

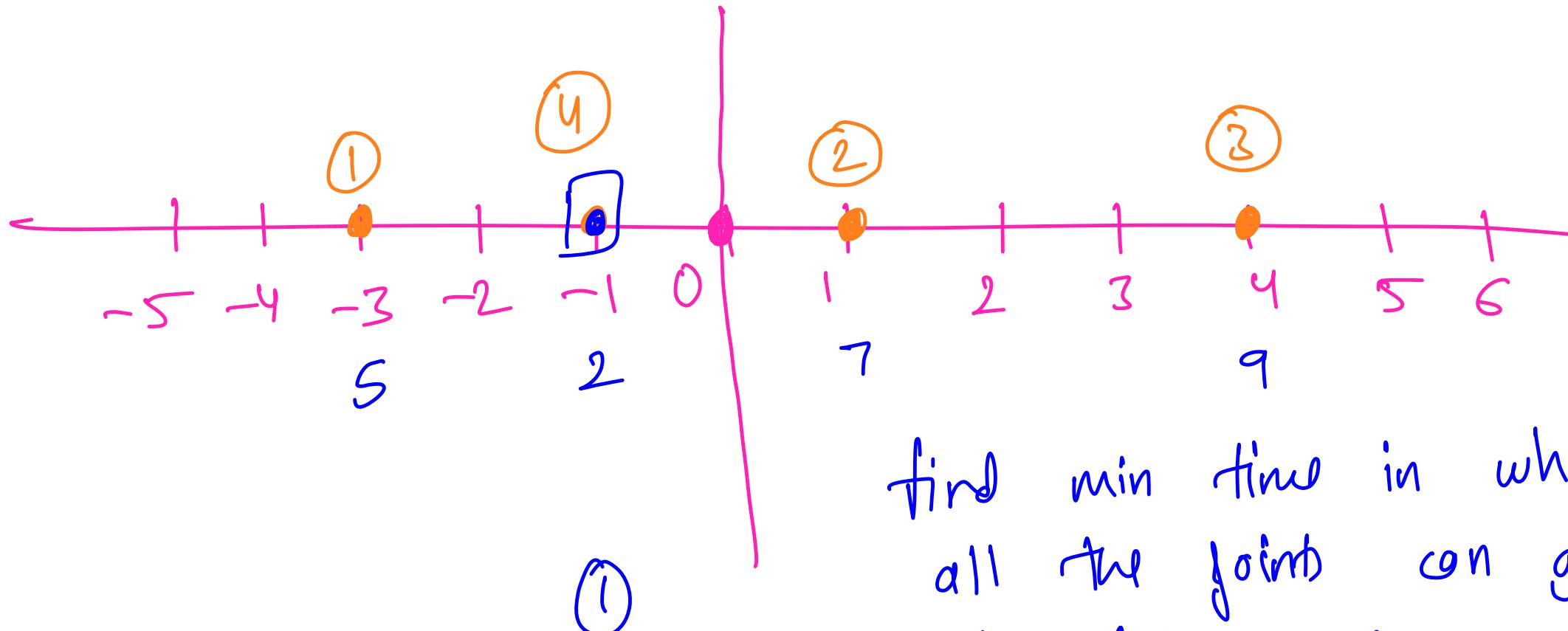
Advanced Binary Search



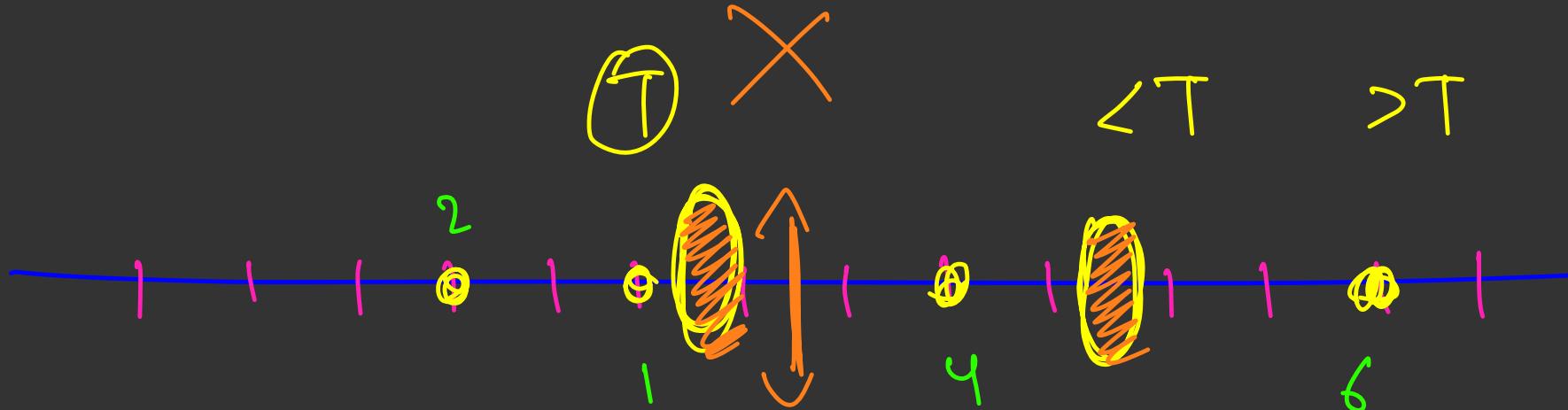
Problem Solving 2

Problem 1: Get Together

n points



find min time in which
all the points can gather
at the same co-ordinate



$$\max_{i \rightarrow 0 \text{ to } n-1} \left(\frac{|x - x_i^*|}{v_i^*} \right) = \frac{10^9}{10^6}$$

$$2 \times 10^9 \times 10^6 \rightarrow \underline{\underline{2 \times 10^{15}}}$$

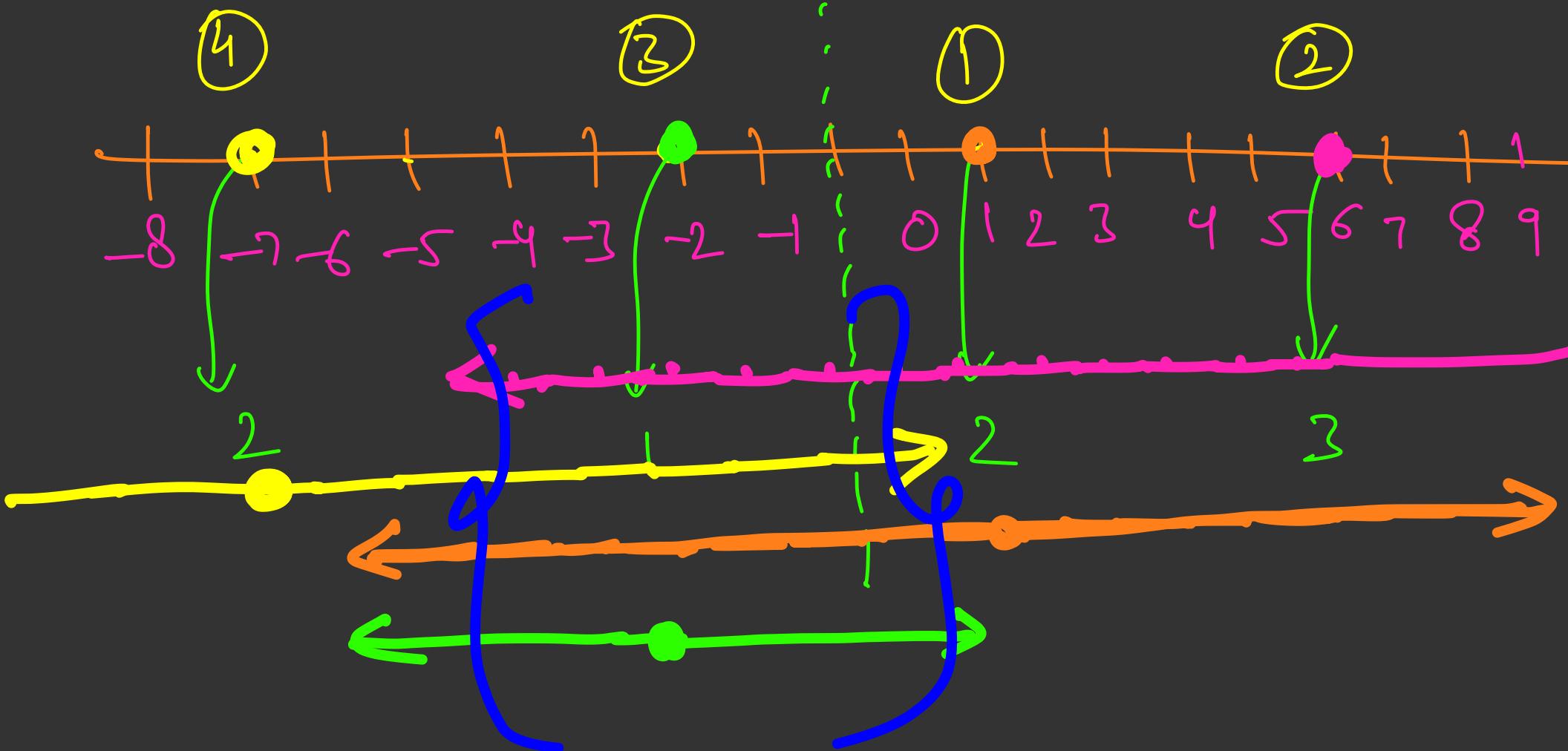
$$f(x) = \max_{i \rightarrow 0 \text{ to } n-1} \left\{ \frac{|x - x_i|}{v_i} \right\}$$

binary search m time .

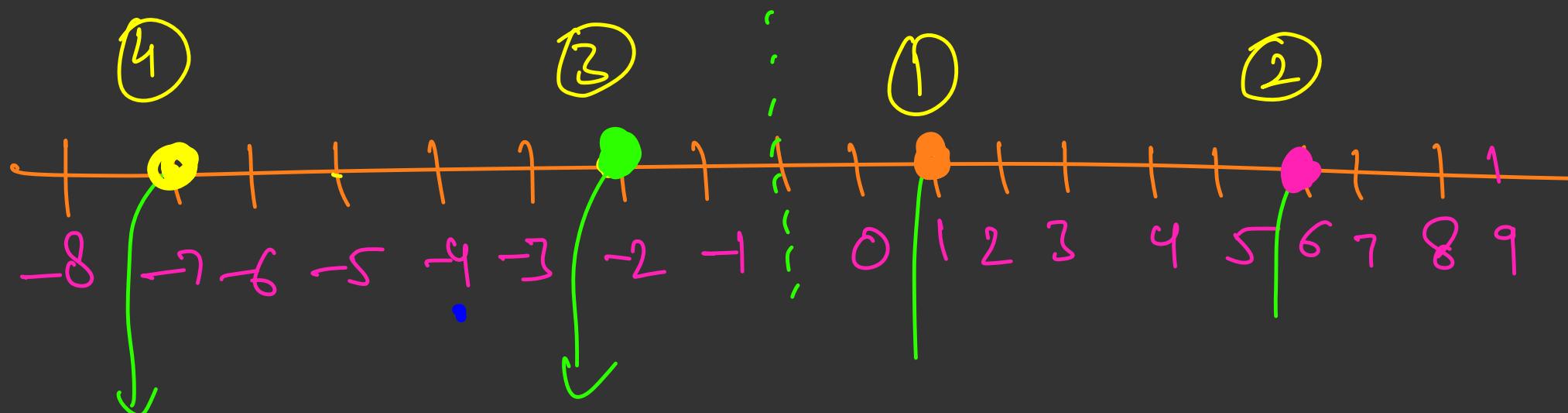
$f(t) = \begin{cases} T & \text{if all points gathered together in } \leq t \text{ time} \\ f_{\text{slow}} & \text{otherwise} \end{cases}$

fffff-ffffTTTTTTTTTTTTTTT

time = 4s



time = 2



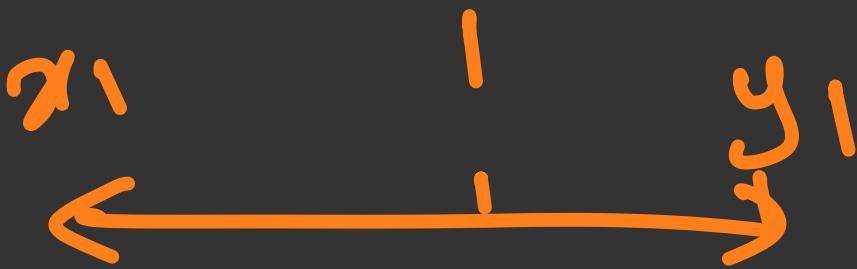
2

1

2

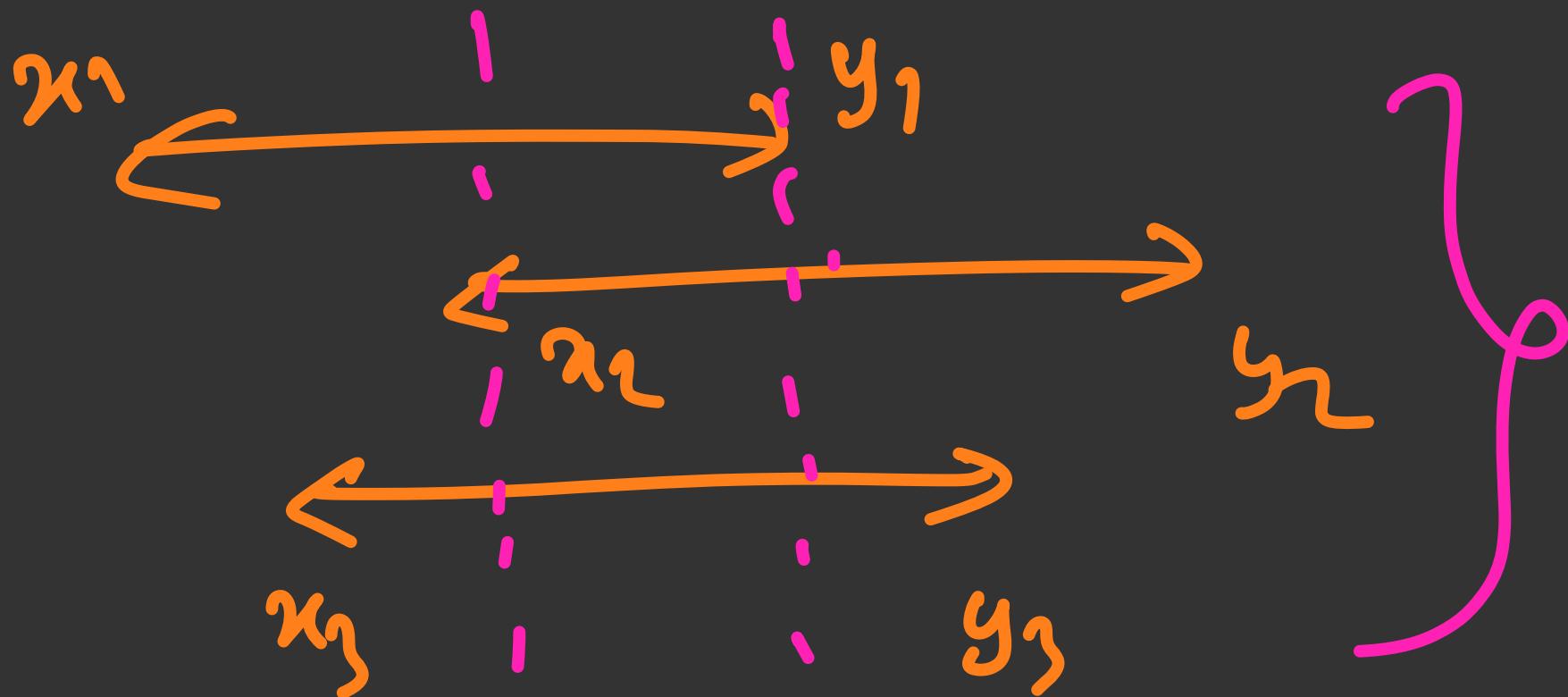
3



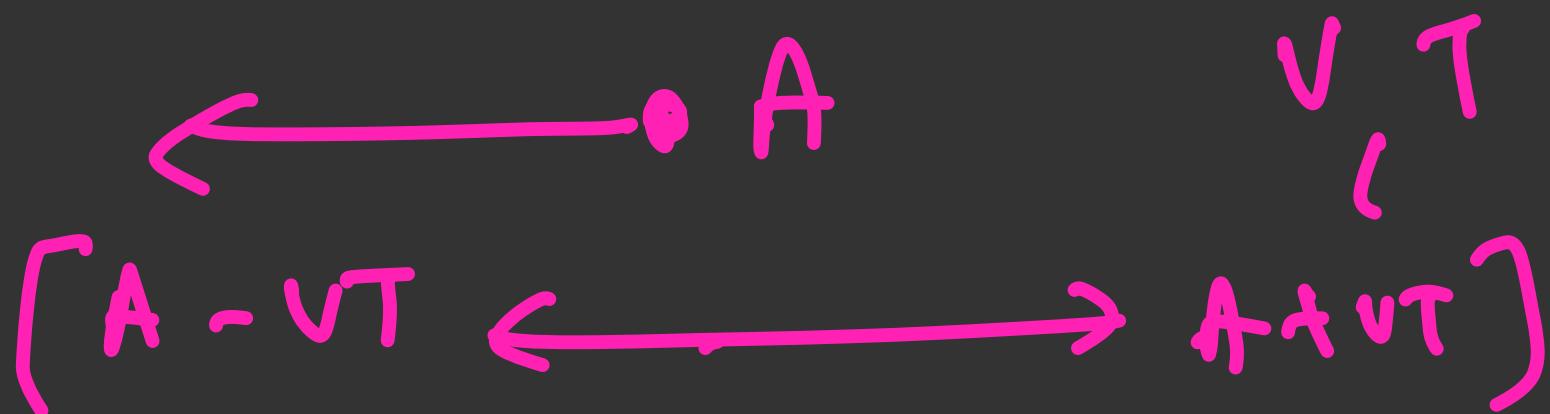


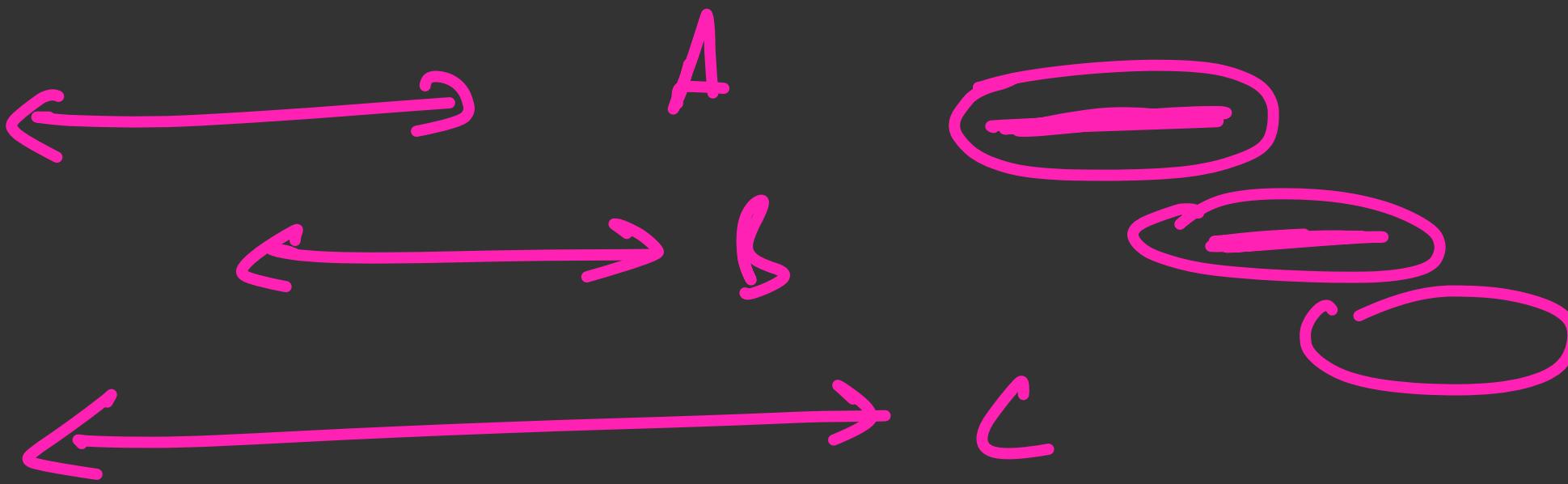
$\max(x_1, x_2) \leq \min(y_1, y_2)$





$$\max(x_1, x_2, x_3) \leq \min(y_1, y_2, y_3)$$





intersection (A, B, C)

intersection (intersection (A, B), C)

```

bool checker(double t, vector<pair<double, double>>& people){
    pair<double, double> curr = {-1e18, 1e18};
    for(auto i : people){
        double x = i.first;
        double speed = i.second;
        pair<double, double> range = {x - speed * t, x + speed * t};
        curr = {max(curr.first, range.first), min(curr.second, range.second)};
        if(curr.first > curr.second)
            return false;
    }
    return true;
}
void solve(){
    int n;
    cin >> n;
    vector<pair<double, double>> people(n);
    for(int i = 0; i < n; i++){
        cin >> people[i].first >> people[i].second;
    }
    double left = 0, right = 1e9;
    for(int iteration = 0; iteration < 60, iteration++){
        double mid = (left + right) / 2;
        if(checker(mid, people)){
            right = mid;
        }else{
            left = mid;
        }
    }
    cout << setprecision(7) << fixed << right << endl;
}

```

precision required

$\log(10^{15})$

10^{-6}

$-10^9 \leq x \leq 10^9$

$1 \leq N \leq 10^9$

$\log(10^3) = 10$
 SS
 10^{15}
 $=$
 Diagram:
 A circle contains three nodes: 10^6 , 10^9 , and 10^3 . Arrows point from 10^6 to 10^9 and from 10^9 to 10^3 .
Problem 3

Solution Code

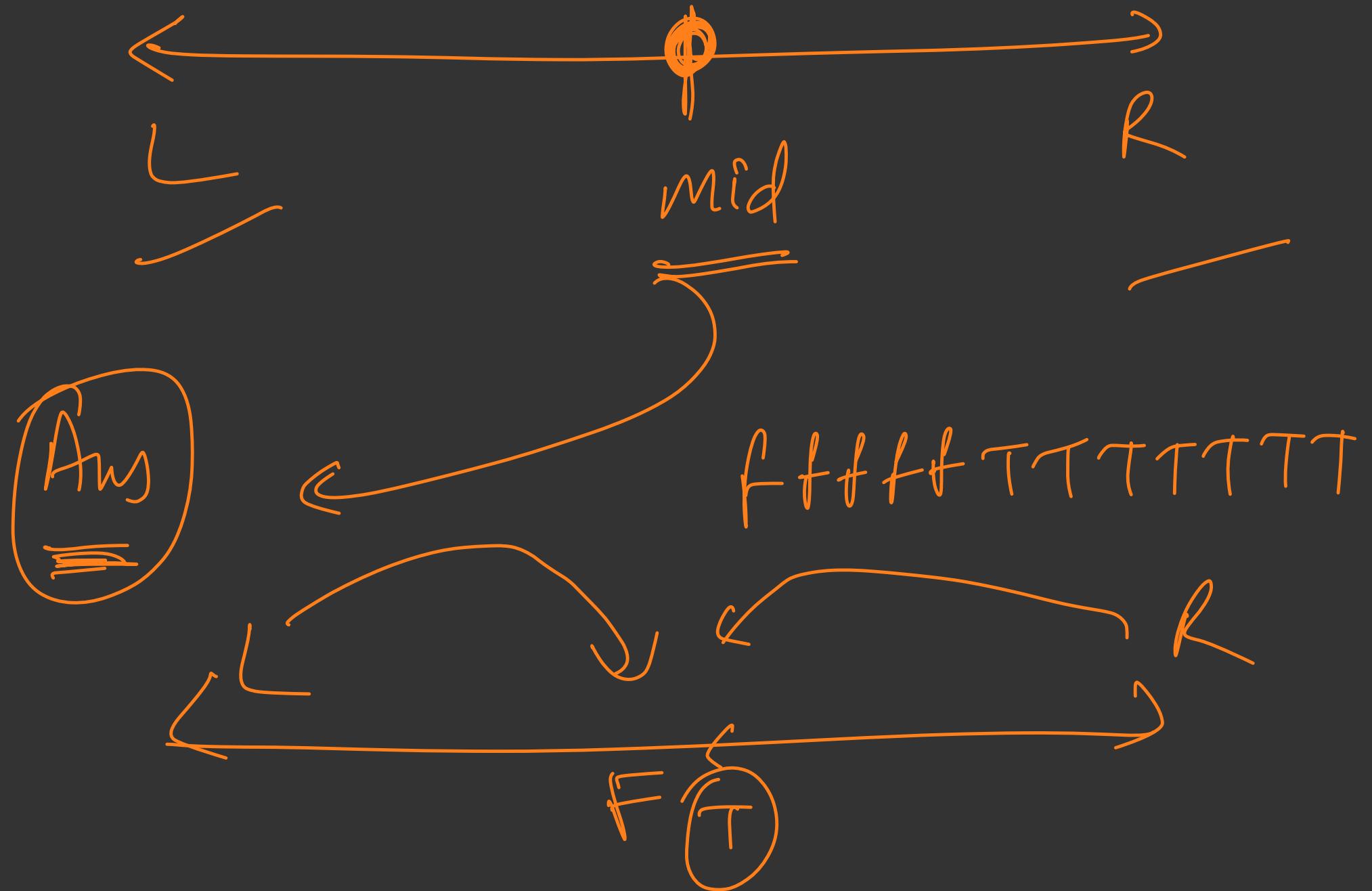
$$10^9 \times 10^7$$

~~~~~  
 $10^{16}$

$10^9$

$10^9$

$\log(10^{16})$



Method ①

ffffTTTTTTTTT



maintain aw variat&φ

$$f = \text{mid} - \text{error}$$

$$L = \text{mid} + \text{error}$$

Method ⑫



# Problem 2: Tracking Segments

## [CP-31 1600: P5]