IT-UNIVERSITY OF COPENHAGEN

INTELLIGENT SYSTEMS PROGRAMMING

Mandatory exercise 9

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1)

A point in n-dimensions has n numbers that indicate where it is located. In one dimension a point has the form (x), in two dimension (x, y), in three (x, y, z) and so on. A unit hypercube in n dimension has corner points in all permutations of the coordinates $(x, y, z...n)$ where the valid domain is $\{0, 1\}$.

The corner points for a 2-hypercube are therefore:

$$(0, 0), (0, 1), (1, 0), (1, 1)$$

and the corner points for a 3-hypercube are:

$$(0, 0, 0), (0, 0, 1), (0, 1, 0), (0, 1, 1), (1, 0, 0), (1, 0, 1), (1, 1, 0), (1, 1, 1)$$

The number of possible permutations for a point in n-dimensions where the valid domain is $\{0, 1\}$ is 2^n. A hypercube in n dimensions therefore has 2^n corner points as other hypercubes are just a scaled unit hypercube.

2)

Wikipedia defines a hypercube as: "a closed, compact, convex figure whose 1-skeleton consists of groups of opposite parallel line segments aligned in each of the space's dimensions, perpendicular to each other and of the same length[1]"

Therefore a 2-hypercube, a hypercube in two dimensions, has two pairs of parallel lines.

Example of line coordinates in a 2-hypercube where C_x is a constant and x and y are variables:
(C_1, y)
$(C_1 + 1, y)$
(x, C_2)
$(x + 1, C_2)$

Example of line coordinates in a 3-hypercube where C_x is a constant and x, y and z are variables:

1. (C_1, C_2, z)
2. $(C_1 + 1, C_2, z)$
3. $(C_1, C_2 + 1, z)$
4. $(C_1 + 1, C_2 + 1, z)$
5. (C_1, y, C_3)
6. $(C_1 + 1, y, C_3)$
7. $(C_1, y, C_3 + 1)$
8. $(C_1 + 1, y, C_3 + 1)$

[1] https://en.wikipedia.org/wiki/Hypercube

9. (x, C_2, C_3)
10. $(x, C_2 + 1, C_3)$
11. $(x, C_2, C_3 + 1)$
12. $(x, C_2 + 1, C_3 + 1)$

3)

4)