AAE1001 Introduction to Artificial Intelligence and Data Analytics in Aerospace and Aviation Engineering

Week 8 (Project Tasks)

Dr Guohao Zhang, assisted by

Dr Penghui XU, Mr Zekun ZHANG, Mr Di HAI, Mr Yidi CHEN, Mr Zhen LYU

Necessary Information

- Course Repository (project download) link:
- https://github.com/IPNL-POLYU/PolyU_AAE1001_Github_Project

- TA Information & Contact:

Group 1-3: Dr Penghui XU - pengh.xu@polyu.edu.hk

Group 4-6: Mr Zekun ZHANG - zekun.zhang@connect.polyu.hk

Group 7-8: Mr Di HAI - 23037537R@connect.polyu.hk

Group 9-10: Mr Yidi CHEN - yi-di.chen@connect.polyu.hk

Group 11-12: Mr Zhen LYU - zhenn.lyu@connect.polyu.hk

Project Compulsory Tasks

Project Tasks for Flight Path Planning

1. Find an appropriate aircraft model that achieve the minimum cost for the challenge assigned to your group.
2. Design a new cost area that can reduce the cost of the route.
3. Design a new aircraft model within the constrains to achieve minimum cost for your group challenge.
4. Additional Tasks (see different slide)

The assessment of path planning part is based on the completion and the performance of 1, 2, 3 **(compulsory)** and 4 (additional), according to your: codes, answers on your report, and presentation

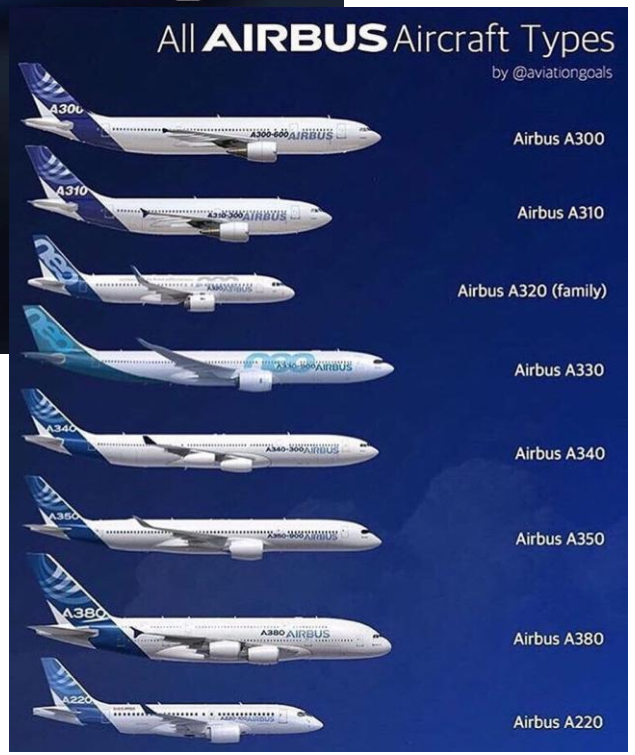
Task 1

Find an appropriate aircraft model that achieve minimum cost for each scenario for the challenge assigned to your group.

Aircraft Models

Many types of aircrafts nowadays
(Airbus, Boeing, Bombardier and more)

Each aircraft has different properties
-Capacity (Passenger and cargo) / **COST!**



- Costs of operating an aircraft might include:
  - **Crew cost**
  - **Fuel cost**
  - **Other operational costs**
  - **To keep it simple, costs can be approximated by:**

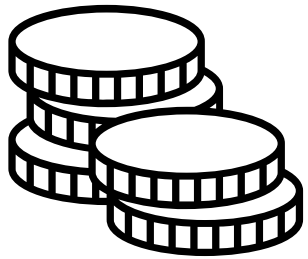
$$C = C_F \cdot \Delta F \cdot T_{best} + C_T \cdot T_{best} + C_c$$

C_F=cost of fuel per kg
ΔF=trip fuel

C_T=time related cost per minute of flight
ΔT=trip time

C_c=fixed cost independent of time

Task 1



Three scenarios with different requirements

Find the **shortest route** from the departure point to the arrival point, then **determine the aircraft type** for each scenario to achieve **minimum cost** while satisfying **passenger needs**

3 main factors affecting the total cost in this project:

- **Shortest distance**
- **Cost intensive area**
- **Aircraft fuel and time costs from different model**

Check out the example to understand this task better!

Task 1

Restrictions and rules:

- Only consider cruise time
- All aircrafts take 1 minute between nearby nodes ($\sqrt{2}$ minute on diagonal movement)
- Each group must use their own obstacle set
- 30% and 15% additional flight time for cost intensive area for Time and Fuel (e.g., 1min -> 1.3min)
- **You must calculate the travelling time for the fastest path by using and modifying the program**
- Only consider one type (from provided three) of aircraft in each scenario
- Time cost stays the same regardless of any vacancy in an aircraft
- Trip cost can be calculated manually, or automatically in program (bonus)

Cost Specification

	A321neo	A330-900neo	A350-900
Fuel Consumption rate (kg/min)	54	84	90
Passenger Capacity	200	300	350
Time cost (Low) ($/min)	10	15	20
Time cost (Medium) ($/min)	15	21	27
Time cost (High) ($/min)	20	27	34
Fixed Cost (C_c) ($)	1800	2000	2500
Source: https://www.airlines-inform.com/			

$$C = C_F \cdot \Delta F \cdot T_{best} + C_T \cdot T_{best} + C_c$$

C_F=cost of fuel per kg
C_T=time related cost per minute of flight
C_c=fixed cost independent of time

ΔF=trip fuel
ΔT=trip time

Task 1 - Example to Accomplish this Task

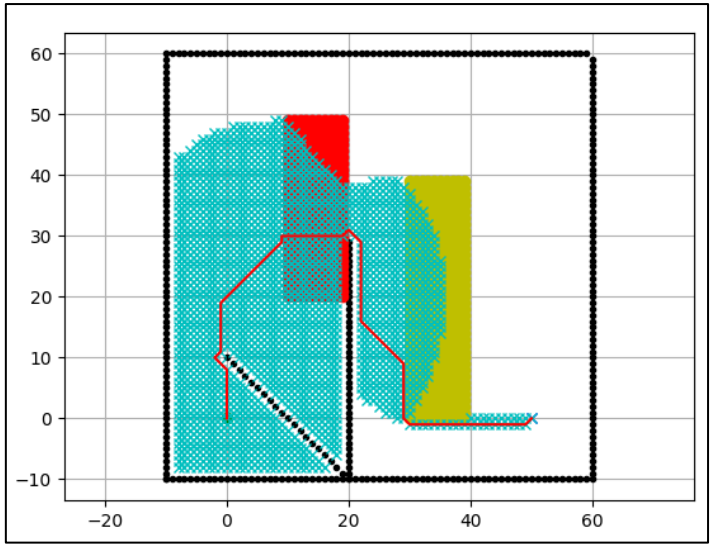
Scenario:

1. 2000 passengers travel from start to destination this week
2. 10 flights maximum for one week
3. Time cost = low, Fuel cost = 0.8 $/kg

First step: Find the shortest path for your obstacle set

1. Set up your obstacles and cost intensive areas using the path planning programme
2. Modify the program so it will calculate the time travelled, hence finds the fastest path (remember to modify cost intensive areas!)

**In this example, the shortest path is planned to be 100 minutes. Considering the cost intensive areas, the fastest path is 120 minutes*



What the working program should look like

*Task 1 tutorial video: https://youtu.be/hmlWX5OEs5U

Task 1 - Example to Accomplish this Task

Second step: Consider the cost factors

1. Count number of flights for aircraft models

Maximum 10 flights for 2000 passengers:
ten A321 flights, seven A330 flights or six A350 flights

2. Calculate trip cost from available numbers:

A321: (0.8$/kg x 54 kg/min x 120min + 10 $/min x 120 min + 1800) x 10 flights = $81840
A330: (0.8$/kg x 84 kg/min x 120min + 15 $/min x 120 min + 2000) x 7 flights = $83048
A350: (0.8$/kg x 90 kg/min x 120min + 20 $/min x 120 min + 2500) x 6 flights = $81240

(can be done inside programme, bonus)

3. As the total cost of operating A350 is the lowest, the answer for this example is **6 flights of A350**!

Cost Specification

	A321neo	A330-900neo	A350-900
Fuel Consumption rate (kg/min)	54	84	90
Passenger Capacity	200	300	350
Time cost (Low) ($/min)	10	15	20
Time cost (Medium) ($/min)	15	21	27
Time cost (High) ($/min)	20	27	34
Fixed Cost (C_c) ($)	1800	2000	2500
Source: https://www.airlines-inform.com/			

$$C = C_F \cdot \Delta F \cdot T_{best} + C_T \cdot T_{best} + C_c$$

C_F=cost of fuel per kg
C_T=time related cost per minute of flight
C_c=fixed cost independent of time

ΔF=trip fuel
ΔT=trip time

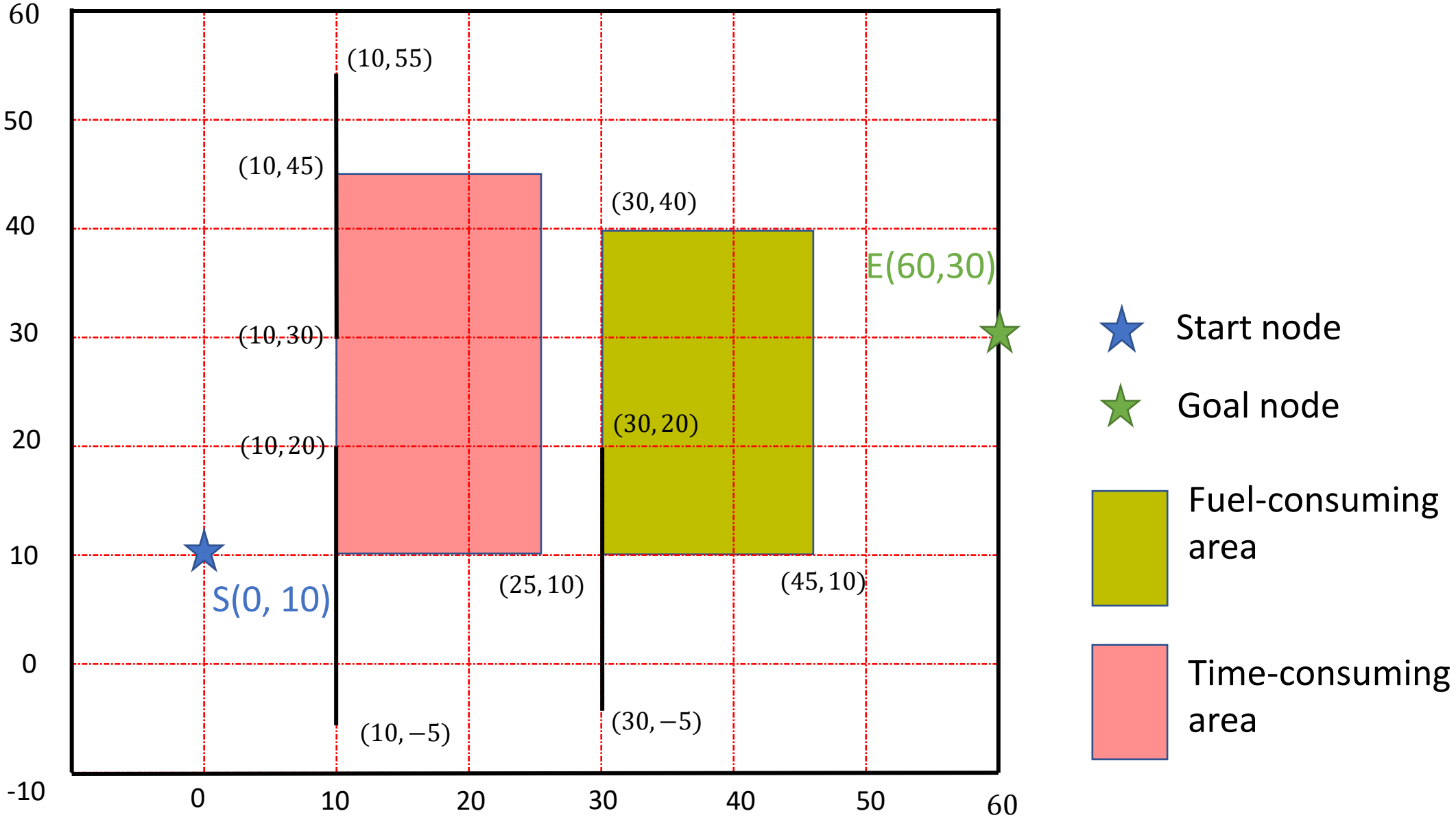
Task 1 - Scenarios

Scenario 1
1. 3300 Passengers need to travel within this week from the start to the destination
2. 13 flights maximum for one week
3. Time cost = medium and Fuel cost = 0.85 $/kg

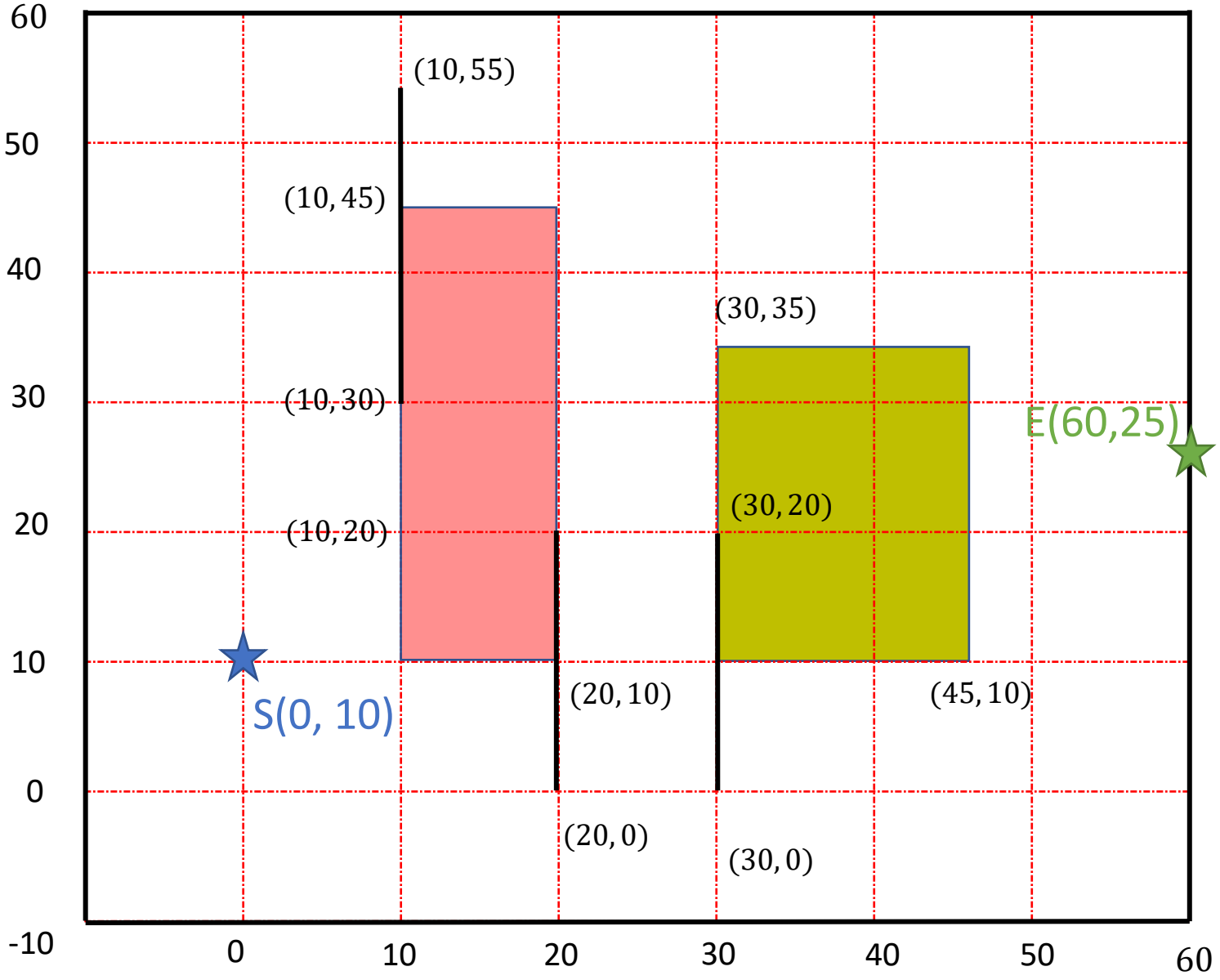
Scenario 2
1. 1500 Passengers need to travel within this month from the start to the destination
2. 7 flights maximum for one week
3. Time cost = high and Fuel cost = 0.96 $/kg

Scenario 3
1. 2250 Passengers need to travel within this week from the start to the destination
2. 25 flights maximum for one week
3. Time cost = low and Fuel cost = 0.78 $/kg

Group 1


60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
(10, 55)
(10, 45)
(10, 30)
(10, 20)
(10, −5)
(30, 40)
(30, 20)
(30, −5)
(25, 10)
(45, 10)
S(0, 10)
E(60,30)
Start node
Goal node
Fuel-consuming area
Time-consuming area

Group 2



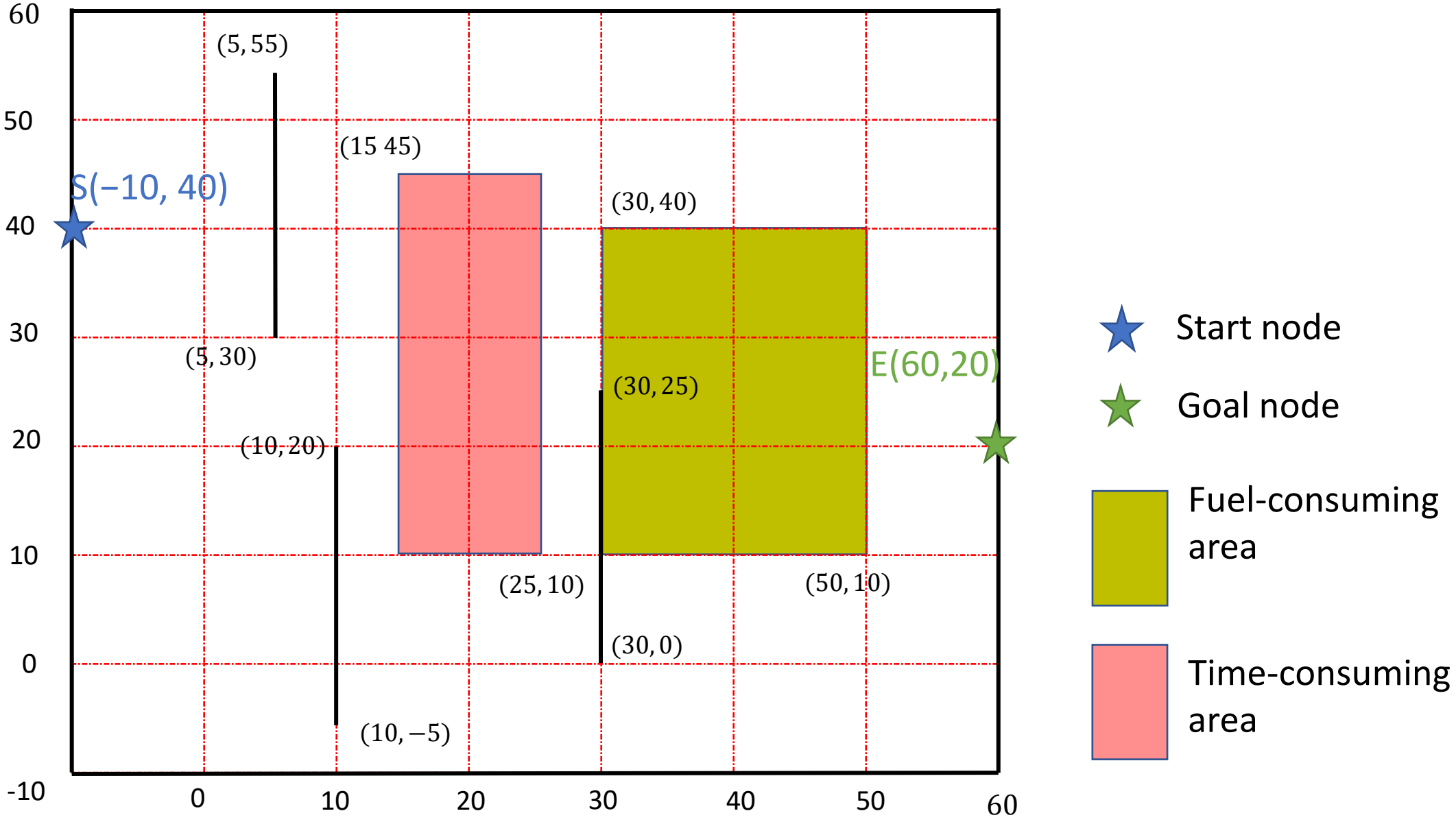
Start node

Goal node

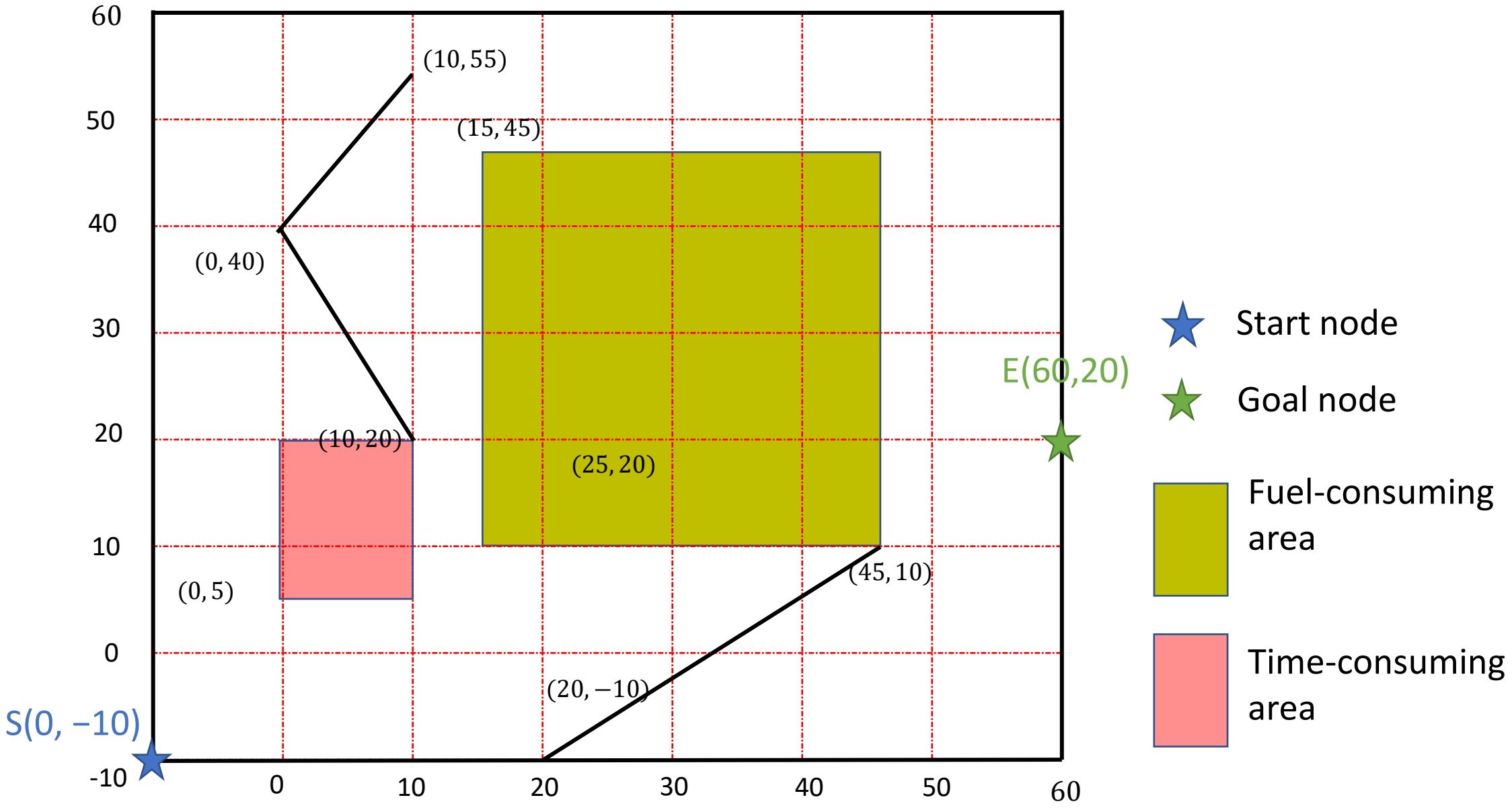
Fuel-consuming area

Time-consuming area

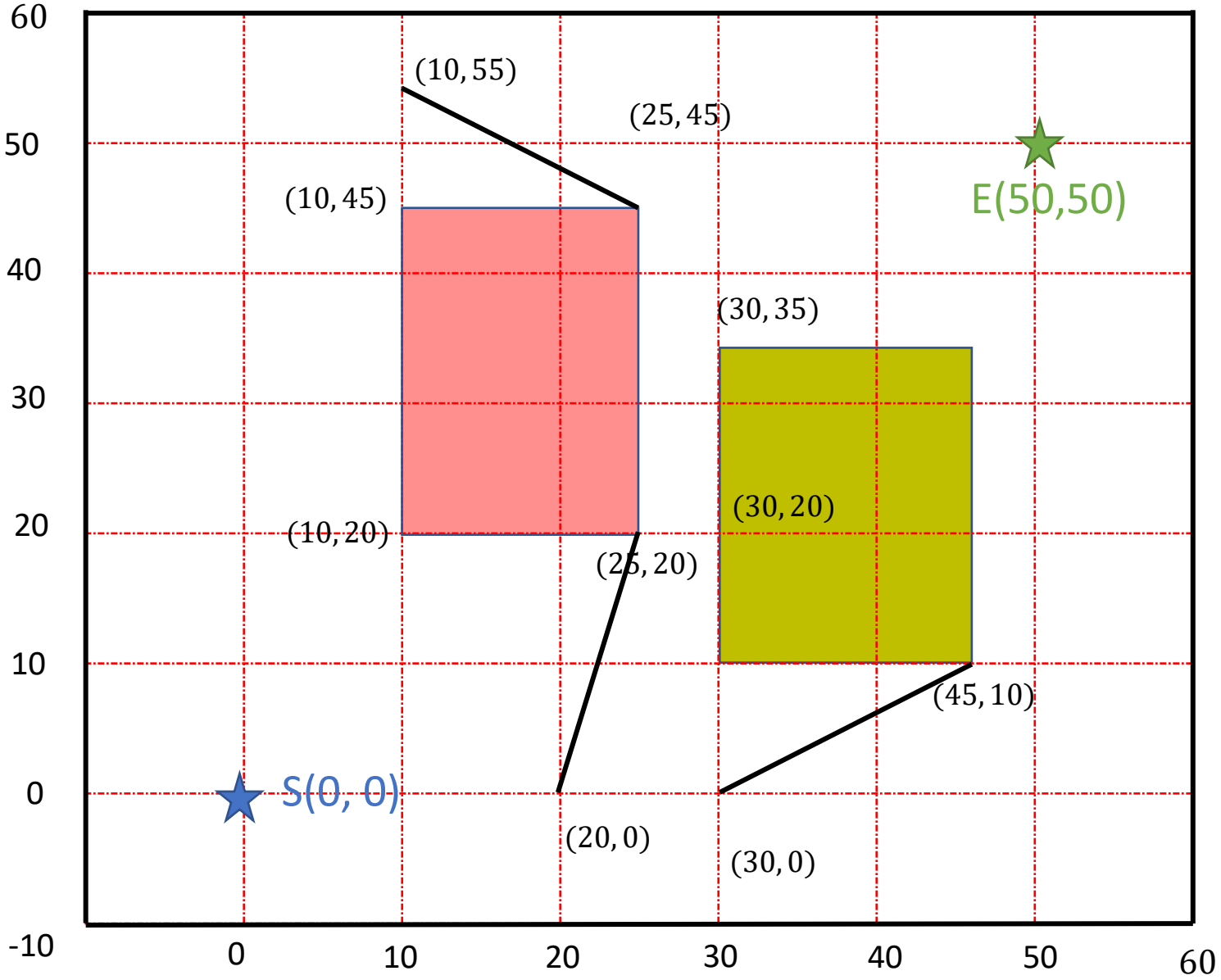
Group 3


60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
(5, 55)
(15 45)
S(−10, 40)
(30, 40)
(5, 30)
(30, 25)
E(60,20)
(10, 20)
(25, 10)
(50, 10)
(30, 0)
(10, −5)
Start node
Goal node
Fuel-consuming area
Time-consuming area

Group 4


60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
(10, 55)
(15, 45)
(0, 40)
(10, 20)
(25, 20)
(0, 5)
(45, 10)
(20, −10)
S(0, −10)
E(60,20)
Start node
Goal node
Fuel-consuming area
Time-consuming area

Group 5



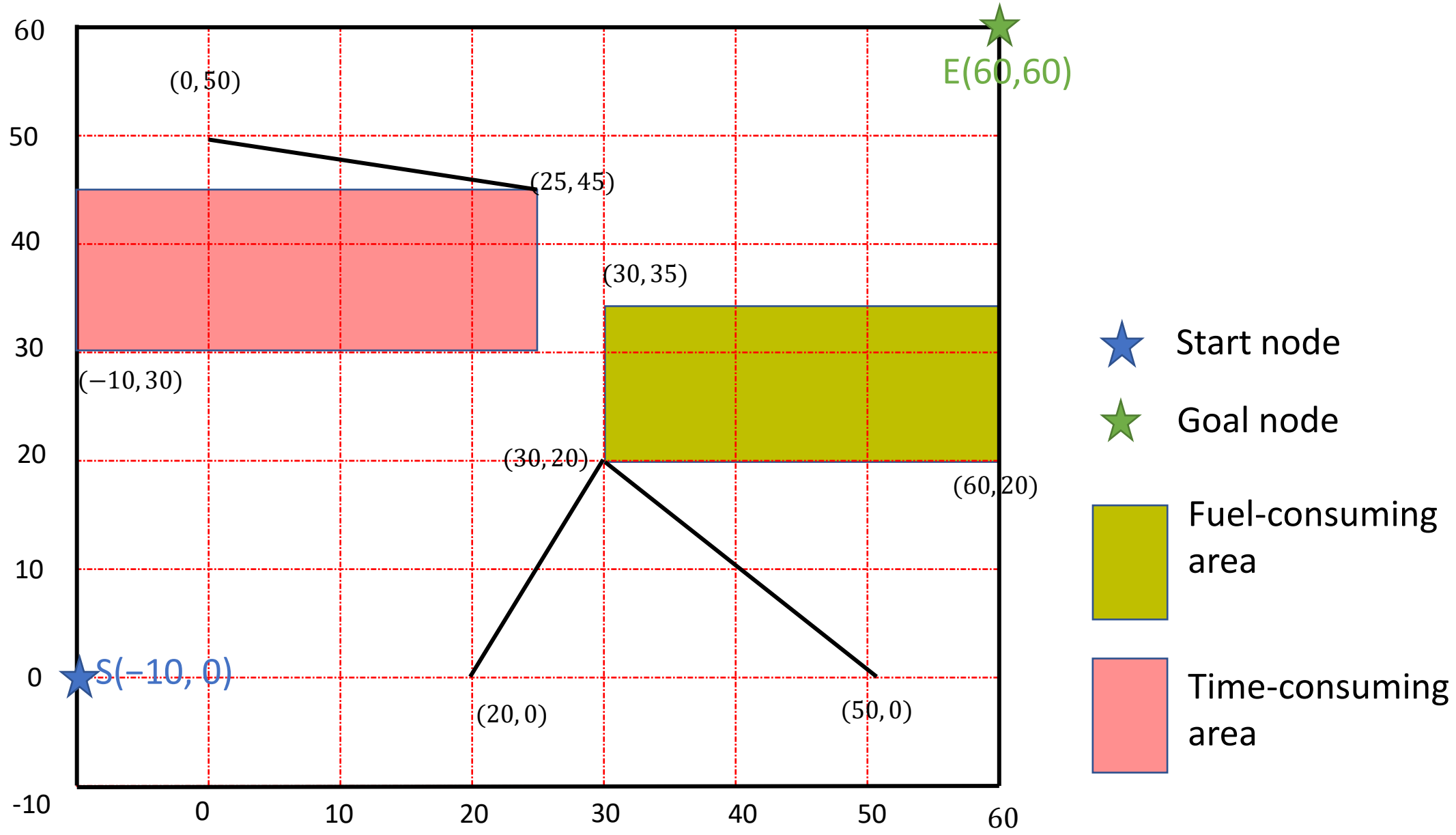
Start node

Goal node

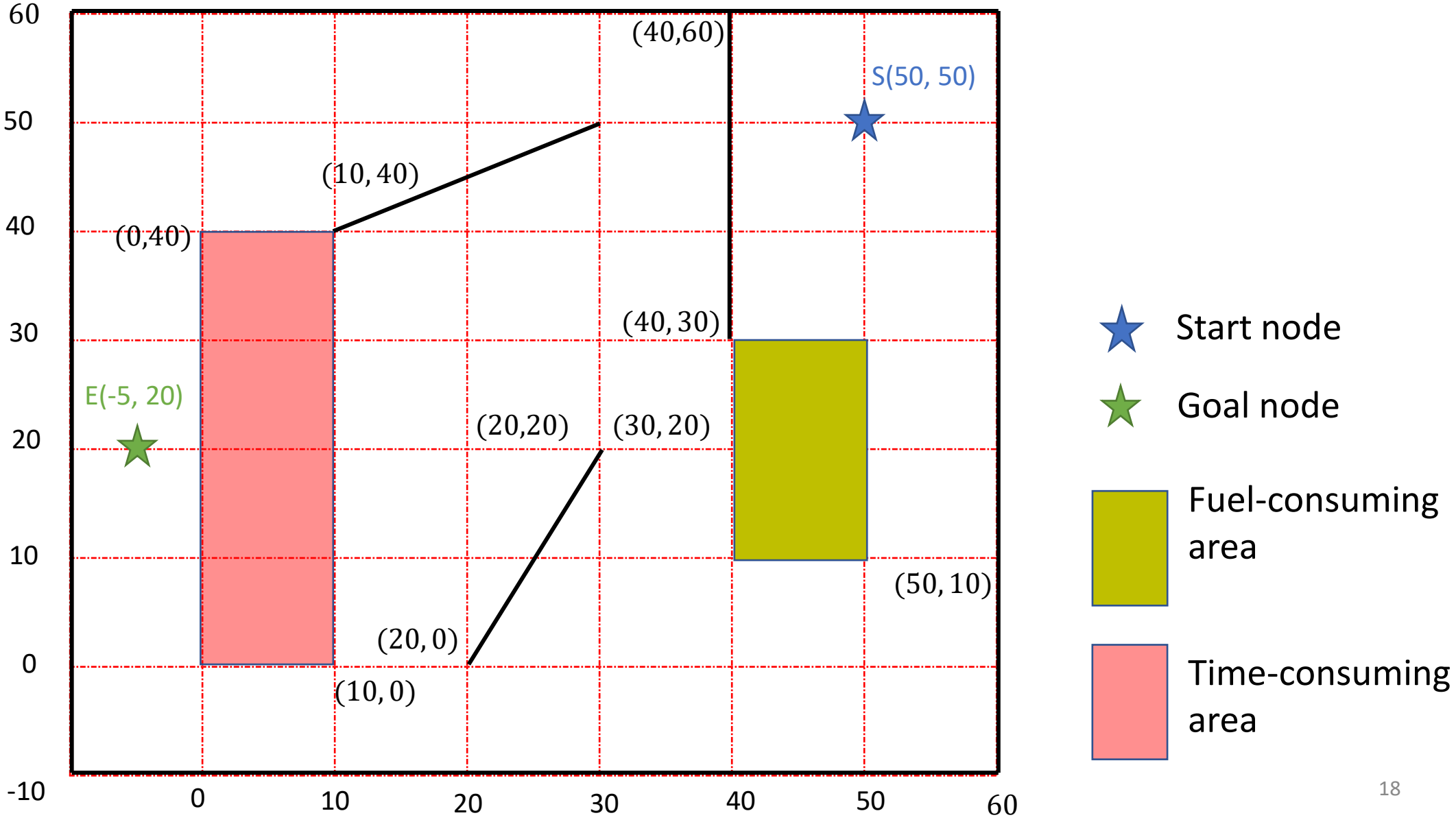
Fuel-consuming area

Time-consuming area

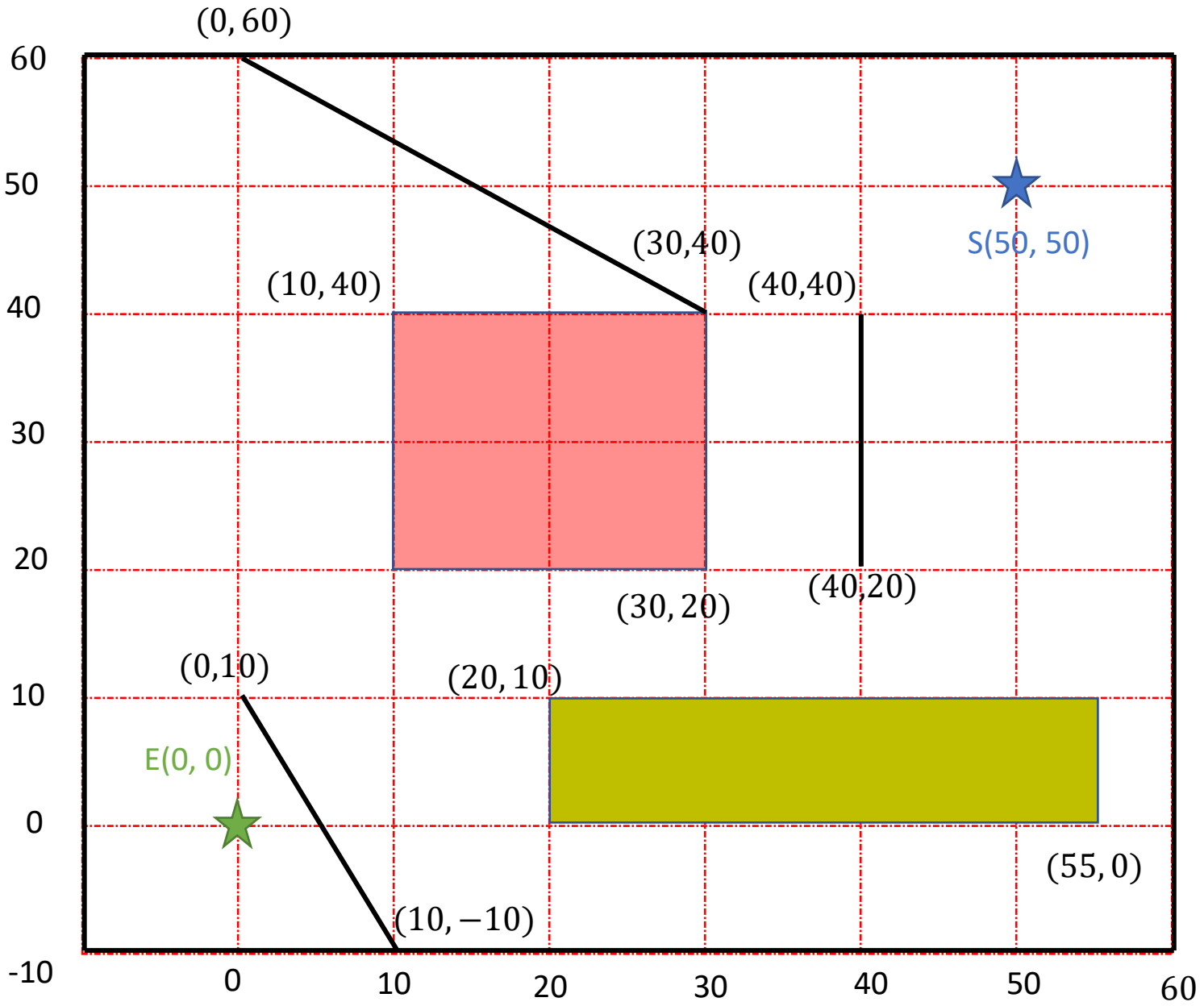
Group 6


60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
(0, 50)
(25, 45)
(30, 35)
(−10, 30)
(30, 20)
(60, 20)
(20, 0)
(50, 0)
E(60,60)
S(−10, 0)
Start node
Goal node
Fuel-consuming area
Time-consuming area

Group 7


60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
(40,60)
S(50, 50)
(10, 40)
(0,40)
(40, 30)
E(-5, 20)
(20,20)
(30, 20)
(50, 10)
(20, 0)
(10, 0)
Start node
Goal node
Fuel-consuming area
Time-consuming area

Group 8



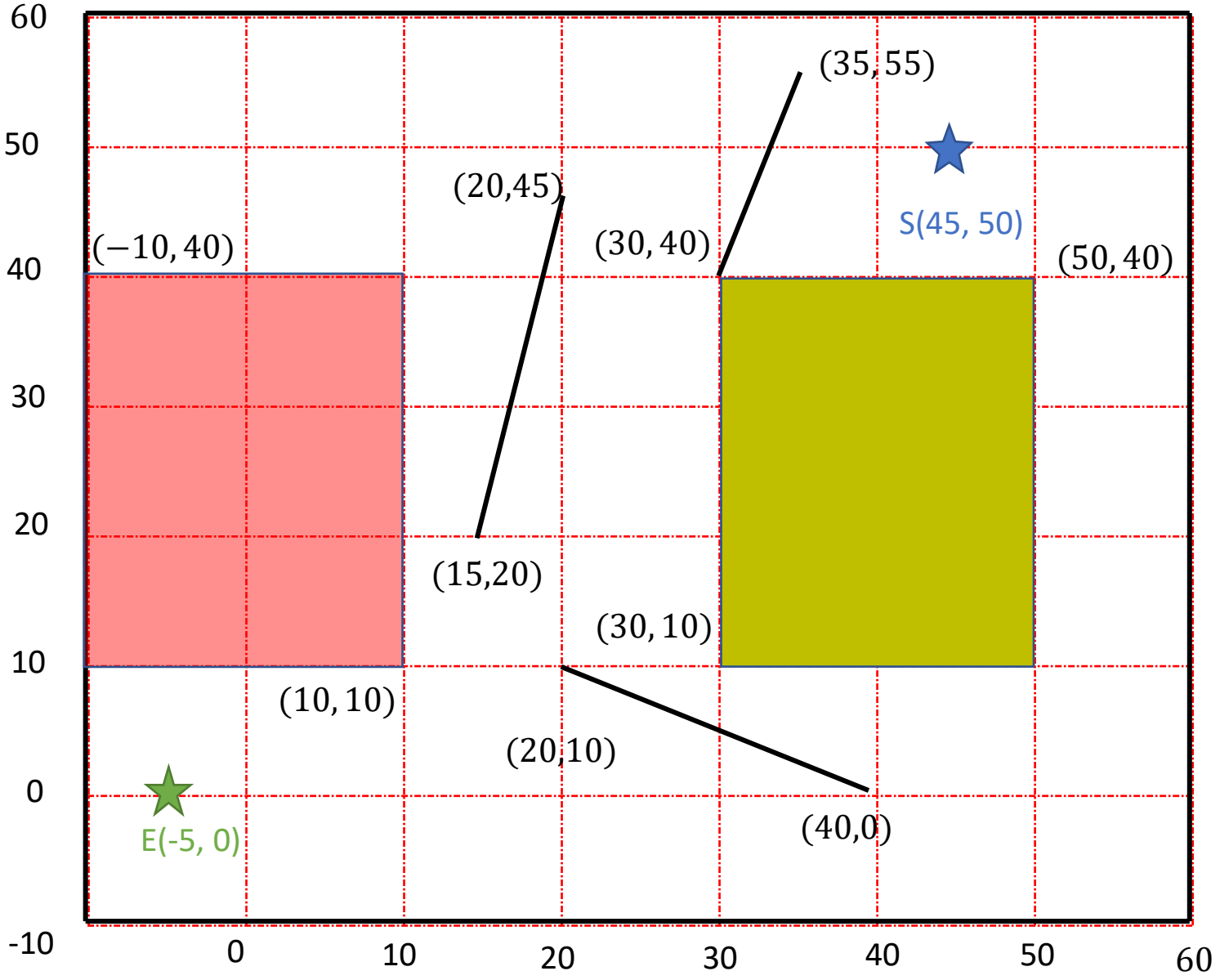
Start node

Goal node

Fuel-consuming area

Time-consuming area

Group 9



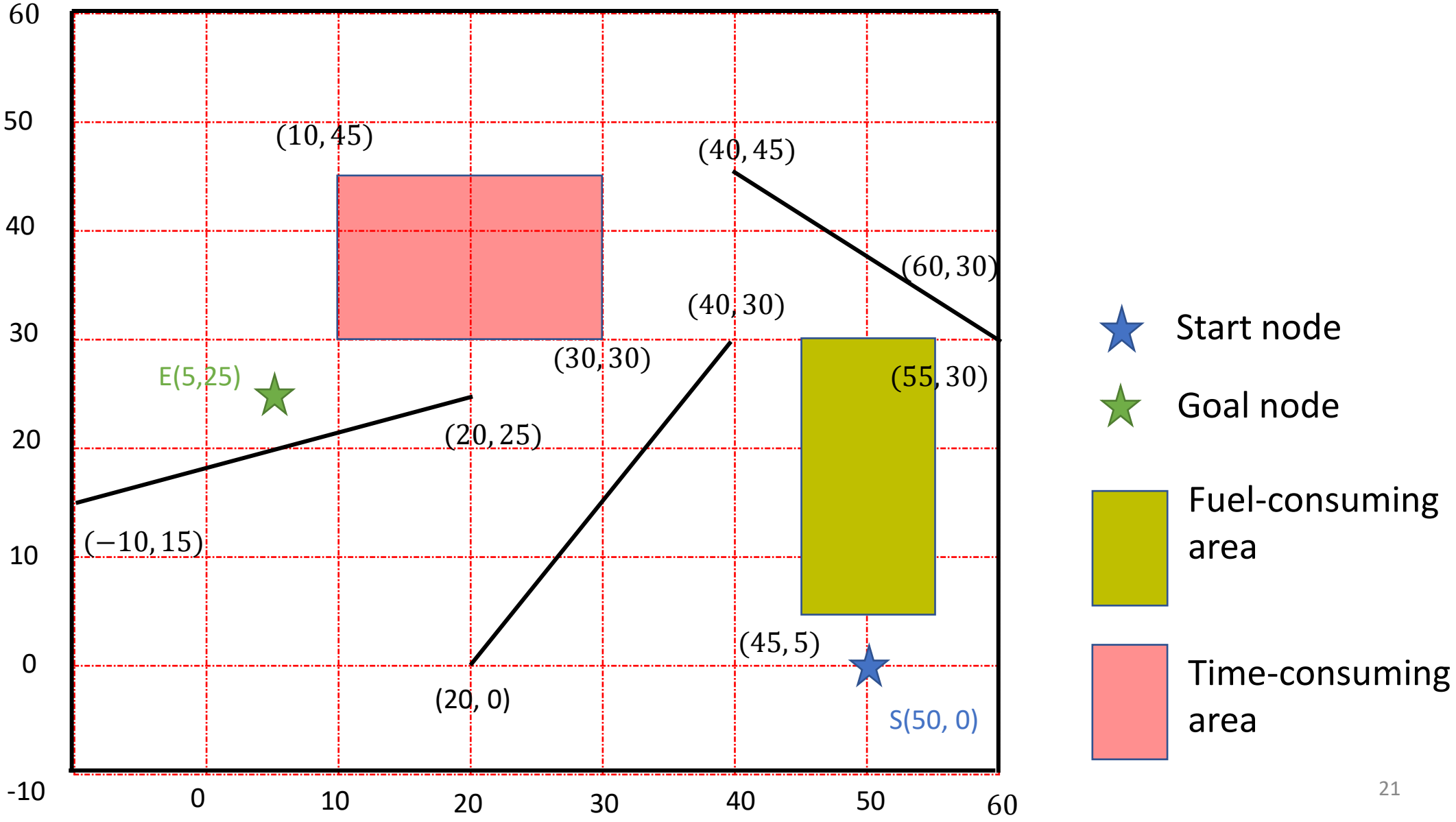
Start node

Goal node

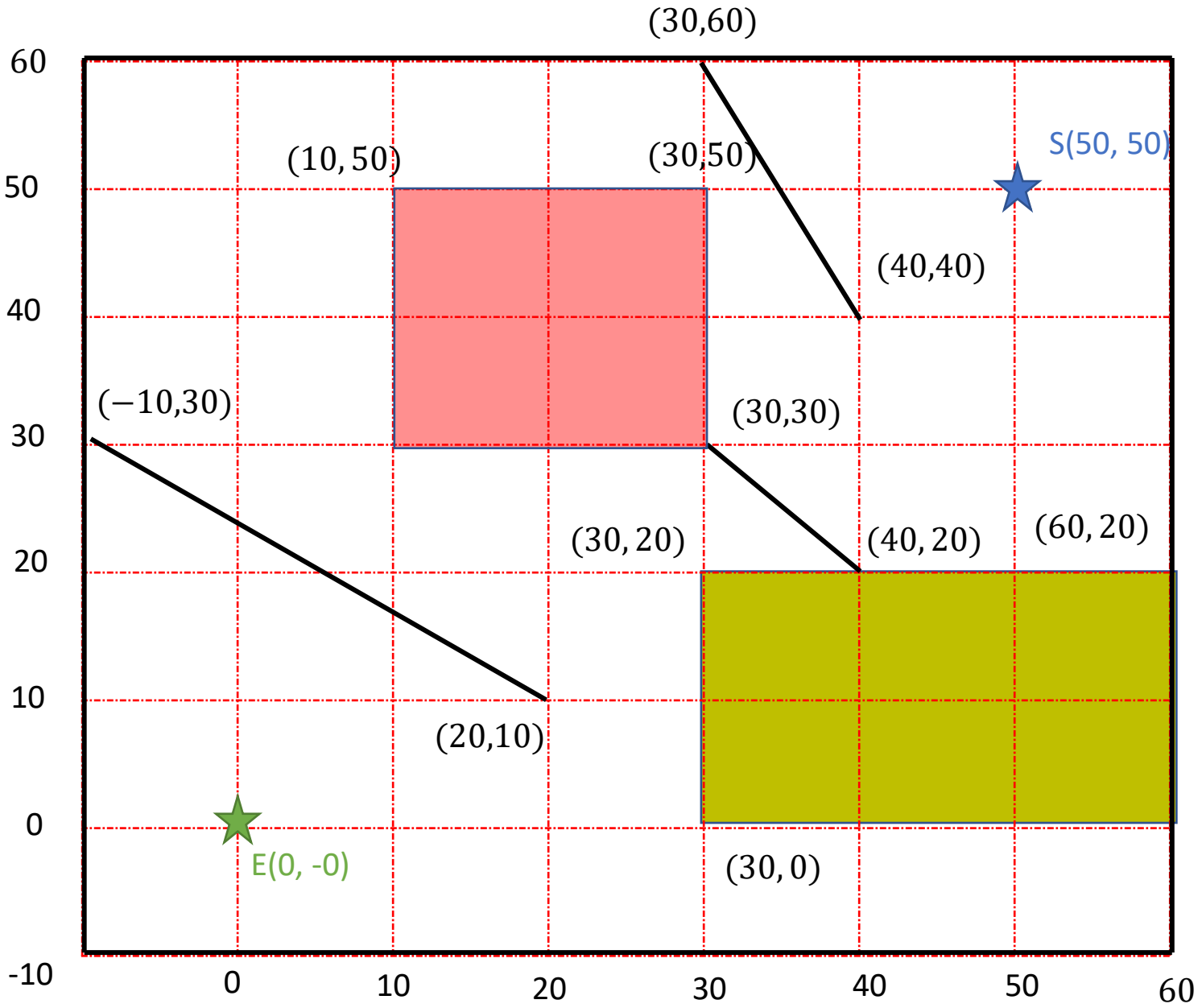
Fuel-consuming area

Time-consuming area

Group 10


60
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
(10, 45)
(40, 45)
(60, 30)
(40, 30)
(30, 30)
(55, 30)
E(5,25)
(20, 25)
(−10, 15)
(45, 5)
(20, 0)
S(50, 0)
Start node
Goal node
Fuel-consuming area
Time-consuming area

Group 11



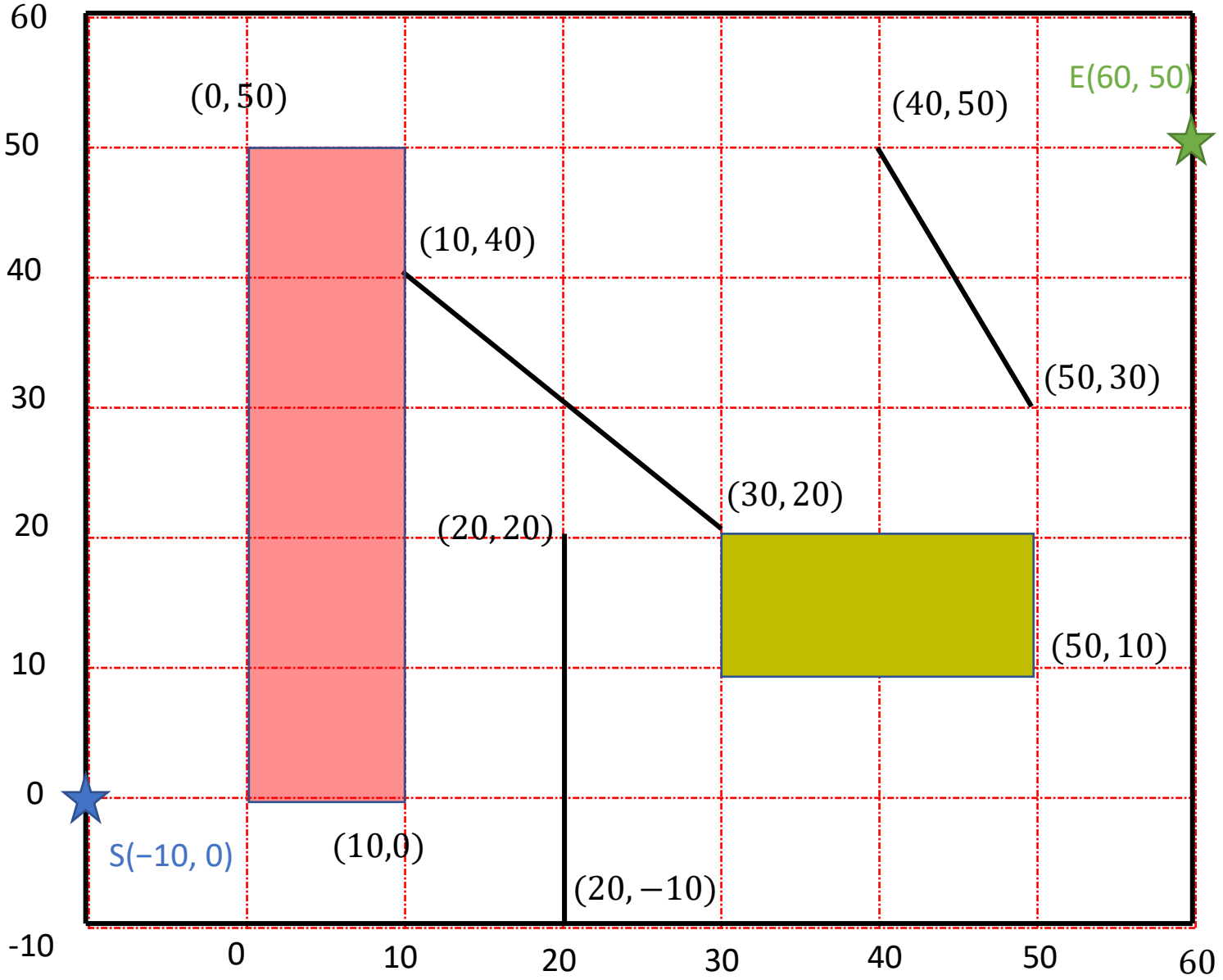
Start node

Goal node

Fuel-consuming area

Time-consuming area

Group 12



Start node

Goal node

Fuel-consuming area

Time-consuming area

Have fun with your tasks ☺