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SSW 567

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# Homework 06

**Assignment**

Part I

Assignment: The Software Engineering Department at Stevens Institute of Technology is launching a new website to help students plan their class schedules. We need to support the following configurations:

- Operating System: Mac OSX, Linux, and Windows 10
  - {OSX, Linux, Win10}
- Browser: Safari, Firefox, and Chrome
  - Note: Safari, Firefox, and Chrome are available on Mac OSX, Linux, and Windows 10
  - {Safari, Firefox, Chrome}
- Student Type: Undergraduate and Graduate
  - {U,G}
- Student Location: On Campus or Remote
  - {C,R}

**Questions and Answers**

1. What is the total number of test cases for exhaustive testing? Show the exhaustive list of all combinations. 36
2. What are the factors and levels for each factor? OS (3), Browser (3), Type (2), Location (2)
3. How many test cases do we need for Pairwise Orthogonal Array Testing? 9
4. Select and show the proper Orthogonal Array L9
5. Populate and show the Orthogonal Array with the appropriate values for this problem

Solution: In total, there are **four factors** for this scenario. They are the **operating system**, **browser**, **student type**, and **student location**. There are **three levels for the operating system** (OSX, Linux, and Win10), **three levels for the browser** (Safari, Firefox, and Chrome), **two levels for the student type** (U, G), and **two levels for the student location** (C,R). A breakdown of these factors is present in the table found below.

| Factors, Part I | | | | |
|---|---|---|---|---|
| Factor | Values | | | Level |
| Operating System | OSX | Linux | Win10 | 3 |
| Browser | Safari | Firefox | Chrome | 3 |
| Student Type | U | G | -- | 2 |
| Student Location | C | R | -- | 2 |

This results in there being thirty-six possible combinations for students to choose from. This number is obtained by multiplying together the amount of values for each factor. Therefore, to test the system most exhaustively with each combination getting its own test case, **thirty-six test cases** should be used. A list of these combinations is present below.

| Combination Table, Part I | | | | |
|---|---|---|---|---|
| Combination | Operating System | Browser | Student Type | Student Location |
| 1 | OSX | Safari | U | C |
| 2 | OSX | Safari | U | R |
| 3 | OSX | Safari | G | C |
| 4 | OSX | Safari | G | R |
| 5 | OSX | Firefox | U | C |
| 6 | OSX | Firefox | U | R |
| 7 | OSX | Firefox | G | C |
| 8 | OSX | Firefox | G | R |
| 9 | OSX | Chrome | U | C |
| 10 | OSX | Chrome | U | R |
| 11 | OSX | Chrome | G | C |
| 12 | OSX | Chrome | G | R |
| 13 | Linux | Safari | U | C |
| 14 | Linux | Safari | U | R |
| 15 | Linux | Safari | G | C |
| 16 | Linux | Safari | G | R |
| 17 | Linux | Firefox | U | C |
| 18 | Linux | Firefox | U | R |
| 19 | Linux | Firefox | G | C |
| 20 | Linux | Firefox | G | R |
| 21 | Linux | Chrome | U | C |
| 22 | Linux | Chrome | U | R |
| 23 | Linux | Chrome | G | C |
| 24 | Linux | Chrome | G | R |
| 25 | Win10 | Safari | U | C |
| 26 | Win10 | Safari | U | R |
| 27 | Win10 | Safari | G | C |
| 28 | Win10 | Safari | G | R |
| 29 | Win10 | Firefox | U | C |
| 30 | Win10 | Firefox | U | R |
| 31 | Win10 | Firefox | G | C |
| 32 | Win10 | Firefox | G | R |
| 33 | Win10 | Chrome | U | C |
| 34 | Win10 | Chrome | U | R |
| 35 | Win10 | Chrome | G | C |
| 36 | Win10 | Chrome | G | R |

To test this scenario using Pairwise Orthogonal Array Testing most effectively, **nine test cases** are required. This therefore warrants the use of an **L9 orthogonal array**, shown below.

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L9 Orthogonal Array

| Experiment Number | Column 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 |
| 2 | 1 | 2 | 2 | 2 |
| 3 | 1 | 3 | 3 | 3 |
| 4 | 2 | 1 | 2 | 3 |
| 5 | 2 | 2 | 3 | 1 |
| 6 | 2 | 3 | 1 | 2 |
| 7 | 3 | 1 | 3 | 2 |
| 8 | 3 | 2 | 1 | 3 |
| 9 | 3 | 3 | 2 | 1 |

The **populated array** for this scenario is shown in the table below.

| Populated Orthogonal Array, Part I | | | | |
|---|---|---|---|---|
| Experiment | Operating System | Browser | Student Type | Student Location |
| 1 | OSX | Safari | U | C |
| 2 | OSX | Firefox | G | R |
| 3 | OSX | Chrome | U | C |
| 4 | Linux | Safari | G | R |
| 5 | Linux | Firefox | U | C |
| 6 | Linux | Chrome | G | R |
| 7 | Win10 | Safari | U | C |
| 8 | Win10 | Firefox | G | R |
| 9 | Win10 | Chrome | U | C |

Part II

Assignment: You are selling a bicycle store support application. It has the following configuration options: 1) On-line sales or retail in-store 2) USA or Canada stores 3) Payment by Visa or American Express Only (no cash) 4) Selling bicycles only or doing maintenance and sales

**Questions and Answers:**

1. How many combinations of these 4 variables are there? 16
2. How many tests do you need to cover all combinations of any one variable? 8
3. What is the orthogonal array which you can use for this problem? How many test cases does it represent? L8; 8
4. If you had 7 variables with 2 values each, which array would you use? L8
5. How many test cases does an L8 array represent? 8

Solution: There are a total of **sixteen combinations** for these variables. As there are four variables, and two possible values for each variable, this is obtained by the formula $2^4$, which is equal to sixteen. A list of these variables and their values is shown below.

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| Variables and their Values, Part II | | | |
|---|---|---|---|
| Variable | Values | | Level |
| Sale Type | Online | Retail | 2 |
| Location | USA | Canada | 2 |
| Payment Type | Visa | AMEX | 2 |
| Service | Sales Only | Maintenance and Sales | 2 |

To cover all combinations of any one variable, **eight test cases** are required. The most optimal array for this problem is the **L8 Orthogonal Array**, **representing 8 test cases**. This would hold true even for a scenario with seven variables of two values each, as **L8 contains seven factors each of two levels**. An L8 array represents **eight test cases**, and the completed array for this scenario is seen below.

| Populated Orthogonal Array, Part II | | | | |
|---|---|---|---|---|
| Experiment | Sale Type | Location | Payment Type | Service |
| 1 | Online | USA | Visa | Sales Only |
| 2 | Online | USA | Visa | Maintenance and Sales |
| 3 | Online | Canada | AMEX | Sales Only |
| 4 | Online | Canada | AMEX | Maintenance and Sales |
| 5 | Retail | USA | Visa | Sales Only |
| 6 | Retail | USA | Visa | Maintenance and Sales |
| 7 | Retail | Canada | AMEX | Sales Only |
| 8 | Retail | Canada | AMEX | Maintenance and Sales |

Part III

Assignment: Your company provides online books for various readers. The ones you need to worry about are Kindle, iPad and Zok. There are 4 different classes of books you need to worry about - textbooks (which have lots of equations), poetry (where the formatting is extremely important), graphic novels, and regular novels. They also can be ordered in three different languages, English, Spanish, and Japanese.

**Questions and Answers:**

1. What is the total number of test cases for all combinations? 36
2. What is the minimum number of tests for pairwise testing? 12
3. You decide to use orthogonal arrays to help with your testing. Which table should you use? L16B

Solution: There are a total of **thirty-six combinations** for these variables. As there are two variables of level three and one variable of level four, the total number of combinations is derived from the formula $3^2*4$. As the highest-leveled variable is that of level four, in total **twelve tests are required at a minimum** to enable pairwise testing. This is a result of the highest level, four, times the smallest level, three. The most optimal orthogonal array to use for this situation is **L16B**, as this is the first array that accounts for a variable with a level of four.

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Part IV

Assignment: We need to do some configuration testing on a new version of an application. There are 5 different operating systems we need to test on, 3 different browsers, and 3 different languages (English, Spanish, and Martian)

**Answer these questions:**

1. How many combinations are there of these variables? 45
2. Which orthogonal array should you use? L25
3. How many individual tests do you need to run for all combinations of two variables? (Not the minimum number of tests for any pair of variables) 39

Solution: In total, there are **forty-five combinations** of variables. This is derived by the formula 5*3*3, with each number representing the level of a variable (operating system, browser, and language respectively). The most optimal orthogonal array for this situation is **L25**, as this array can accommodate a five-value variable. To run tests for all combinations of two variables, **thirty-nine tests** in total are required. This is made up of the fifteen operating system and browser tests, the fifteen operating system and language tests, and the nine browser and language tests.

**Summary**

This assignment featured the use of orthogonal arrays to help analyze the testing requirements of various systems. To accomplish this, the factors affecting these systems were examined and their characteristics such as level were compared to determine the total amount of tests required. From here, the use of combination charts and orthogonal arrays helped identify each of the individual test cases required and translate their contents and characteristics to any would-be developer.

**Reflection**

I found this assignment to be useful in identifying, planning, and organizing the various test cases required to comprehensively test a program. The use of orthogonal arrays is new to me, but I can appreciate their importance and the efficiency that they provide testers. I found the use of mathematical formulas to compute the exact required number of testes to be especially useful. By doing this, the requirements of the testing plan can be accurately determined before development even begins on the system.