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Test design techniques
Equivalent classes as the base for test design

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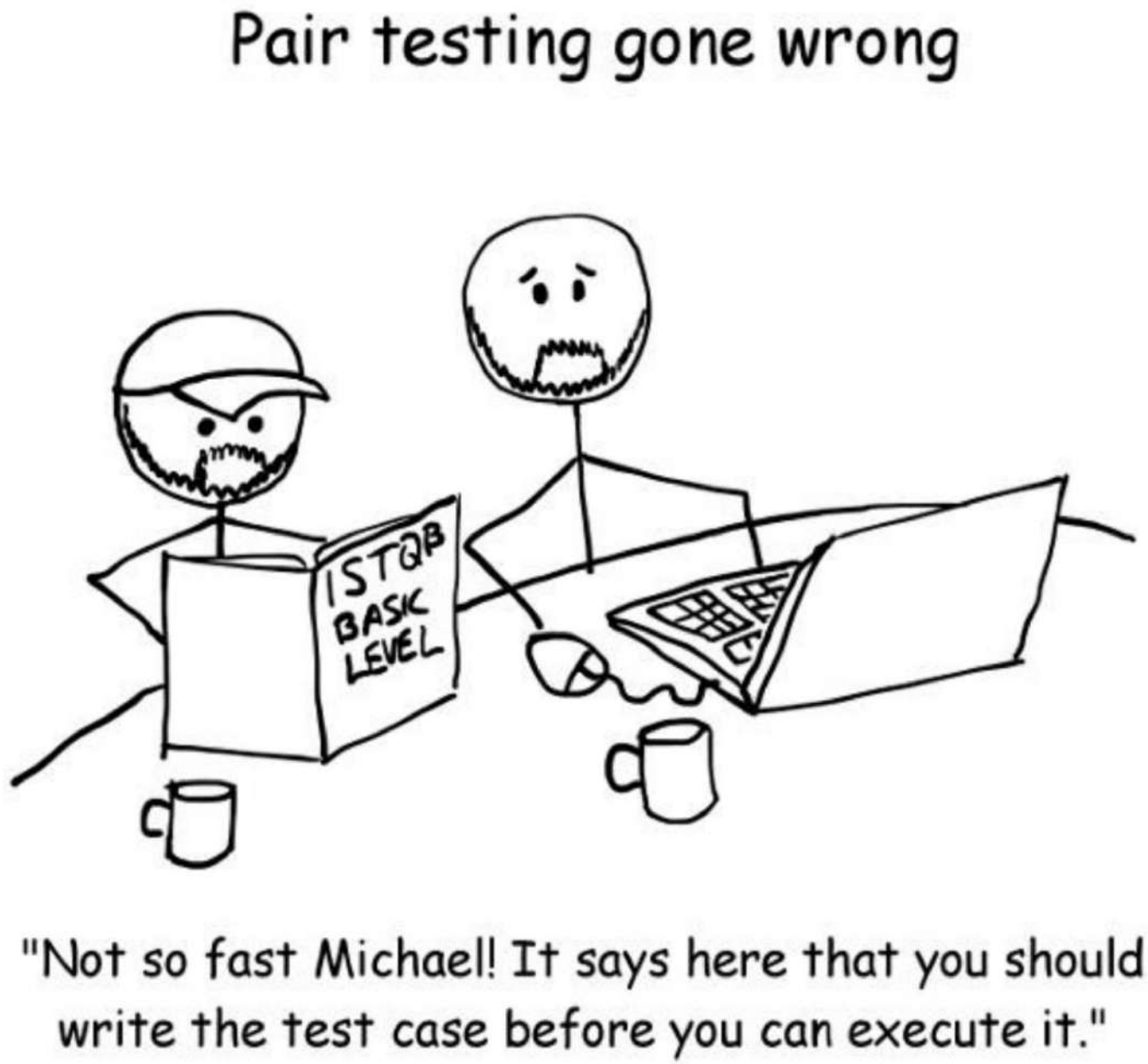
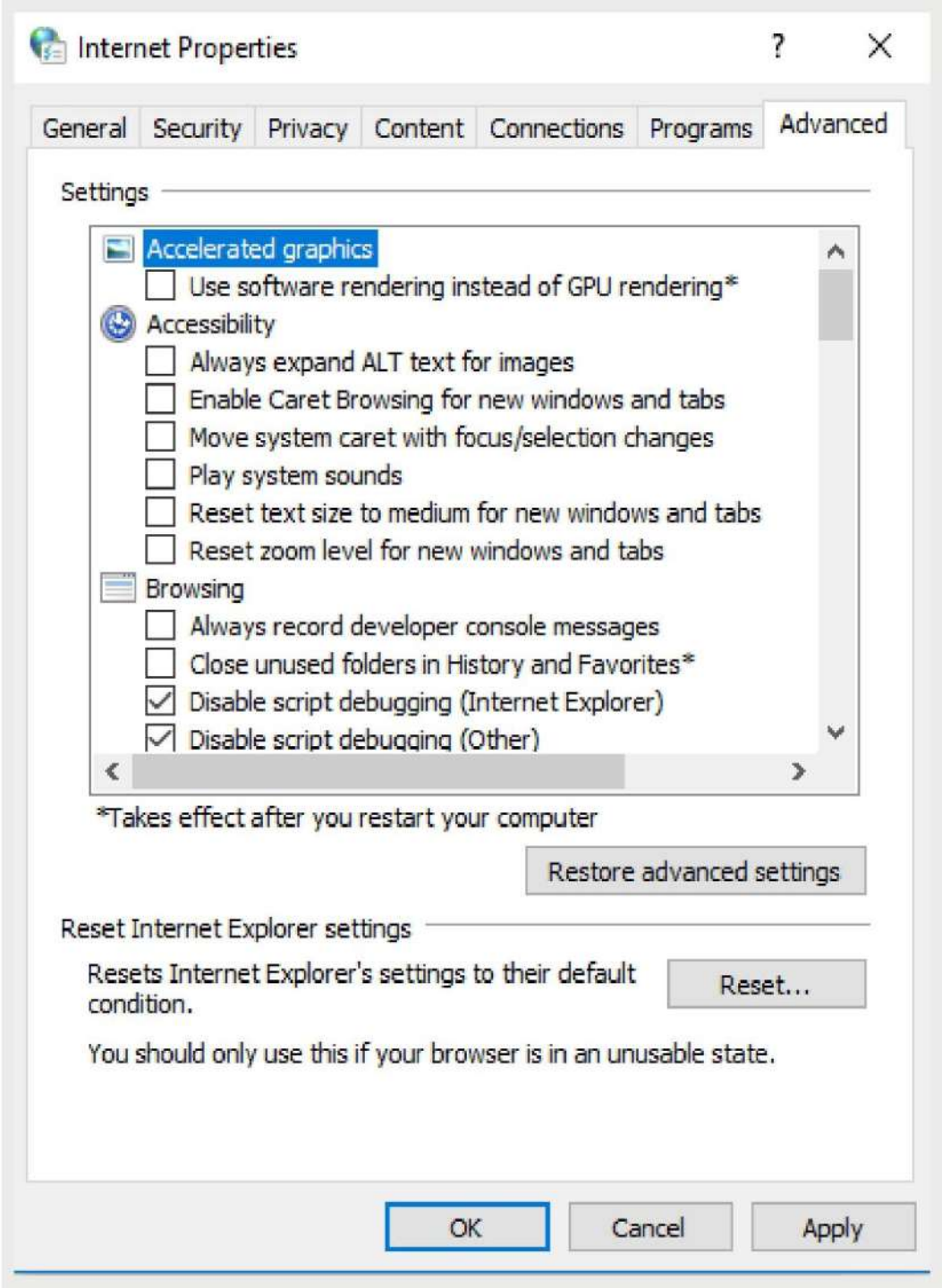
Content

- ✓ What is test design?
- ✓ Equivalence class partitioning (ECP)
- ✓ Pairwise testing
- ✓ Boundary Value Analysis



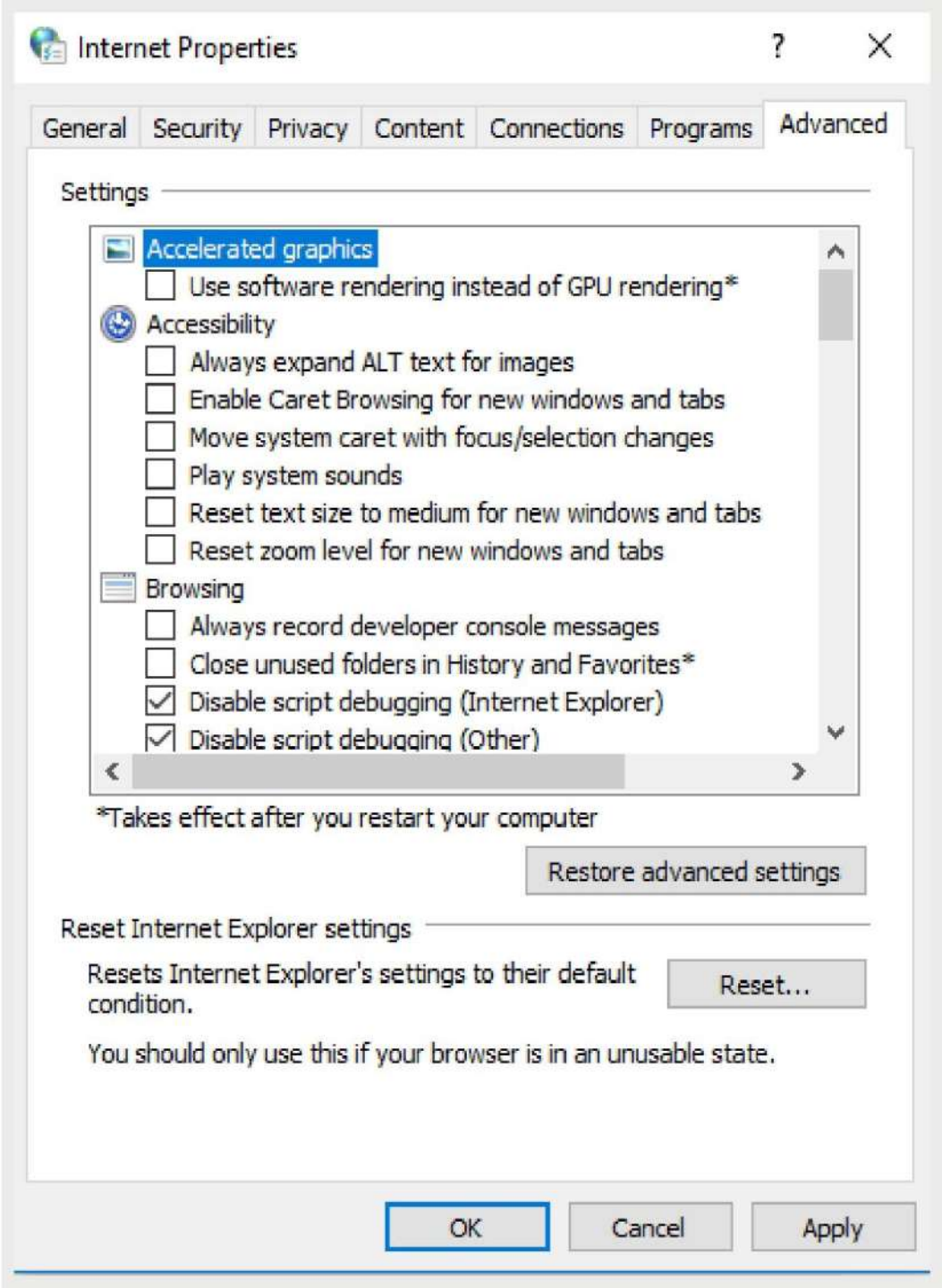
What is test design?

How many tests do we need?



How many tests do we need?

- ✓ 53 binary conditions
- ✓ 1 condition with 3 options
- ✓ 1 condition with 4 options



How many tests do we need?

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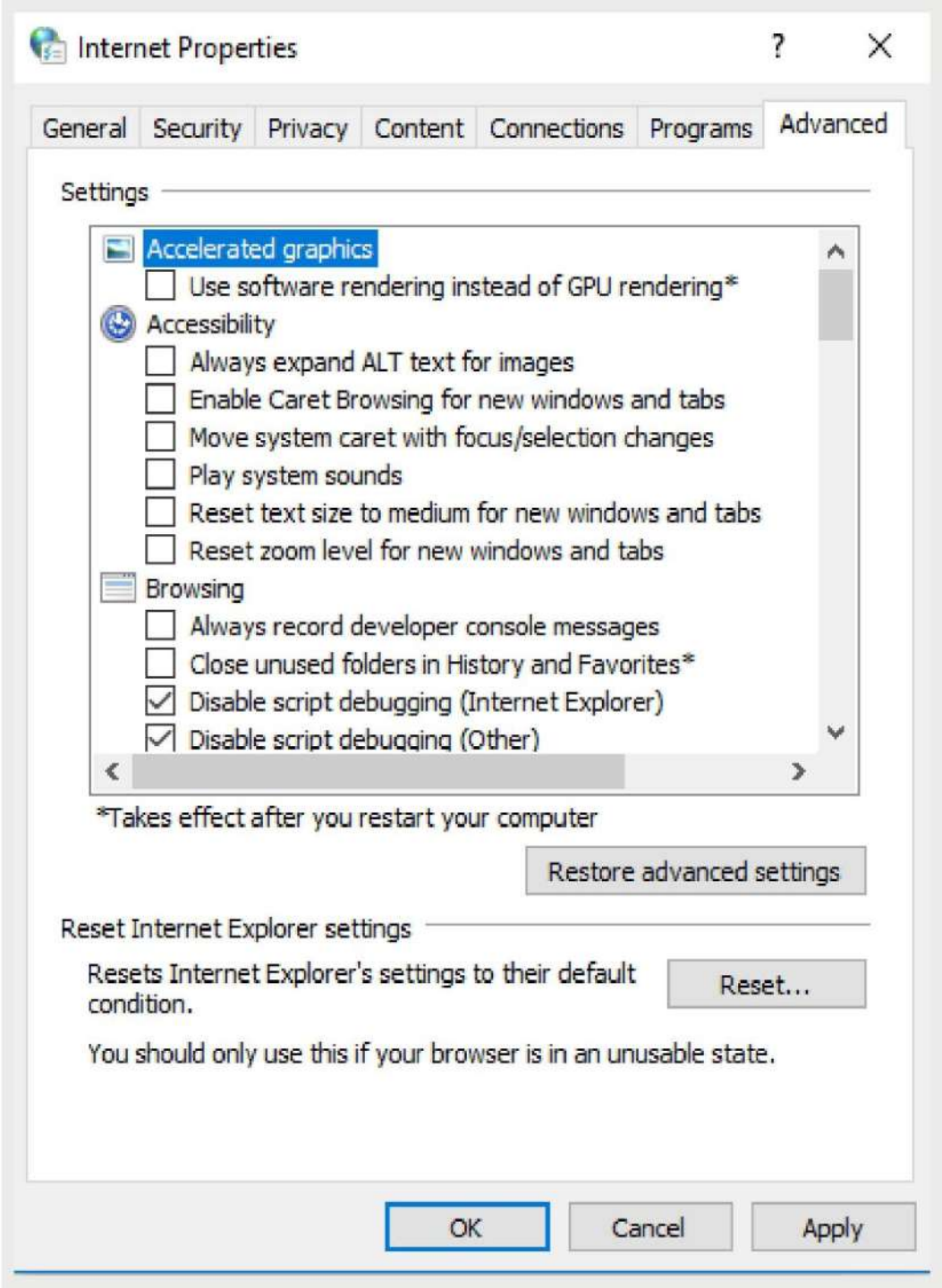
$2^{53} * 3 * 4 = 108,086,391,056,891,904$ possible combinations of conditions



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- ✓ 53 binary conditions
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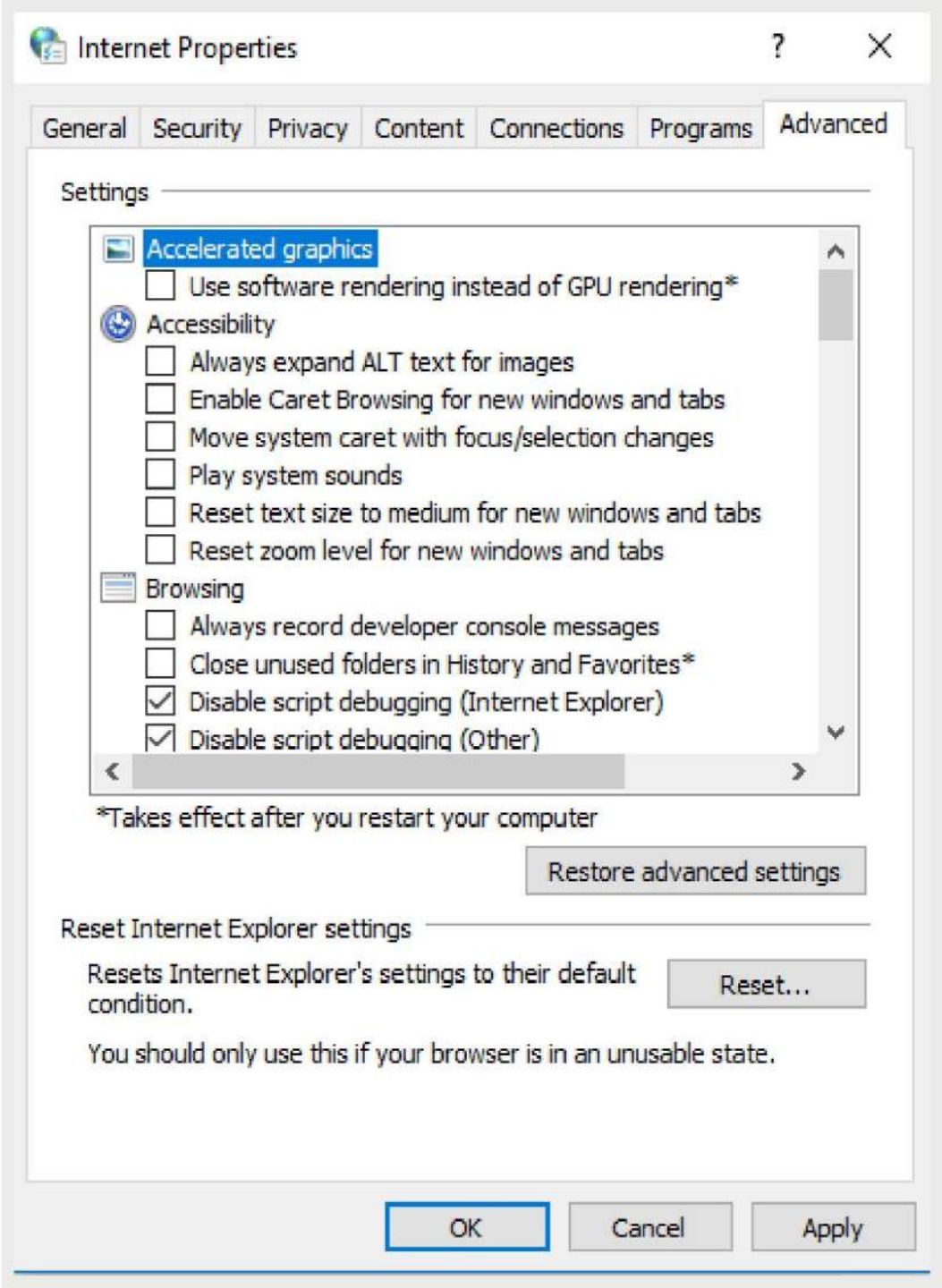
$2^{53} * 3 * 4 = 108\ 086\ 391\ 056\ 891\ 904$ possible combinations of conditions

1 second per test execution:

108086391056891904 sec = 30023997515803 3.067 hours

= 34273969766.9 years to test all possible combinations.



What is test design?

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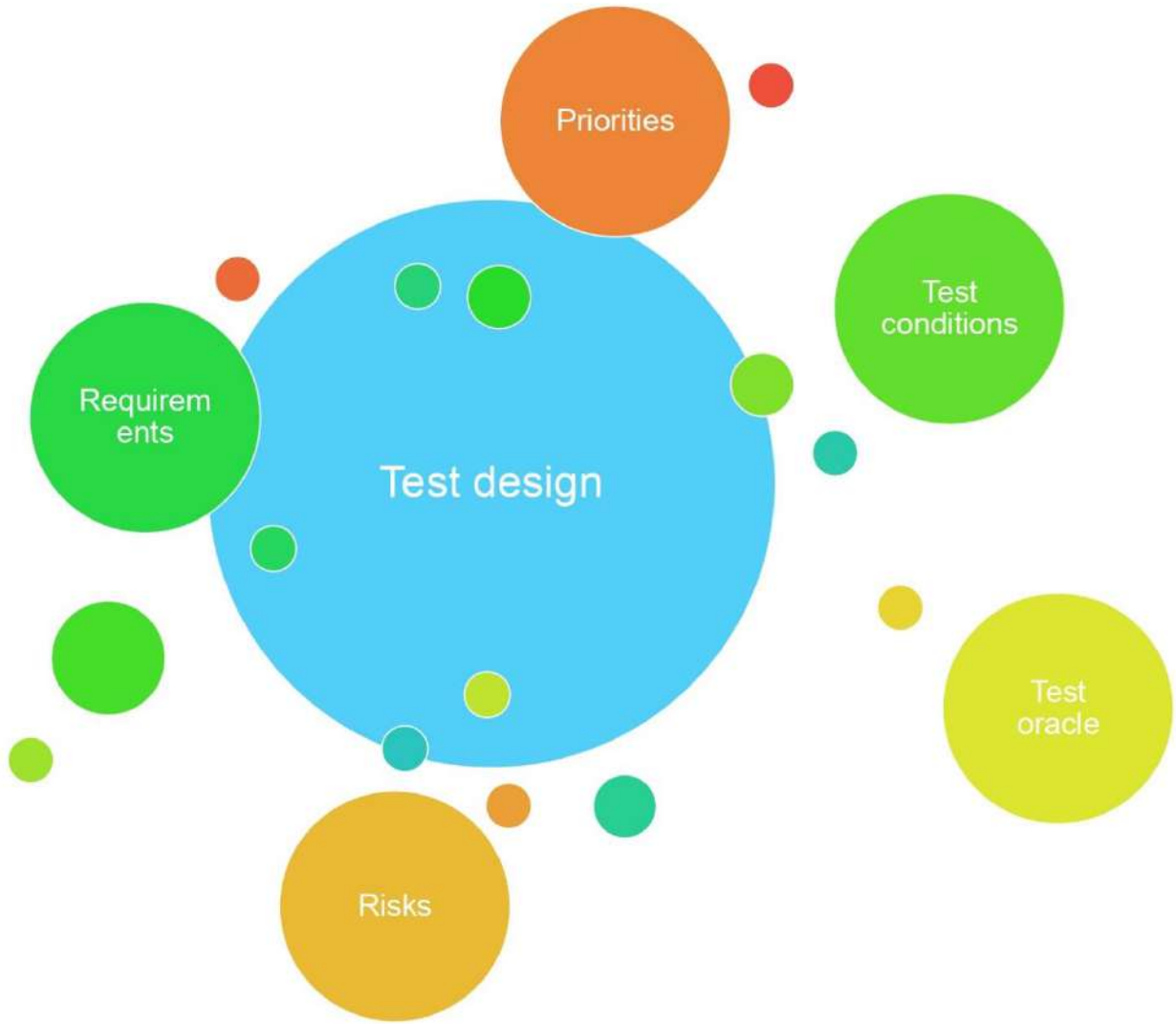

Software testing techniques

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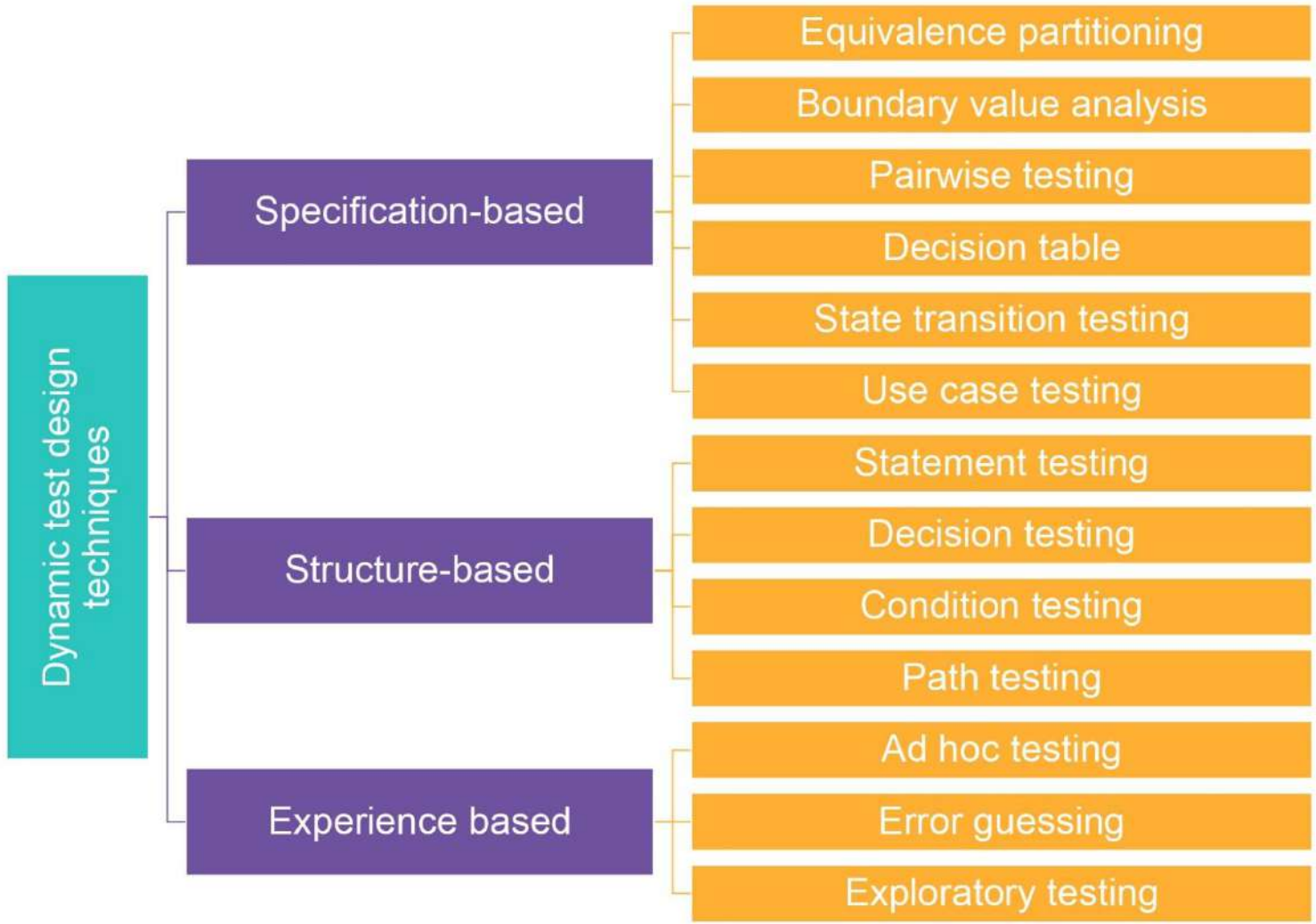

Software testing techniques

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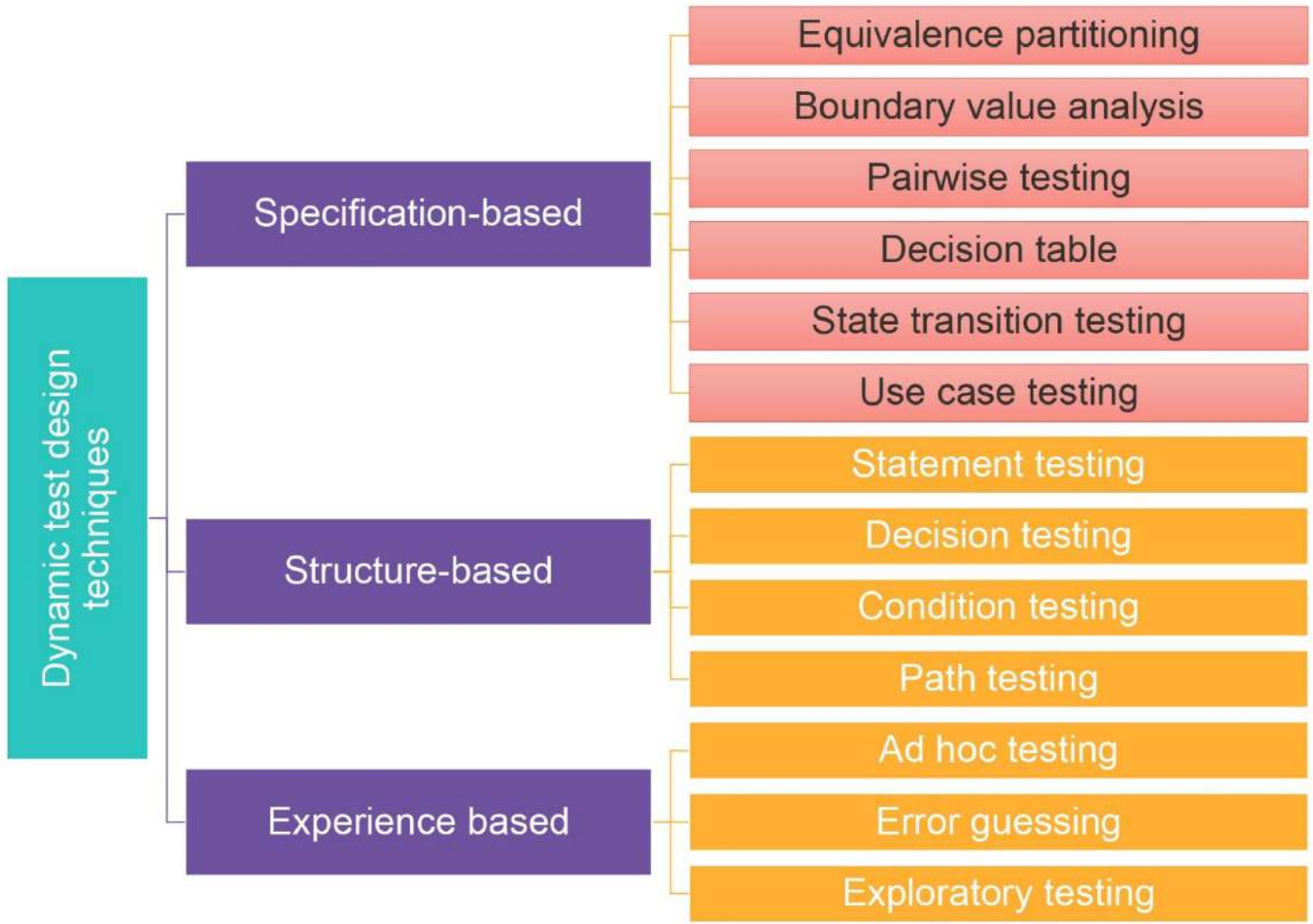
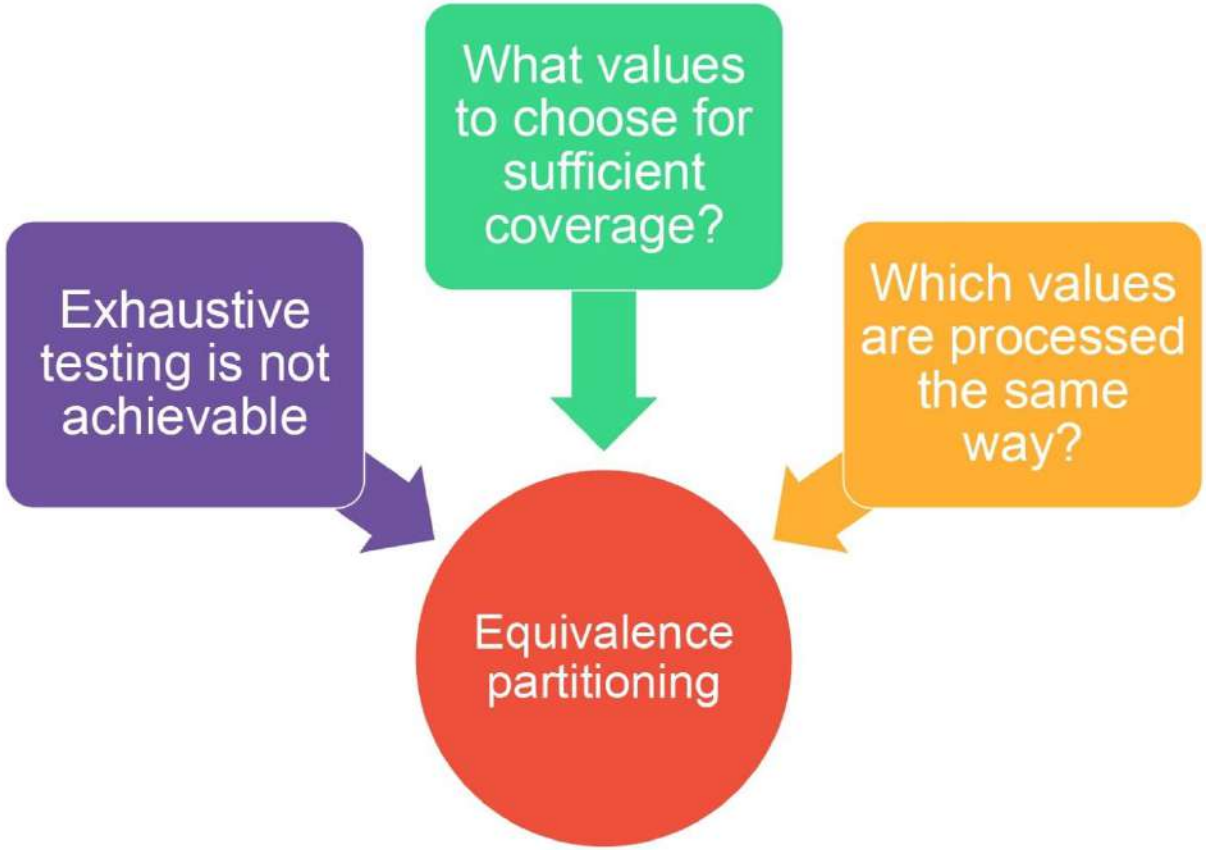


Equivalence class partitioning (ECP)

Base ideas


What values to choose for sufficient coverage?
Exhaustive testing is not achievable
Which values are processed the same way?
Equivalence partitioning


CABRIOLET
MID SIZE
COMPACT SUV
MINIVAN
STANDARD SUV
COUPE
COMPACT CAR
PICKUP

Equivalence classes

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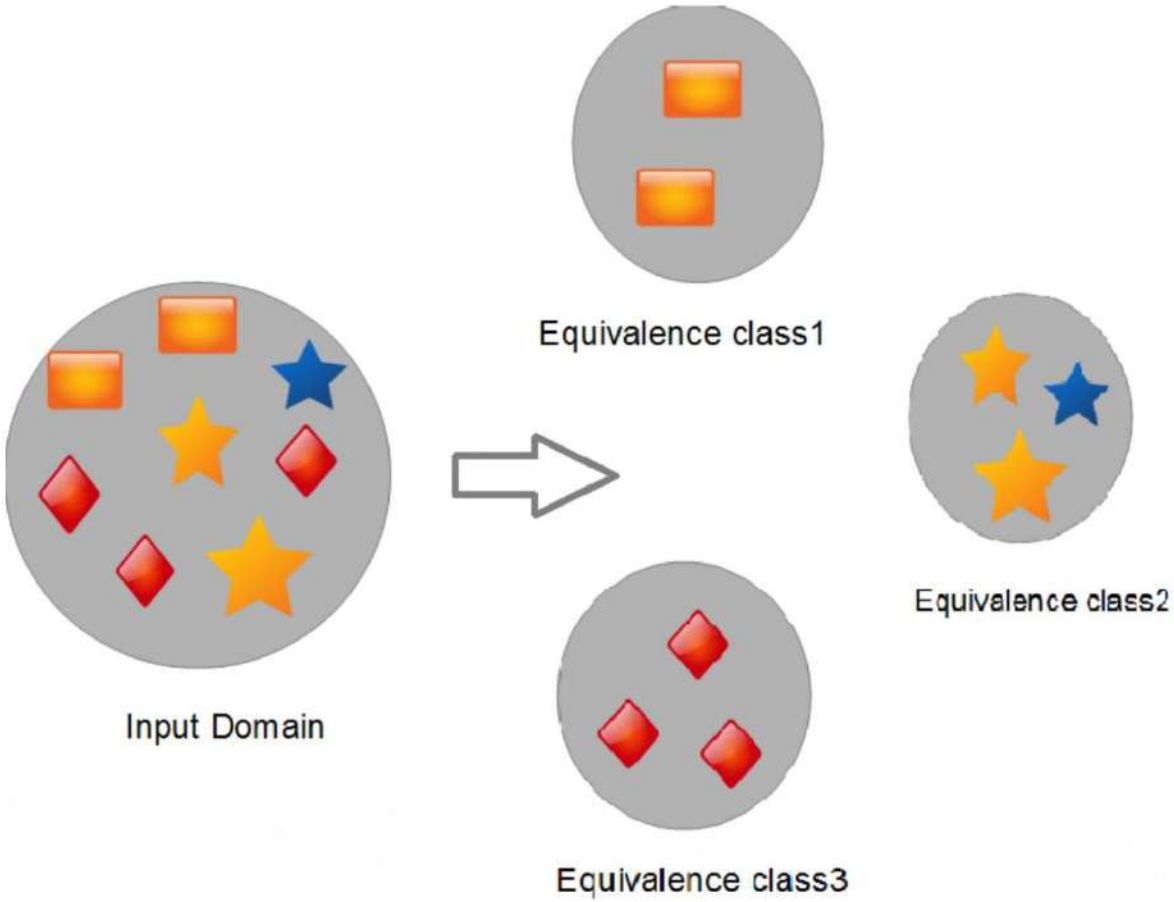

- ✓ Input domain
- ✓ Output domain – double-checking
- ✓ Grey box – refinement of a set of classes

Example

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Example. Calculation of the commission when canceling air tickets:

- ✓ 5 days before departure, the commission is 0%
- ✓ Less than 5 days, but more than 24 hours - 50%
- ✓ Less than 24 hours, but before departure - 75%
- ✓ After departure - 100%

Example

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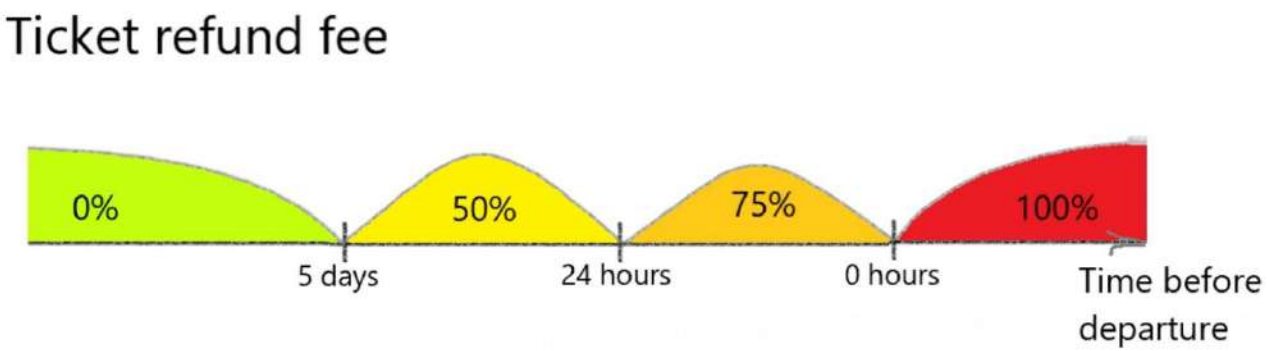

Example

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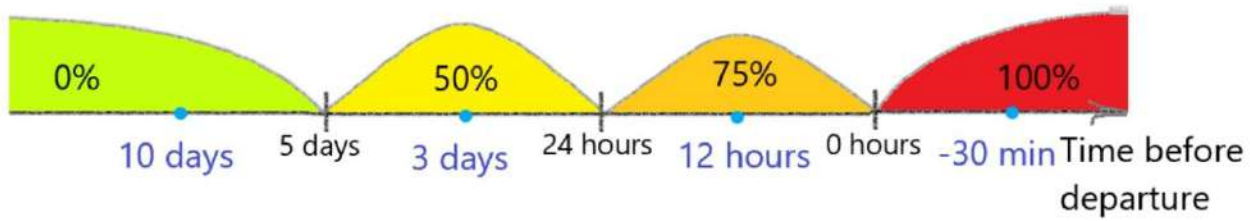
Ticket refund fee



Detect equivalence classes			
t > 5 days	24 hours < t < 5 days	0 hours < t < 24 hours	t < 0 hours
Choose a value in each class			
10 days	3 days	12 hours	-30 minutes
Run tests			
fee 0%.	fee 50%.	fee 75%.	fee 100%.

How to detect equivalence classes

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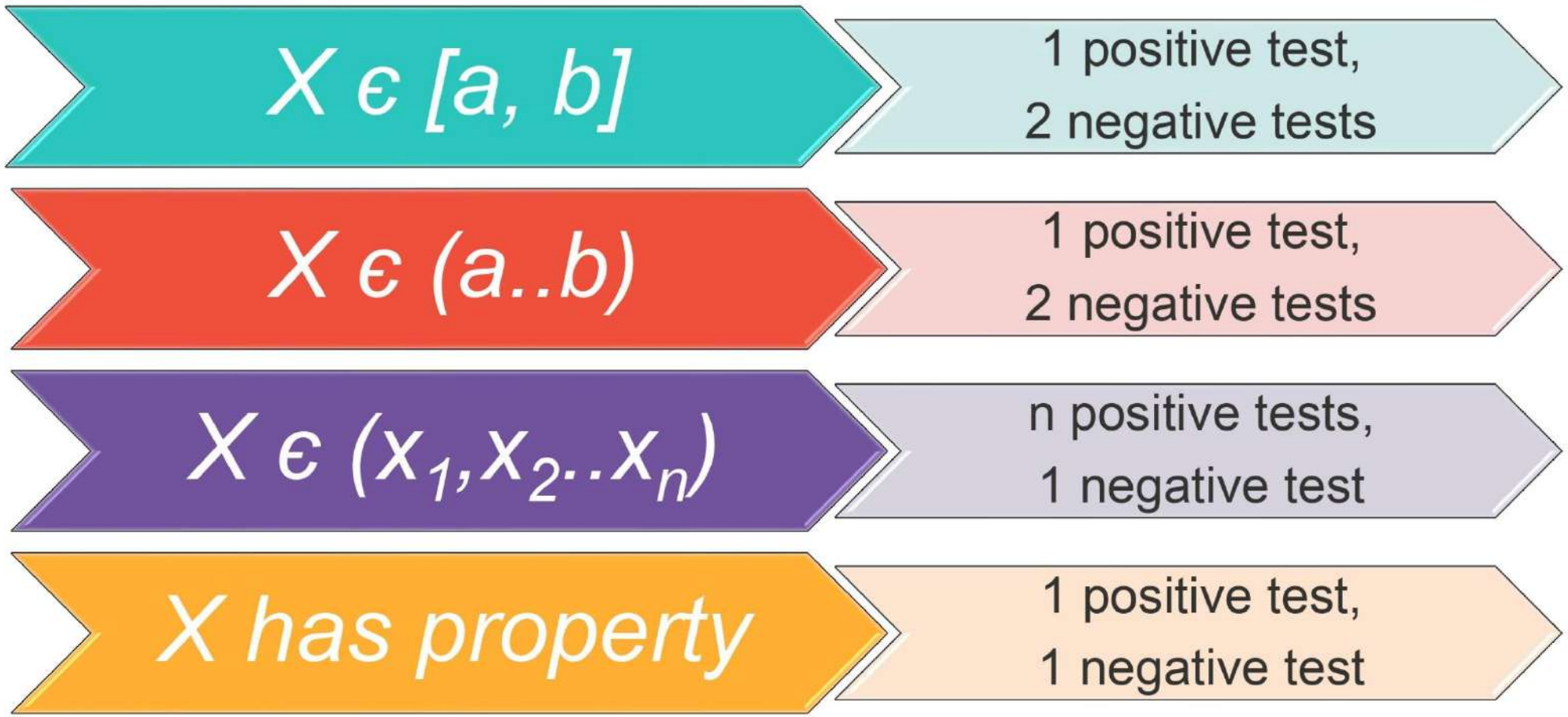

Superposition of conditions/parameters

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X – string

Length X ϵ [1, 10]

The first letter is capitalized or it is digit

Superposition of conditions/parameters

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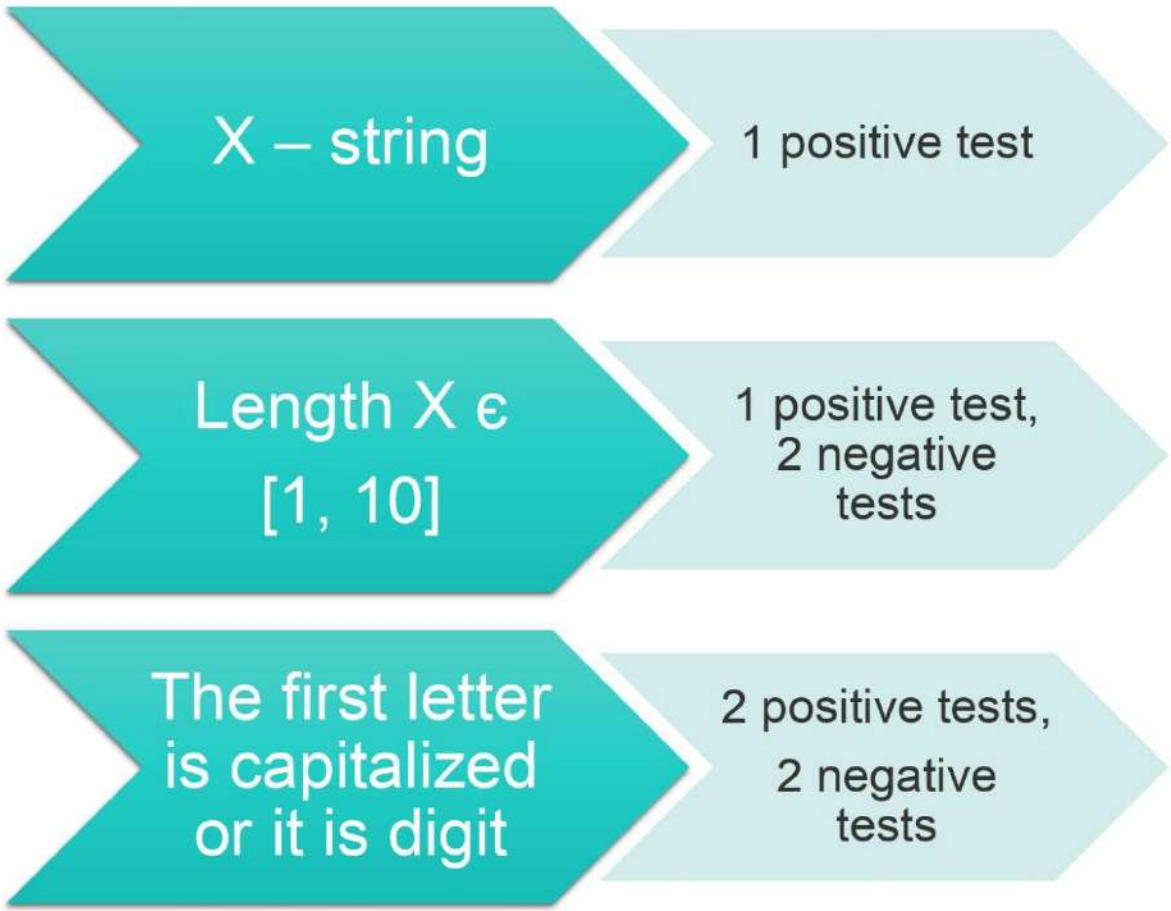

Superposition of conditions/parameters

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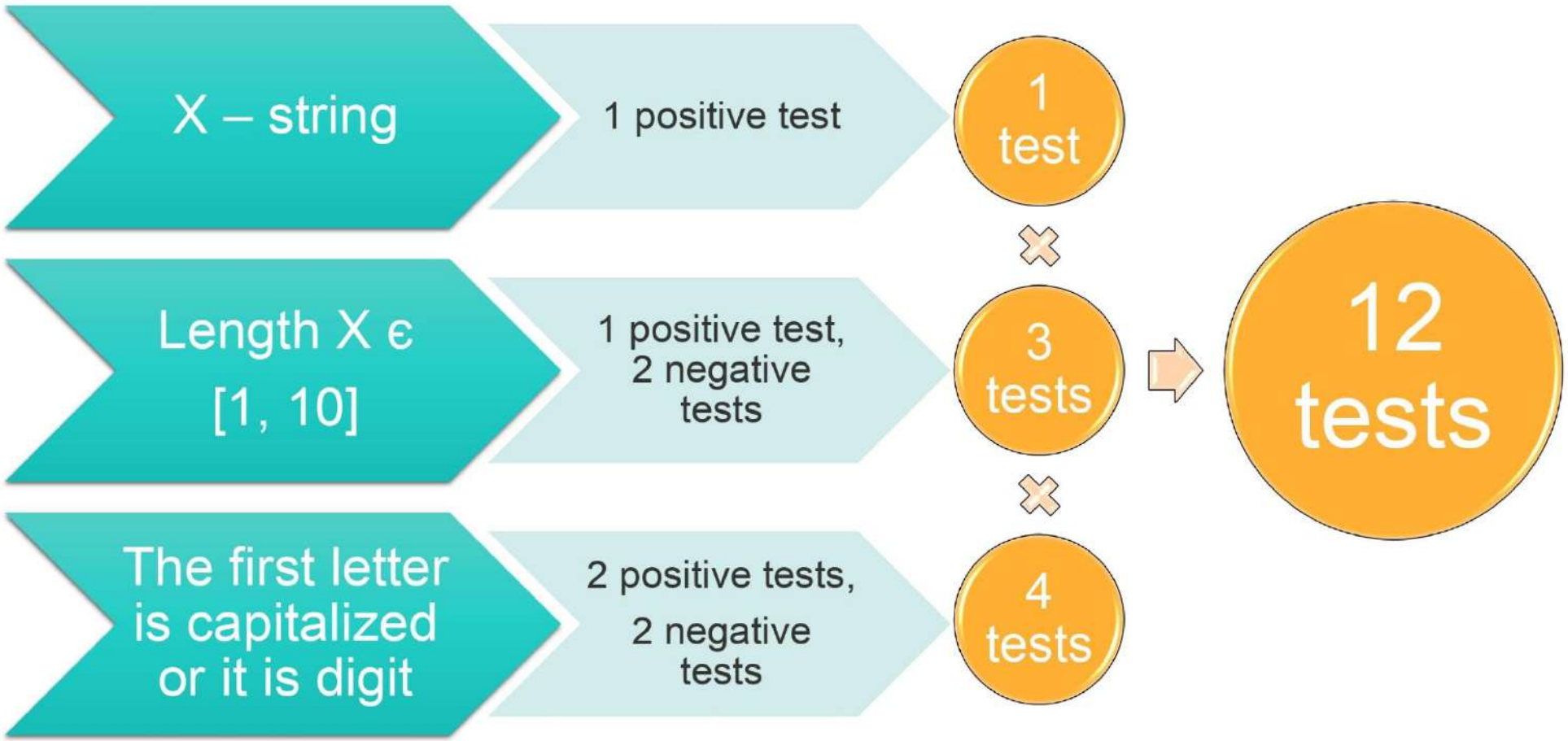

Combinatorial explosion

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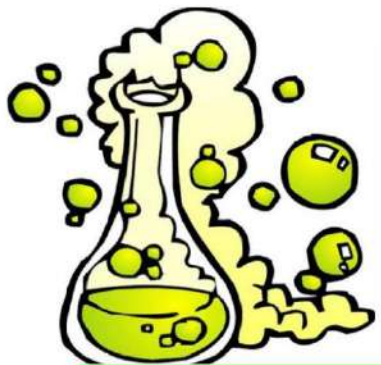
Classes for each condition



Superposition of conditions

Superposition of parameters

Exponential growth of test set

Combinatorial explosion

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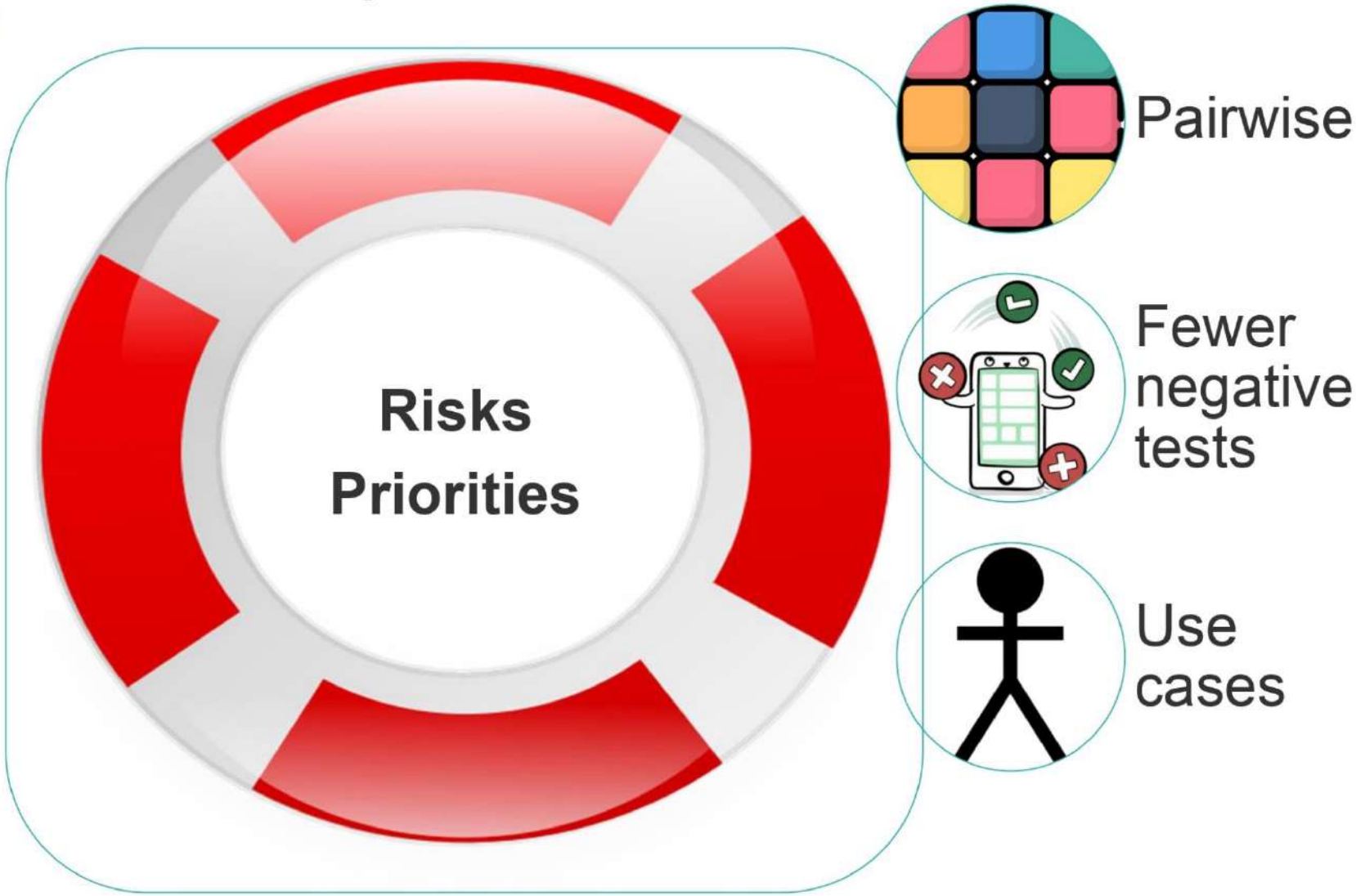
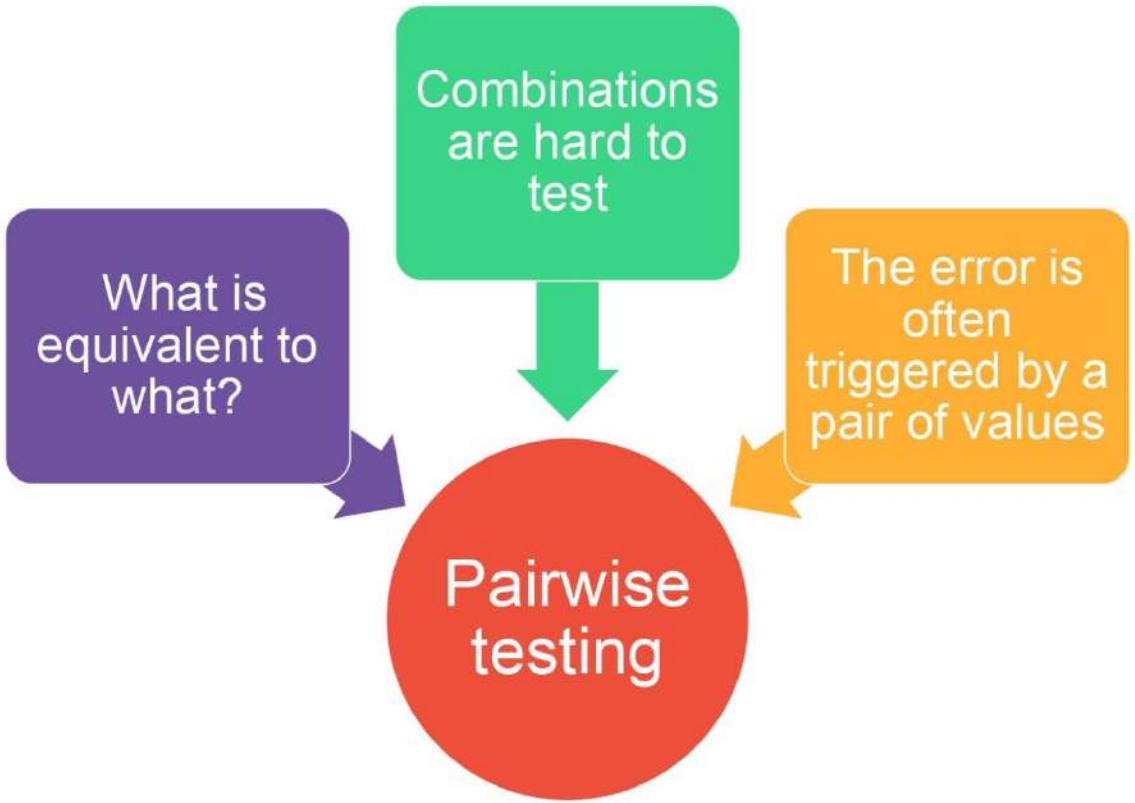
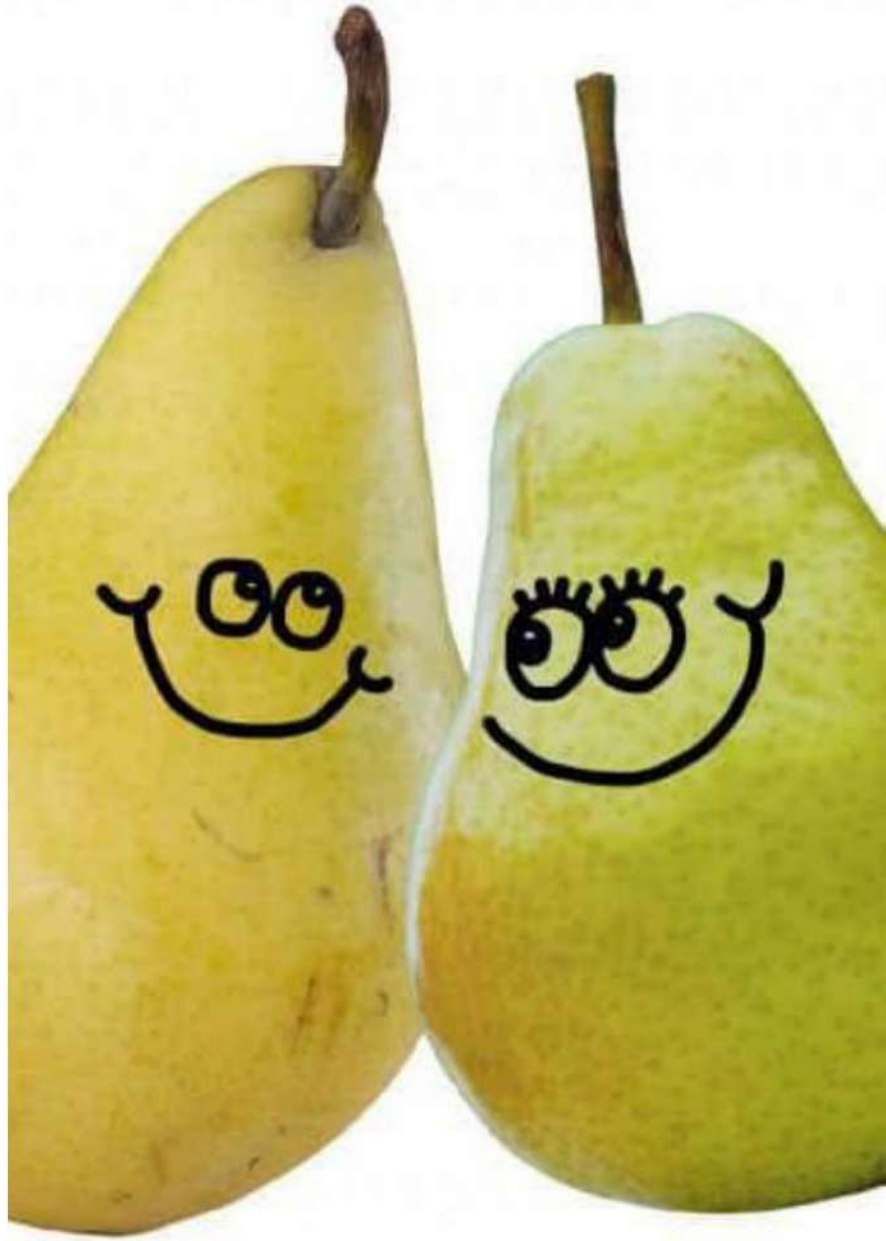


Pairwise testing

Base ideas


Combinations are hard to test
What is equivalent to what?
The error is often triggered by a pair of values
Pairwise testing



Example

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Flashlight mobile application

- ✓ works with iOS and Android
- ✓ has three brightness modes
- ✓ allows you to light constantly or flash in strobe mode.

Example

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	OS	Brightness	Light type
1	iOS	1	Constant
2	iOS	1	Strobe
3	iOS	2	Constant
4	iOS	2	Strobe
5	iOS	3	Constant
6	iOS	3	Strobe
7	Android	1	Constant
8	Android	1	Strobe
9	Android	2	Constant
10	Android	2	Strobe
11	Android	3	Constant
12	Android	3	Strobe

	OS	Brightness	Light type
1	iOS	1	Constant
2	iOS	2	Strobe
3	Android	2	Constant
4	Android	3	Constant
5	Android	1	Strobe
6	iOS	3	Strobe
7	iOS	2	Constant

How good does it work?

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Table 2. Fault classification for injected faults

Fault Type	LAS	DMAS
2-way	30	29
3-way	4	12
4-way	7	1
> 4-way	7	3
Not Found	34	43

D. M. Cohen, S. R. Dalal, M. L. Fredman, and G. C. Patton, "The AETG System: An Approach to Testing Based on Combinatorial Design," IEEE Transactions on Software Engineering, vol. 23, no. 7, pp. 437-444, 1997

Pros and cons of pairwise testing

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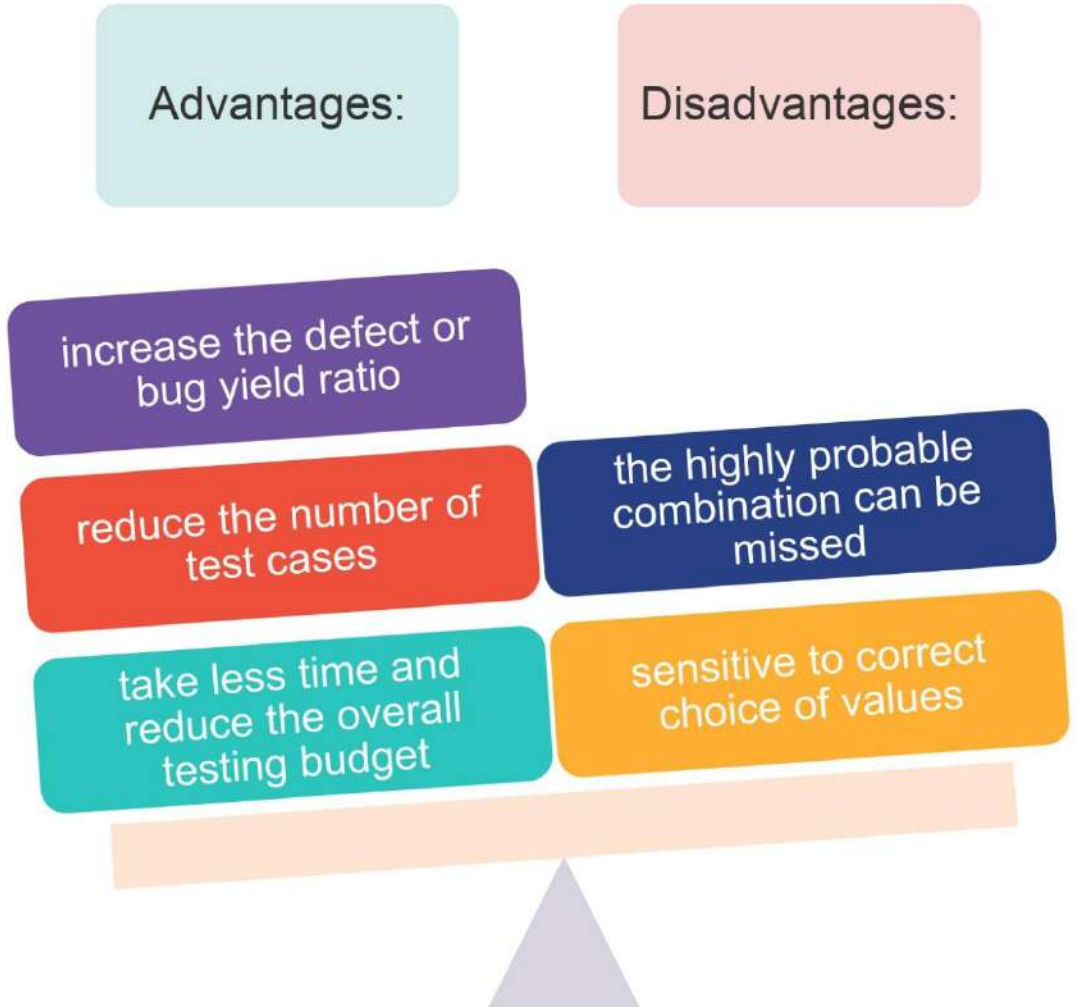

Pairwise tools

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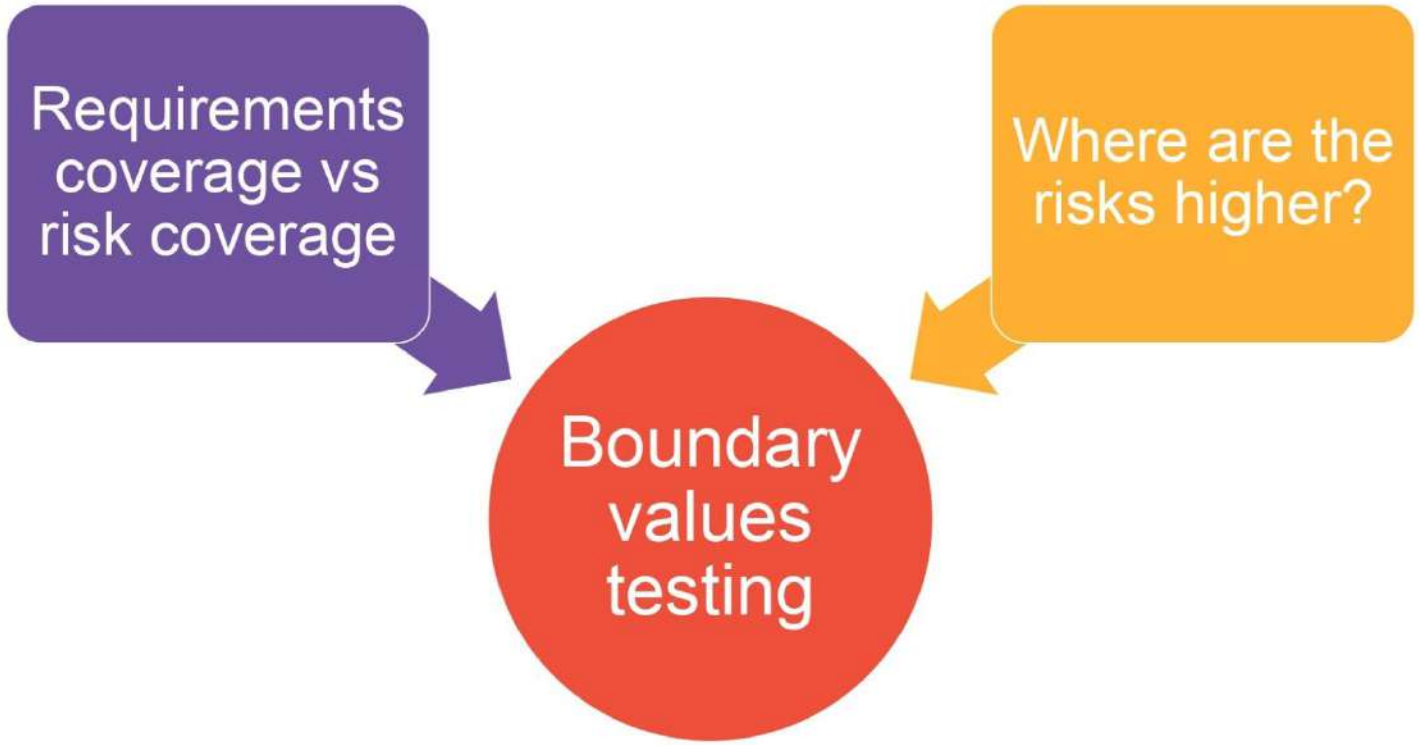
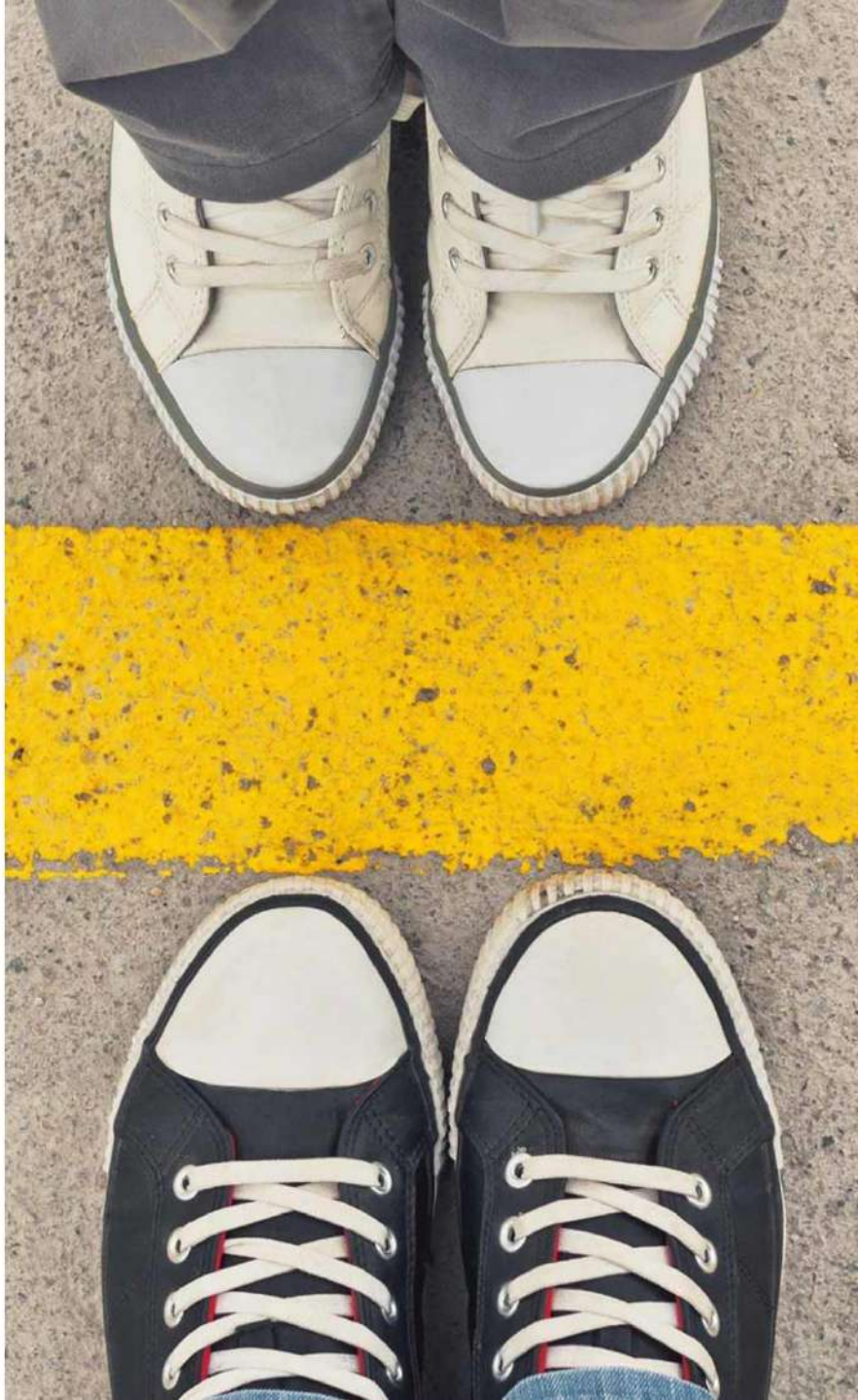
- ✓ **PICT** — *'Pairwise Independent Combinatorial Testing', provided by Microsoft Corp.*
- ✓ **IBM FoCuS** — *'Functional Coverage Unified Solution', provided by IBM.*
- ✓ **ACTS** — *'Advanced Combinatorial Testing System', provided by NIST, an agency of the US Government.*
- ✓ **Hexawise**
- ✓ **Jenny**
- ✓ **Pairwise** *by Inductive AS*
- ✓ **VPTag free All-Pair Testing Tool.**

Boundary Value Analysis

Base ideas


Requirements coverage vs risk coverage
Where are the risks higher?
Boundary values testing



What values are boundary?

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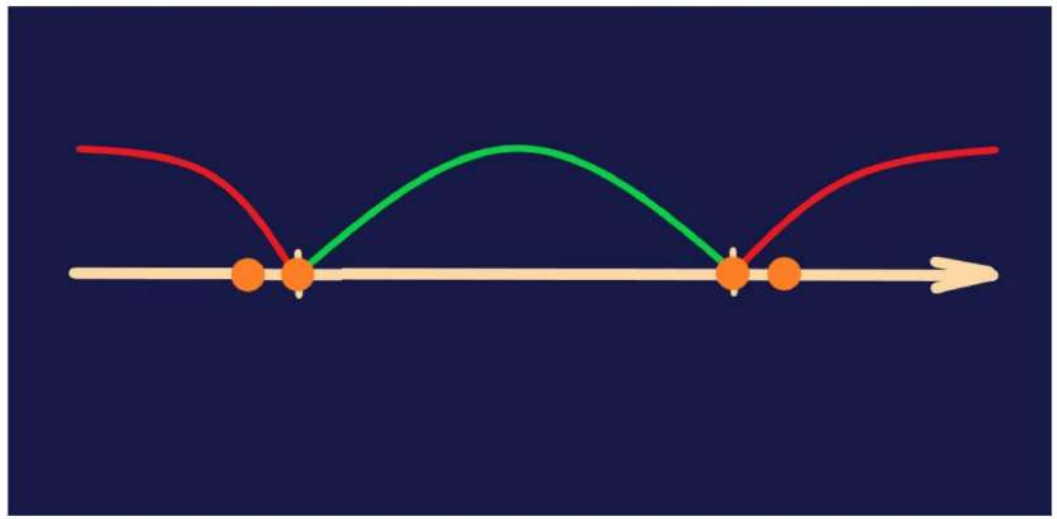

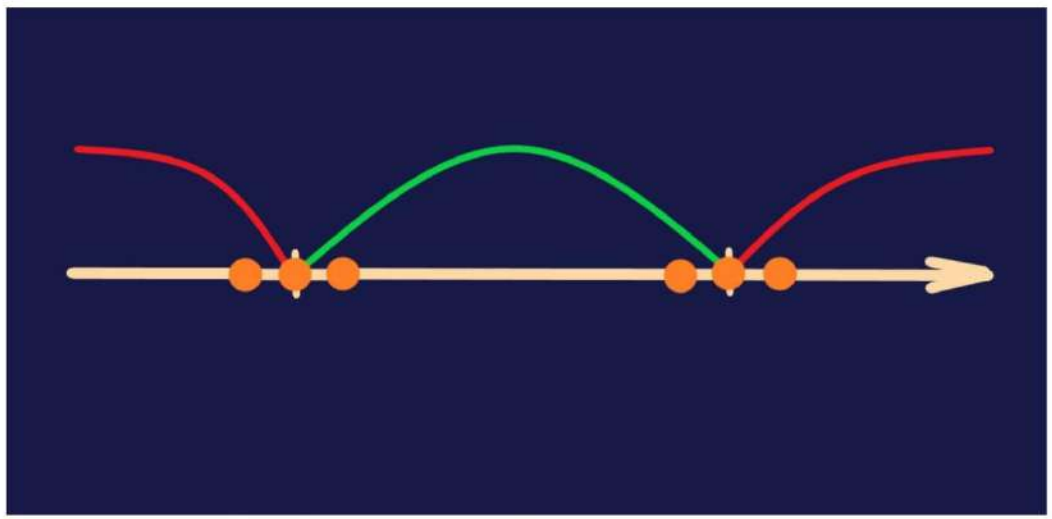

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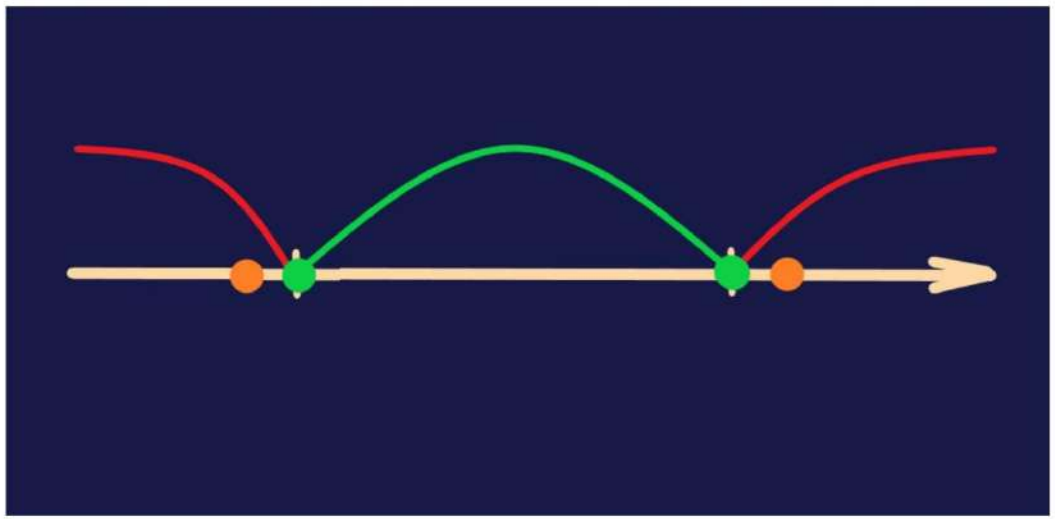

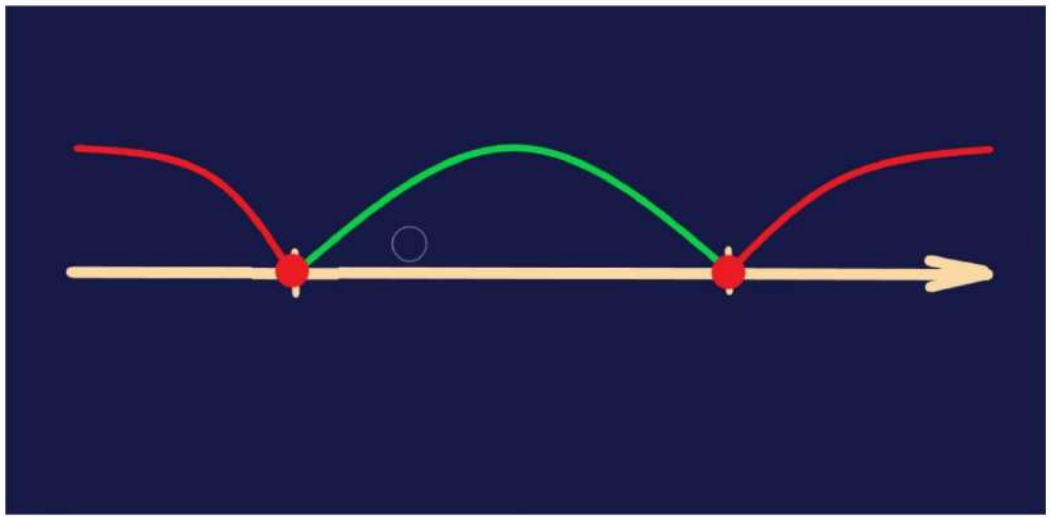

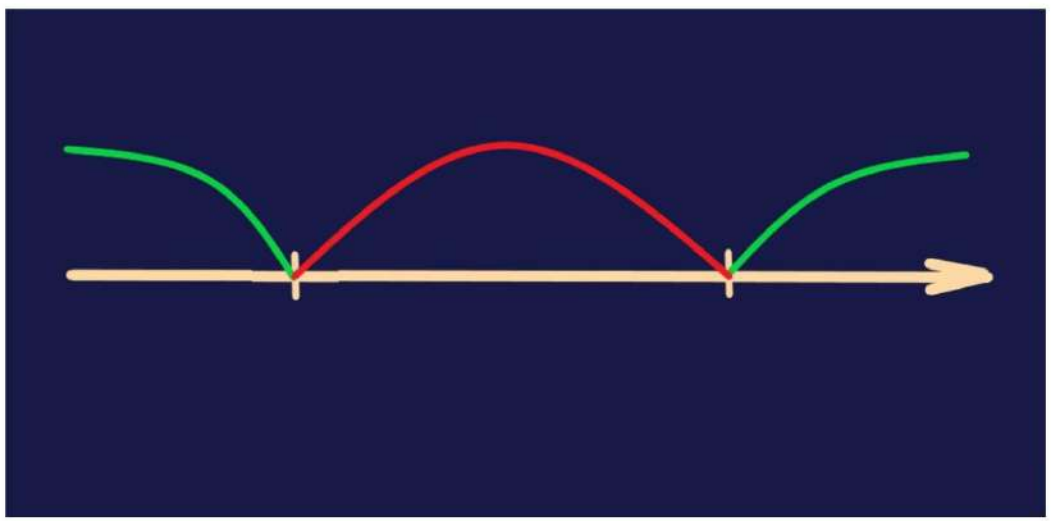

What values are boundary?

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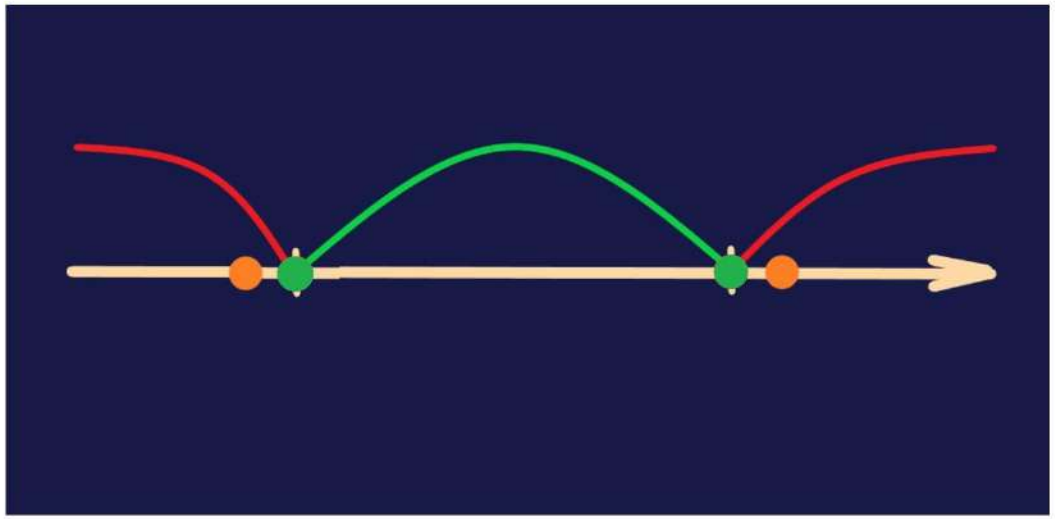

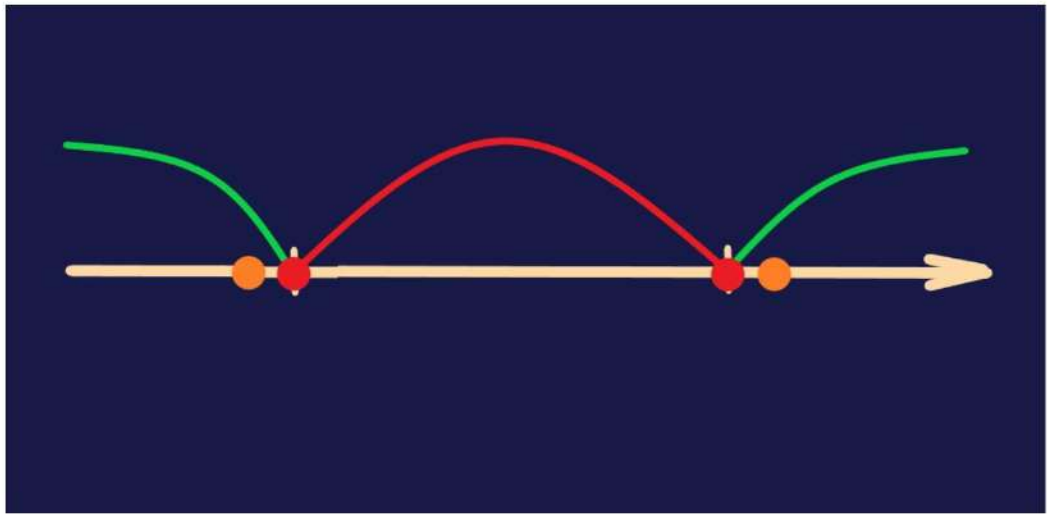

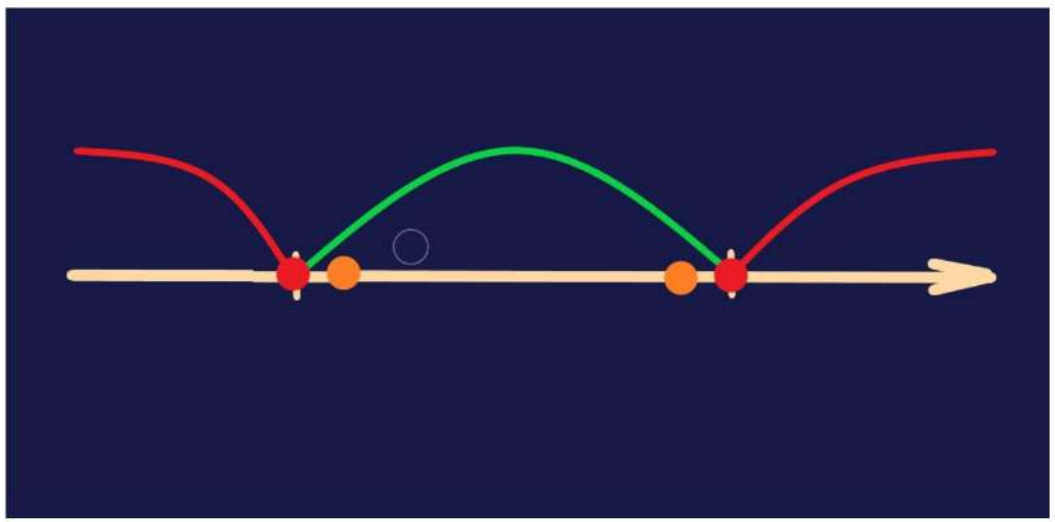

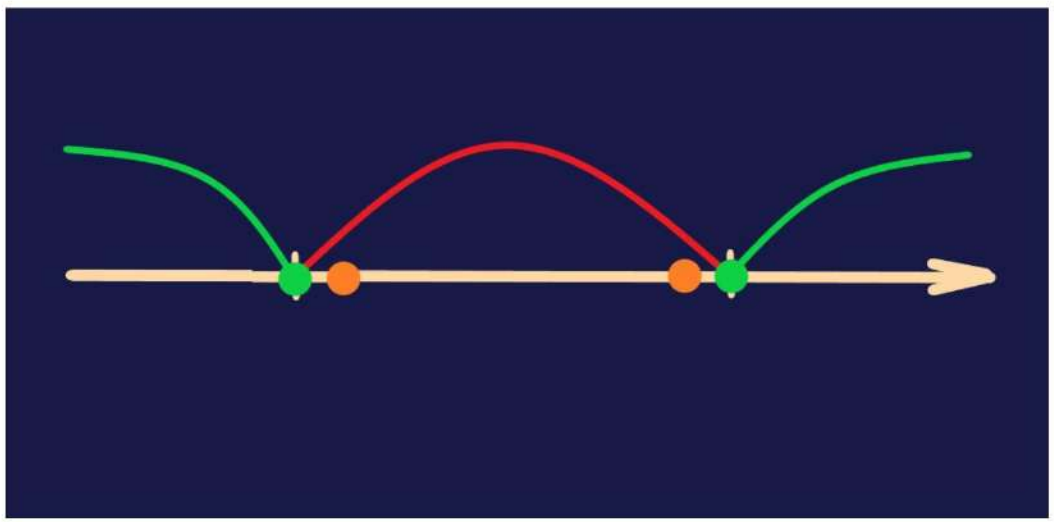

Above and below the minimum and maximum
What does it mean?

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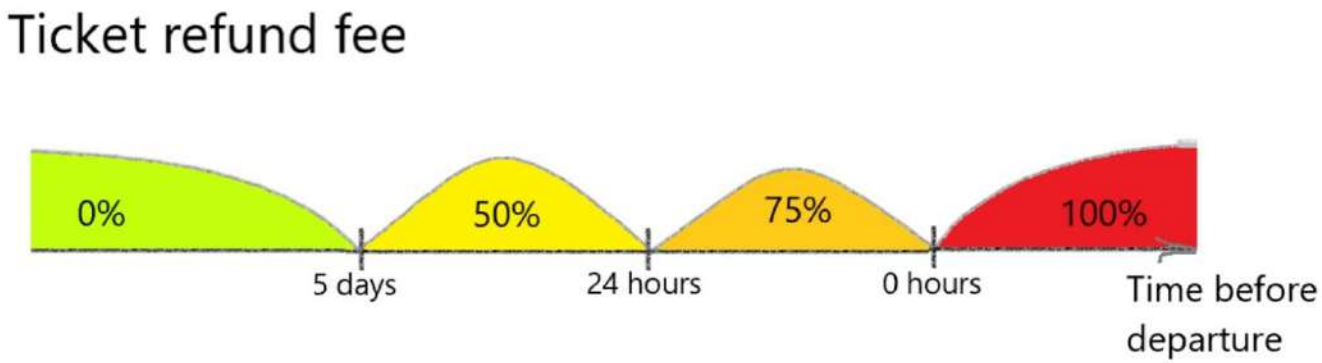


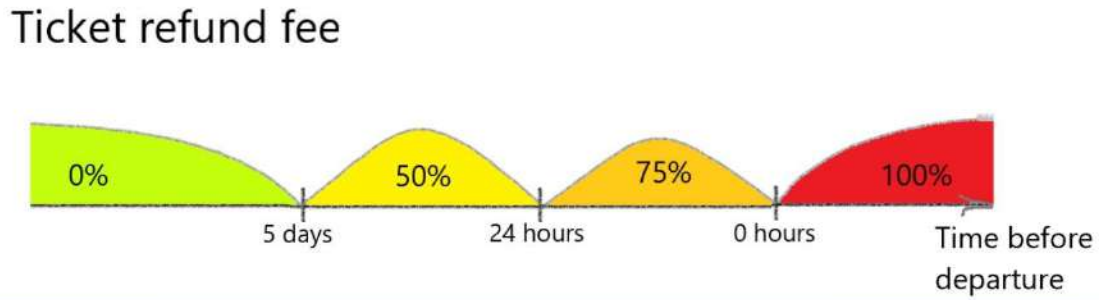
1 day?

1 hour?

1 minute?

1 second?

Example



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Detect equivalence classes			
t > 5 days	24 hours <= *t* <= 5 days	0 hours < *t* < 24 hours	*t* <= 0 hours

Detect boundary values		
5 days	24 hours	0 hours

Determine the class for each of boundary values		
2 class	2 class	4 class

Select the boundary values and closest to them in the adjacent class.					
5d +1s	5d	24ч	24h - 1s	1s	0

Run tests					
0%	50%	50%	75%	75%	100%

Boundaries – what is it?

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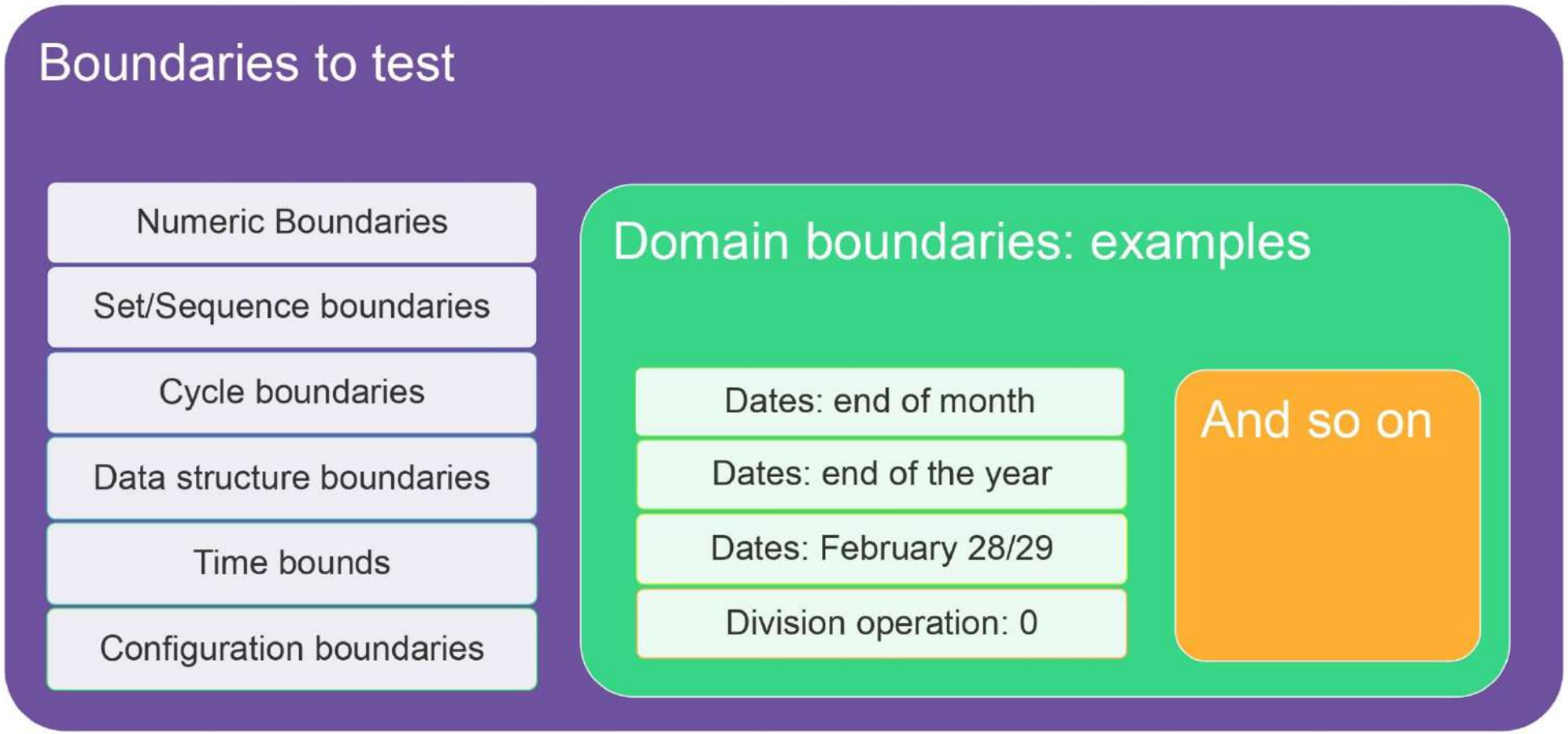

Compatibility testing – case for boundary values analysis

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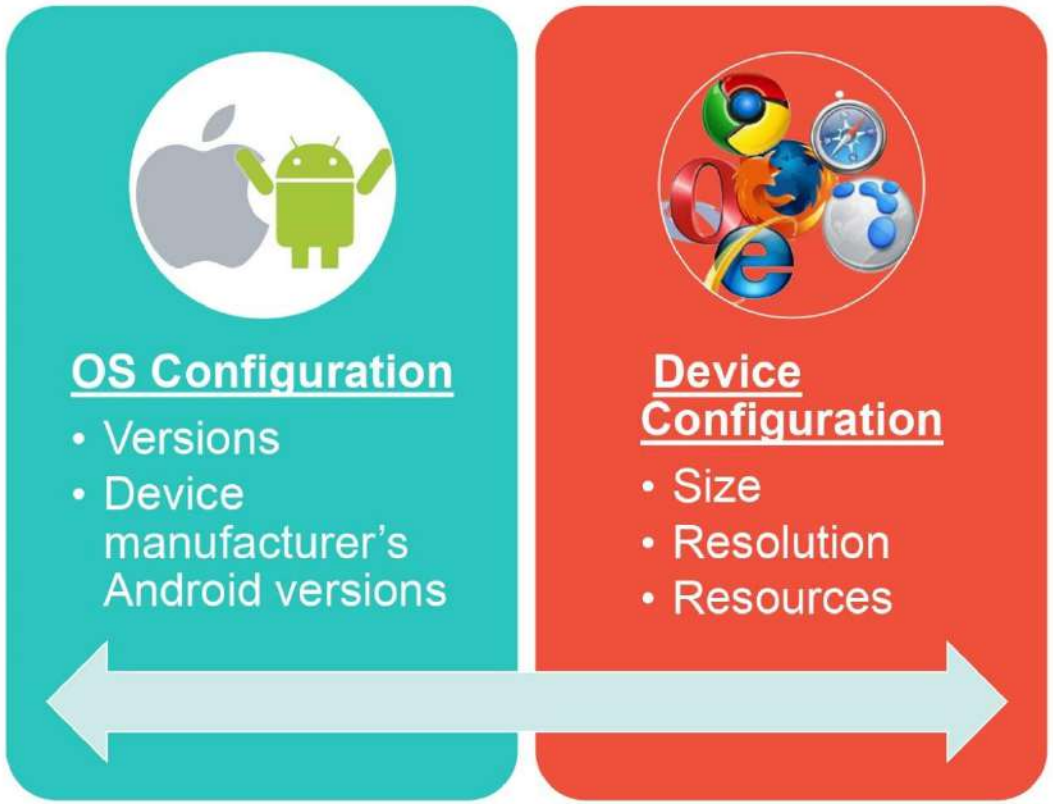

Questions

Thanks for attention!