9/3/23 <u>How do you do optimization on a computer</u>;

It is slightly different from what we do with our hand

How to write it as a program?

Forward methods, central difference

~~Given a point, whether ...~~

- Find min of J(w)
- First, a crude approach to find bounds (2 values where you select to get a minimum

This is called <u>bracketing approach</u>

- use a more sophisticated method to find min

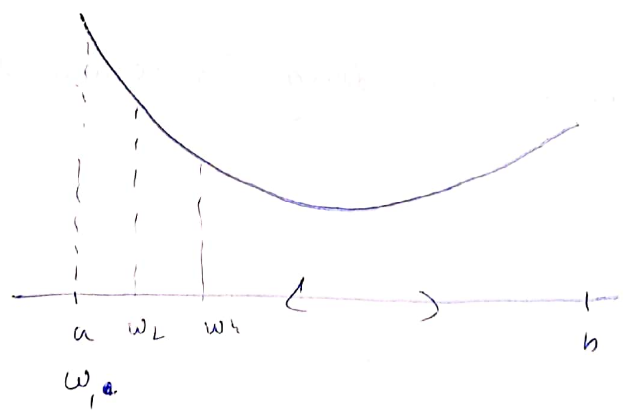
In general:

- ID initial guess & function values
- Make appropriate guess for w & change its dirn. correspondingly

- Bracketing method:
  - Exhaustive search
  - Bounding phase
- Region elim approach
  - interval halving
  - fibbo search
  - golden search ratio
- Gradient based ones
  - Newton Raphson
  - Bisection
  - Secant

Exhaustive search method

- Let n be no. of intermediate points



Take a & b & ~~and~~ divide into n equal parts

We hope that between some 2 values, we get a minima

Step 1: $\Delta w_0 = \frac{b-a}{n}$

$w_1 = a, \quad w_2 = w_1 + \Delta w, \quad w_3 = w_2 + \Delta w$

a & b are the initial guesses. We are doing a coarse approximation. We aren't even looking at 10^{-5} or 10^{-6} precision

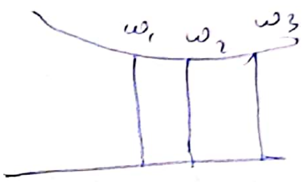
Once we bracket, we will perform some other method,

- Step 2:

$J(w_1) \geq J(w_2) \leq J(w_3)$, then

min lies between w_1 & w_3.

We don't take w_2 as it can be on either side of minima.



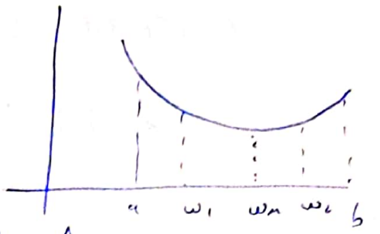
- Else:
  - $w_1 = w_2$, $w_2 = w_3$, $w_3 := w_2 + \Delta w$
  - Go to step 3

- Step 3:
  - Is $w_3 \leq b$, then go to step 2
  - otherwise, no min between a & b
  - Min could be the boundary point too

We can approach minima by doing this recursively.

Region Elimination method.

Overall idea



- $w_1 \leq w_2$, if $J(w_1) \geq J(w_2)$
- Remove region (a, w_1)

we get a & b from bounds of exhaustive search / some initial value of a & b

Step 1

- choose a, b, $w_m = \frac{a+b}{2}$,

Step 2

Set : $w_1 = a + \frac{L}{4}$, $w_2 = b - \frac{L}{4}$ [4 parts)

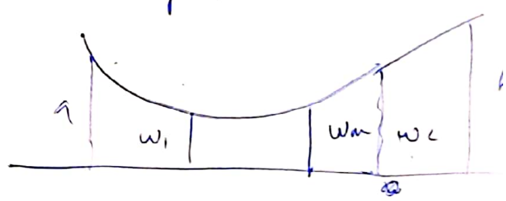
Step 3 . • If $J(w_1) < J(w_m)$, then it is within (a, w_m).

Remove $(w_m - b)$

ie Set $b \to w_m$, go to step 5.

$w_m \to w_1$

$a \to a$



- Else
  - go to step 4

Step 4 :

- If $J(w_2) < J(w_m)$

Definitley not between a & w_m

- Set

$a \to w_m$

$w_m \to w_2$

$b \to b$

go to step 5

- Else :
  - $a = w_1$, $b = w_2$,

  goo to step 5

Step 5:

- Calculate $L = b - a$
    - If $|L| < \varepsilon$
        - Terminate
    - Else
        - goto step 2