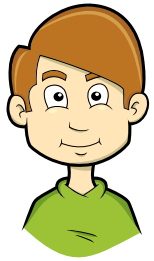
Particle Swarm Optimization

Inspiration

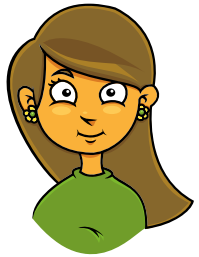
PSO search strategy

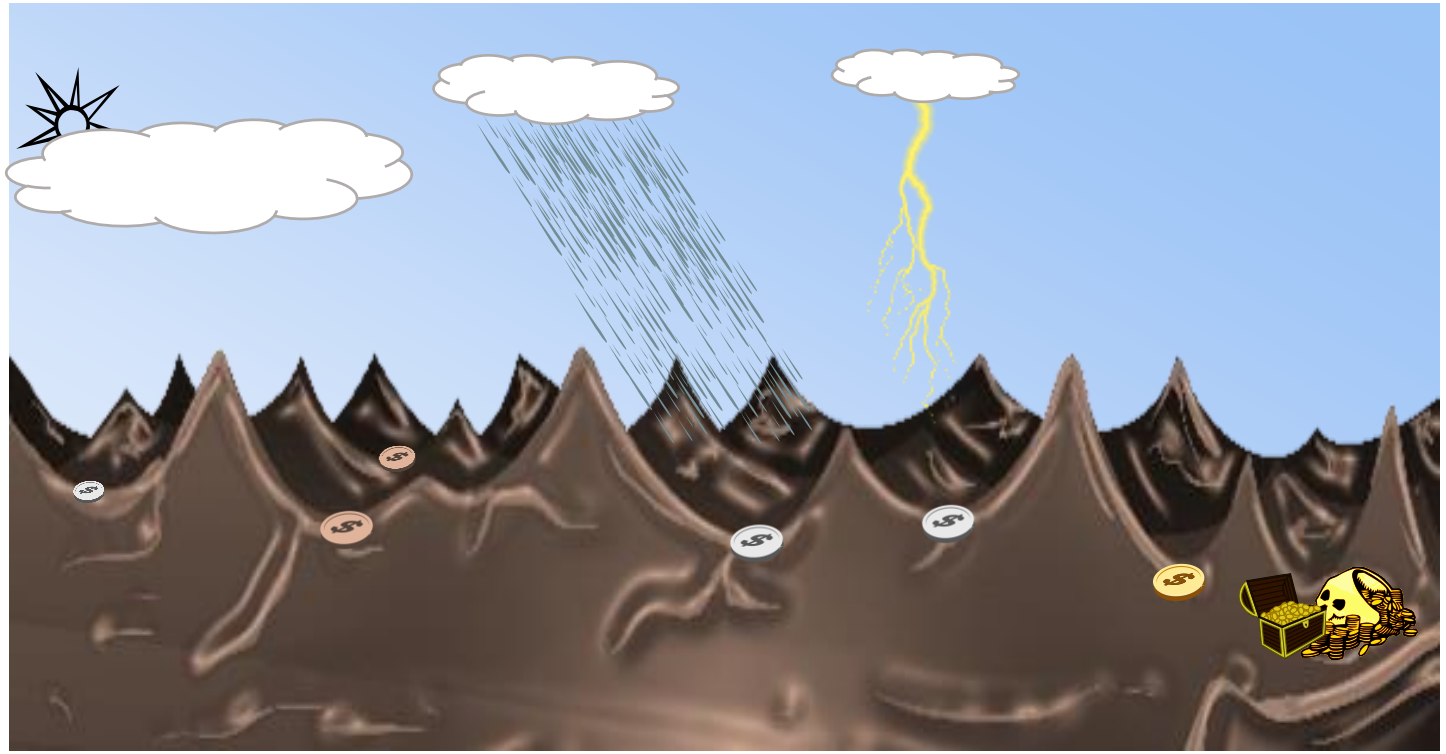
Bob



Anthony

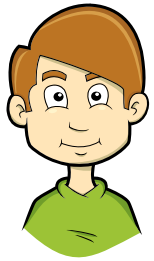
Jennifer





PSO search strategy

Bob



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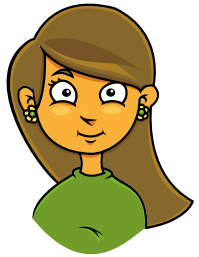

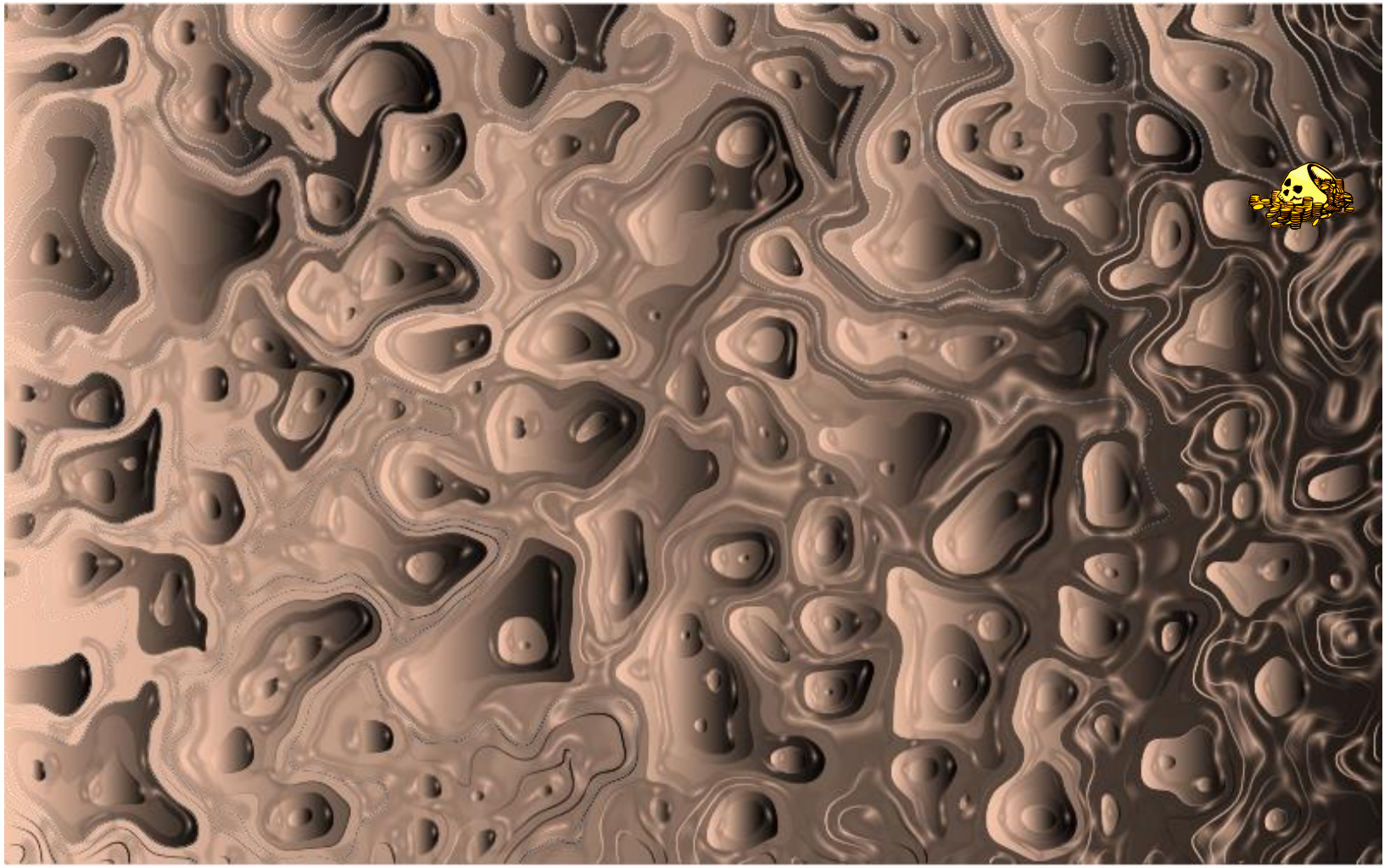

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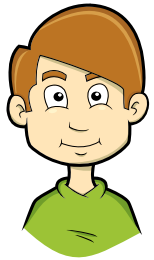

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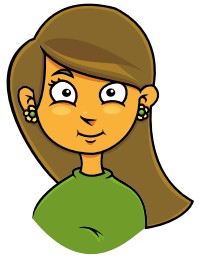


Personal best location

10 km

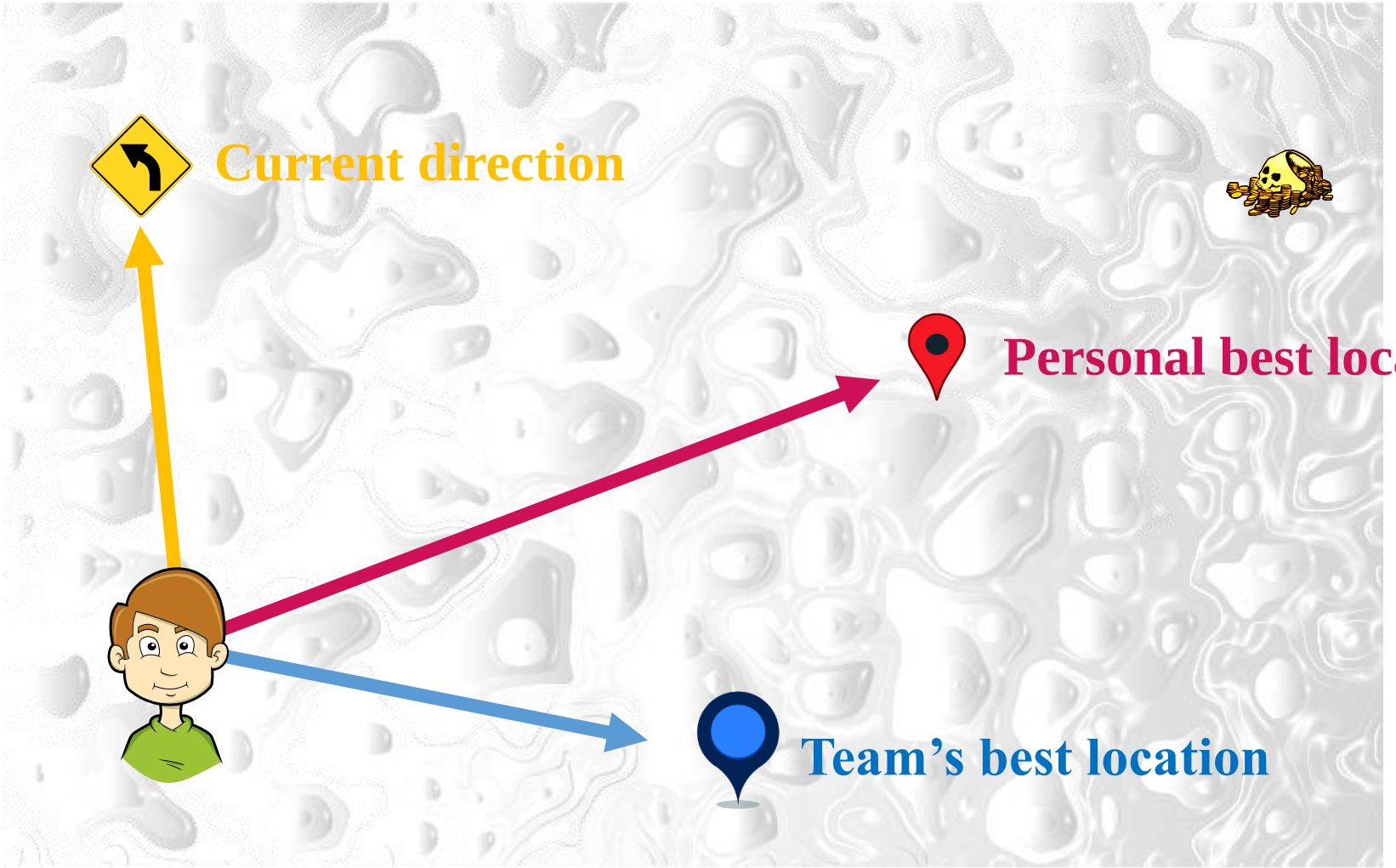
Team best location

10 km

Current direction

10 km

PSO search strategy



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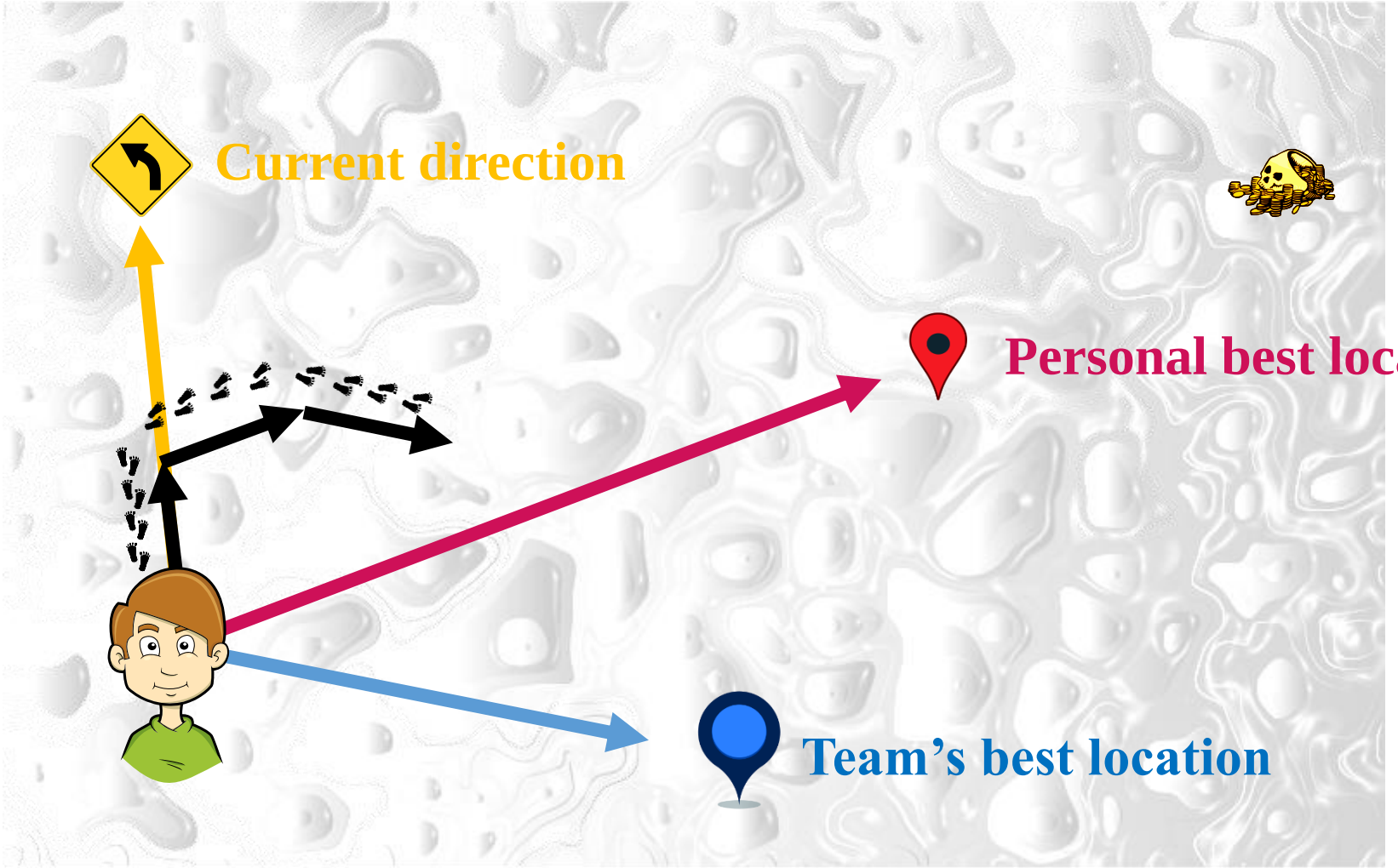

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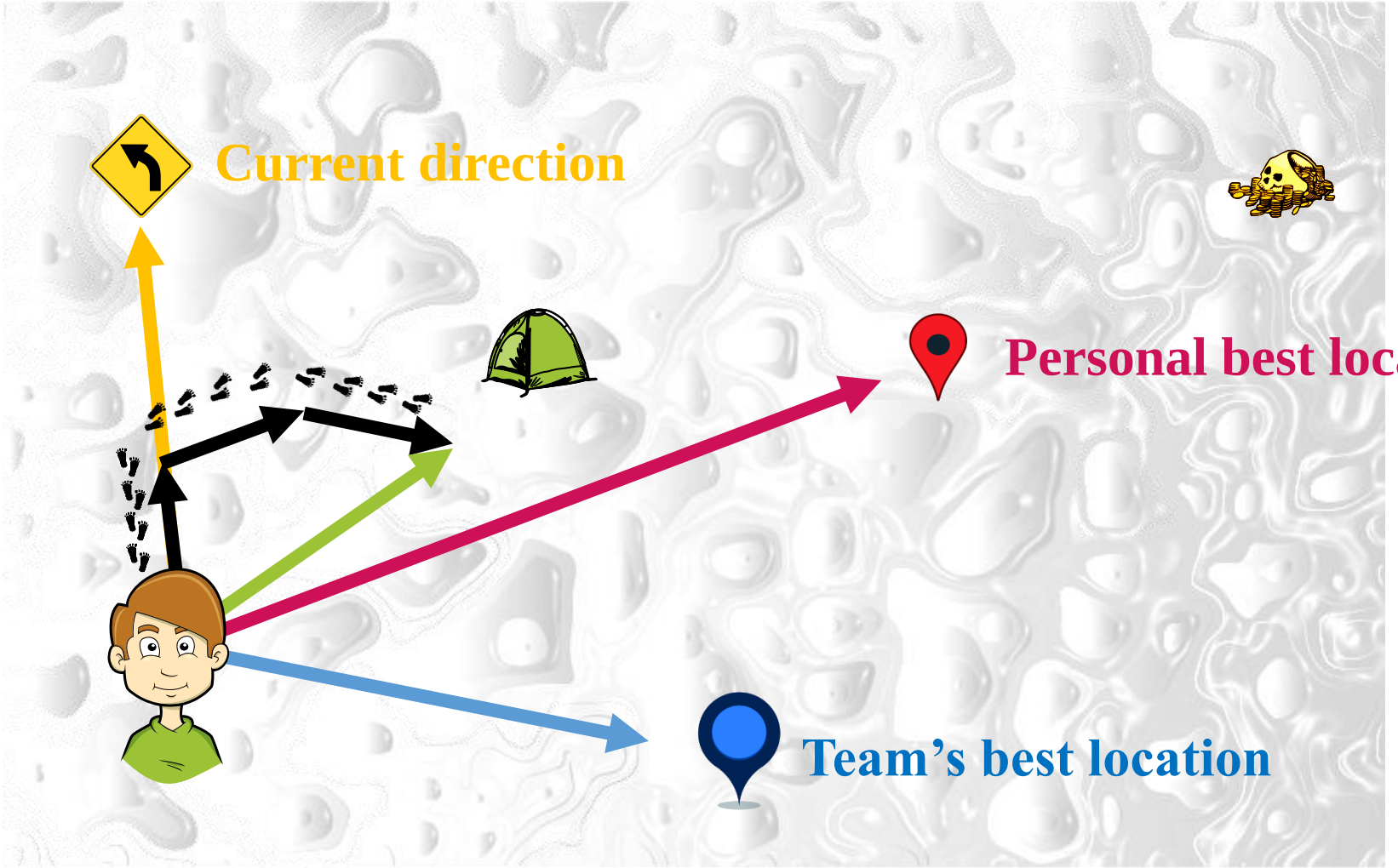

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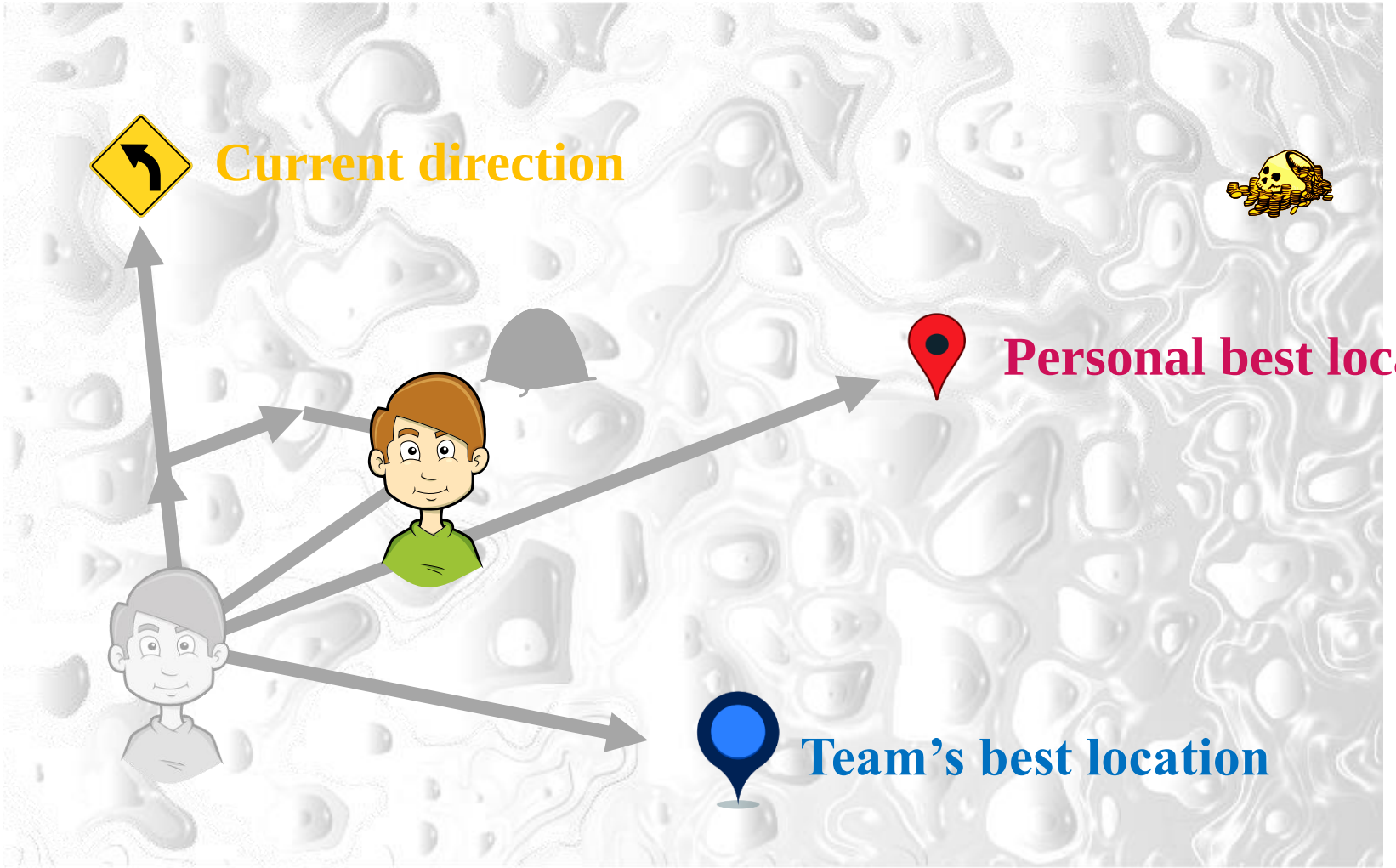

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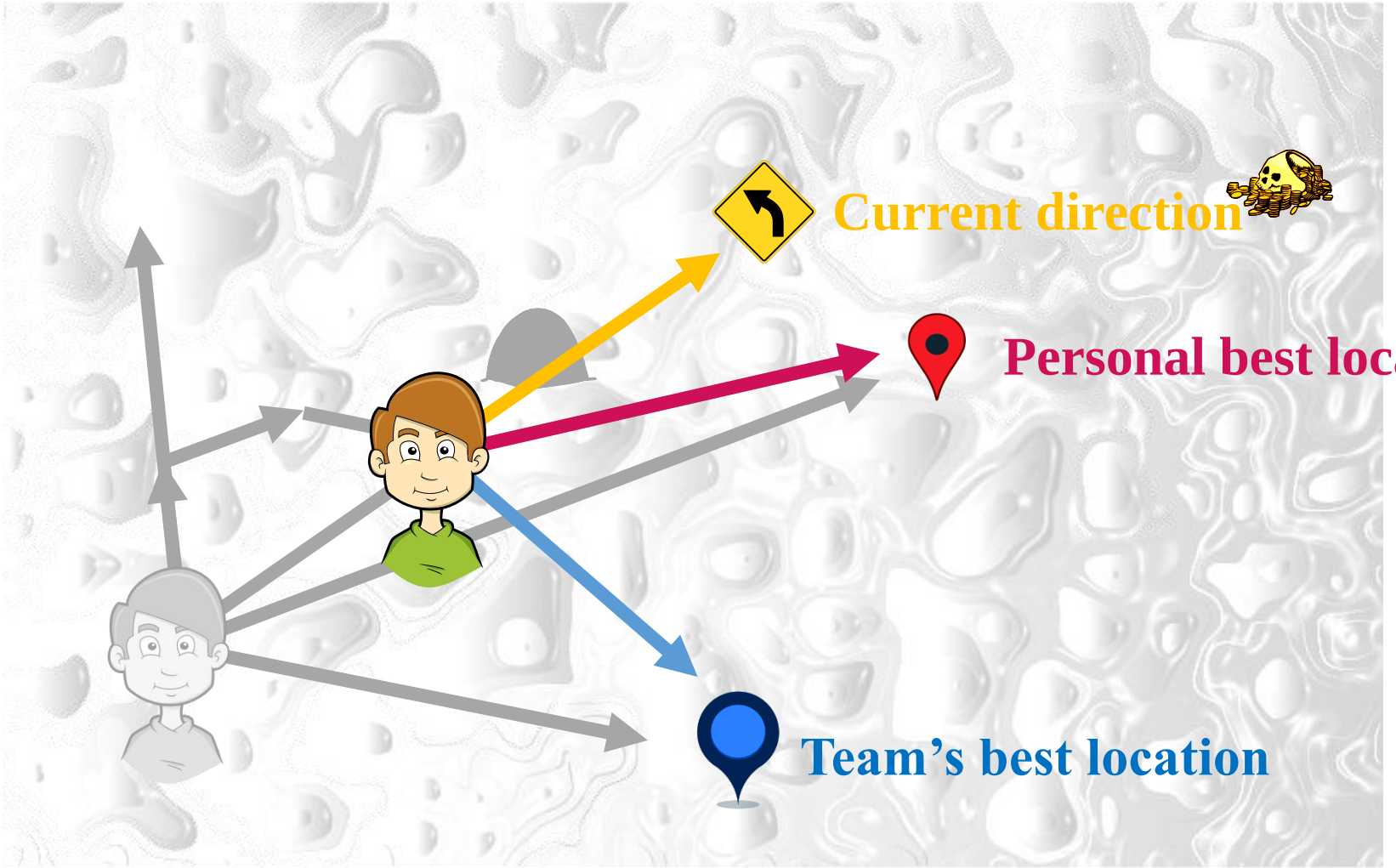

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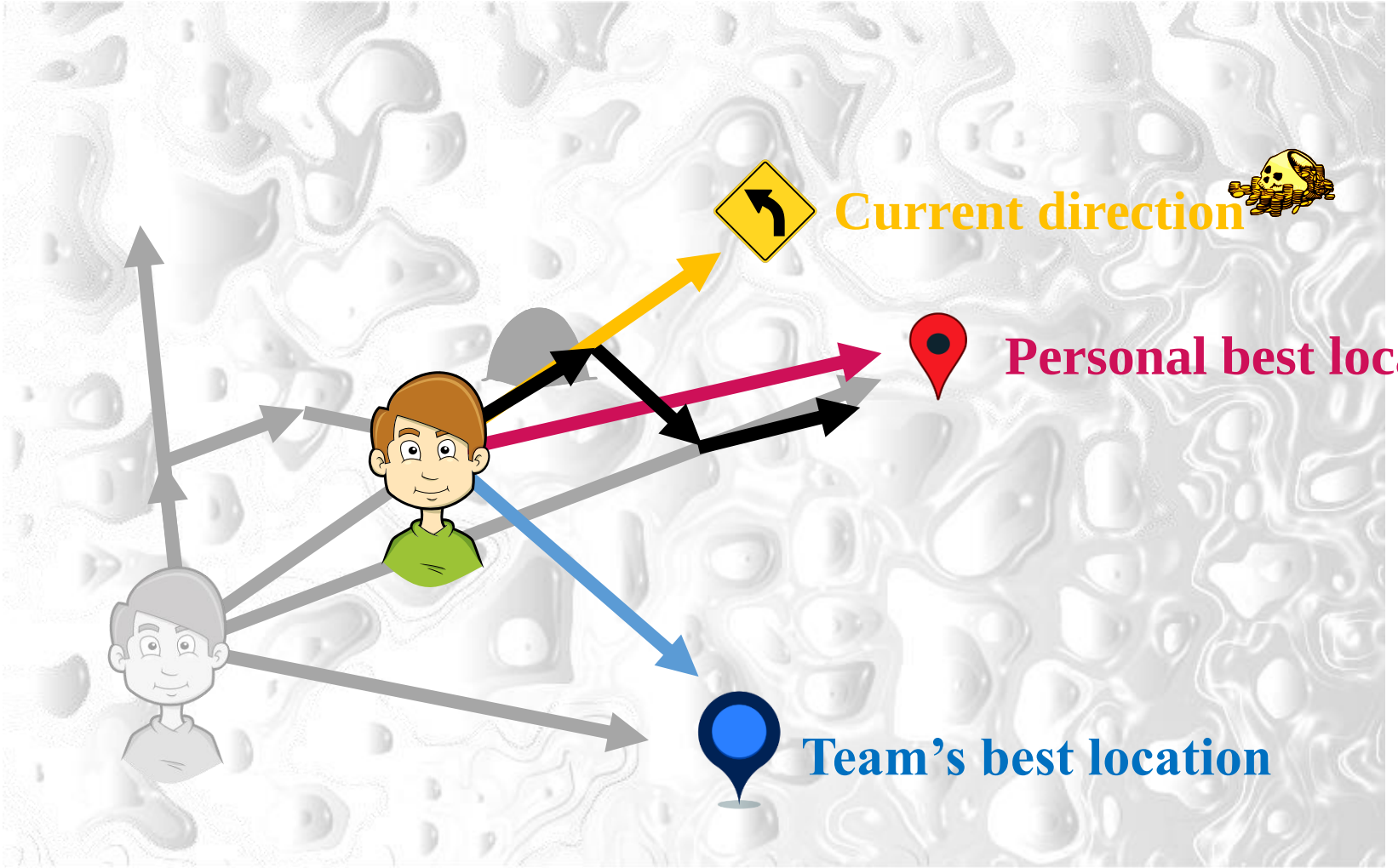

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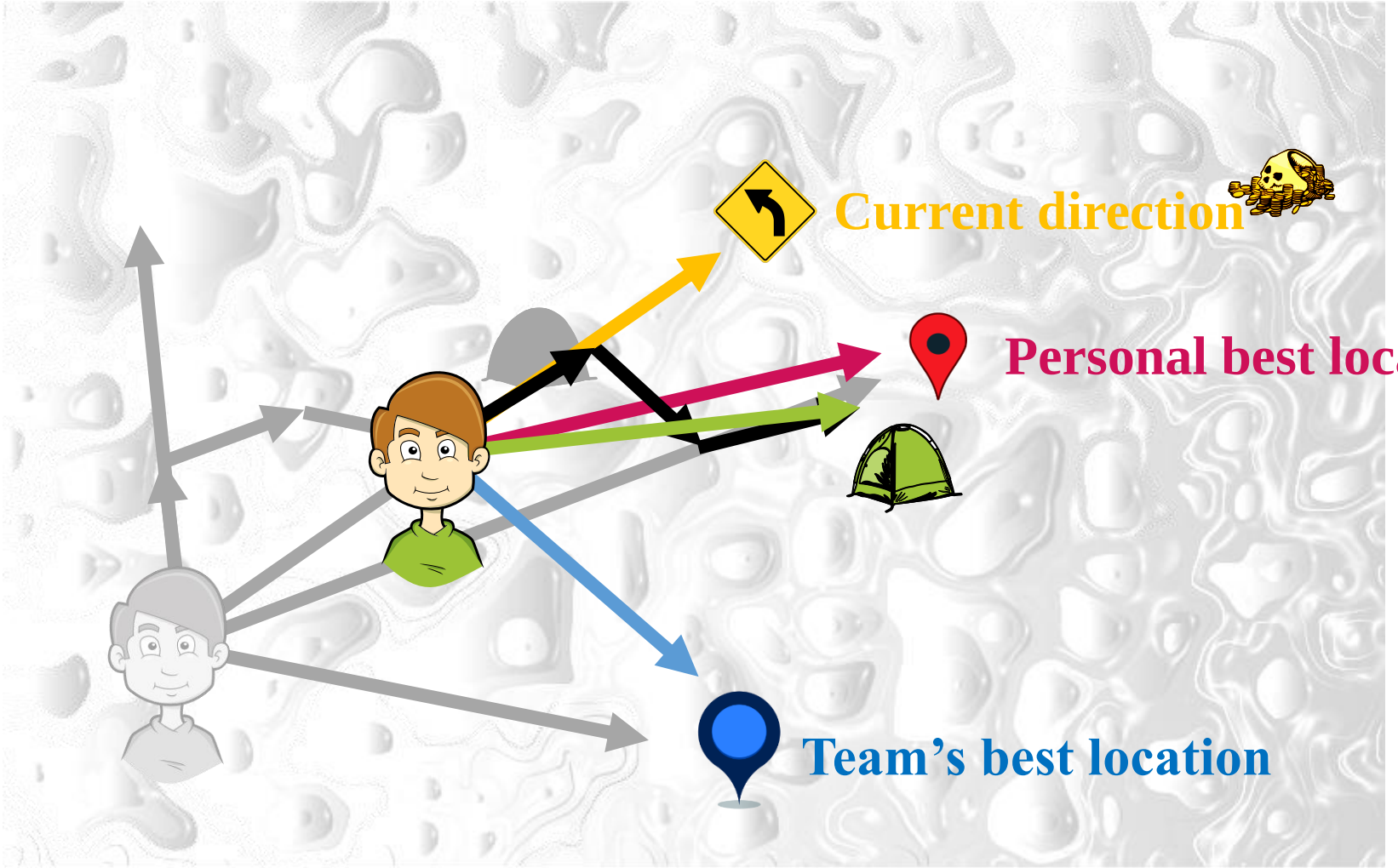

PSO search strategy

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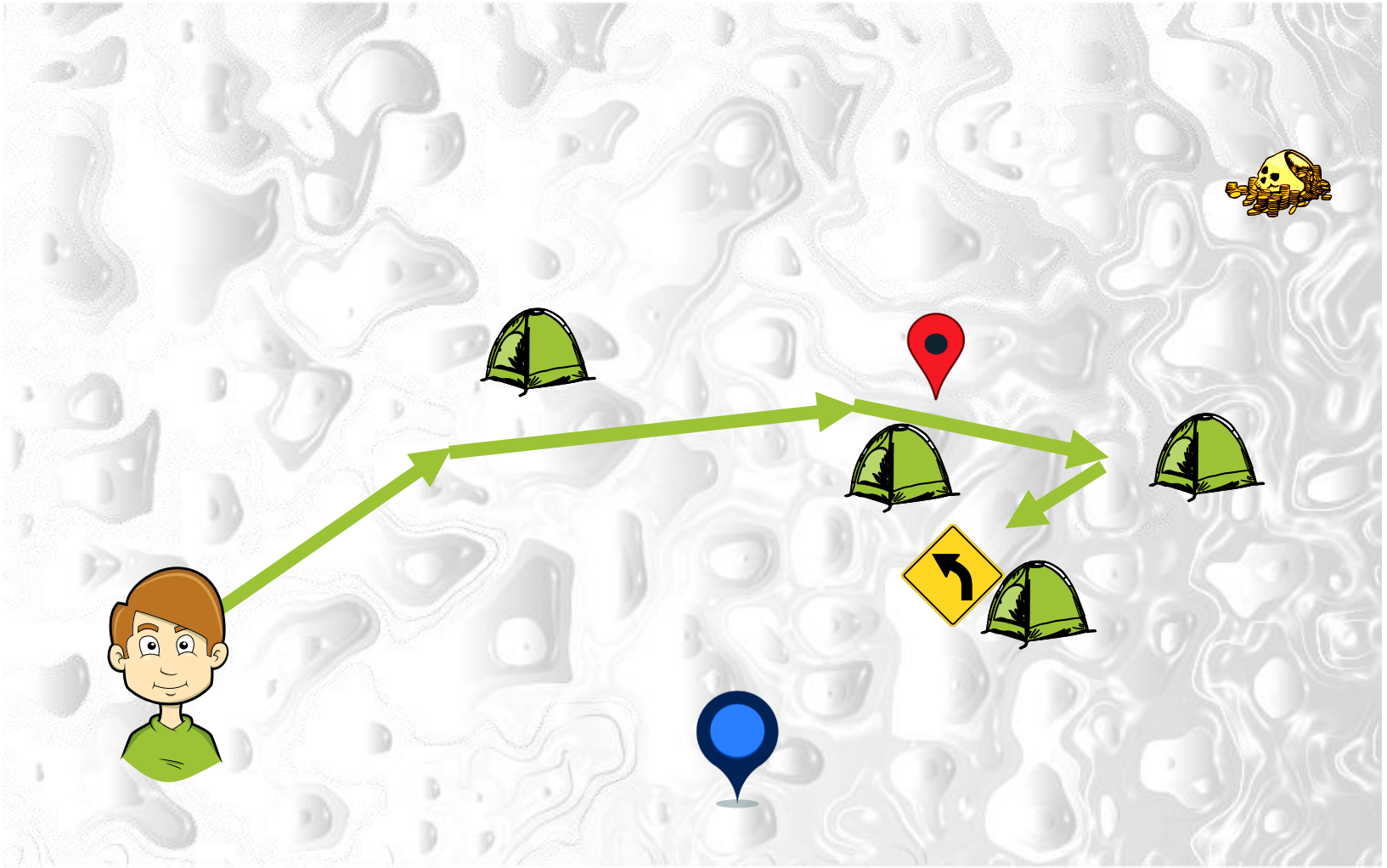

PSO search strategy

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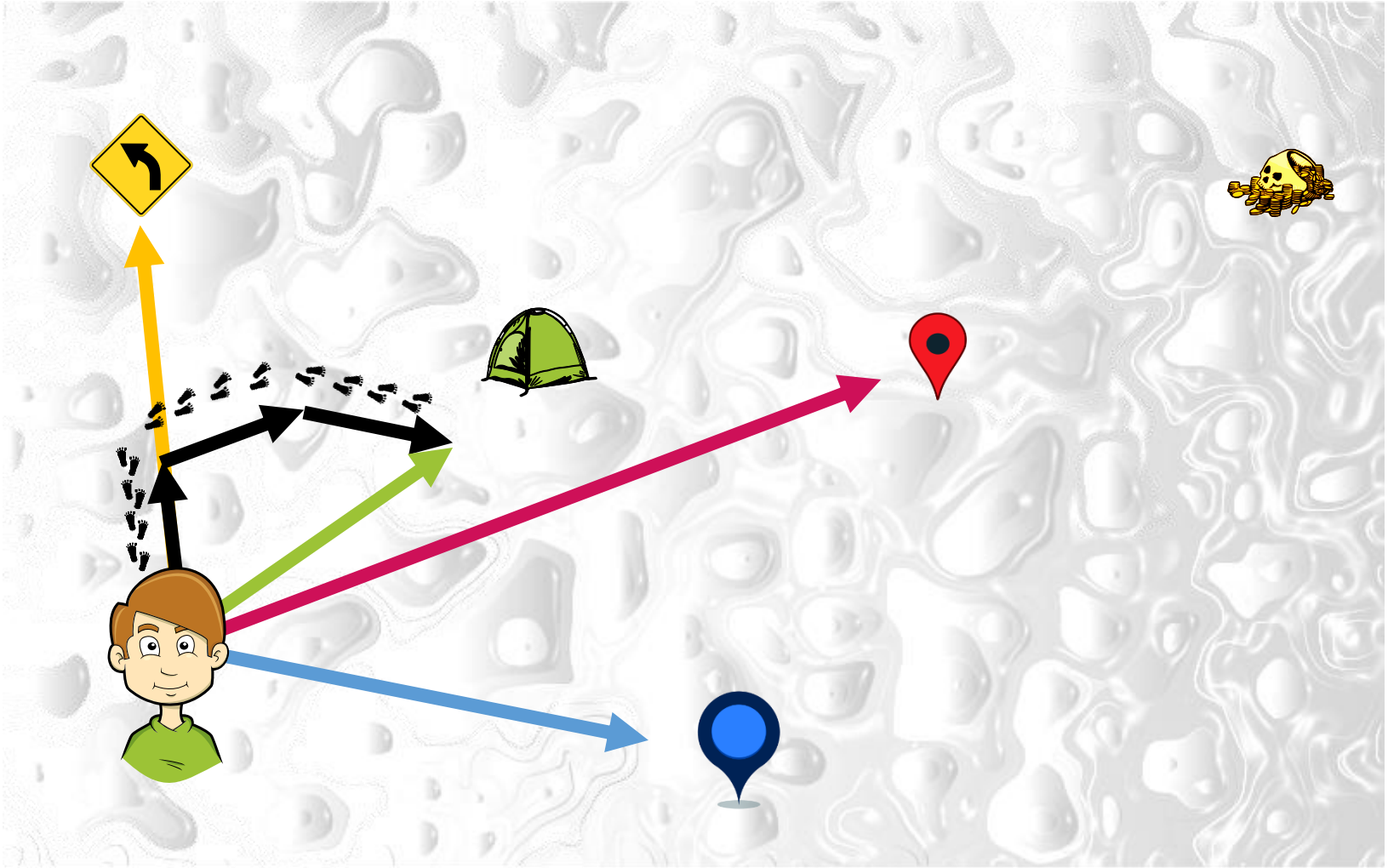

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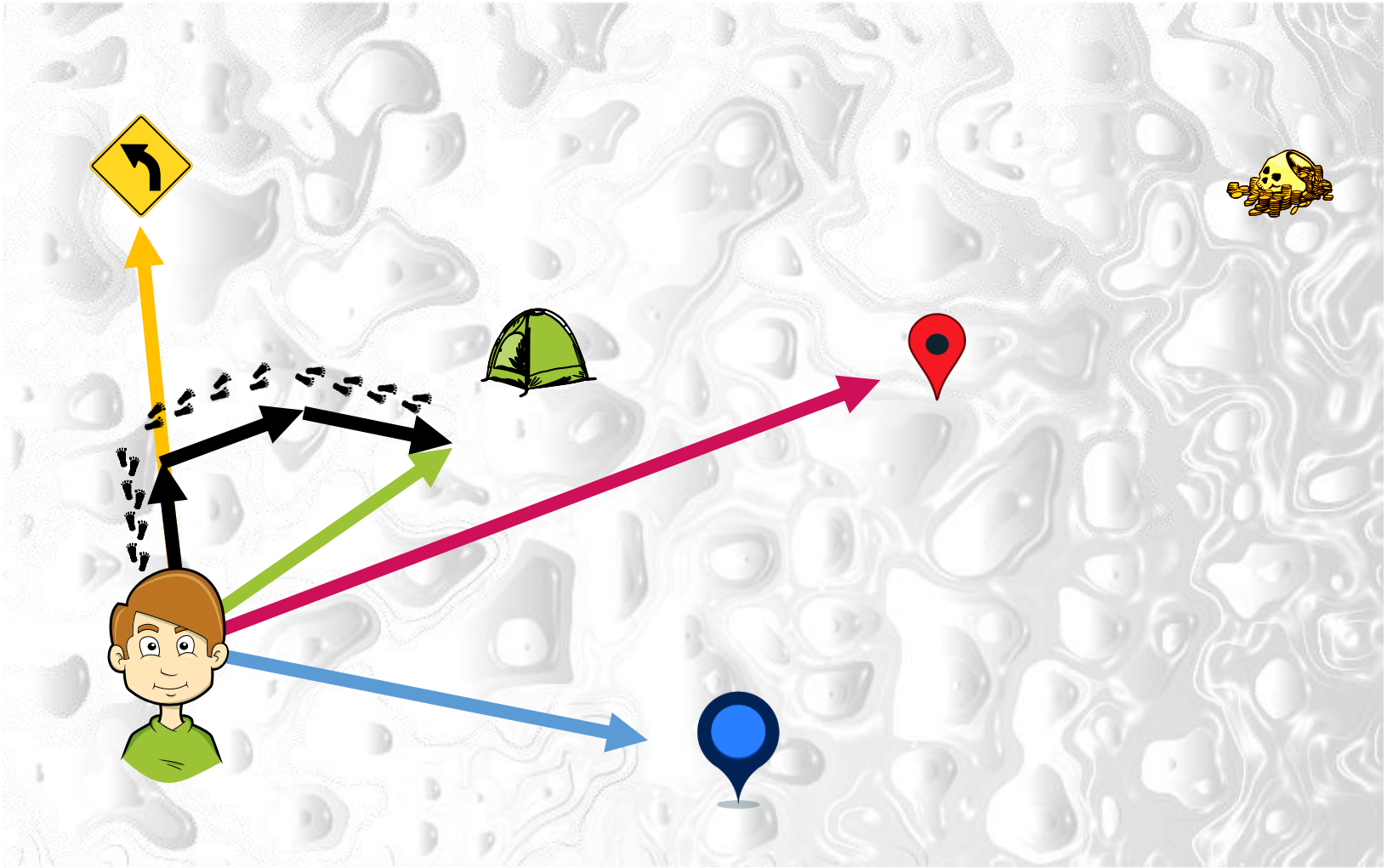


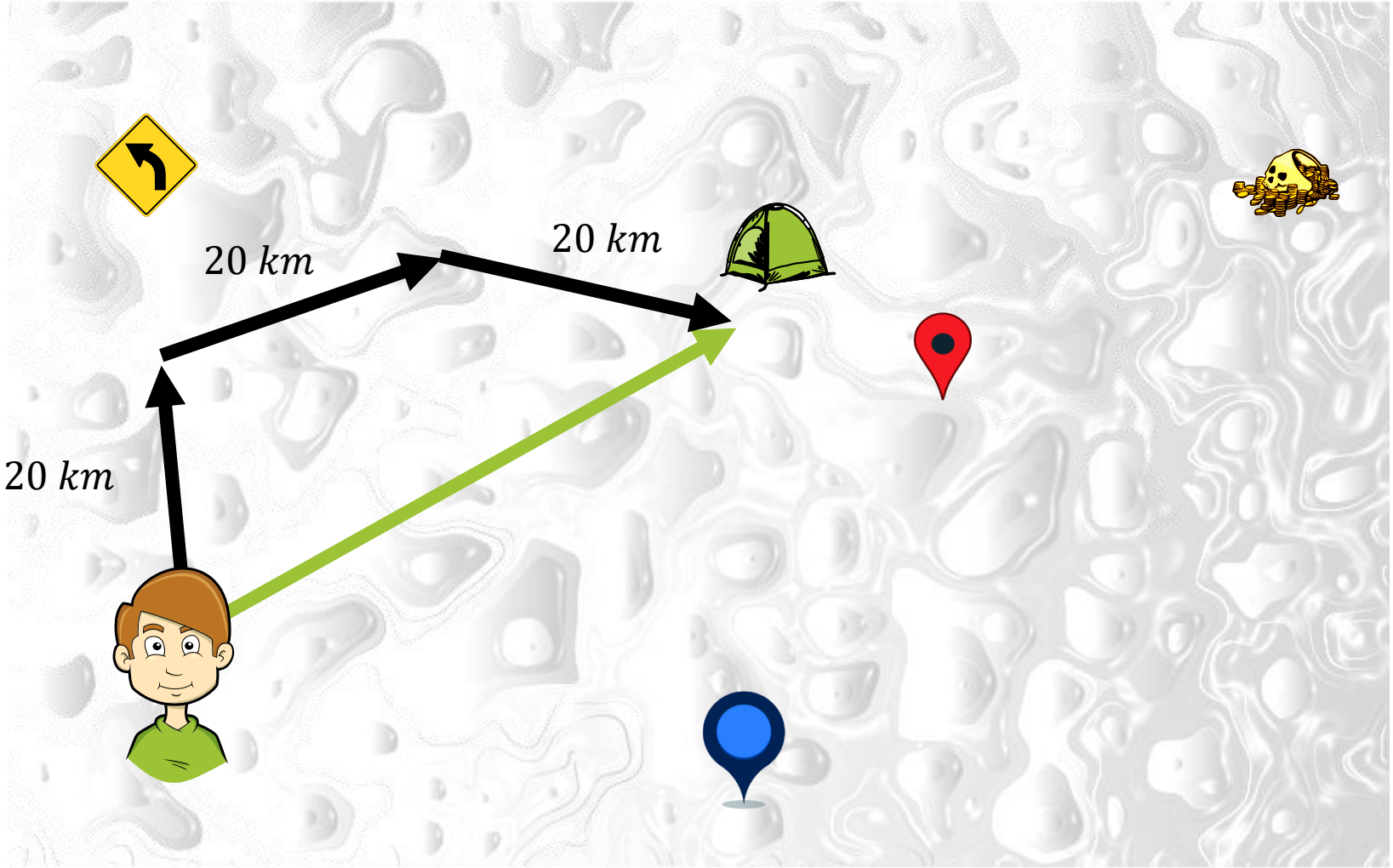
$2 \times r \times 10\ km$

$r\ in\ [0,1]$

PSO search strategy

$$2 \times r \times 10\ km$$
$$r\ in\ [0,1]$$

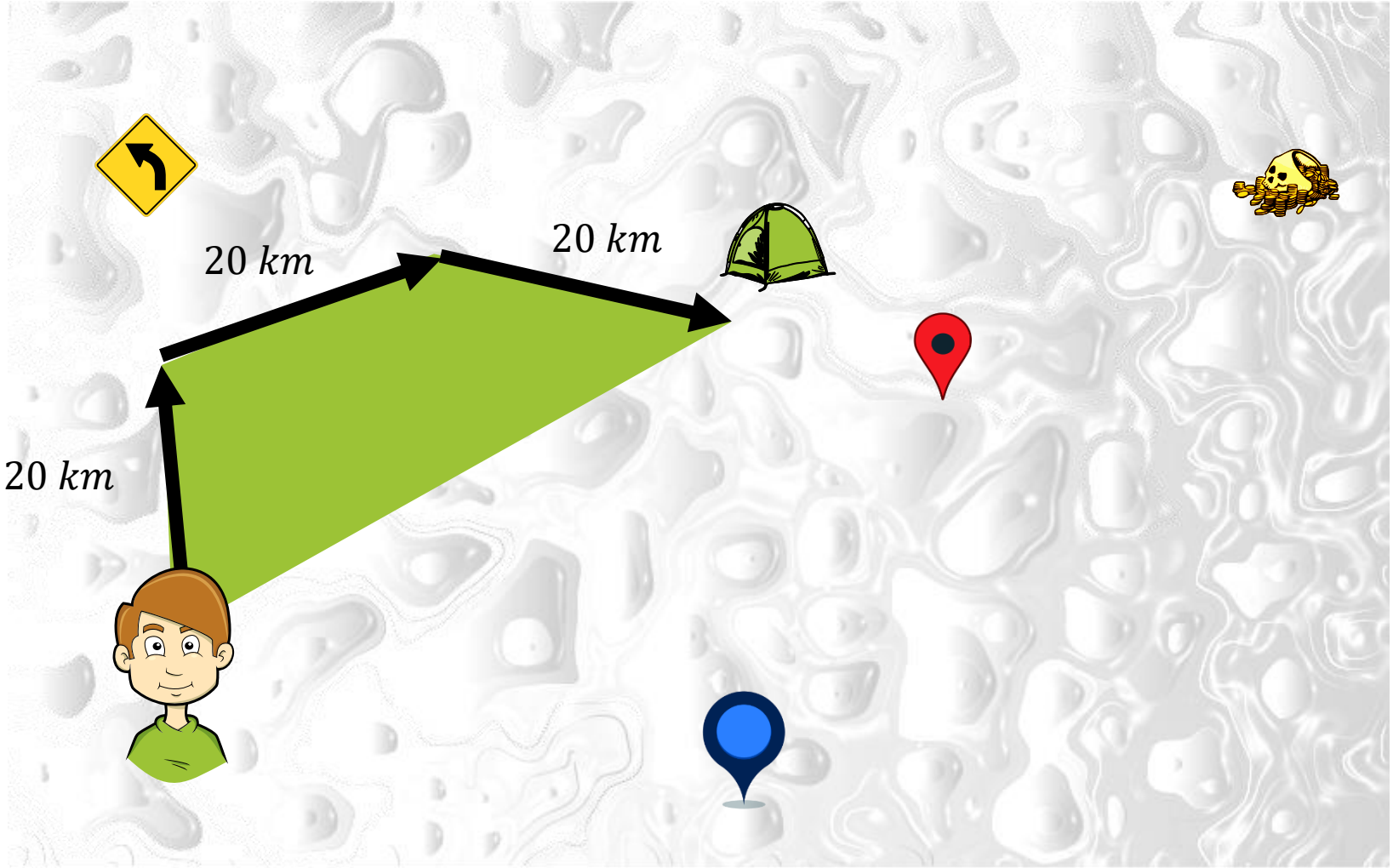
PSO search strategy



$2 \times r \times 10\ km$

$r\ in\ [0,1]$

PSO search strategy



$2 \times r \times 10\ km$

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PSO search strategy

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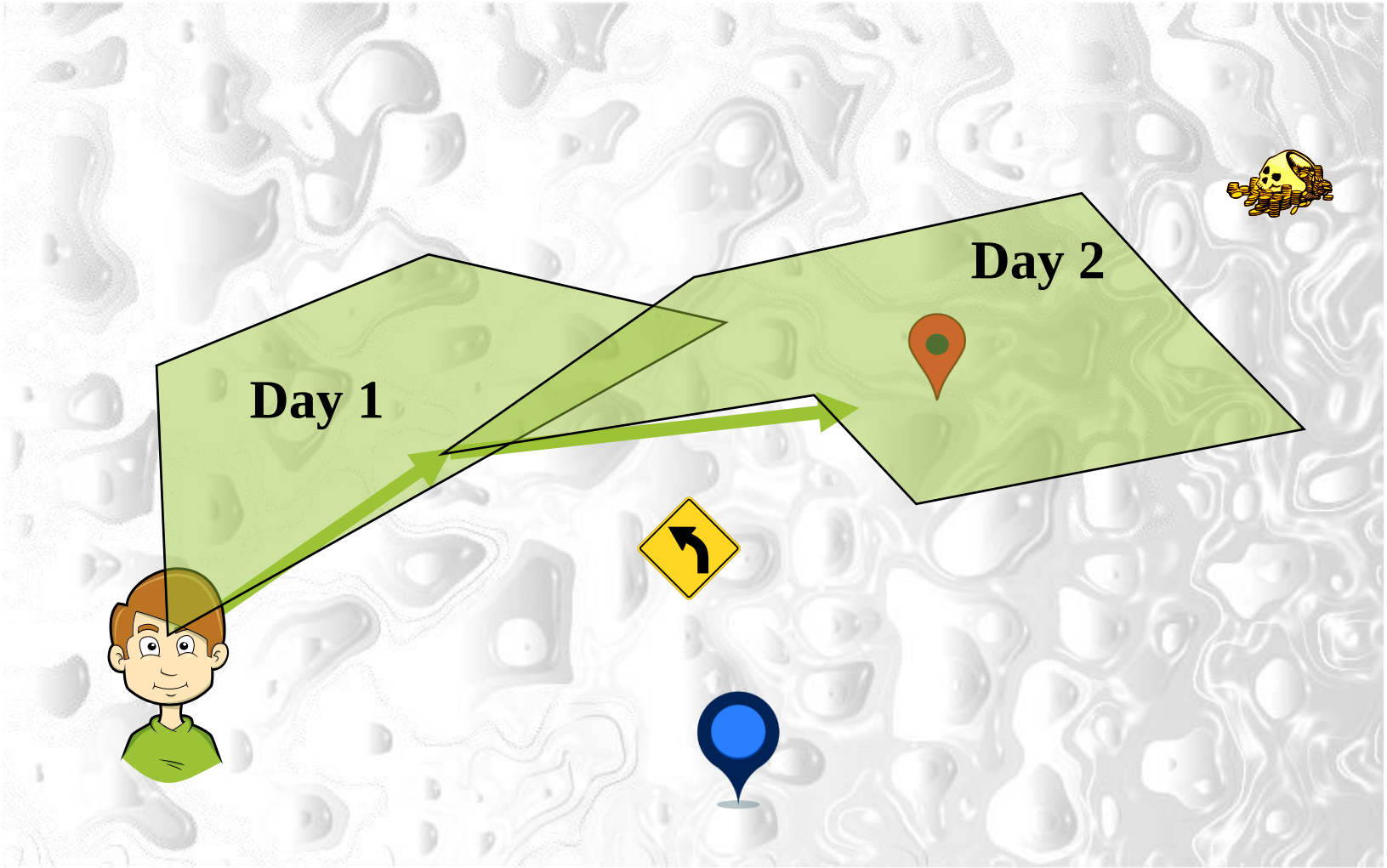

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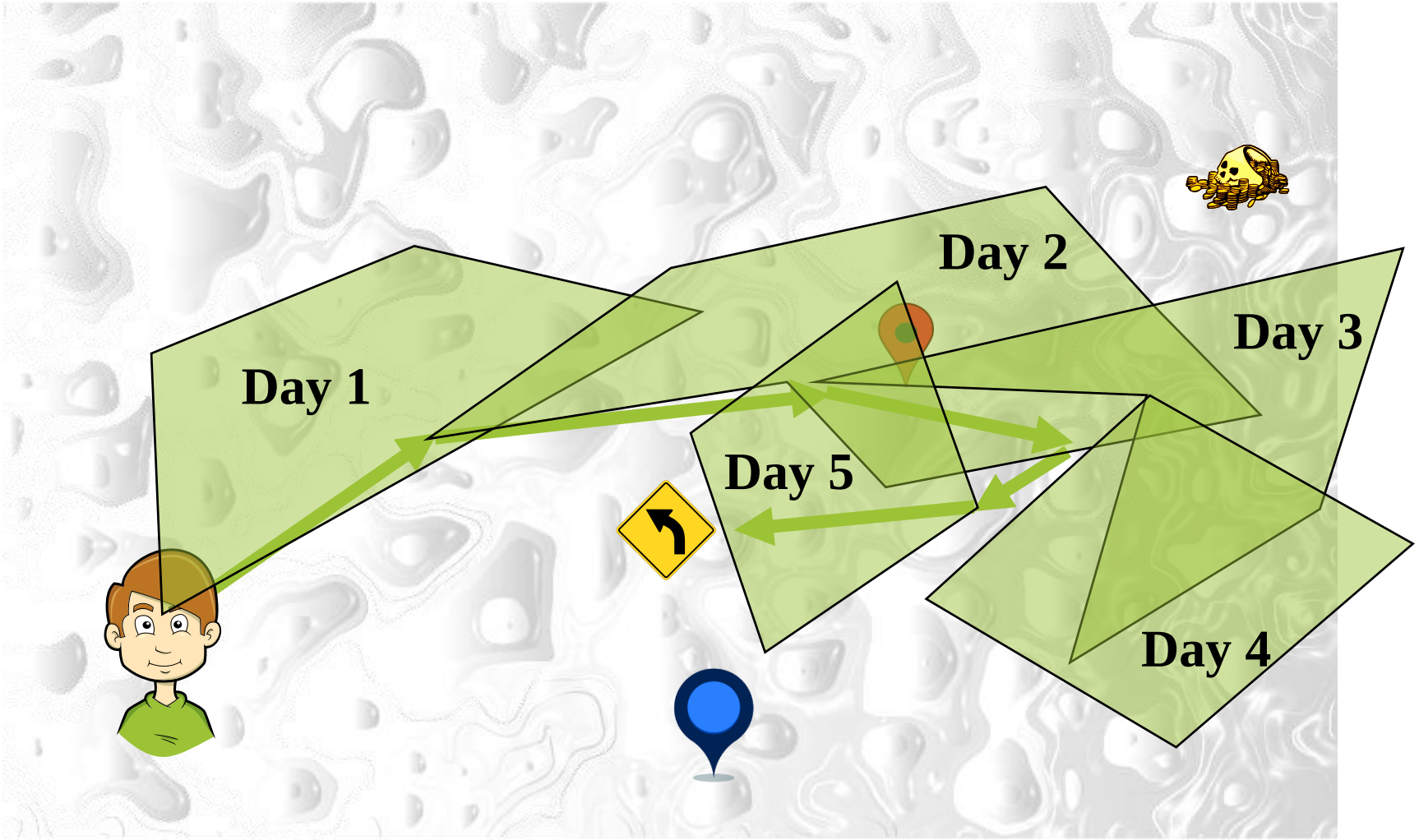

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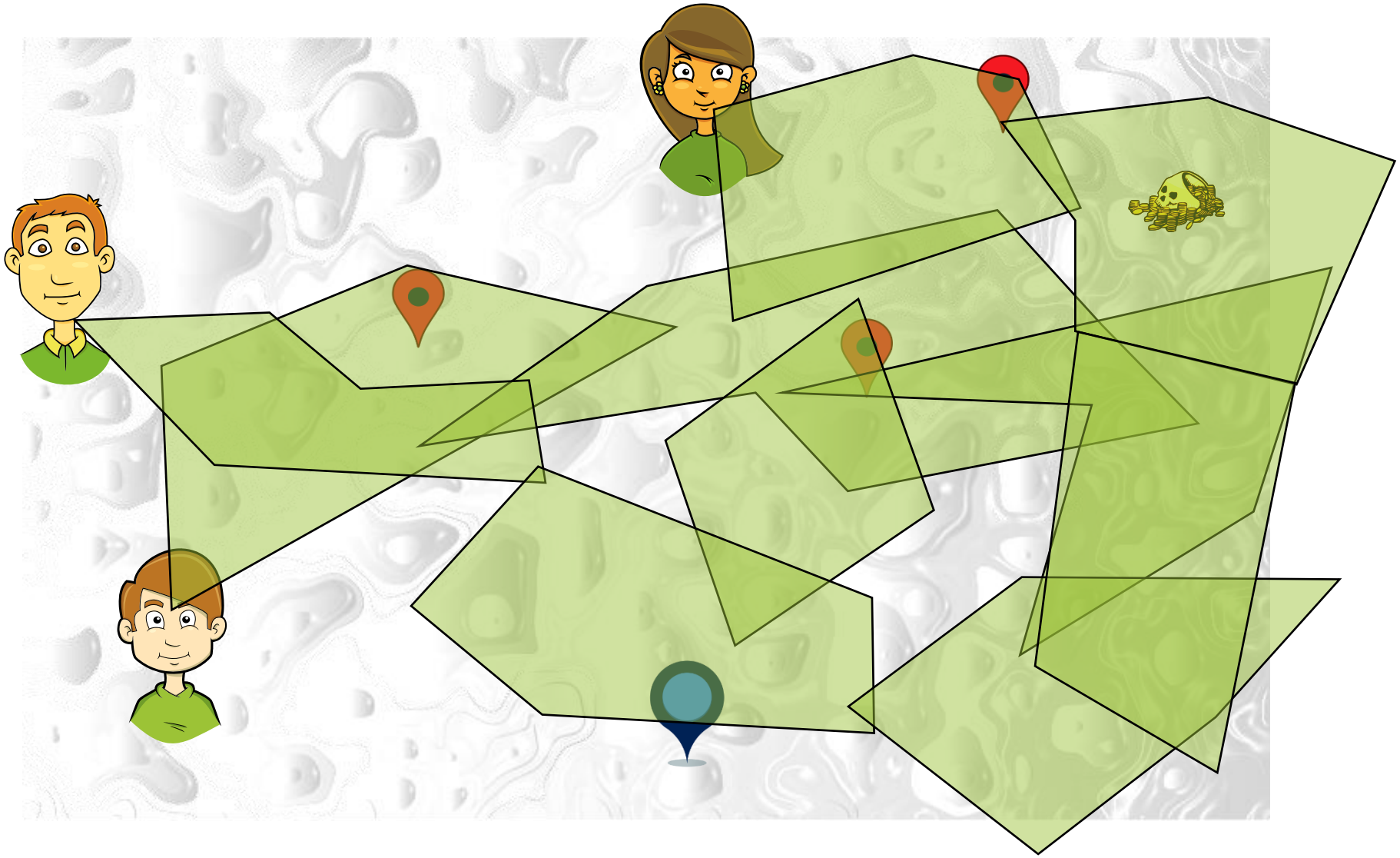

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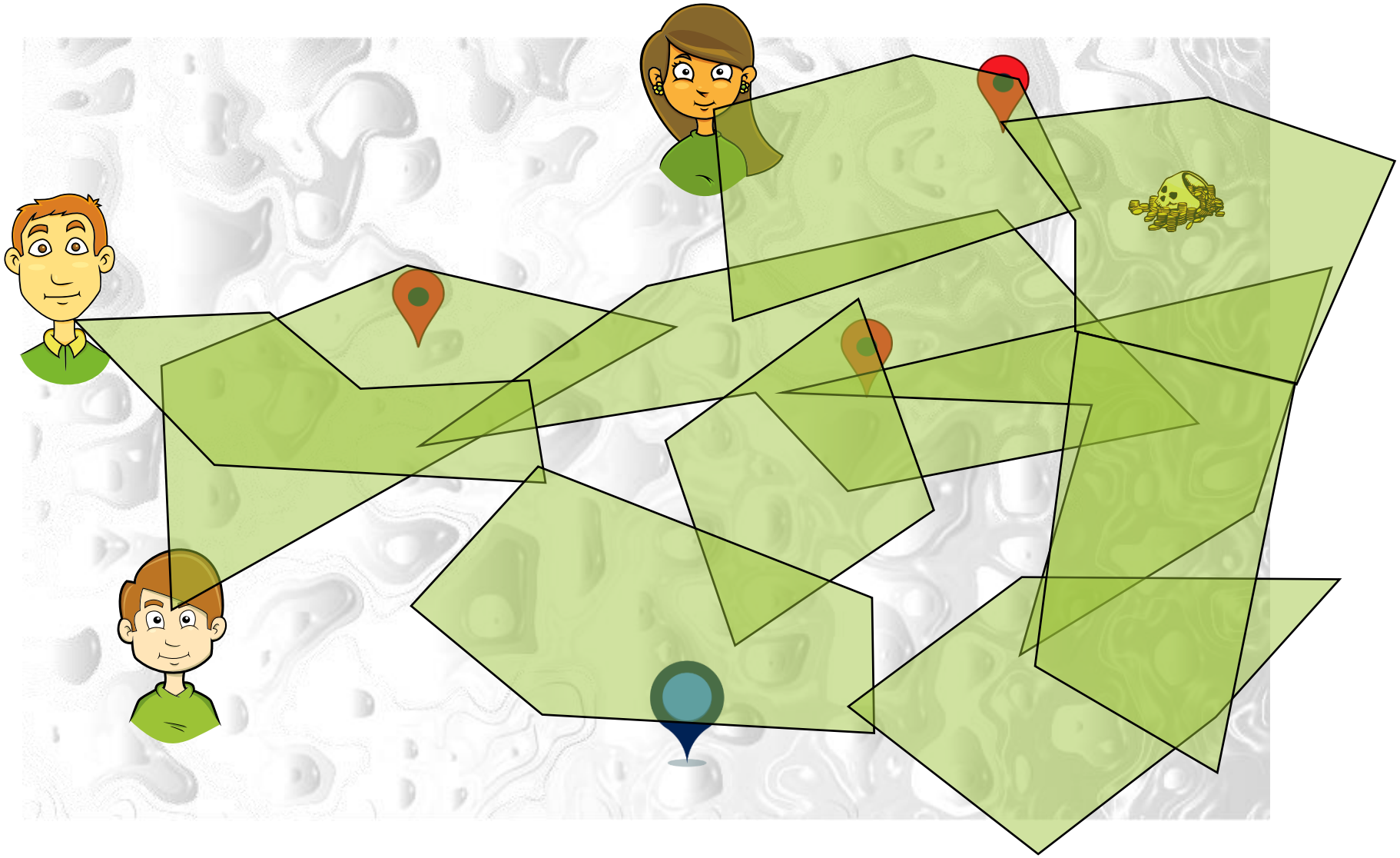

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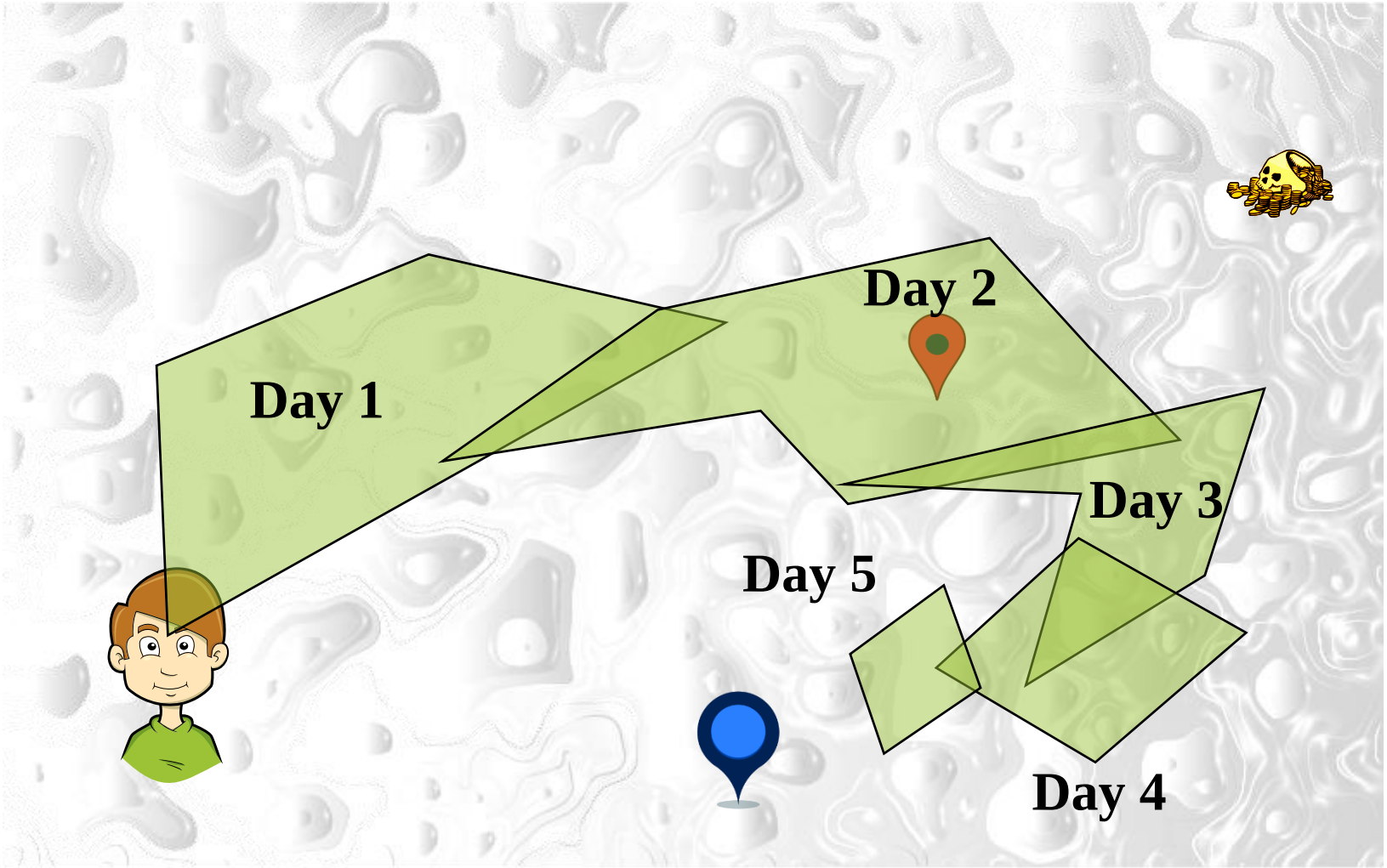

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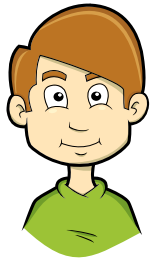
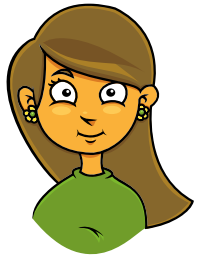


$$\overrightarrow{X_1^d} = [x_1^d, y_1^d]$$

Anthony

$$\overrightarrow{X_2^d} = [x_2^d, y_2^d]$$

Jennifer



$$\overrightarrow{X_3^d} = [x_3^d, y_3^d]$$

$$\overrightarrow{X_i^d} = [x_i^d, y_i^d, z_i^d, \dots]$$

PSO search strategy

$$\overrightarrow{V_i^{d+1}} = 2r_1 \overrightarrow{V_i^d} + 2r_2 \left(\overrightarrow{P_i^d} - \overrightarrow{X_i^d} \right) + 2r_3 \left(\overrightarrow{G^d} - \overrightarrow{X_i^d} \right)$$

Next velocity (tomorrow)

Current velocity (today)

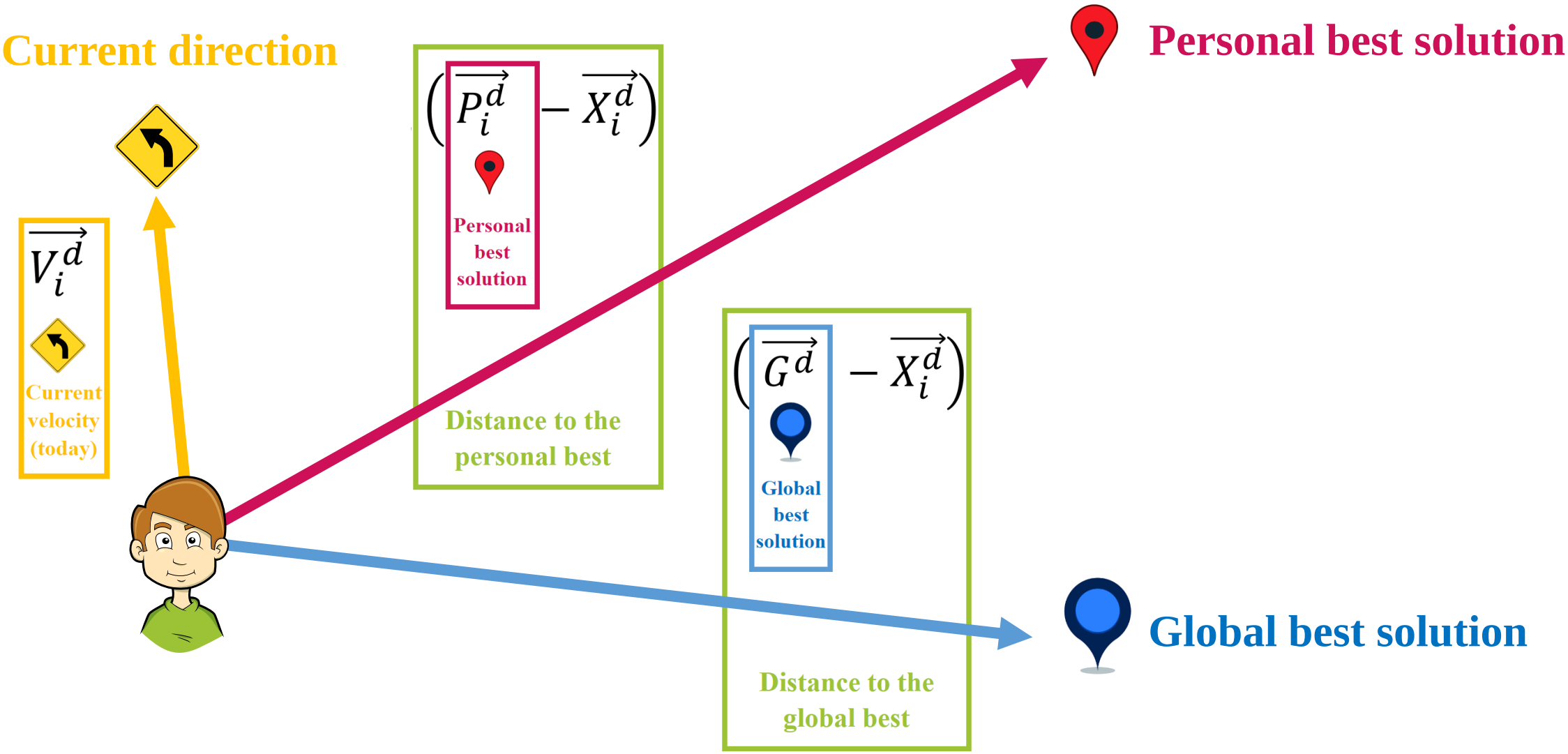
Personal best solution

Distance to the personal best

Global best solution

Distance to the global best

PSO search strategy



PSO search strategy

$$\overrightarrow{X_i^{d+1}} = \overrightarrow{X_i^{d}} + \overrightarrow{V_i^{d+1}}$$

Position in day *d+1*

Position in day *d*

Velocity in day *d+1*

Mathematical model of PSO

$$\overrightarrow{X_i^{t+1}} = \overrightarrow{X_i^t} + \overrightarrow{V_i^{t+1}}$$

$$\overrightarrow{V_i^{t+1}} = w\overrightarrow{V_i^t} + c_1 r_1 \left(\overrightarrow{P_i^t} - \overrightarrow{X_i^t}\right) + c_2 r_2 \left(\overrightarrow{G^t} - \overrightarrow{X_i^t}\right)$$

Inertia

Cognitive component

Social component

Mathematical model of PSO

$$\overrightarrow{X_i^{t+1}} = \overrightarrow{X_i^t} + \overrightarrow{V_i^{t+1}}$$

$$\overrightarrow{V_i^{t+1}} = w\overrightarrow{V_i^t} + c_1 r_1 \left(\overrightarrow{P_i^t} - \overrightarrow{X_i^t}\right) + c_2 r_2 \left(\overrightarrow{G^t} - \overrightarrow{X_i^t}\right)$$

Inertia

Cognitive component

Social component

Exploration and exploitation in PSO

$$\overrightarrow{X_i^{t+1}} = \overrightarrow{X_i^t} + \overrightarrow{V_i^{t+1}}$$

$$\overrightarrow{V_i^{t+1}} = w\overrightarrow{V_i^t} + c_1 r_1 \left(\overrightarrow{P_i^t} - \overrightarrow{X_i^t}\right) + c_2 r_2 \left(\overrightarrow{G^t} - \overrightarrow{X_i^t}\right)$$

Inertia

Cognitive component

Social component

Pseudo code of PSO

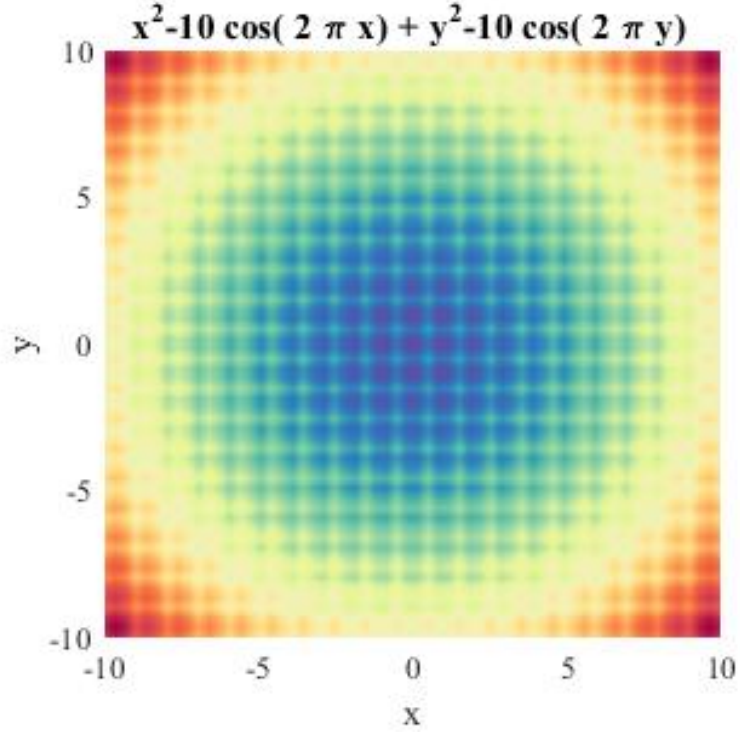
```
Initialize the controlling parameters (N, c1, c2, Wmin, Wmax, Vmax, and MaxIter)

Initialize the population of N particles

do
    for each particle
        calculate the objective of the particle
        Update PBEST if required
        Update GBEST if required
    end for

    Update the inertia weight
    for each particle
        Update the velocity (V)
        Update the position (X)
    end for

white the end condition is not satisfied

Return GBEST as the best estimation of the global optimum
```

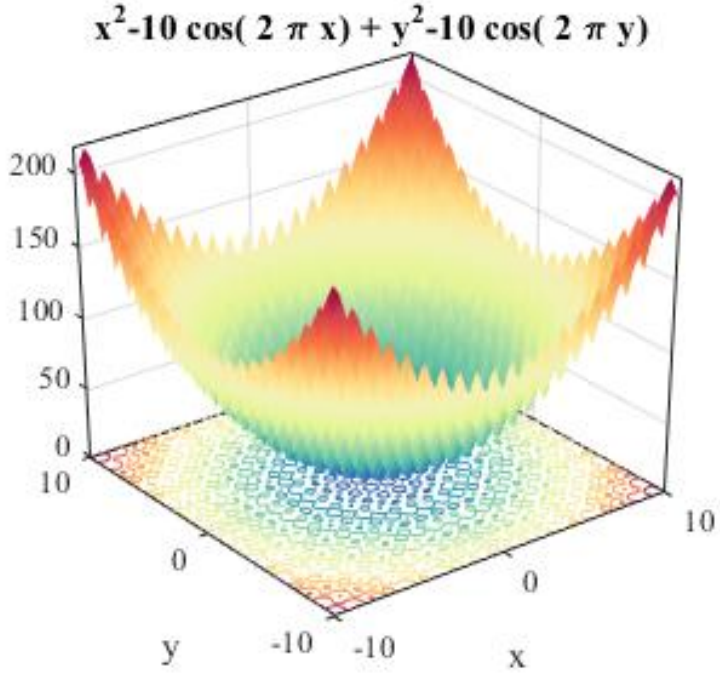
Test function

w 

c_1 

c_2 





Simulation of PSO

Effect of parameters

w 

Effect of parameters