X	On Campus - Secured	No	0	
Stock	Delegate	Android	On Campus - Secured	Yes	0	

**Test Case 15: View Advisee Roster (F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	5	11, 22, 32, 43, 48
IE	Delegate	Windows 10	Off Campus	No	5	11, 22, 32, 43, 48
Chrome	Faculty	Windows 7	On Campus - Secured	No	5	11, 22, 32, 43, 48
Chrome	Admin	Windows 10	On Campus - Unsecured	No	5	11, 22, 32, 43, 48
Chrome	Delegate	OS X	Off Campus	No	4	11, 22, 32, 43
Chrome	Faculty	Android	On Campus - Unsecured	Yes	8	11, 22, 32, 43, 54, 55, 60, 67
Chrome	Admin	iOS	On Campus - Secured	Yes	9	11, 22, 32, 43, 54, 55, 60, 67, 70
Firefox	Delegate	Windows 7	Off Campus	No	5	11, 22, 32, 43, 48
Firefox	Faculty	Windows 10	On Campus - Secured	No	5	11, 22, 32, 43, 48
Firefox	Admin	OS X	On Campus - Unsecured	No	4	11, 22, 32, 43
Firefox	Delegate	Android	On Campus - Secured	Yes	8	11, 22, 32, 43, 54, 55, 60, 67
Safari	Faculty	OS X	Off Campus	No	4	11, 22, 32, 43
Safari	Delegate	iOS	On Campus - Unsecured	Yes	9	11, 22, 32, 43, 54, 55, 60, 67, 70
Stock	Admin	Android	Off Campus	Yes	10	11, 22, 32, 43, 54, 55, 60, 67, 71, 73
Safari	Faculty	iOS	Off Campus	Yes	9	11, 22, 32, 43, 54, 55, 60, 67, 70
IE	Faculty	Windows 7	On Campus - Secured	No	5	11, 22, 32, 43, 48
Stock	Faculty	Android	On Campus - Unsecured	Yes	10	11, 22, 32, 43, 54, 55, 60, 67, 71, 73
Safari	Admin	OS X	On Campus - Secured	No	4	11, 22, 32, 43
Stock	Delegate	Android	On Campus - Secured	Yes	10	11, 22, 32, 43, 54, 55, 60, 67, 71, 73

**Test Case 16: Search Advisee Roster (F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	2	25, 53
IE	Delegate	Windows 10	Off Campus	No	2	25, 53
Chrome	Faculty	Windows 7	On Campus - Secured	No	2	25, 53
Chrome	Admin	Windows 10	On Campus - Unsecured	No	2	25, 53
Chrome	Delegate	OS X	Off Campus	No	1	25
Chrome	Faculty	Android	On Campus - Unsecured	Yes	5	25, 55, 68, 69, 75
Chrome	Admin	iOS	On Campus - Secured	Yes	5	25, 55, 68, 69, 75
Firefox	Delegate	Windows 7	Off Campus	No	2	25, 53
Firefox	Faculty	Windows 10	On Campus - Secured	No	2	25, 53
Firefox	Admin	OS X	On Campus - Unsecured	No	1	25
Firefox	Delegate	Android	On Campus - Secured	Yes	5	25, 55, 68, 69, 75
Safari	Faculty	OS X	Off Campus	No	1	25
Safari	Delegate	iOS	On Campus - Unsecured	Yes	5	25, 55, 68, 69, 75
Stock	Admin	Android	Off Campus	Yes	5	25, 55, 68, 69, 75
Safari	Faculty	iOS	Off Campus	Yes	5	25, 55, 68, 69, 75
IE	Faculty	Windows 7	On Campus - Secured	No	2	25, 53
Stock	Faculty	Android	On Campus - Unsecured	Yes	5	25, 55, 68, 69, 75
Safari	Admin	OS X	On Campus - Secured	No	1	25
Stock	Delegate	Android	On Campus - Secured	Yes	5	25, 55, 68, 69, 75

**Test Case 17: Create Appointment with Non-Advisee (F, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	N/A	
IE	Delegate	Windows 10	Off Campus	No	0	
Chrome	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	N/A	
Chrome	Delegate	OS X	Off Campus	No	0	
Chrome	Faculty	Android	On Campus - Unsecured	Yes	0	
Chrome	Admin	iOS	On Campus - Secured	Yes	N/A	
Firefox	Delegate	Windows 7	Off Campus	No	0	
Firefox	Faculty	Windows 10	On Campus - Secured	No	0	
Firefox	Admin	OS X	On Campus - Unsecured	No	N/A	
Firefox	Delegate	Android	On Campus - Secured	Yes	0	
Safari	Faculty	OS X	Off Campus	No	0	
Safari	Delegate	iOS	On Campus - Unsecured	Yes	0	
Stock	Admin	Android	Off Campus	Yes	N/A	
Safari	Faculty	iOS	Off Campus	Yes	0	
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Stock	Faculty	Android	On Campus - Unsecured	Yes	0	
Safari	Admin	OS X	On Campus - Secured	No	N/A	
Stock	Delegate	Android	On Campus - Secured	Yes	0	

**Test Case 18: See Non-Advisee Appointments in Roster (F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	1	22
IE	Delegate	Windows 10	Off Campus	No	1	22
Chrome	Faculty	Windows 7	On Campus - Secured	No	1	22
Chrome	Admin	Windows 10	On Campus - Unsecured	No	1	22
Chrome	Delegate	OS X	Off Campus	No	1	22
Chrome	Faculty	Android	On Campus - Unsecured	Yes	1	22
Chrome	Admin	iOS	On Campus - Secured	Yes	1	22
Firefox	Delegate	Windows 7	Off Campus	No	1	22
Firefox	Faculty	Windows 10	On Campus - Secured	No	1	22
Firefox	Admin	OS X	On Campus - Unsecured	No	1	22
Firefox	Delegate	Android	On Campus - Secured	Yes	1	22
Safari	Faculty	OS X	Off Campus	No	1	22
Safari	Delegate	iOS	On Campus - Unsecured	Yes	1	22
Stock	Admin	Android	Off Campus	Yes	1	22
Safari	Faculty	iOS	Off Campus	Yes	1	22
IE	Faculty	Windows 7	On Campus - Secured	No	1	22
Stock	Faculty	Android	On Campus - Unsecured	Yes	1	22
Safari	Admin	OS X	On Campus - Secured	No	1	22
Stock	Delegate	Android	On Campus - Secured	Yes	1	22

**Test Case 19: View Calendar of Appointments and Unavailable Times in Week Format  
(F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
IE	Delegate	Windows 10	Off Campus	No	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Faculty	Windows 7	On Campus - Secured	No	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Admin	Windows 10	On Campus - Unsecured	No	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Chrome	Delegate	OS X	Off Campus	No	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
Chrome	Faculty	Android	On Campus - Unsecured	Yes	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 60, 64
Chrome	Admin	iOS	On Campus - Secured	Yes	13	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 60, 64, 70
Firefox	Delegate	Windows 7	Off Campus	No	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Firefox	Faculty	Windows 10	On Campus - Secured	No	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Firefox	Admin	OS X	On Campus - Unsecured	No	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
Firefox	Delegate	Android	On Campus - Secured	Yes	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 60, 64
Safari	Faculty	OS X	Off Campus	No	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45
Safari	Delegate	iOS	On Campus - Unsecured	Yes	13	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 60, 64, 70
Stock	Admin	Android	Off Campus	Yes	14	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 60, 64, 71, 72
Safari	Faculty	iOS	Off Campus	Yes	13	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 60, 64, 70
IE	Faculty	Windows 7	On Campus - Secured	No	12	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 48, 50
Stock	Faculty	Android	On Campus - Unsecured	Yes	14	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 60, 64, 71, 72
Safari	Admin	OS X	On Campus - Secured	No	10	1, 6, 13, 14, 16, 19, 35, 37, 42, 45

Stock	Delegate	Android	On Campus - Secured	Yes	14	1, 6, 13, 14, 16, 19, 35, 37, 42, 45, 60, 64, 72, 72
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**Test Case 20: View Calendar of Appointments and Unavailable Times in Month Format  
(F, A, D)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
IE	Delegate	Windows 10	Off Campus	No	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Faculty	Windows 7	On Campus - Secured	No	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Admin	Windows 10	On Campus - Unsecured	No	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Chrome	Delegate	OS X	Off Campus	No	8	6, 13, 14, 16, 19, 35, 42, 45
Chrome	Faculty	Android	On Campus - Unsecured	Yes	10	6, 13, 14, 16, 19, 35, 42, 45, 60, 64
Chrome	Admin	iOS	On Campus - Secured	Yes	11	6, 13, 14, 16, 19, 35, 42, 45, 60, 64, 70
Firefox	Delegate	Windows 7	Off Campus	No	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Firefox	Faculty	Windows 10	On Campus - Secured	No	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Firefox	Admin	OS X	On Campus - Unsecured	No	8	6, 13, 14, 16, 19, 35, 42, 45
Firefox	Delegate	Android	On Campus - Secured	Yes	10	6, 13, 14, 16, 19, 35, 42, 45, 60, 64
Safari	Faculty	OS X	Off Campus	No	8	6, 13, 14, 16, 19, 35, 42, 45
Safari	Delegate	iOS	On Campus - Unsecured	Yes	11	6, 13, 14, 16, 19, 35, 42, 45, 60, 64, 70
Stock	Admin	Android	Off Campus	Yes	12	6, 13, 14, 16, 19, 35, 42, 45, 60, 64, 71, 72
Safari	Faculty	iOS	Off Campus	Yes	11	6, 13, 14, 16, 19, 35, 42, 45, 60, 64, 70
IE	Faculty	Windows 7	On Campus - Secured	No	10	6, 13, 14, 16, 19, 35, 42, 45, 48, 50
Stock	Faculty	Android	On Campus - Unsecured	Yes	12	6, 13, 14, 16, 19, 35, 42, 45, 60, 64, 71, 72
Safari	Admin	OS X	On Campus - Secured	No	8	6, 13, 14, 16, 19, 35, 42, 45



Stock	Delegate	Android	On Campus - Secured	Yes	12	6, 13, 14, 16, 19, 35, 42, 45, 60, 64, 71, 72
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**Test Case 21: Opt Out of Adviser Scheduling Application (F, A)**

Browser	User Type	Operating System	Network	Mobile ?	# Bugs	Bug ID's
IE	Admin	Windows 7	On Campus - Unsecured	No	0	
IE	Delegate	Windows 10	Off Campus	No	N/A	
Chrome	Faculty	Windows 7	On Campus - Secured	No	0	
Chrome	Admin	Windows 10	On Campus - Unsecured	No	0	
Chrome	Delegate	OS X	Off Campus	No	N/A	
Chrome	Faculty	Android	On Campus - Unsecured	Yes	0	
Chrome	Admin	iOS	On Campus - Secured	Yes	0	
Firefox	Delegate	Windows 7	Off Campus	No	N/A	
Firefox	Faculty	Windows 10	On Campus - Secured	No	0	
Firefox	Admin	OS X	On Campus - Unsecured	No	0	
Firefox	Delegate	Android	On Campus - Secured	Yes	N/A	
Safari	Faculty	OS X	Off Campus	No	0	
Safari	Delegate	iOS	On Campus - Unsecured	Yes	N/A	
Stock	Admin	Android	Off Campus	Yes	0	
Safari	Faculty	iOS	Off Campus	Yes	0	
IE	Faculty	Windows 7	On Campus - Secured	No	0	
Stock	Faculty	Android	On Campus - Unsecured	Yes	0	
Safari	Admin	OS X	On Campus - Secured	No	0	
Stock	Delegate	Android	On Campus - Secured	Yes	N/A	

Table 17: *Pairwise Test Results by Test Case – Considering Mobile*

## CHAPTER 6: CONCLUSIONS AND RECOMMENDATION

Given the research questions:

*(RQ1) Do combinatorial testing methods allow for a reduced amount of testing, while maintaining a high level of quality?*

Yes, the Each Choice method allowed us to significantly reduce the number of tests, while maintaining a high level of quality.

*(RQ2) Do combinatorial testing methods increase the effectiveness of testing without increasing the testing effort?*

Yes, because the Each Choice method allowed for such a drastic reduction in the number of tests, mobile testing could be incorporated into the testing phase. Even with the new configurations to test, the total testing effort was still smaller than what the original testing procedure entailed. Testing the new configurations introduced new bugs for mobile devices and browsers.

*(RQ3) What are the practical benefits of applying combinatorial testing methods to web applications?*

There are many practical benefits of applying combinatorial testing methods to web applications. The Each Choice and pairwise methods can tailor needs of different business goals. The goals can include significantly reducing testing efforts while maintaining quality, reducing testing efforts while increasing the effectiveness, and increasing testing efforts to increase confidence in test results. While theoretically, pairwise may be considered a better testing approach, practically Each Choice can be considered a best approach for certain business goals.

In conclusion, we found that the original testing of the application was thorough. While it was good enough to detect the same bugs as the pairwise and Each Choice approaches, it was not systematic and did not allow time for mobile testing. The purely pairwise method and Each Choice

method did not reveal any new bugs but reduced the number of configurations. Reducing these also reduces the effort required in testing. Although pairwise testing requires completing more tests than Each Choice, the latter cannot produce better results than pairwise testing, although it can reduce the testing time. The Each Choice testing method allowed for testing an extra parameter (mobile) without exceeding the time and resource restriction as originally faced in testing. While no new bugs were found when considering the operational profile, there is greater confidence in the test results that the application is ready for use by its main audience. In this case study, pairwise was not the most beneficial testing method, but it is usually considered to be the better testing alternative (compared to Each Choice) when sufficient resources are available. With the results of fewer tests, new configurations, and better detection rates, this study recommends that the Each Choice testing method with the inclusion of the mobile device parameter be implemented as the preferred testing approach for web applications.

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