

Utilizing Chat-GPT and CAGen for Design of Experiments: An Exhaustive Report

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Abstract—This report utilizes DOE tool(CAGen) and Generative AI tool(Chat-GPT 4.0 mini) to generate test cases for pairwise combination of test cases using Design of experiments and evaluate the effectiveness of test cases generated while assessing both tools.

Keywords: Design of Experiments, Pairwise combination, CAGen, Chat-GPT 4.0 mini, Software Testing.

AnkrPt Pairwise [1]. In this study I have used CAGen to develop Design of Experiments which is easy to use. It requires an Input Parameter Model which contains Name, value and cardinality. Here, Name specifies the specification of our mobile application, Values are the parameter values and cardinality determines the number of values.

CAGen covered 25 pairwise combinations of Authentication, Connectivity, Memory, Battery Level with type of phone through the test cases.

I. DEVELOPMENT OF TEST CASES USING DOE TOOL

There are several open-source tools available for Design of Experiments like Pairwise Pict Online, CAGen, Pairwiser, Testcover.com,

Type of Phone	Authentication	Connectivity	Memory	Battery Level
iphone 14	Fingerprint	Wireless	128 GB	< 20%
iphone 14	Face Recognition	3G	256 GB	20-39%
iphone 14	Text Password	4G LTE	512 GB	40-59%
iphone 14	Fingerprint	5G Edge	1 TB	60-79%
iphone 14	Text Password	Wireless	256 GB	80-100%
iphone 13	Fingerprint	3G	512 GB	< 20%
iphone 13	Face Recognition	4G LTE	1 TB	20-39%
iphone 13	Text Password	5G Edge	128 GB	40-59%
iphone 13	Face Recognition	Wireless	256 GB	60-79%
iphone 13	Text Password	3G	1 TB	80-100%
Galaxy Z	Fingerprint	4G LTE	256 GB	< 20%
Galaxy Z	Face Recognition	5G Edge	512 GB	20-39%
Galaxy Z	Text Password	Wireless	1 TB	40-59%
Galaxy Z	Face Recognition	3G	128 GB	60-79%
Galaxy Z	Fingerprint	4G LTE	128 GB	80-100%
Huawei Mate	Face Recognition	5G Edge	256 GB	< 20%
Huawei Mate	Text Password	Wireless	512 GB	20-39%
Huawei Mate	Fingerprint	3G	1 TB	40-59%
Huawei Mate	Text Password	4G LTE	128 GB	60-79%
Huawei Mate	Face Recognition	5G Edge	512 GB	80-100%

Fig - 1 : Snippet of Test cases generated by CAGen

Google Pixel 7	Text Password	Wireless	1 TB	< 20%
Google Pixel 7	Fingerprint	3G	128 GB	20-39%
Google Pixel 7	Face Recognition	4G LTE	256 GB	40-59%
Google Pixel 7	Text Password	5G Edge	512 GB	60-79%
Google Pixel 7	Text Password	Wireless	1 TB	80-100%

Fig - 1 : Snippet of Test cases generated by CAGen

II. DEVELOPMENT OF TEST CASES USING CHAT-GPT

Generative AI tools include ChatGPT, Bard. I have used ChatGPT-4.0 mini for generating test cases using DOE technique with specifications (Type of Phone, Authentication, Connectivity, Memory, Battery Level).

develop a set of test cases using pairwise combination DOE technique for below mentioned specification of a mobile application

Type of phone - iPhone 14, iPhone 13, Galaxy Z, Huawei Mate, Google Pixel 7
 Authentication - Fingerprint, Face recognition, Text Password
 Connectivity - Wireless, 3G, 4G LTE, 5G Edge
 Memory - 128 GB, 256 GB, 512GB, 1TB
 Batter Level - <20%, 20-39%, 40-59%, 60-79%, 80-100%

Fig - 2 : prompt used for generating test cases using Generative AI

To generate test cases using the **Pairwise Combination Design of Experiments (DOE)** technique will combine each factor from the mobile application specification with all other factors in pairs. goal is to ensure that each pair of options from different factors is covered at least once across test cases. This helps ensure that interactions between different variables are tested thoroughly reducing the number of tests needed while still covering a wide range of combinations.

Factors:

- Type of Phone**
 - iPhone 14
 - iPhone 13
 - Galaxy Z
 - Huawei Mate
 - Google Pixel 7
- Authentication**
 - Fingerprint
 - Face recognition
 - Text Password
- Connectivity**
 - Wireless

Fig - 3 : Result Generated by AI Tool

- 3G
 - 4G LTE
 - 5G Edge
- Memory**
 - 128 GB
 - 256 GB
 - 512 GB
 - 1TB
 - Battery Level**
 - <20%
 - 20-39%
 - 40-59%
 - 60-79%
 - 80-100%

Step 1: Create All Possible Pairwise Combinations

We generate all combinations where each pair of factors interacts at least once. For instance:

- Phone Type + Authentication**
 (iPhone 14 + Fingerprint), (iPhone 14 + Face recognition), (iPhone 14 + Text Password), etc.
- Phone Type + Connectivity**
 (iPhone 14 + Wireless), (iPhone 14 + 3G), (iPhone 14 + 4G LTE), etc.

Step 2: Generate Minimal Test Cases

To reduce the number of tests, we can use tools or algorithms to find the minimum set of tests that cover all pairwise combinations of factors.

Example Test Cases (Using Pairwise Combination):

Here are a few example test cases that cover the pairwise combinations:

Test Case	Type of Phone	Authentication	Connectivity	Memory	Battery Level
1	iPhone 14	Fingerprint	Wireless	128 GB	<20%
2	iPhone 13	Face recognition	3G	256 GB	20-39%
3	Galaxy Z	Text Password	4G LTE	512 GB	40-59%
4	Huawei Mate	Fingerprint	5G Edge	1TB	60-79%
5	Google Pixel 7	Face recognition	Wireless	128 GB	80-100%
6	iPhone 14	Text Password	3G	256 GB	<20%
7	iPhone 13	Fingerprint	4G LTE	512 GB	20-39%
8	Galaxy Z	Face recognition	5G Edge	1TB	40-59%
9	Huawei Mate	Text Password	Wireless	128 GB	60-79%
10	Google Pixel 7	Fingerprint	3G	256 GB	80-100%
11	iPhone 14	Face recognition	4G LTE	512 GB	<20%
12	iPhone 13	Text Password	5G Edge	1TB	20-39%
13	Galaxy Z	Fingerprint	Wireless	128 GB	40-59%
14	Huawei Mate	Face recognition	3G	256 GB	60-79%
15	Google Pixel 7	Text Password	4G LTE	512 GB	80-100%

Fig - 3 : Result Generated by AI Tool

The Generative AI tool generated a total of 15 test cases covering combinations of specifications.

III. ASSESSMENT OF THE TEST CASES

The test cases generated by DOE(CAGen) tool ensures maximum coverage, includes various variations with a structured approach of generating test cases covering a single type of phone at a time. Optimally avoided generating redundant test cases.

While the test cases generated by Generative AI tool(Chat-GPT) covered various combinations of test cases without redundancy, but missed

several combinations and lacks structure in test case generation.

IV. ASSESSMENT OF DOE TOOL

Test cases generated by CAGen were very efficient covering diverse combinations of test cases without any redundancy in test cases.

A. Features and Functionalities

CAGen Automatically detects the cardinality for each parameter(name) and type from the values entered. It allows importing workspaces from local computer or use prior workspaces created in the tool. It allows exporting the generated test cases to multiple formats which include .csv file, clipboard of computer, clipboard of Matlab, and clipboard of Python.

B. Scope Covered by the Tool

Supports three types of algorithms to generate test cases and provides 1-way to 5-way coverage. Along with the number of times a t-way combination appears in test cases through lambda. Using 2-way coverage, all possible combinations of test cases are covered, generating 25 test cases.

C. Performance of the tool

CAGen efficiently generated required number of pairwise combination of test cases ensuring test case coverage and avoiding redundancy while maintaining structure.

D. Ease of Use

CAGen's simple user interface ensures that no prior knowledge on tool is required making it easy to generate test cases.

1. Add all the parameters and its values.
2. Add t-way combination required.
3. Generate test cases.

V. ASSESSMENT OF GENERATIVE AI TOOL

The Generative AI Tool is very easy to use, with less steps compared to the DOE Tool working solely with a single prompt. Even though test case coverage is not up to the mark as that of DOE Tool, usage of optimized (model trained on Software testing) Generative AI tool can increase productivity by minimizing the time required in usage of Domain specific tools.

REFERENCES

- [1] GeeksforGeeks, "Combinatorial Testing Tools in Software Testing," <https://www.geeksforgeeks.org/combinatorial-testing-tools-in-software-testing/> (accessed Feb. 17, 2025).