
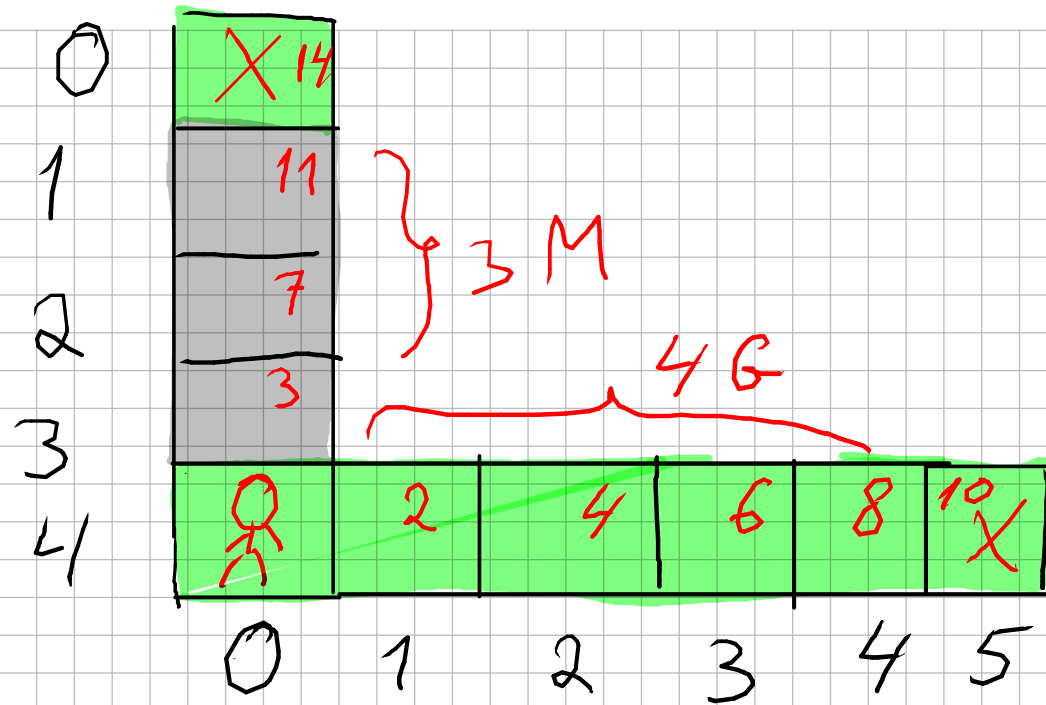


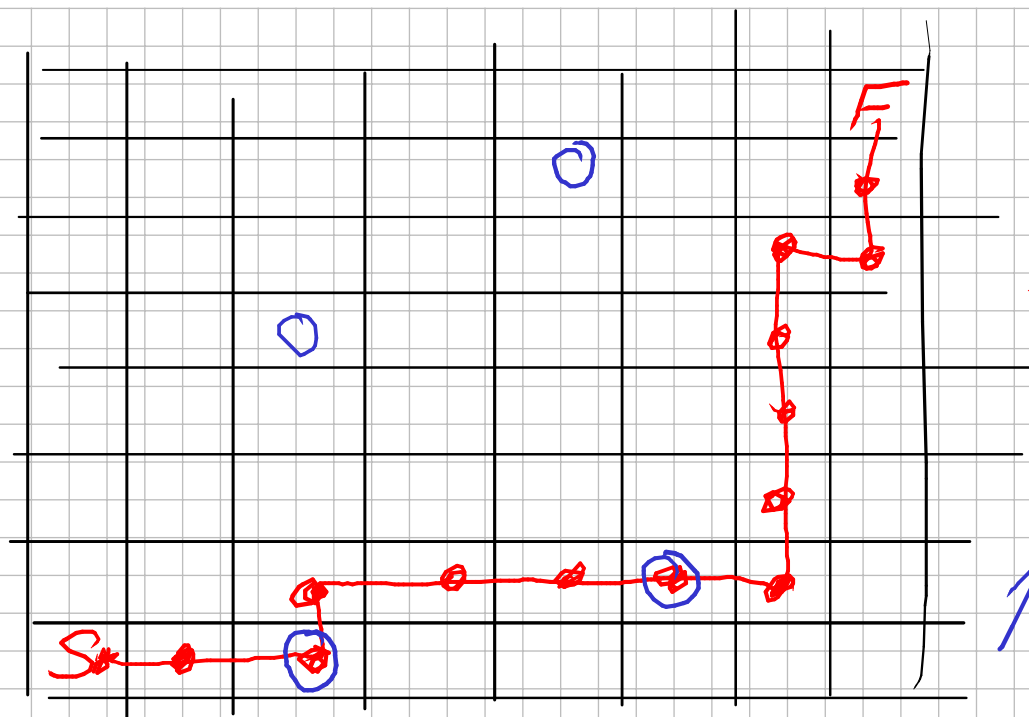
	0	1	2	3	4
0	2 <sub>4</sub>	3 <sub>6</sub>	4 <sub>8</sub>	5 <sub>11</sub>	6 <sub>12</sub> <del>X</del>
1	1 <sub>2</sub>	2 <sub>5</sub>	3 <sub>7</sub>	4 <sub>9</sub>	5 <sub>10</sub>
2		1 <sub>2</sub>	2 <sub>4</sub>	3 <sub>6</sub>	4 <sub>8</sub>
3	1 <sub>2</sub>	2 <sub>5</sub>	3 <sub>6</sub>	4 <sub>8</sub>	5 <sub>10</sub>
4	2 <sub>4</sub>	3 <sub>6</sub>	4 <sub>8</sub>	5 <sub>10</sub>	6 <sub>12</sub>

$$G - G = 2$$

$$G - M = 3$$

$$M - M = 4$$





$$\begin{aligned} \text{Total cost} &= \\ &= \sum \delta(i, i+1) = \\ &= \sum \text{ter. cost} \end{aligned}$$

$$14 \cdot 2 = 28$$

$$\delta(i, i+1) = \begin{matrix} \text{terrain cost} \\ \text{to} \end{matrix} \begin{matrix} \text{from } i \\ i+1 \end{matrix}$$

$$\text{terrain\_cost} + a \cdot z + b \cdot \text{noise}$$

$$z = \begin{cases} 0 & \text{if node} \notin G \\ 1 & \text{if node} \in G \end{cases}$$

$\sum_{\text{trajectory}}$

$a \cdot z$

общий вклад

комн. а7 на траектории

$$\sum_{\text{trajectory}} a \cdot z = a \cdot \sum_{\text{traj.}} z = \star$$

*There are  $|G|$  goals on the map in total*

*Any trajectory w/b loops visits no more than all Goals.*

$$0 \leq \star \leq a \cdot |G|$$

*Even if I can't compute  $(\star)$  in advance because I don't know what trajectory we end up with, I can still assess lower and upper boundaries for the value.*

$\text{terrain\_cost} + a * r + b * \text{noise}$  ← for each transition

Total Cost + Total Reward + Total Noise

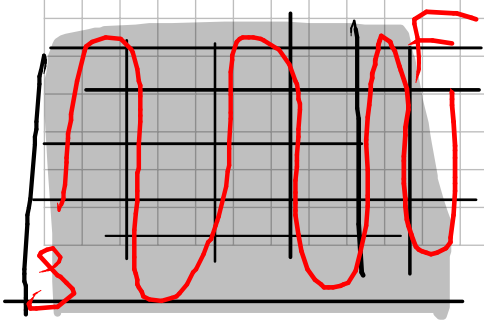
↖ for the whole trajectory

$$0 \leq \text{Total Cost} = \sum_{\text{trajectory}} \text{terrain cost} =$$

$$= tc(0,1) + tc(1,2) + \dots + tc(n-1,n) \quad \left| \begin{array}{l} n = |\text{traj.}| \\ \text{number of} \\ \text{transitions} \end{array} \right.$$

$$\leq \text{Max}[\text{terrain\_cost}] \cdot \text{Max}[\text{trajectory length}] =$$

$$= 4 \cdot |Map|$$



even though the formula is Total Cost + Total Reward + Total Noise, we mainly optimize the Total Cost component (because we are looking for the shortest path).

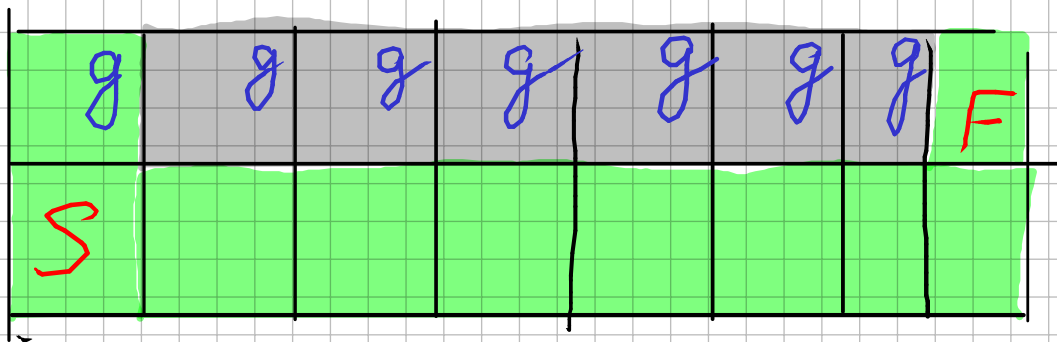
e.g. suppose we have two trajectories A and B.

Total Cost for A is 82

Total Cost for B is 83

$$\Delta = 1$$

A doesn't visit any goals, but B visits every single goal. Regardless, we choose A over B because A is shorter.

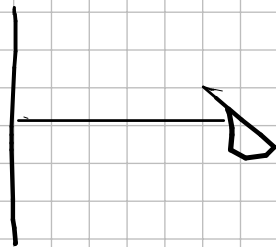


Total Cost is a discrete value with a step of "1".

So how do we choose formula for Total Reward so that it doesn't mess up priority over Total Cost.

$$V_1 = 82 + 0$$

$$V_2 = 83 - a \cdot |G|$$



$$V_1 < V_2$$

$$82 + 0 < 83 - a \cdot |G|$$

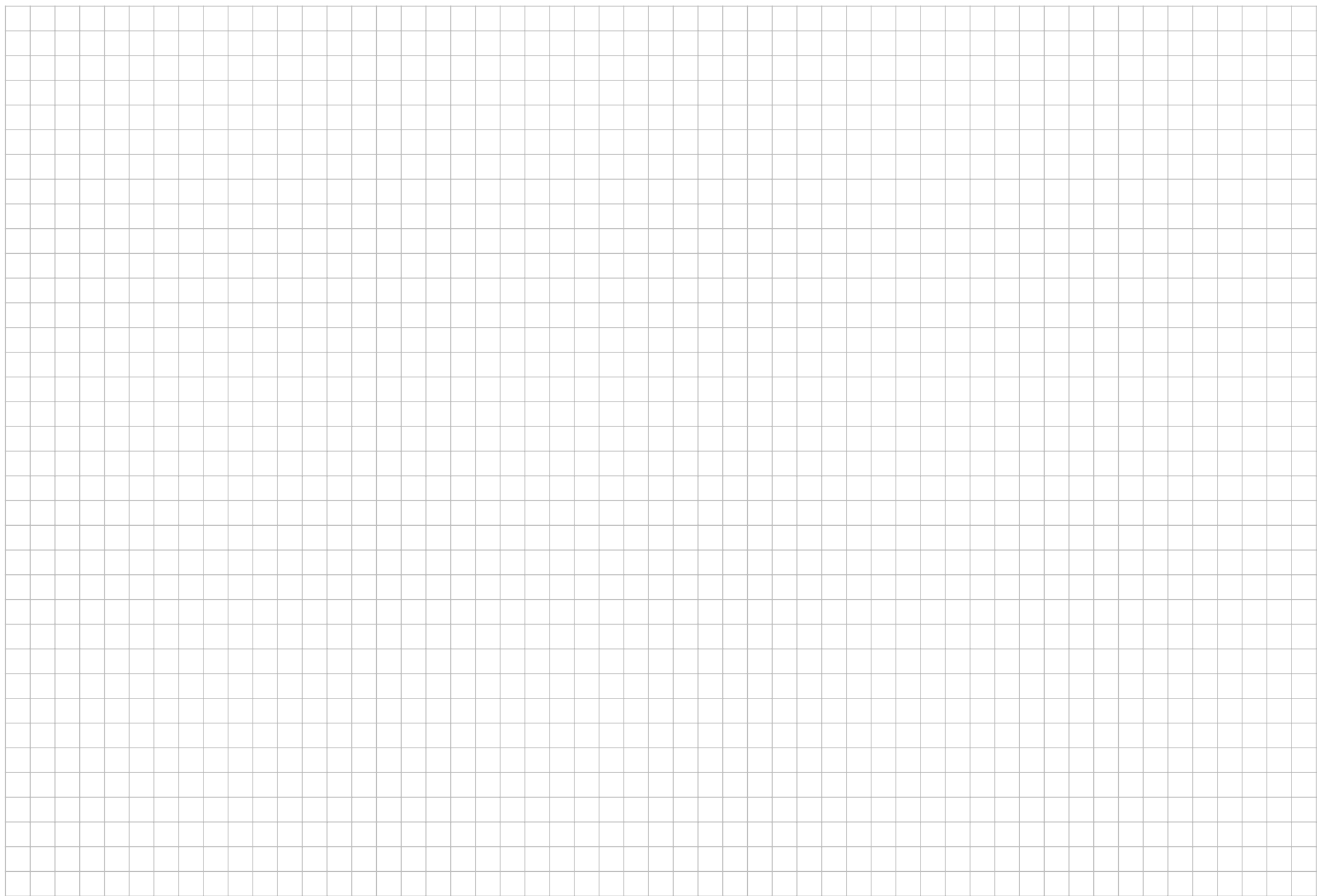
$$a \cdot |G| < 1$$

$$a < \frac{1}{|G|}$$

$$a = \frac{1}{2|G|}$$

$$a = \frac{1}{|G| + 1}$$





random variable that is uniformly distributed

$$\text{Total Noise} = \sum_{\text{traject}} b \cdot U[-1; 1] =$$

$$= \underbrace{b U[-1; 1] + b U[-1; 1] + \dots + b U[-1; 1]}_{n = |\text{trajectory}| \text{ terms in total}} =$$

$$= b \cdot u_1 + b \cdot u_2 + \dots + b \cdot u_{|\text{traject}|} =$$

$$= b \cdot (u_1 + u_2 + \dots + u_{|\text{traject}|}) = (*)$$

$$-1 \leq u_1 \leq 1$$

$$-1 \leq u_2 \leq 1$$

$$-1 \leq u_{|\text{traject}|} \leq 1$$

$$b(-1 + (-1) + \dots + (-1)) \leq (*) \leq b(1 + 1 + \dots + 1)$$

$$-b \cdot |\text{traject}| \leq (*) \leq b \cdot |\text{traject}|$$

$$\sum_{i=1}^{30} \iff 1 \leq i \leq 30$$

$$\sum_{i \in \{1..30\}} \iff 1 \leq i \leq 30$$

$$\sum_{\{1..30\}} \iff 1 \leq i \leq 30$$

$| \cdot |$  — notation for 'norm'

'norm' is numeric characteristic of some object

Examples:

norm for numbers: module, absolute value

$$|-2,8| = 2,8$$

$$\forall x, y, |x| + |y| \geq |x+y| \quad \rightarrow$$

norm for vectors: length, Pythagoras theorem

$$V = (1, 3, -2) ; |V| = \sqrt{1^2 + 3^2 + (-2)^2}$$

norm for sets: number of elements (in case set is finite)

$$S = \{ "a", "z", "y" \}$$

$$|S| = 3$$

$$S + P = \{ "a", "b", "z", "y" \}$$

$$P = \{ "b", "a" \}$$

$$|P| = 2$$

$$|S+P| = 4 \leq |S| + |P|$$



$$\text{terrain\_cost} + a * r + b * \text{noise}$$

$$1) \quad 82 + 0 \quad V \quad 83 - a \cdot |G|$$

$$2) \quad 3 + 0 \quad V \quad 4 - a \cdot |G|$$

$$3) \quad 0 + 0 \quad V \quad \Delta TC - a \cdot |G|$$

↗ "1

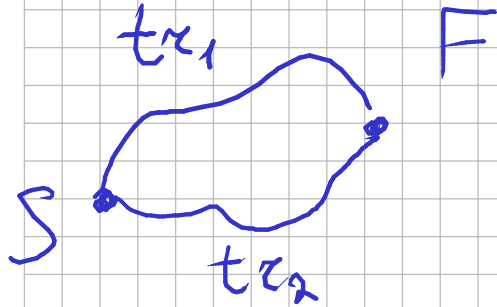
notation for discretization step of  
Total Cost

$$0 + b \cdot |Map| \quad V \quad \Delta TC - b \cdot |Map|$$

$$\underbrace{\text{terrain\_cost}} + \underbrace{a * r + b * \text{noise}}$$

$$\Delta TC = 1$$

$$\Delta TR = 1$$



$tr_1$  : 4 goals collected

$tr_2$  : 5 goals collected

$$TR_1 = \frac{1}{2|G|} \cdot 4 = a \cdot 4$$

$$TR_2 = a \cdot 5$$

Suppose Map has  
10 Goals in total

$$\Delta TR = a$$

$$\boxed{TC + TR + TN}$$

$$\times 82 - 4a - 6 \cdot |Map|$$

$$\checkmark 82 - 5a + 6 \cdot |Map|$$

big  $\downarrow$   
small  $\uparrow$

$$b < \frac{a}{2 \cdot |Map|}$$

$$a = \frac{1}{2 \cdot |G|}$$

$$b = \frac{1}{8 \cdot |G| \cdot |Map|}$$