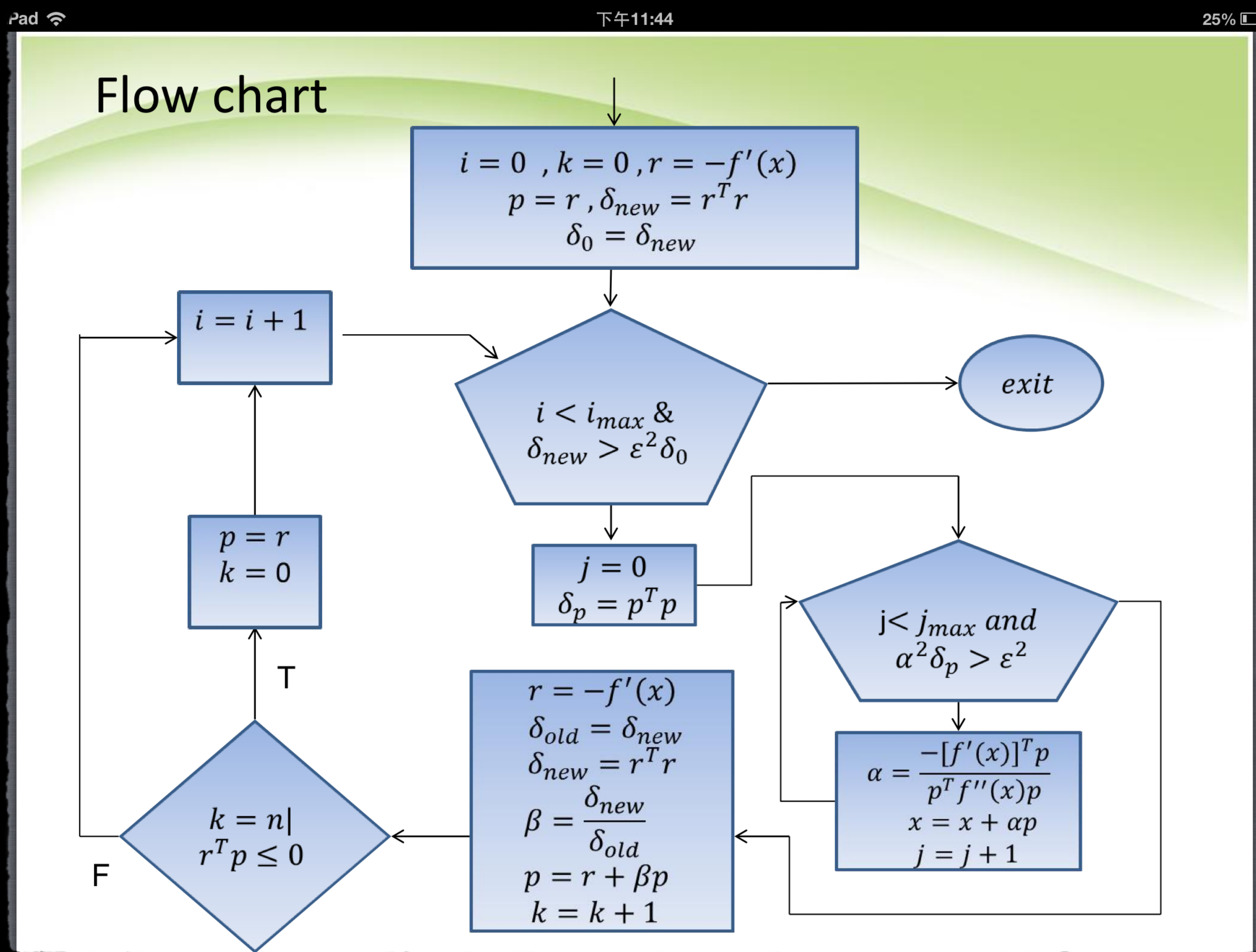


Implementation of Nonlinear CG method

Expansion at x =b

Root at b
The second term is zero

$$f(x) \approx f(b) + f'(b)(x-b) + \frac{f''(b)}{2}(x-b)^2$$

Root at x=b

The third term is negligible for some positive small ε if

$$\frac{1}{2} f''(b)(x-b)^2 < \varepsilon \cdot f(b)$$

$$\text{or } (x-b)^2 < 2\varepsilon \frac{f(b)}{f''(b)}$$

$$\frac{|x-b|}{b} < \sqrt{\varepsilon}\sqrt{\frac{2|f(b)|}{b^2 f''(b)}}$$

Halting condition

The reason for writing the inequality in this way is that the left hand side is the relative error in , and that for most functions, the final square root is a number of order unity.

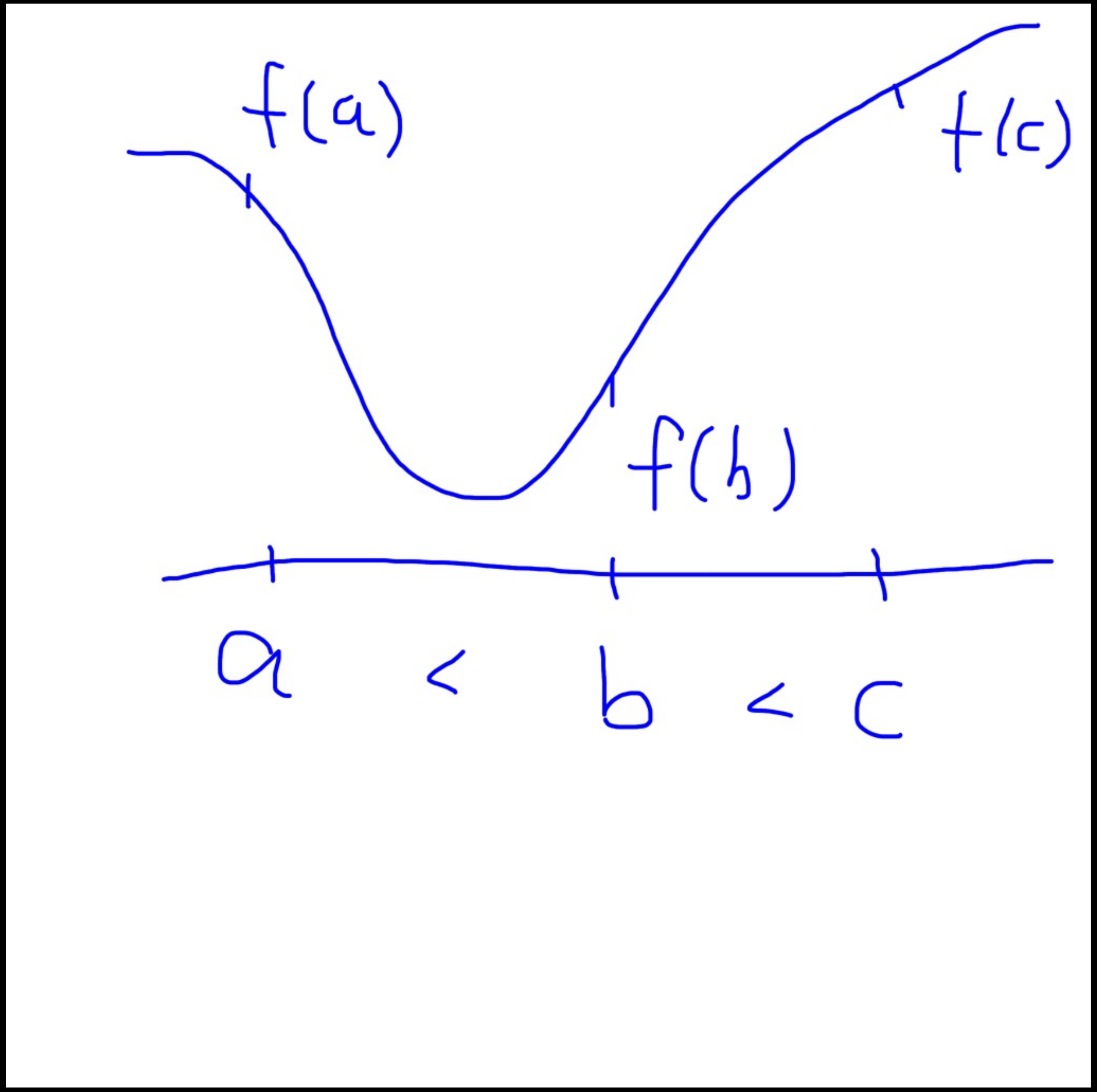
Therefore, as a rule of thumb, it is hopeless to ask for bracketing with a width of less than $\sqrt{\varepsilon}$. Knowing this inescapable fact will save you a lot of useless bisection!

Choose a new x

- a,b and c define a bracket
- $$\frac{b-a}{c-a}=W$$

  $$\frac{c-b}{c-b}=1-W$$

  $$\frac{x-b}{c-a}=Z$$

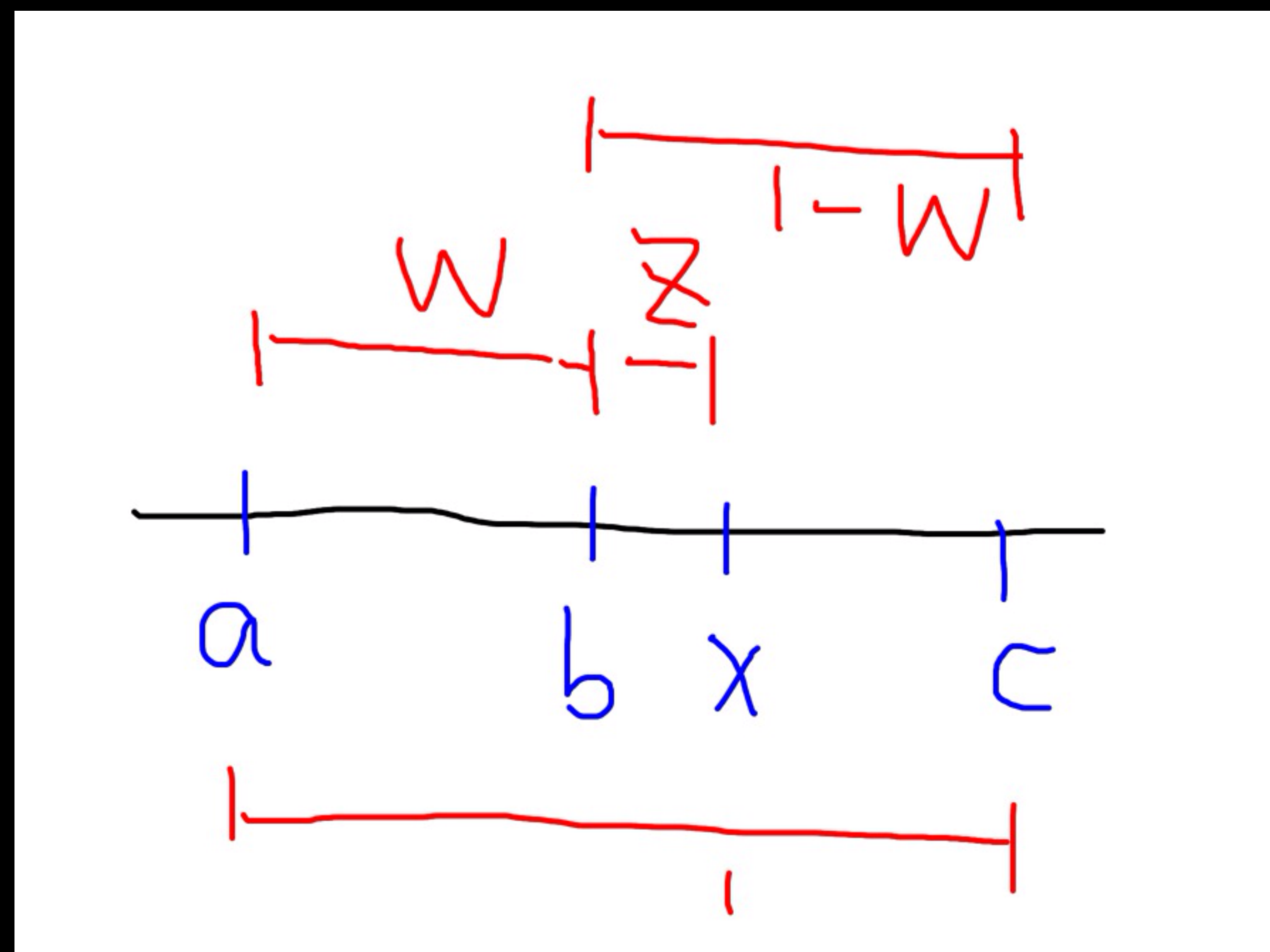


Next two intervals

- The length of the next bracket will be W+Z or 1-W

$$W + Z = 1 - W$$

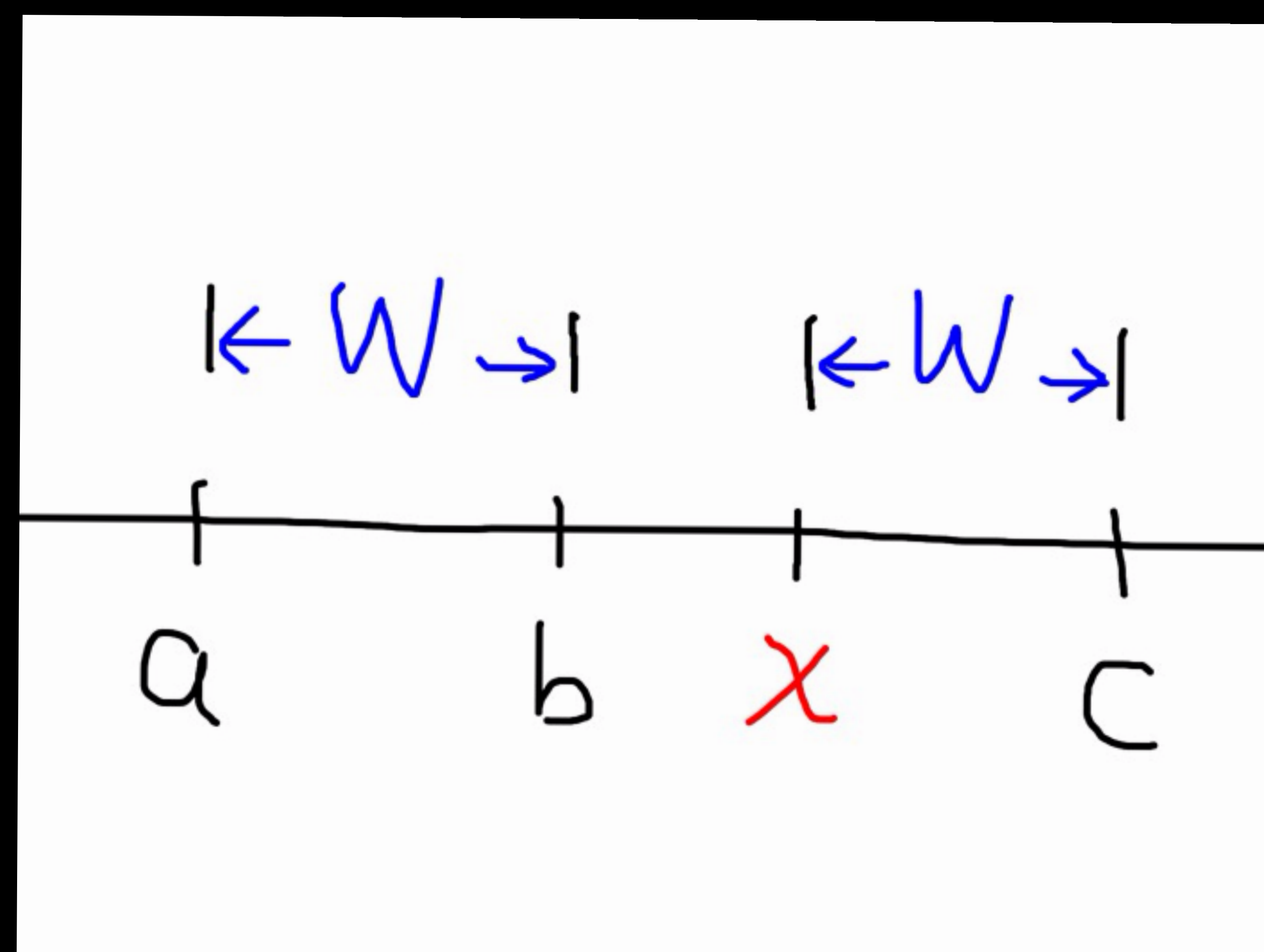
$$Z = 1 - 2W$$



Choose a new x

the new point is the symmetric point to b in the interval, namely with |b-a| equal to |c-x|.

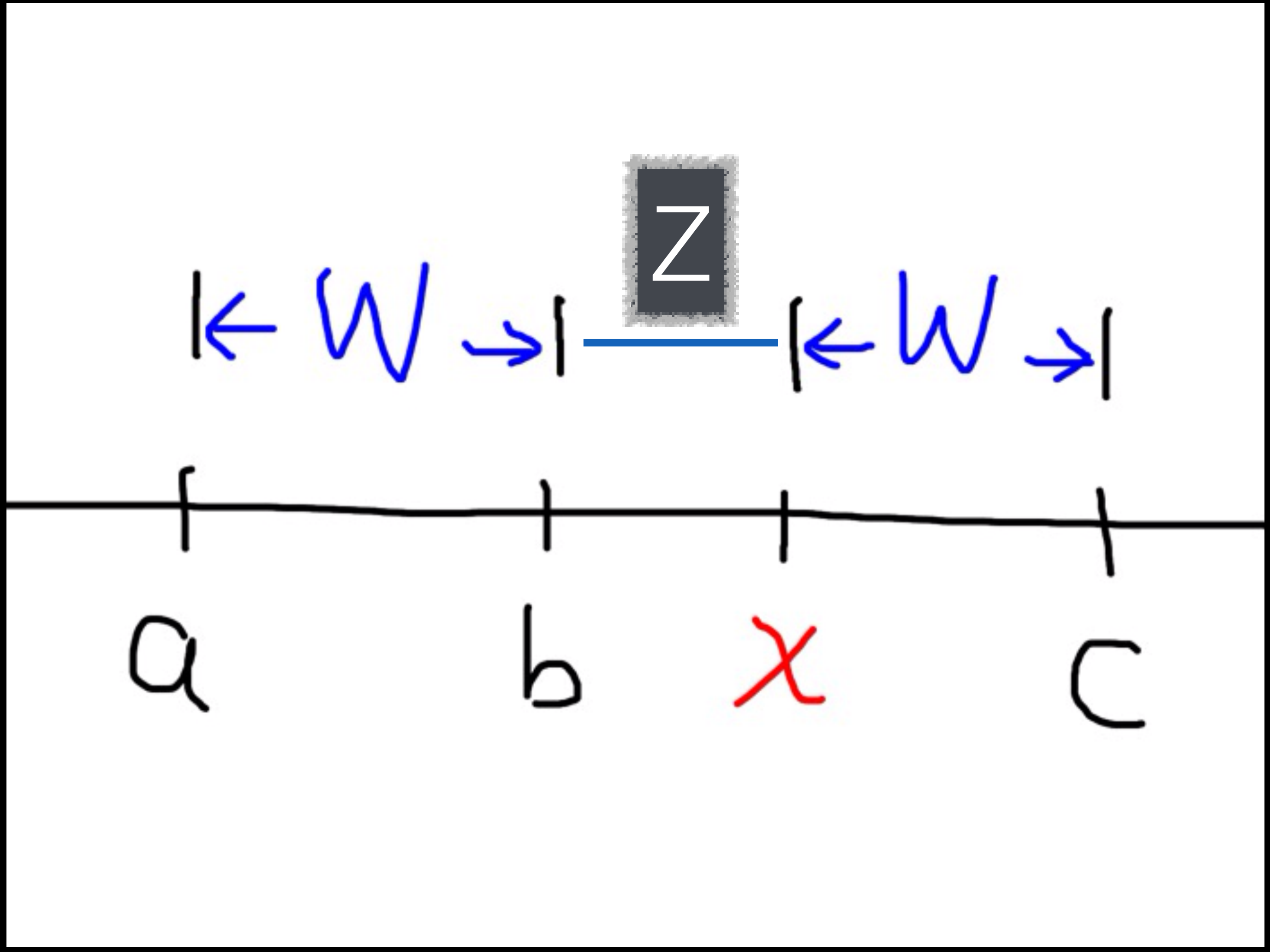
W < 1/2
X lies on the larger segment



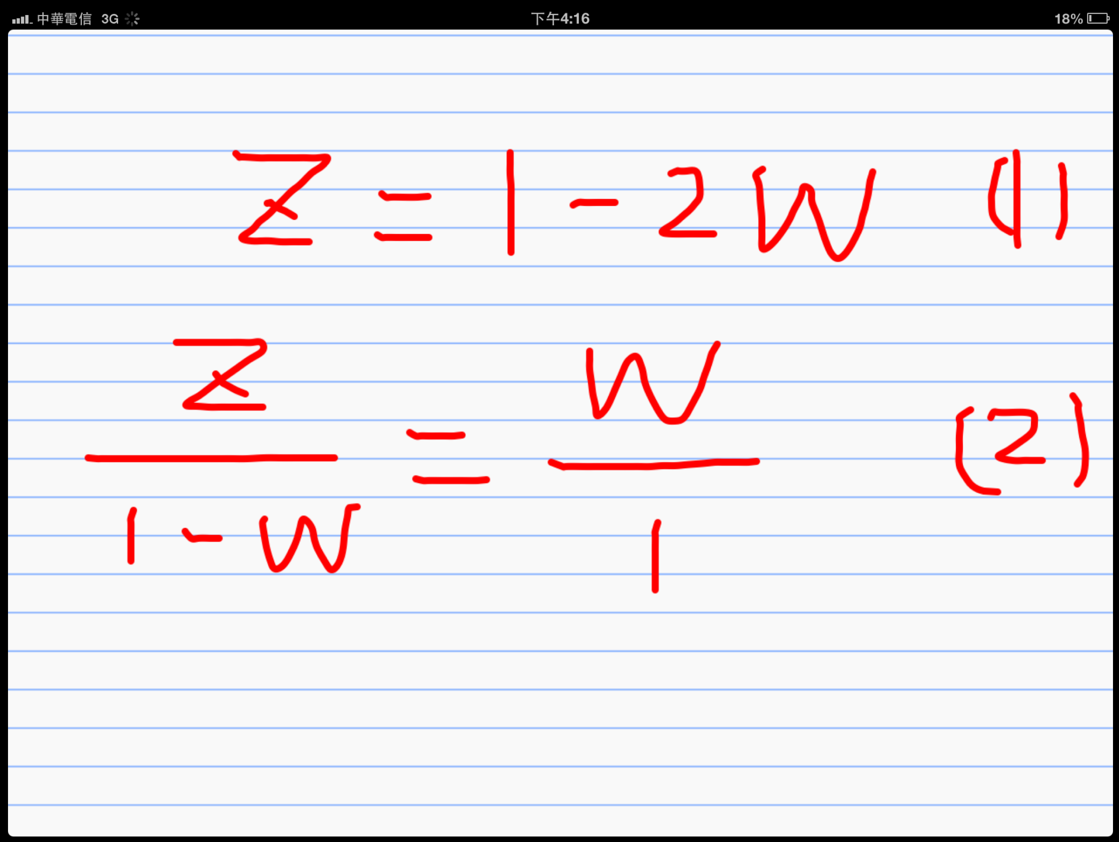
To maintain a constant ratio

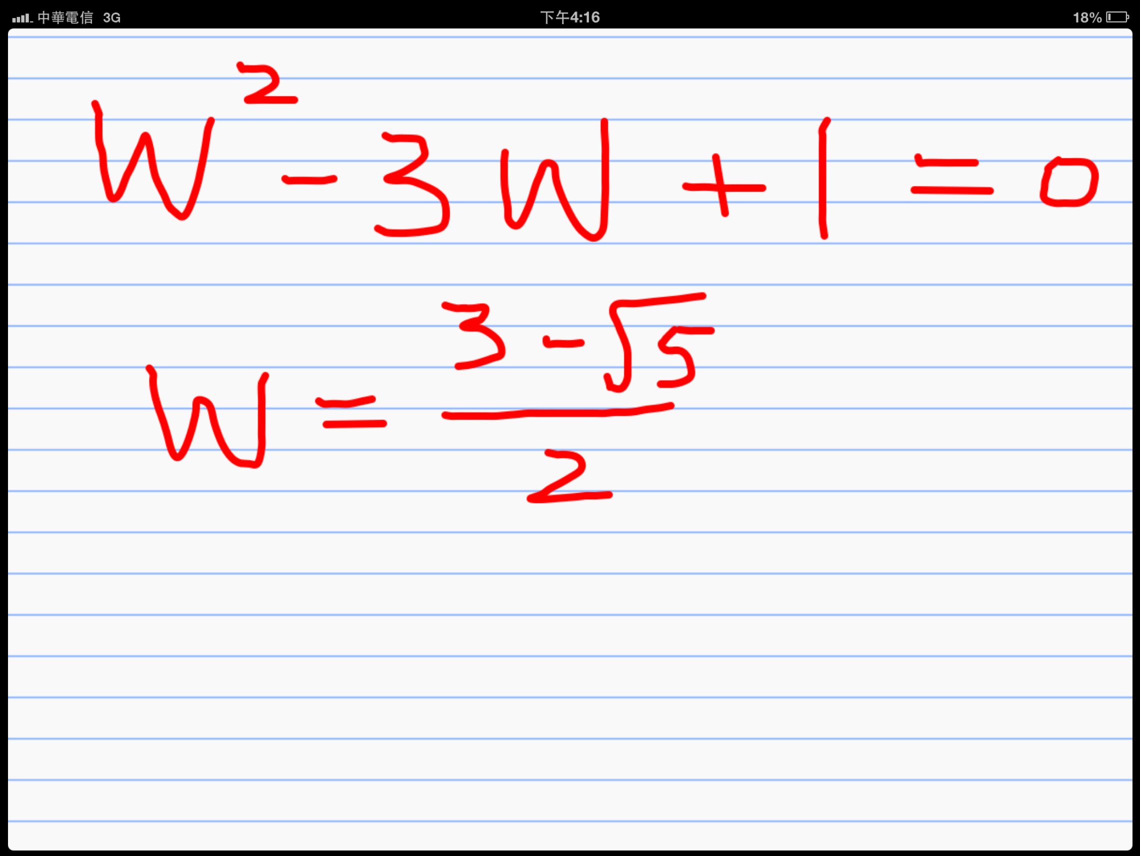
- The next bracket will be in length of 1-W
- a,b,x or b,x,c

$$\frac{Z}{1-W} = \frac{W}{1}$$

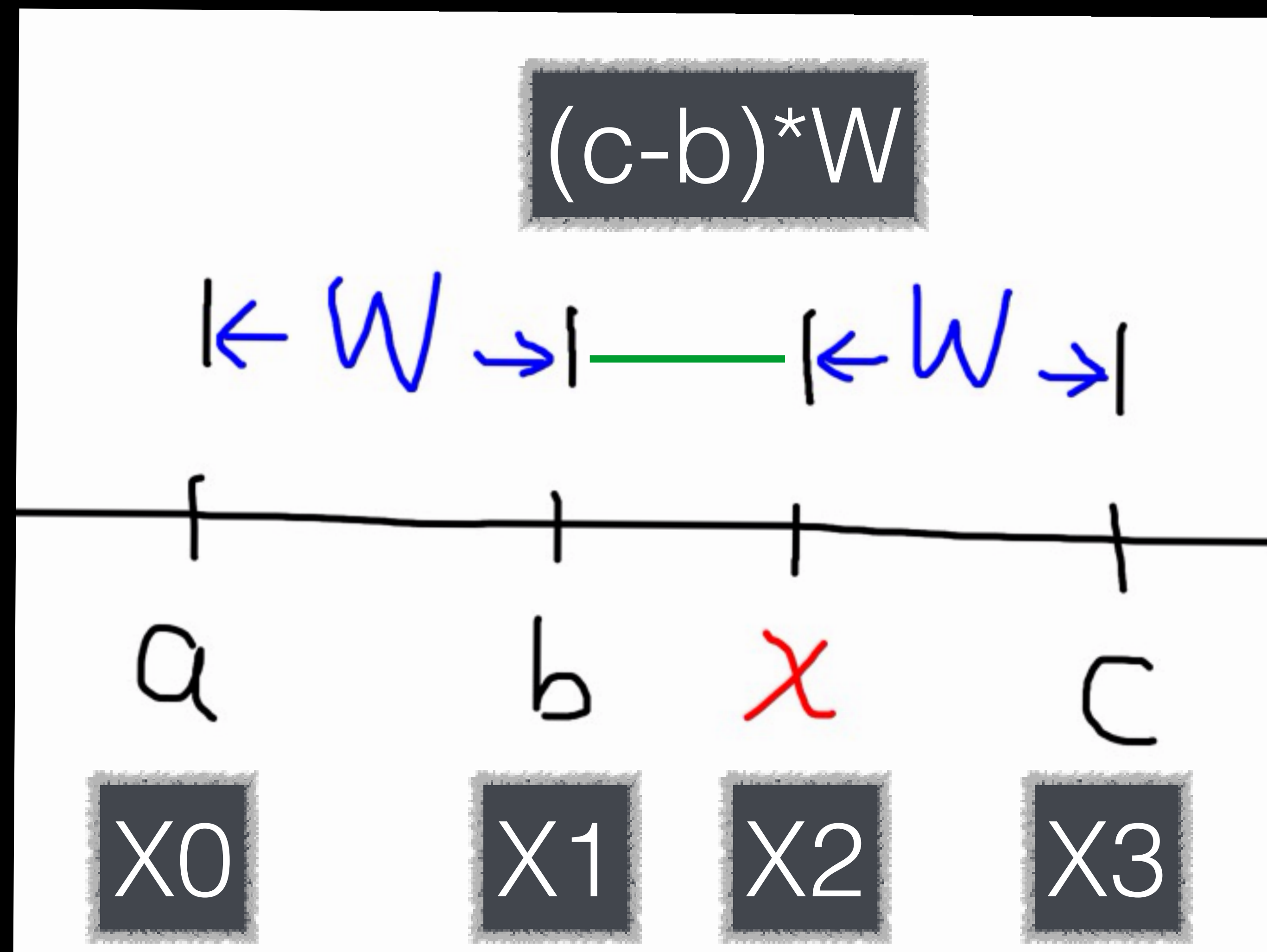


Why golden ratio?

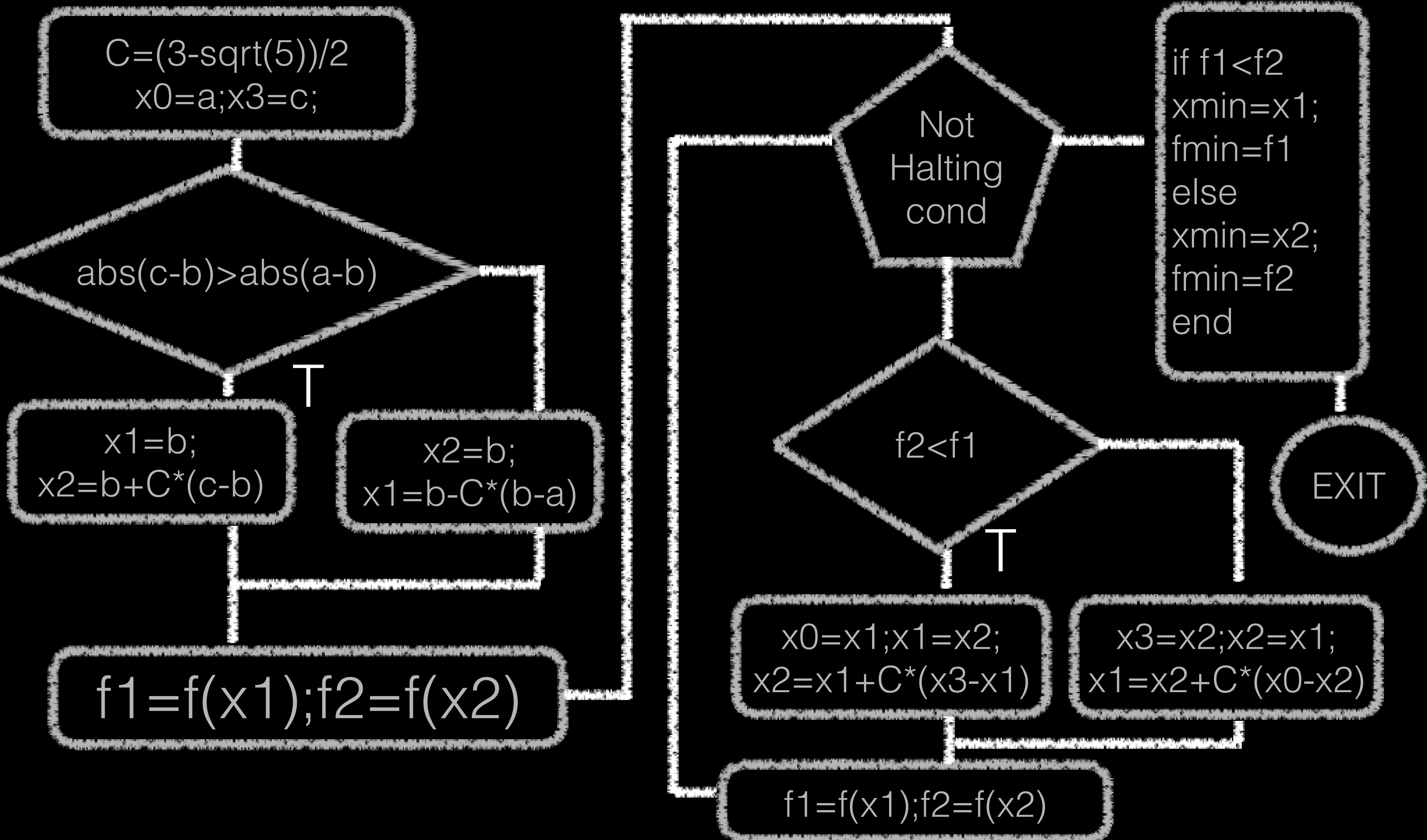




Setting



function Brent (a,b,c,f)



Halting condition

```
abs(x3-x0)>
tol(abs(x1)+abs(x2))
```

Parabolic interpolation

- A quadratic polynomial that passes (a fa), (b fb) and (c fc)
- Find the minimum

How to select x

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$(a\ fa),\ (b\ fb),\ (c\ fc)$

$$x = b - \frac{1}{2}\,\frac{(b-a)^2[fb-fc] - (b-c)^2[fb-fa]}{(b-a)(fb-fc) - (b-c)[fb-fa]}$$

Quadratic polynomial

A linear combination of three Lagrange polynomials

$$f(x) = f_a \frac{(x-b)(x-c)}{(a-b)(a-c)} + f_b \frac{(x-a)(x-c)}{(b-a)(b-c)} + f_c \frac{(x-a)(x-b)}{(c-a)(c-b)}$$

Find the minimum

- Set zero to the interpolating quadratic polynomial

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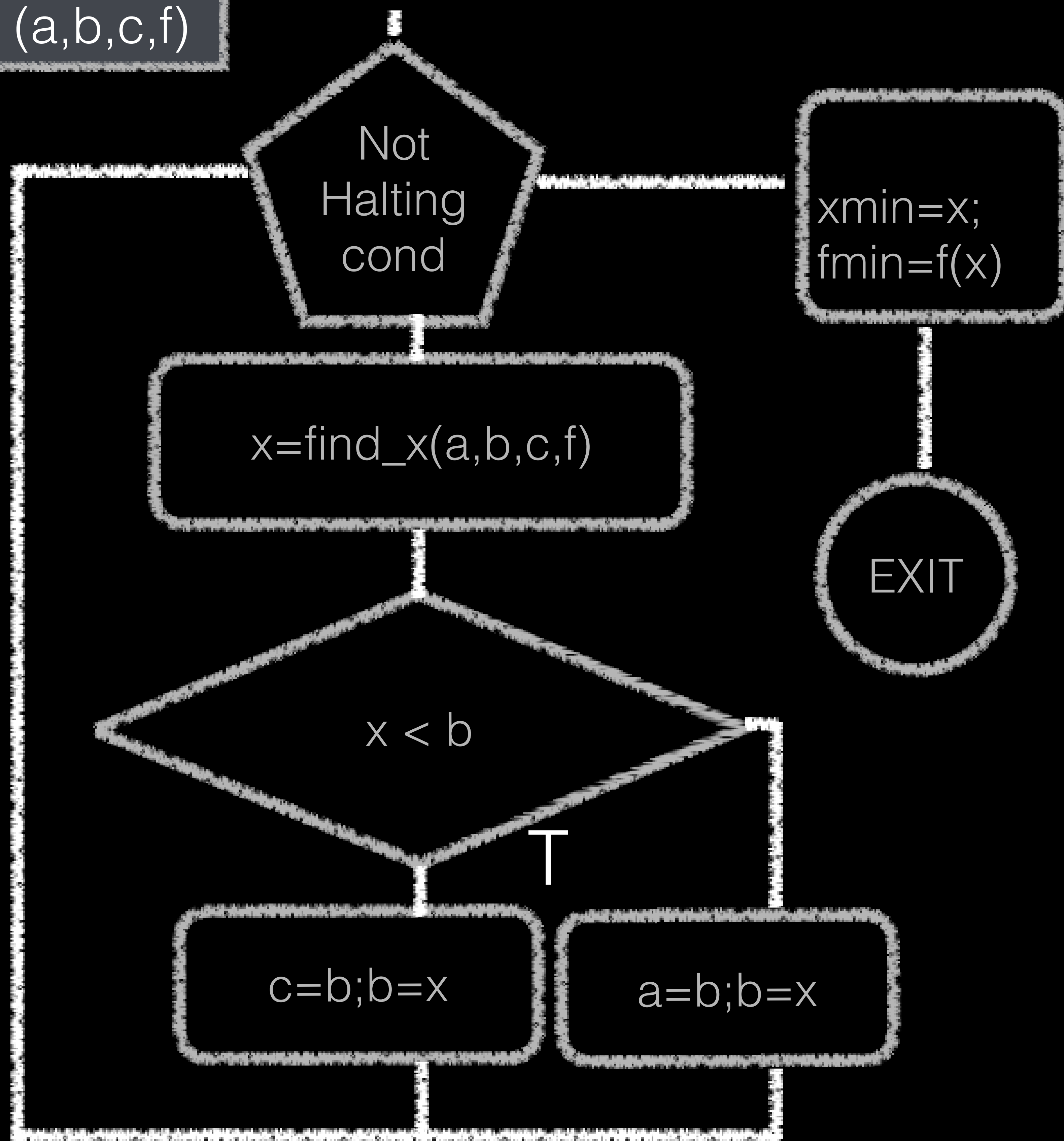
$$f'(x) = f_a \frac{(x-b)+(x-c)}{(a-b)(a-c)} + f_b \frac{(x-c)+(x-a)}{(b-c)(b-a)} + f_c \frac{(x-a)+(x-b)}{(c-a)(c-b)} = 0$$

function parabolic (a,b,c,f)



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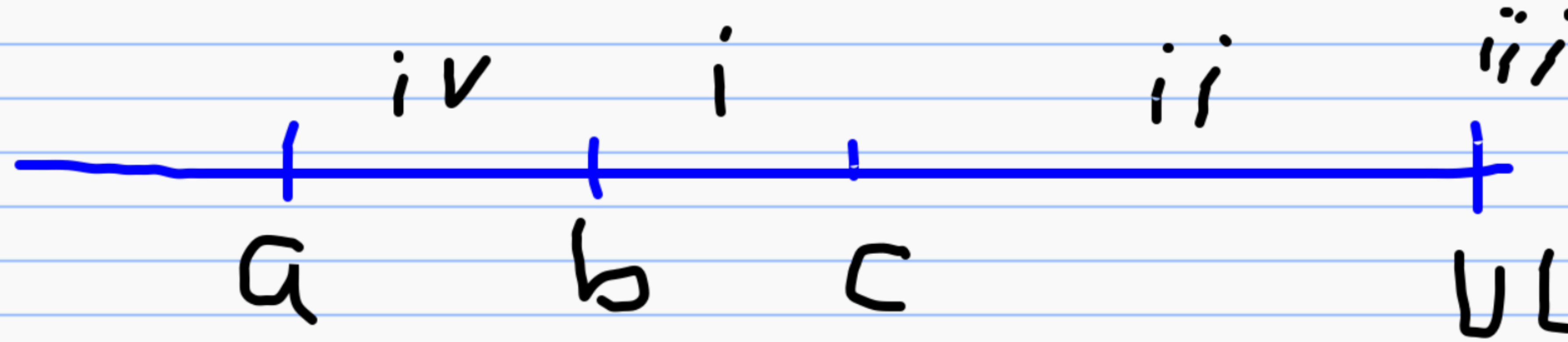
Routine for Initially Bracketing a Minimum

- A minimum is known to be bracketed only when there is a triplet of points, a < b<c, such that f(b) is less than both f(a) and f(b).

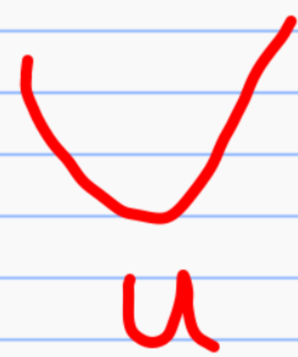
$a < b, \; fa > fb$



$c \leftarrow b + G(b-a)$

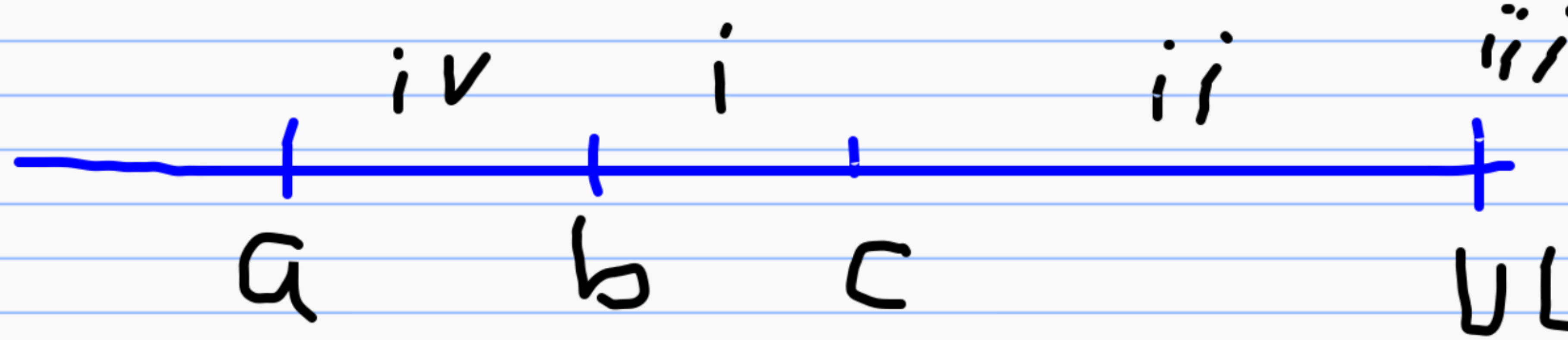
$UL \leftarrow b + 1000(c-b)$

$u \leftarrow \text{min\_q}(a,b,c)$

(i) 

(a, u, c)

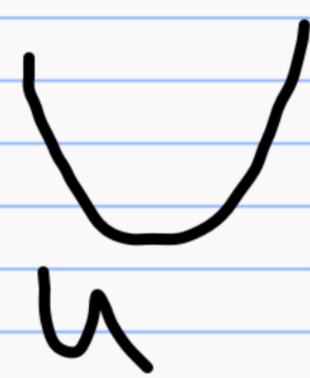
$a < b, \; fa > fb$



(i)

(a, b, u)

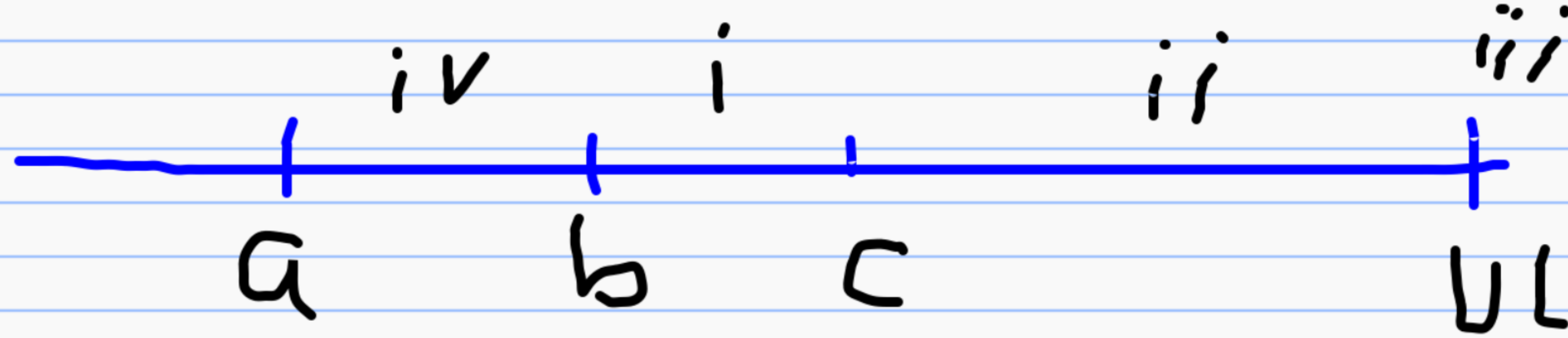
(ii)



$v \leftarrow u + G(u - c)$

(c, u, v)

$a < b, \; fa > fb$



(iii) $u \leftarrow UL$

(b, c, u)

(iv) $u \leftarrow c + G(c - b)$

(b, c, u)

Case i

Two situations in case i return a bracket
The other situations need further iterations for bracketing

Routines

- Switch roles of a and b such that fa > fb
- First guess for c.
- While not HC
    - Compute u by parabolic extrapolation from a, b, c. TINY is used to prevent any possible division by zero.
    - u in (b, c)
        - fc > fu : return (b,u,c)
        - fb < fu : return (a,b,u)
    - u in (c, uL) : v <- c+G(u-c); (a,b,c) <- (c,u,v)
    - Parabolic fit is between c and its limit.
    - u > uL: u <- uL; (a,b,c) <- (b,c,u)
        - %Reject parabolic u, use default magnification.
        - %Limit parabolic u to maximum allowed value.
    - u< b
        - Eliminate oldest point and continue.

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mnbrak.m

http://meteo.macc.unican.es/prometeo/temp/carmen/07_NNMeteo/dani/viento_ordenado/toolboxes/adaboost/@rbf_net_w/private/mnbrak.m

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