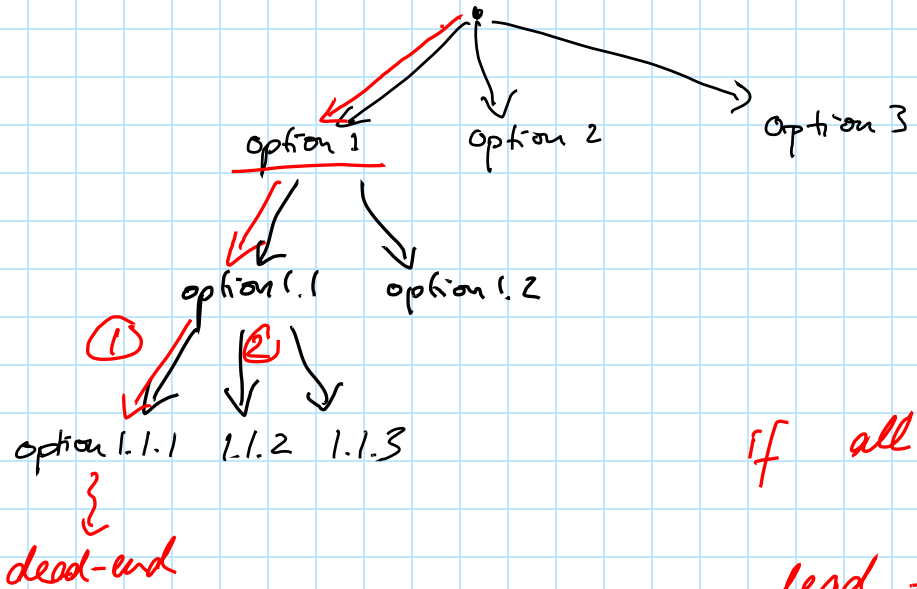
CS 340 – lecture 33 – Dec 02

6.5 Backtracking

assume an algorithm constructs a solution in stages;

at every stage there are several options

idea:
- choose any option and proceed until reaching a "dead-end".
- then "back-track" to the point where the most recent choice was made
- mark this choice as "dead-end" and pick alternate choice



if all of 1.1.1, 1.1.2, 1.1.3 lead to dead-ends, mark 1.1 as dead-end check 1.2 next

⇝ cf. DFS !

- use this technique if solutions can be considered as extending "partial solutions" and when you can quickly check for dead-ends
- marking a branch as "dead-end" is called pruning.

Example 54 Sudoku.

Example 55 Turnpike Reconstruction Problem

(application in reconstruction of DNA sequences)

given: a multi-set of distances

$$D = \{ d_1, d_2, \dots, d_z \}$$

(multi-set = set with repetitions / multiplicities of elements)

where $z = \frac{N(N-1)}{2}$ for some N

$= \binom{N}{2}$

task: find N numbers $x_1, \dots, x_N \in \mathbb{R}$ such that D is the multi-set of distances between two numbers x_i, x_j, for all i, j, $1 \le i < j \le N$.

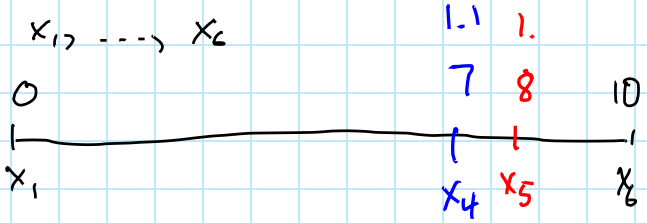
always set $x_1 = 0$, $x_1 < x_2 < x_3 < \dots < x_N$.

Example 56

e.g., $D = \{1, 2, 2, 2, 3, 3, 3, 4, 5, 5, 5, 6, 7, 8, 10\}$

$z = |D| = 15 = \frac{6 \cdot 5}{2}$ $\rightsquigarrow N = 6$

$\rightsquigarrow$ goal. find 6 "points" $x_1, \dots, x_6$



$x_1 = 0$

$\downarrow d_z = 10$

$x_6 = 10$

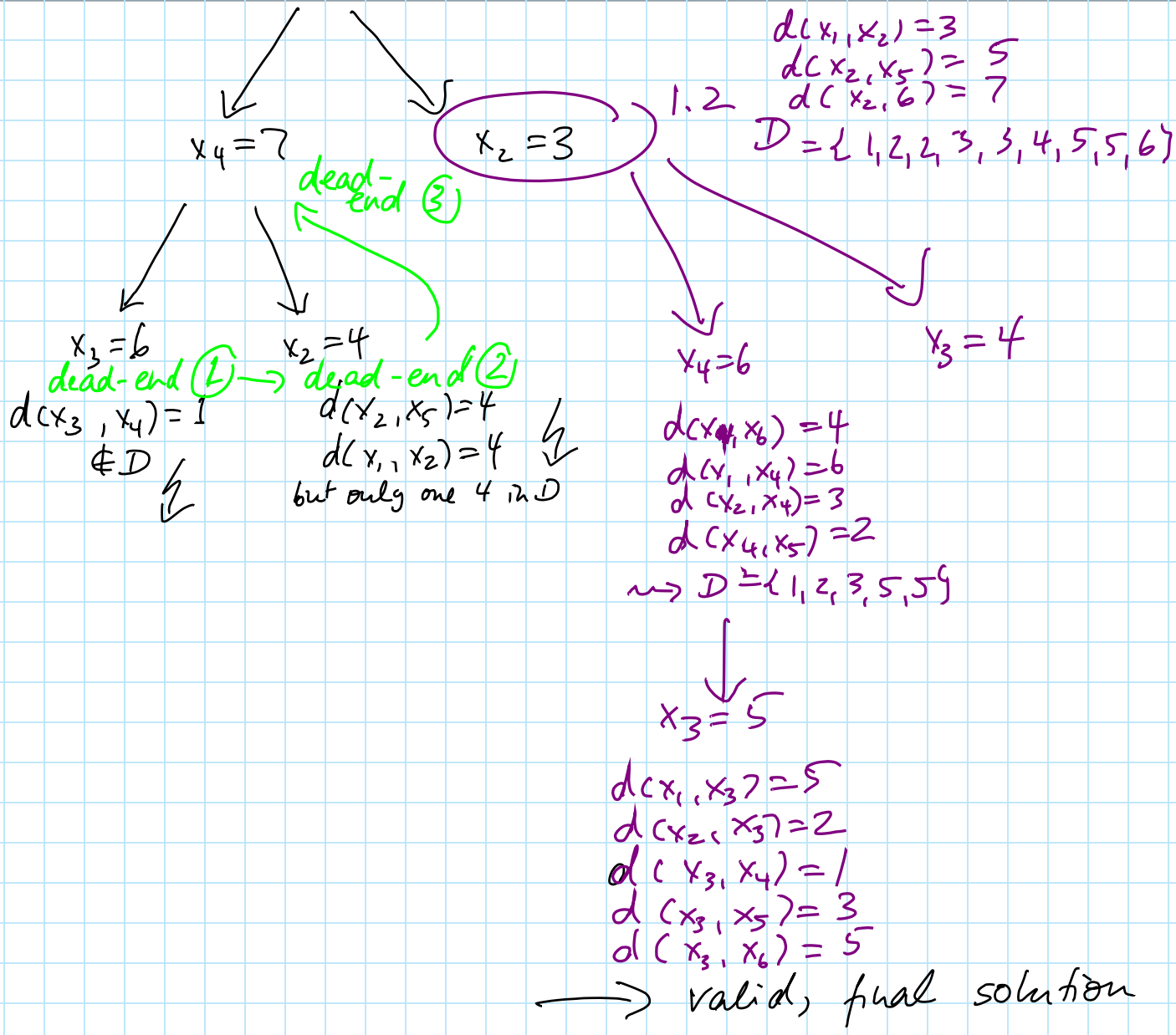
$d(x_5, x_1) = 8$

$d(x_5, x_6) = 2$

$D = \{1, 2, 2, 3, 3, 3, 4, 5, 5, 5, 6, 7\}$

$d_{z-1} = 8$ $\quad$ $d_{z-1} = 8$

$x_5 = 8$ $\quad$ $x_2 = 2$



$\rightsquigarrow$ solution $(x_1, x_2, x_3, x_4, x_5, x_6) = (0, 3, 5, 6, 8, 10)$