Specification Based Testing – Part 2

Design of Experiments

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Objective

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Apply Design of Experiments to develop tests

Background

- Design of Experiments (DOE) is a systematic approach for evaluating a system or process
- DOE is heavily utilized in manufacturing and quality engineering
- DOE enables efficient investigation of the behavior of a system

Traditional Experimentation

- Traditional evaluation of the behavior of a system involves designing an experiment in which one factor is modified and the behavior on the system is assessed
- For example, consider varying oven temperature on the impact of the quality of a pizza

Weakness of Traditional Approach

- **The behavior of most systems is impacted by many factors**
- **Factors may also combine to create interactions**
- **In the pizza case, additional factors include:**
  - Rack positioning
  - Cook time

DOE Advantages

- DOE enables examination of the impact of a single factor as well as combinations of factors
- Values / ranges must be determined for each factor to investigate
- Experiments (runs) are made with combinations of the factors being considered and their impact on the system

Pizza Example Factors

Cook time

- Low / Med / High

Rack position

- 1 / 2 / 3 / 4 / 5

Temperature

- 350 / 375 / 400

Full DOE Combinations

- 45 Runs

DOE Classification

Full factorial design

- Tests for every factor value combination
- Pizza example

Fractional factorial design

- Only a fraction of all combinations are addressed
- Orthogonal arrays often used to address limited combinations of factors

Design of Experiments Pairwise Combinations

1. Identify the parameters that define each configuration
2. Partition each of the parameters
3. Specify constraints prohibiting particular combinations of configuration partitions

Design of Experiments Pairwise Combinations

4. **Specify configurations to test which cover all pairwise combinations of configuration parameter partitions satisfying the constraint**
   - “For any two parameters P1 and P2 and for any partition value V1 for P1 and V2 for P2, there is a specified configuration where P1 has the value V1 and P2 has the value V2. “

Pizza Example

1	Med	350
2	Low	350
3	High	350
4	Low	350
5	Low	350
1	Low	375
2	High	375
3	Med	375
4	Med	375
5	Med	375
1	High	400
2	Med	400
3	Low	400
4	High	400
5	High	400

Experiences with DOE in Software Testing

- Several companies have used DOE in software testing and have reported good results
- DOE has been shown to achieve reasonable code coverage

Warning

- Many software functions contain many parameters and factors
- Pairwise combination testing may leave many functions untested with normal, everyday scenarios

Summary