

The background of the page is a detailed sci-fi illustration. On the left, a large, dark, industrial structure floats in the sky, emitting blue light. In the center, a tall, dark tower with yellow lights at the top stands on a rocky outcrop. To the right, a dark, angular structure is perched on a cliff. In the foreground, a rocky cliff with a cave entrance is visible. At the bottom left, two small figures stand near a dark, low-profile vehicle. A small, round, metallic object with a face-like design is visible on the bottom right. The sky is a mix of light blue and white, suggesting a hazy or cloudy atmosphere.

DELIVERABLE 2: Report By:

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Deliverable 2: Planning Solutions

1) Defining a set of problem files for the domain designed for Deliverable 1

We implemented 3 problem files:

- 10x Hikers (half alive, half dead)
- 11x Hikers (varying levels of injury)
- 12x Hikers (half alive, half dead)

All problem files include 2x Helicopter, 2x Ambulance, 2x CableCar, 3x Rescuer, 10xLocation. For each of these problem files please see:

- [Appendix 2.1a](#) to view the PDDL code for these problems.
- [Appendix 2.1b](#) to view the 10x Hiker Problem & Goal State as an Image.
- [Appendix 2.1c](#) to view the 11x Hiker Problem & Goal State as an Image.
- [Appendix 2.1d](#) to view the 12x Hiker Problem & Goal State as an Image.
- [Appendix 2.1e](#) to view the Valid locations Person/Vehicle objects; and the object properties as an image (i.e. the distance between locations, vehicle capacity etc).

2) Solving the problems using one or more planners

We used the Optic to solve our set of problems:

| 10x Hikers | 11x Hikers | 12x Hikers |
|---------------------------|--------------------------|---------------------------|
| ; States evaluated: 39432 | ; States evaluated: 5691 | ; States evaluated: 54734 |
| ; Cost: 30692.073 | ; Cost: 25513.069 | ; Cost: 27808.075 |
| ; Time 297.73 | ; Time 35.34 | ; Time 456.37 |

OPTIC took 297.73 seconds to solve the 10x Hiker problem (where half were alive and the other half were dead). It took 35.34 seconds to solve the 11x Hiker problem (with varying levels of injury). It took 456.37 seconds to solve the 12x Hiker problem (where half were alive and the other half were dead).

10x Hiker Problem:

The main steps OPTIC takes to reach our goal:

1. cc0 takes **p2** to the baseOfMountain where p2 is checked by d1 and taken by am0 to the **medcen**.
2. res1 takes **p4** to the baseOfMountain from where res0 then takes p4 to the **medCen**.
3. res0 takes **p3** to the baseOfMountain from where res1 takes p3 to the **medCen**.
4. res0 takes **p9** to the **morgue**.
5. res0 takes **p1** to the **medCen**.
6. res0 takes **p0** to the middleOfMountain from where res1 takes p0 to the **medCen**.
7. res0 takes **p7** to the middleOfMountain from where res1 takes p7 to the **morgue**.
8. res0 takes **p5** to the middleOfMountain from where res1 takes p5 to the **morgue**.
9. res0 takes **p8** to the **morgue**.
10. res0 takes **p6** to the baseOfMountain where they are checked by d1 and taken by amb0 to the **morgue**.

11x Hiker Problem:

The main steps OPTIC takes to reach this problems goal:

1. res1 takes **p10** (at middle of mountain) moving them to the **morgue** (res1 then moves back to the top of the mountain).
2. res1 attaches **p2** (at the top of the mountain), moving them to the **medCen**.
3. res0 attaches **p3** (at the small rock), moving them to the **baseOfMountain**.
4. res1 attaches **p4** (at the small ledge), moving them to the **baseOfMountain**.
Then, res0 attaches p4 from the baseOfMountain, moving them to the **medCen**.
5. res1 attaches **p9** (at the cliff edge), moving them to the **morgue**.
6. res1 attaches **p1** (at the cliff edge), moving them to the **medCen**.
7. res1 attaches **p7** (at the big ledge), moving them to the middleOfMountain.
res0 finds p7 at the middleOfMountain, moving them to the **medCen**.
8. res1 attaches **p5** (at the big ledge), leaving them at the middleOfMountain.
p5 boards the cable car at the middle of the mountain, arriving at the **baseOfMountain**.
9. res0 attaches **p8** (at the big rock), leaving them at the middleOfMountain.
res1 moves them to the **medCen**.
10. res0 attaches **p6** (at the big rock), leaving them at the middleOfMountain.
p6 boards the cable car, arriving at the **baseOfMountain**.
11. res0 attaches **p0** (at the bigLedge), leaving them at the middleOfMountain.
p0 boards the cable car, arriving at the **baseOfMountain**.

12x Hiker Problem:

The main steps OPTIC takes to reach our goal:

1. cc0 takes **p2** to the baseofmountain where p2 is checked by d1 and taken by am0 to the **medcen**
2. res1 takes **p10** to the **morgue**
3. res1 takes **p4** to the baseofmountain from where res0 then takes p4 to the **medcen**
4. res0 takes **p3** to the baseofmountain from where res1 takes p3 to the **medcen**
5. res0 takes **p9** to the **morgue**
6. res0 takes **p11** to the **morgue**
7. res0 takes **p1** to the **medcen**
8. res0 takes **p5** to the middleofmountain from where res1 takes p5 to the **medcen**
9. res0 takes **p0** to the middleofmountain from where res1 takes p0 to the **medcen**
10. res0 takes **p7** to the middleofmountain from where res1 takes p7 to the medcen, where p7 is checked by d0 and taken to the **morgue** by amb0
11. res0 takes **p8** to the **morgue**
12. res0 takes **p6** to the baseofmountain where they are checked by d1 and taken by amb0 to the **morgue**

A table representing the order OPTIC solves our problem can be found in [Appendix 2.2a](#). It also includes the specific levels of injury, the hikers' initial location and their goal location.

This plan is interesting because we noticed that the rescuers leave some hikers at the middle of the mountain where the hiker boards a cable car to reach their goal (i.e. 11x Hiker problem). We originally assumed the 'secureXToRescuer' function would assign 1 rescuer throughout the whole journey – this was not the case. Our planner also used 2 rescuers, so that the hiker is stranded for a while. We understood that the planner must believe this is the most optimal solution.

The planner returned very similar pattern for the 10 & 12 People solution. This is expected as most hiker's remain in their same location.

The planner seemed to order the rescue by the hiker's initial location. For example, the "smallRock", "bigRock", "cliffEdge" initial locations are grouped together when analysing the order

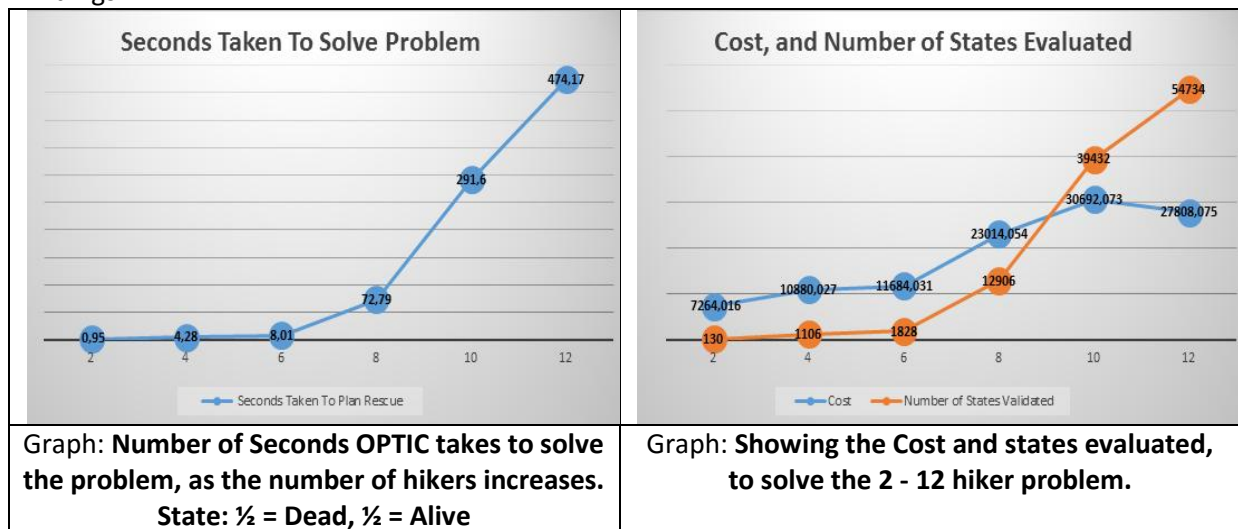
OPTIC reached the goal. This is interesting because we began to understand how the planner works.

The 11P problem never used ambulance or helicopters (mixed injury level), whereas the 10P & 12P problem did (half-injured, half dead) use an ambulance. We initially thought this was the case because of the restrictions we placed on the locations the ambulance & Helicopter can travel. However the 12P problem used this vehicle more often. OPTIC's solution in code is in our [Appendix 2.2b](#).

3) Writing a report describing the results of the experimental analysis

We assumed that the hikers only travel in pairs for the experimental analysis, so only an even numbers took the trek. After the accident half are uninjured and alive, the other half are unconscious and dead. We experiment with 2 - 12 hikers.

We record the states evaluated, cost and time OPTIC takes to complete the rescue. Below are our findings:



The x-axis is number of hikers. The time taken to solve the problem increases as the number of hikers increases. The difference between the time taken to rescue 2 and 4 hikers are very small (3.33 seconds). Factors which we need to consider when interpreting this data is that the hikers have been randomly scattered in various locations. We ensured this distorted our reading to a minimum, by ensuring the same person remained in their same position for all the problem files. More details of the hiker's locations and goal state are in [Appendix 2.3a](#).

Other factors which we kept constant include the number of vehicles, locations, paramedics and rescuers (which remained the same as the original problem file). It's clear the number of states evaluated increases in with more hikers. The growth rate of the cost is far more modest. The cost increases for 2-10 people, but dips at 12. This could be caused by optic not being able to handle such large pieces of data; or OPTIC could have found an optimal solution to the 12 people problem (which was not found with 10 people). The graph data is represented in a table in [Appendix 2.3b](#).

A problem we encountered is that OPTIC crashed after 12 people. Below is the error message which was returned when testing for 14 hikers.

```
(21.000 | 12414.036)b (20.000 | 12418.037)b (19.000 | 12418.038)b (18.000 | 12578.039)terminate called after
throwing an instance of 'std::bad_alloc'
what(): std::bad_alloc
684749382 [sig] optiic-clp 7832 open_stackdumpfile: Dumping stack trace to optiic-clp.exe.stackdump
C:\OptiicForWindows>
```

We ran the original tests on:

CPU: i5-4200U @ 1.60GHz

RAM: 8GB

We also tested on various computers.

Appendix (2)

2.1a – PDDL CODE

i. 10x People to be rescued:

```
( define (problem mountResc10People)
(:domain mountainRescueDomain)

(:objects
  h0 h1 - helicopter
  p0 p1 p2 p3 p4 p5 p6 p7 p8 p9 - personToBeRescued
  d0 d1 - paramedic
  cc0 cc1 - cableCar
  amb0 amb1 - ambulance
  res0 res1 res2 - rescuer
  medCen morgue baseOfMountain smallLedge smallRock cliffEdge middleOfMountain bigLedge
  bigRock topOfMountain - location
)
(:init

  ( hasPetrolStation baseOfMountain)

  ( validForAmb baseOfMountain) ( validForAmb medCen) ( validForAmb morgue)

  ( validForHelicopter baseOfMountain) ( validForHelicopter topOfMountain) ( validForHelicopter
  medCen)

  ( validForCC baseOfMountain) ( validForCC topOfMountain) ( validForCC middleOfMountain)

  ( personAt p0 bigLedge) ( personAt p1 cliffEdge) ( personAt p2 topOfMountain)
  ( personAt p3 smallRock) ( personAt p4 smallLedge) ( personAt p5 bigLedge) ( personAt p6 bigRock)
  ( personAt p7 bigLedge) ( personAt p8 bigRock) ( personAt p9 cliffEdge)

  ( personAt d1 baseOfMountain) ( personAt d0 medCen)

  ( personAt res0 topOfMountain) ( personAt res1 middleOfMountain)
  ( personAt res2 baseOfMountain)

  ( = (fuelLeft h0) 750) ( = (fuelMax h0) 750) ( = (fuelLeft h1) 750) ( = (fuelMax h1) 750)
  ( = (fuelLeft amb0) 750) ( = (fuelMax amb0) 750) ( = (fuelLeft amb1) 750) ( = (fuelMax amb1) 750)

  ( vehicleAt cc0 baseOfMountain) ( vehicleAt cc1 topOfMountain) ( vehicleAt h0 topOfMountain)
  ( vehicleAt h1 medCen) ( vehicleAt amb0 baseOfMountain) ( vehicleAt amb1 medCen)

  ( = (passengers h0) 0) ( = (capacity h0) 2) ( = (passengers h1) 0) ( = (capacity h1) 2)
  ( = (passengers cc0) 0) ( = (capacity cc0) 6) ( = (passengers cc1) 0) ( = (capacity cc1) 6)
```

(= (passengers amb0) 0) (= (capacity amb0) 1) (= (passengers amb1) 0) (= (capacity amb1) 1)

(= (withRescuer res0) 0) (= (maxWithRescuer res0) 1) (= (withRescuer res1) 0)

(= (maxWithRescuer res1) 2) (= (withRescuer res2) 0) (= (maxWithRescuer res2) 1)

(= (distance topOfMountain bigRock) 145) (= (distance bigRock bigLedge) 105)

(= (distance bigLedge middleOfMountain) 36) (= (distance middleOfMountain cliffEdge) 75)

(= (distance cliffEdge smallRock) 145) (= (distance smallRock smallLedge) 51)

(= (distance smallLedge baseOfMountain) 15) (= (distance baseOfMountain medCen) 145)

(= (distance medCen baseOfMountain) 145) (= (distance medCen morgue) 100)

(= (distance morgue medCen) 100) (= (distance baseOfMountain morgue) 15)

(= (distance morgue baseOfMountain) 15) (= (distance middleOfMountain baseOfMountain) 200)

(= (distance baseOfMountain middleOfMountain) 200)

(= (distance middleOfMountain topOfMountain) 200)

(= (distance topOfMountain middleOfMountain) 200)

(= (distance topOfMountain baseOfMountain) 400)

(= (distance baseOfMountain topOfMountain) 400)

(= (timeForVehicle amb0 baseOfMountain medCen) 60)

(= (timeForVehicle amb0 medCen baseOfMountain) 60)

(= (timeForVehicle amb0 medCen morgue) 8) (= (timeForVehicle amb0 morgue medCen) 8)

(= (timeForVehicle amb0 baseOfMountain morgue) 3)

(= (timeForVehicle amb0 morgue baseOfMountain) 3)

(= (timeForVehicle amb1 baseOfMountain medCen) 60)

(= (timeForVehicle amb1 medCen baseOfMountain) 60)

(= (timeForVehicle amb1 medCen morgue) 8) (= (timeForVehicle amb1 morgue medCen) 8)

(= (timeForVehicle amb1 baseOfMountain morgue) 3)

(= (timeForVehicle amb1 morgue baseOfMountain) 3)

(= (timeForVehicle h0 baseOfMountain medCen) 50)

(= (timeForVehicle h0 medCen baseOfMountain) 50)

(= (timeForVehicle h0 baseOfMountain topOfMountain) 150)

(= (timeForVehicle h0 topOfMountain baseOfMountain) 150)

(= (timeForVehicle h0 topOfMountain medCen) 180)

(= (timeForVehicle h0 medCen topOfMountain) 180)

(= (timeForVehicle cc0 middleOfMountain baseOfMountain) 100)

(= (timeForVehicle cc0 baseOfMountain middleOfMountain) 100)

(= (timeForVehicle cc0 middleOfMountain topOfMountain) 100)

(= (timeForVehicle cc0 topOfMountain middleOfMountain) 100)

(= (timeForVehicle cc0 baseOfMountain topOfMountain) 200)

(= (timeForVehicle cc0 topOfMountain baseOfMountain) 200)

(= (timeForVehicle cc1 middleOfMountain baseOfMountain) 100)

(= (timeForVehicle cc1 baseOfMountain middleOfMountain) 100)

(= (timeForVehicle cc1 middleOfMountain topOfMountain) 100)

```

( = (timeForVehicle cc1 topOfMountain middleOfMountain) 100)
( = (timeForVehicle cc1 baseOfMountain topOfMountain) 200)
( = (timeForVehicle cc1 topOfMountain baseOfMountain) 200)

( = (timeForRescuer res0 baseOfMountain medCen) 300)
( = (timeForRescuer res0 medCen baseOfMountain) 300)
( = (timeForRescuer res0 baseOfMountain morgue) 30)
( = (timeForRescuer res0 morgue baseOfMountain) 30)
( = (timeForRescuer res0 baseOfMountain middleOfMountain) 400)
( = (timeForRescuer res0 middleOfMountain baseOfMountain) 400)
( = (timeForRescuer res0 baseOfMountain topOfMountain) 800)
( = (timeForRescuer res0 topOfMountain baseOfMountain) 800)
( = (timeForRescuer res0 topOfMountain middleOfMountain) 400)
( = (timeForRescuer res0 middleOfMountain topOfMountain) 400)
( = (timeForRescuer res0 topOfMountain morgue) 900)
( = (timeForRescuer res0 morgue topOfMountain) 900)
( = (timeForRescuer res0 topOfMountain medCen) 1000)
( = (timeForRescuer res0 medCen topOfMountain) 1000)
( = (timeForRescuer res0 morgue medCen) 160) ( = (timeForRescuer res0 medCen morgue) 160)
( = (timeForRescuer res0 morgue middleOfMountain) 460)
( = (timeForRescuer res0 middleOfMountain morgue) 460)
( = (timeForRescuer res0 middleOfMountain medCen) 560)
( = (timeForRescuer res0 medCen middleOfMountain) 560)
( = (timeForRescuer res0 topOfMountain bigRock) 1450)
( = (timeForRescuer res0 bigRock bigLedge) 1050)
( = (timeForRescuer res0 bigLedge middleOfMountain) 360)
( = (timeForRescuer res0 middleOfMountain cliffEdge) 750)
( = (timeForRescuer res0 cliffEdge smallRock) 1450)
( = (timeForRescuer res0 smallRock smallLedge) 510)
( = (timeForRescuer res0 smallLedge baseOfMountain) 150)
( = (timeForRescuer res0 baseOfMountain medCen) 1450)
( = (timeForRescuer res0 medCen baseOfMountain) 1450)
( = (timeForRescuer res0 medCen morgue) 1000)
( = (timeForRescuer res0 morgue medCen) 1000)
( = (timeForRescuer res0 baseOfMountain morgue) 150)
( = (timeForRescuer res0 morgue baseOfMountain) 150)
( = (timeForRescuer res0 middleOfMountain baseOfMountain) 2000)
( = (timeForRescuer res0 baseOfMountain middleOfMountain) 2000)
( = (timeForRescuer res0 middleOfMountain topOfMountain) 2000)
( = (timeForRescuer res0 topOfMountain middleOfMountain) 2000)
( = (timeForRescuer res0 topOfMountain baseOfMountain) 4000)
( = (timeForRescuer res0 baseOfMountain topOfMountain) 4000)

( = (timeForRescuer res1 baseOfMountain medCen) 300)
( = (timeForRescuer res1 medCen baseOfMountain) 300)

```

(= (timeForRescuer res1 baseOfMountain morgue) 30)
 (= (timeForRescuer res1 morgue baseOfMountain) 30)
 (= (timeForRescuer res1 baseOfMountain middleOfMountain) 400)
 (= (timeForRescuer res1 middleOfMountain baseOfMountain) 400)
 (= (timeForRescuer res1 baseOfMountain topOfMountain) 800)
 (= (timeForRescuer res1 topOfMountain baseOfMountain) 800)
 (= (timeForRescuer res1 topOfMountain middleOfMountain) 400)
 (= (timeForRescuer res1 middleOfMountain topOfMountain) 400)
 (= (timeForRescuer res1 topOfMountain morgue) 900)
 (= (timeForRescuer res1 morgue topOfMountain) 900)
 (= (timeForRescuer res1 topOfMountain medCen) 1000)
 (= (timeForRescuer res1 medCen topOfMountain) 1000)
 (= (timeForRescuer res1 morgue medCen) 160) (= (timeForRescuer res1 medCen morgue) 160)
 (= (timeForRescuer res1 morgue middleOfMountain) 460)
 (= (timeForRescuer res1 middleOfMountain morgue) 460)
 (= (timeForRescuer res1 middleOfMountain medCen) 560)
 (= (timeForRescuer res1 medCen middleOfMountain) 560)
 (= (timeForRescuer res1 topOfMountain bigRock) 1450)
 (= (timeForRescuer res1 bigRock bigLedge) 1050)
 (= (timeForRescuer res1 bigLedge middleOfMountain) 360)
 (= (timeForRescuer res1 middleOfMountain cliffEdge) 750)
 (= (timeForRescuer res1 cliffEdge smallRock) 1450)
 (= (timeForRescuer res1 smallRock smallLedge) 510)
 (= (timeForRescuer res1 smallLedge baseOfMountain) 150)
 (= (timeForRescuer res1 baseOfMountain medCen) 1450)
 (= (timeForRescuer res1 medCen baseOfMountain) 1450)
 (= (timeForRescuer res1 medCen morgue) 1000)
 (= (timeForRescuer res1 morgue medCen) 1000)
 (= (timeForRescuer res1 baseOfMountain morgue) 150)
 (= (timeForRescuer res1 morgue baseOfMountain) 150)
 (= (timeForRescuer res1 middleOfMountain baseOfMountain) 2000)
 (= (timeForRescuer res1 baseOfMountain middleOfMountain) 2000)
 (= (timeForRescuer res1 middleOfMountain topOfMountain) 2000)
 (= (timeForRescuer res1 topOfMountain middleOfMountain) 2000)
 (= (timeForRescuer res1 topOfMountain baseOfMountain) 4000)
 (= (timeForRescuer res1 baseOfMountain topOfMountain) 4000)

 (= (timeForRescuer res2 baseOfMountain medCen) 300)
 (= (timeForRescuer res2 medCen baseOfMountain) 300)
 (= (timeForRescuer res2 baseOfMountain morgue) 30)
 (= (timeForRescuer res2 morgue baseOfMountain) 30)
 (= (timeForRescuer res2 baseOfMountain middleOfMountain) 400)
 (= (timeForRescuer res2 middleOfMountain baseOfMountain) 400)
 (= (timeForRescuer res2 baseOfMountain topOfMountain) 800)
 (= (timeForRescuer res2 topOfMountain baseOfMountain) 800)


```
( = (timeForRescuer res2 topOfMountain middleOfMountain) 400)
( = (timeForRescuer res2 middleOfMountain topOfMountain) 400)
( = (timeForRescuer res2 topOfMountain morgue) 900)
( = (timeForRescuer res2 morgue topOfMountain) 900)
( = (timeForRescuer res2 topOfMountain medCen) 1000)
( = (timeForRescuer res2 medCen topOfMountain) 1000)
( = (timeForRescuer res2 morgue medCen) 160) ( = (timeForRescuer res2 medCen morgue) 160)
( = (timeForRescuer res2 morgue middleOfMountain) 460)
( = (timeForRescuer res2 middleOfMountain morgue) 460)
( = (timeForRescuer res2 middleOfMountain medCen) 560)
( = (timeForRescuer res2 medCen middleOfMountain) 560)
( = (timeForRescuer res2 topOfMountain bigRock) 1450)
( = (timeForRescuer res2 bigRock bigLedge) 1050)
( = (timeForRescuer res2 bigLedge middleOfMountain) 360)
( = (timeForRescuer res2 middleOfMountain cliffEdge) 750)
( = (timeForRescuer res2 cliffEdge smallRock) 1450)
( = (timeForRescuer res2 smallRock smallLedge) 510)
( = (timeForRescuer res2 smallLedge baseOfMountain) 150)
( = (timeForRescuer res2 baseOfMountain medCen) 1450)
( = (timeForRescuer res2 medCen baseOfMountain) 1450)
( = (timeForRescuer res2 medCen morgue) 1000)
( = (timeForRescuer res2 morgue medCen) 1000)
( = (timeForRescuer res2 baseOfMountain morgue) 150)
( = (timeForRescuer res2 morgue baseOfMountain) 150)
( = (timeForRescuer res2 middleOfMountain baseOfMountain) 2000)
( = (timeForRescuer res2 baseOfMountain middleOfMountain) 2000)
( = (timeForRescuer res2 middleOfMountain topOfMountain) 2000)
( = (timeForRescuer res2 topOfMountain middleOfMountain) 2000)
( = (timeForRescuer res2 topOfMountain baseOfMountain) 4000)
( = (timeForRescuer res2 baseOfMountain topOfMountain) 4000)
```

```
( notInjured p0) ( notInjured p1) ( notInjured p2) ( notInjured p3) ( notInjured p4)
( injured p5) ( injured p6) ( injured p7) ( injured p8) ( injured p9)
( conscious p0) ( conscious p1) ( conscious p2) ( conscious p3) ( conscious p4)
( notConscious p5) ( notConscious p6) ( notConscious p7) ( notConscious p8) ( notConscious p9)
( alive p0) ( alive p1) ( alive p2) ( alive p3) ( alive p4)
```

```
)
```

```
( :goal
( and
( personAt p0 medCen) ( personAt p1 medCen) ( personAt p2 medCen) ( personAt p3 medCen)
( personAt p4 medCen)
( personAt p5 morgue) ( personAt p6 morgue) ( personAt p7 morgue) ( personAt p8 morgue)
( personAt p9 morgue)
```

```
)
)
(:metric minimize (total-time))
)
```

ii. 11x People to be rescued:

```
( define (problem mountResc11People)
  (:domain mountainRescueDomain)
  (:objects
    h0 h1 - helicopter
    p0 p1 p2 p3 p4 p5 p6 p7 p8 p9 p10 - personToBeRescued
    d0 d1 - paramedic
    cc0 cc1 - cableCar
    amb0 amb1 - ambulance
    res0 res1 res2 - rescuer
    medCen morgue baseOfMountain smallLedge smallRock cliffEdge middleOfMountain bigLedge
    bigRock topOfMountain - location
  )
  (:init
    ( hasPetrolStation baseOfMountain)

    ( validForAmb baseOfMountain) ( validForAmb medCen) ( validForAmb morgue)

    ( validForHelicopter baseOfMountain) ( validForHelicopter topOfMountain)
    ( validForHelicopter medCen)

    ( validForCC baseOfMountain) ( validForCC topOfMountain) ( validForCC middleOfMountain)

    ( personAt p0 bigLedge) ( personAt p1 cliffEdge) ( personAt p2 topOfMountain)
    ( personAt p3 smallRock) ( personAt p4 smallLedge) ( personAt p5 bigLedge) ( personAt p6 bigRock)
    ( personAt p7 bigLedge) ( personAt p8 bigRock) ( personAt p9 cliffEdge)
    ( personAt p10 middleOfMountain)

    ( personAt d1 baseOfMountain) ( personAt d0 medCen)

    ( personAt res0 topOfMountain) ( personAt res1 middleOfMountain)
    ( personAt res2 baseOfMountain)

    (= (fuelLeft h0) 750) (= (fuelMax h0) 750) (= (fuelLeft h1) 750) (= (fuelMax h1) 750)
    (= (fuelLeft amb0) 750) (= (fuelMax amb0) 750) (= (fuelLeft amb1) 750) (= (fuelMax amb1) 750)

    ( vehicleAt cc0 baseOfMountain) ( vehicleAt cc1 topOfMountain) ( vehicleAt h0 topOfMountain)
    ( vehicleAt h1 medCen) ( vehicleAt amb0 baseOfMountain) ( vehicleAt amb1 medCen)

    (= (passengers h0) 0) (= (capacity h0) 2) (= (passengers h1) 0) (= (capacity h1) 2)
    (= (passengers cc0) 0) (= (capacity cc0) 6) (= (passengers cc1) 0) (= (capacity cc1) 6)
```

(= (passengers amb0) 0) (= (capacity amb0) 1) (= (passengers amb1) 0) (= (capacity amb1) 1)

(= (withRescuer res0) 0) (= (maxWithRescuer res0) 1) (= (withRescuer res1) 0)

(= (maxWithRescuer res1) 1) (= (withRescuer res2) 0) (= (maxWithRescuer res2) 1)

(= (distance topOfMountain bigRock) 145) (= (distance bigRock bigLedge) 105)

(= (distance bigLedge middleOfMountain) 36) (= (distance middleOfMountain cliffEdge) 75)

(= (distance cliffEdge smallRock) 145) (= (distance smallRock smallLedge) 51)

(= (distance smallLedge baseOfMountain) 15) (= (distance baseOfMountain medCen) 145)

(= (distance medCen baseOfMountain) 145) (= (distance medCen morgue) 100)

(= (distance morgue medCen) 100) (= (distance baseOfMountain morgue) 15)

(= (distance morgue baseOfMountain) 15) (= (distance middleOfMountain baseOfMountain) 200)

(= (distance baseOfMountain middleOfMountain) 200)

(= (distance middleOfMountain topOfMountain) 200)

(= (distance topOfMountain middleOfMountain) 200)

(= (distance topOfMountain baseOfMountain) 400)

(= (distance baseOfMountain topOfMountain) 400)

(= (timeForVehicle amb0 baseOfMountain medCen) 60)

(= (timeForVehicle amb0 medCen baseOfMountain) 60)

(= (timeForVehicle amb0 medCen morgue) 8) (= (timeForVehicle amb0 morgue medCen) 8)

(= (timeForVehicle amb0 baseOfMountain morgue) 3)

(= (timeForVehicle amb0 morgue baseOfMountain) 3)

(= (timeForVehicle amb1 baseOfMountain medCen) 60)

(= (timeForVehicle amb1 medCen baseOfMountain) 60)

(= (timeForVehicle amb1 medCen morgue) 8) (= (timeForVehicle amb1 morgue medCen) 8)

(= (timeForVehicle amb1 baseOfMountain morgue) 3)

(= (timeForVehicle amb1 morgue baseOfMountain) 3)

(= (timeForVehicle h0 baseOfMountain medCen) 50)

(= (timeForVehicle h0 medCen baseOfMountain) 50)

(= (timeForVehicle h0 baseOfMountain topOfMountain) 150)

(= (timeForVehicle h0 topOfMountain baseOfMountain) 150)

(= (timeForVehicle h0 topOfMountain medCen) 180)

(= (timeForVehicle h0 medCen topOfMountain) 180)

(= (timeForVehicle cc0 middleOfMountain baseOfMountain) 100)

(= (timeForVehicle cc0 baseOfMountain middleOfMountain) 100)

(= (timeForVehicle cc0 middleOfMountain topOfMountain) 100)

(= (timeForVehicle cc0 topOfMountain middleOfMountain) 100)

(= (timeForVehicle cc0 baseOfMountain topOfMountain) 200)

(= (timeForVehicle cc0 topOfMountain baseOfMountain) 200)

(= (timeForVehicle cc1 middleOfMountain baseOfMountain) 100)

(= (timeForVehicle cc1 baseOfMountain middleOfMountain) 100)

(= (timeForVehicle cc1 middleOfMountain topOfMountain) 100)

(= (timeForVehicle cc1 topOfMountain middleOfMountain) 100)

(= (timeForVehicle cc1 baseOfMountain topOfMountain) 200)
 (= (timeForVehicle cc1 topOfMountain baseOfMountain) 200)

(= (timeForRescuer res0 baseOfMountain medCen) 300)
 (= (timeForRescuer res0 medCen baseOfMountain) 300)
 (= (timeForRescuer res0 baseOfMountain morgue) 30)
 (= (timeForRescuer res0 morgue baseOfMountain) 30)
 (= (timeForRescuer res0 baseOfMountain middleOfMountain) 400)
 (= (timeForRescuer res0 middleOfMountain baseOfMountain) 400)
 (= (timeForRescuer res0 baseOfMountain topOfMountain) 800)
 (= (timeForRescuer res0 topOfMountain baseOfMountain) 800)
 (= (timeForRescuer res0 topOfMountain middleOfMountain) 400)
 (= (timeForRescuer res0 middleOfMountain topOfMountain) 400)
 (= (timeForRescuer res0 topOfMountain morgue) 900)
 (= (timeForRescuer res0 morgue topOfMountain) 900)
 (= (timeForRescuer res0 topOfMountain medCen) 1000)
 (= (timeForRescuer res0 medCen topOfMountain) 1000)
 (= (timeForRescuer res0 morgue medCen) 160) (= (timeForRescuer res0 medCen morgue) 160)
 (= (timeForRescuer res0 morgue middleOfMountain) 460)
 (= (timeForRescuer res0 middleOfMountain morgue) 460)
 (= (timeForRescuer res0 middleOfMountain medCen) 560)
 (= (timeForRescuer res0 medCen middleOfMountain) 560)
 (= (timeForRescuer res0 topOfMountain bigRock) 1450)
 (= (timeForRescuer res0 bigRock bigLedge) 1050)
 (= (timeForRescuer res0 bigLedge middleOfMountain) 360)
 (= (timeForRescuer res0 middleOfMountain cliffEdge) 750)
 (= (timeForRescuer res0 cliffEdge smallRock) 1450)
 (= (timeForRescuer res0 smallRock smallLedge) 510)
 (= (timeForRescuer res0 smallLedge baseOfMountain) 150)
 (= (timeForRescuer res0 baseOfMountain medCen) 1450)
 (= (timeForRescuer res0 medCen baseOfMountain) 1450)
 (= (timeForRescuer res0 medCen morgue) 1000)
 (= (timeForRescuer res0 morgue medCen) 1000)
 (= (timeForRescuer res0 baseOfMountain morgue) 150)
 (= (timeForRescuer res0 morgue baseOfMountain) 150)
 (= (timeForRescuer res0 middleOfMountain baseOfMountain) 2000)
 (= (timeForRescuer res0 baseOfMountain middleOfMountain) 2000)
 (= (timeForRescuer res0 middleOfMountain topOfMountain) 2000)
 (= (timeForRescuer res0 topOfMountain middleOfMountain) 2000)
 (= (timeForRescuer res0 topOfMountain baseOfMountain) 4000)
 (= (timeForRescuer res0 baseOfMountain topOfMountain) 4000)

(= (timeForRescuer res1 baseOfMountain medCen) 300)
 (= (timeForRescuer res1 medCen baseOfMountain) 300)
 (= (timeForRescuer res1 baseOfMountain morgue) 30)

(= (timeForRescuer res1 morgue baseOfMountain) 30)
 (= (timeForRescuer res1 baseOfMountain middleOfMountain) 400)
 (= (timeForRescuer res1 middleOfMountain baseOfMountain) 400)
 (= (timeForRescuer res1 baseOfMountain topOfMountain) 800)
 (= (timeForRescuer res1 topOfMountain baseOfMountain) 800)
 (= (timeForRescuer res1 topOfMountain middleOfMountain) 400)
 (= (timeForRescuer res1 middleOfMountain topOfMountain) 400)
 (= (timeForRescuer res1 topOfMountain morgue) 900)
 (= (timeForRescuer res1 morgue topOfMountain) 900)
 (= (timeForRescuer res1 topOfMountain medCen) 1000)
 (= (timeForRescuer res1 medCen topOfMountain) 1000)
 (= (timeForRescuer res1 morgue medCen) 160) (= (timeForRescuer res1 medCen morgue) 160)
 (= (timeForRescuer res1 morgue middleOfMountain) 460)
 (= (timeForRescuer res1 middleOfMountain morgue) 460)
 (= (timeForRescuer res1 middleOfMountain medCen) 560)
 (= (timeForRescuer res1 medCen middleOfMountain) 560)
 (= (timeForRescuer res1 topOfMountain bigRock) 1450)
 (= (timeForRescuer res1 bigRock bigLedge) 1050)
 (= (timeForRescuer res1 bigLedge middleOfMountain) 360)
 (= (timeForRescuer res1 middleOfMountain cliffEdge) 750)
 (= (timeForRescuer res1 cliffEdge smallRock) 1450)
 (= (timeForRescuer res1 smallRock smallLedge) 510)
 (= (timeForRescuer res1 smallLedge baseOfMountain) 150)
 (= (timeForRescuer res1 baseOfMountain medCen) 1450)
 (= (timeForRescuer res1 medCen baseOfMountain) 1450)
 (= (timeForRescuer res1 medCen morgue) 1000)
 (= (timeForRescuer res1 morgue medCen) 1000)
 (= (timeForRescuer res1 baseOfMountain morgue) 150)
 (= (timeForRescuer res1 morgue baseOfMountain) 150)
 (= (timeForRescuer res1 middleOfMountain baseOfMountain) 2000)
 (= (timeForRescuer res1 baseOfMountain middleOfMountain) 2000)
 (= (timeForRescuer res1 middleOfMountain topOfMountain) 2000)
 (= (timeForRescuer res1 topOfMountain middleOfMountain) 2000)
 (= (timeForRescuer res1 topOfMountain baseOfMountain) 4000)
 (= (timeForRescuer res1 baseOfMountain topOfMountain) 4000)

(= (timeForRescuer res2 baseOfMountain medCen) 300)
 (= (timeForRescuer res2 medCen baseOfMountain) 300)
 (= (timeForRescuer res2 baseOfMountain morgue) 30)
 (= (timeForRescuer res2 morgue baseOfMountain) 30)
 (= (timeForRescuer res2 baseOfMountain middleOfMountain) 400)
 (= (timeForRescuer res2 middleOfMountain baseOfMountain) 400)
 (= (timeForRescuer res2 baseOfMountain topOfMountain) 800)
 (= (timeForRescuer res2 topOfMountain baseOfMountain) 800)
 (= (timeForRescuer res2 topOfMountain middleOfMountain) 400)

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( = (timeForRescuer res2 middleOfMountain topOfMountain) 400)
( = (timeForRescuer res2 topOfMountain morgue) 900)
( = (timeForRescuer res2 morgue topOfMountain) 900)
( = (timeForRescuer res2 topOfMountain medCen) 1000)
( = (timeForRescuer res2 medCen topOfMountain) 1000)
( = (timeForRescuer res2 morgue medCen) 160) ( = (timeForRescuer res2 medCen morgue) 160)
( = (timeForRescuer res2 morgue middleOfMountain) 460)
( = (timeForRescuer res2 middleOfMountain morgue) 460)
( = (timeForRescuer res2 middleOfMountain medCen) 560)
( = (timeForRescuer res2 medCen middleOfMountain) 560)
( = (timeForRescuer res2 topOfMountain bigRock) 1450)
( = (timeForRescuer res2 bigRock bigLedge) 1050)
( = (timeForRescuer res2 bigLedge middleOfMountain) 360)
( = (timeForRescuer res2 middleOfMountain cliffEdge) 750)
( = (timeForRescuer res2 cliffEdge smallRock) 1450)
( = (timeForRescuer res2 smallRock smallLedge) 510)
( = (timeForRescuer res2 smallLedge baseOfMountain) 150)
( = (timeForRescuer res2 baseOfMountain medCen) 1450)
( = (timeForRescuer res2 medCen baseOfMountain) 1450)
( = (timeForRescuer res2 medCen morgue) 1000)
( = (timeForRescuer res2 morgue medCen) 1000)
( = (timeForRescuer res2 baseOfMountain morgue) 150)
( = (timeForRescuer res2 morgue baseOfMountain) 150)
( = (timeForRescuer res2 middleOfMountain baseOfMountain) 2000)
( = (timeForRescuer res2 baseOfMountain middleOfMountain) 2000)
( = (timeForRescuer res2 middleOfMountain topOfMountain) 2000)
( = (timeForRescuer res2 topOfMountain middleOfMountain) 2000)
( = (timeForRescuer res2 topOfMountain baseOfMountain) 4000)
( = (timeForRescuer res2 baseOfMountain topOfMountain) 4000)

( injured p1) ( injured p2) ( injured p4) ( injured p7) ( injured p8)
( notInjured p0) ( notInjured p3) ( notInjured p5) ( notInjured p6) ( notInjured p9) ( notInjured p10)
( conscious p0) ( conscious p1) ( conscious p2) ( conscious p3) ( conscious p4) ( conscious p5)
( conscious p6)
( notConscious p7)( notConscious p8) ( notConscious p9) ( notConscious p10)
( alive p0) ( alive p1) ( alive p2) ( alive p3) ( alive p4) ( alive p5) ( alive p6) ( alive p7) ( alive p8)
)
( :goal
( and
( personAt p0 baseOfMountain) ( personAt p3 baseOfMountain) ( personAt p5 baseOfMountain)
( personAt p6 baseOfMountain)
( personAt p1 medCen) ( personAt p2 medCen) ( personAt p4 medCen) ( personAt p7 medCen)
( personAt p8 medCen)
( personAt p9 morgue) ( personAt p10 morgue)
)
)

```



```
)
(:metric minimize (total-time))
)
```

iii. 12x People to be rescued:

```
(define (problem mountResc12People)
  (:domain mountainRescueDomain)

  (:objects
    h0 h1 - helicopter
    p0 p1 p2 p3 p4 p5 p6 p7 p8 p9 p10 p11 - personToBeRescued
    d0 d1 - paramedic
    cc0 cc1 - cableCar
    amb0 amb1 - ambulance
    res0 res1 res2 - rescuer
    medCen morgue baseOfMountain smallLedge smallRock cliffEdge middleOfMountain bigLedge
    bigRock topOfMountain - location
  )
  (:init
    (hasPetrolStation baseOfMountain)
    (validForAmb baseOfMountain) (validForAmb medCen) (validForAmb morgue)
    (validForHelicopter baseOfMountain) (validForHelicopter topOfMountain)
    (validForHelicopter medCen)
    (validForCC baseOfMountain) (validForCC topOfMountain) (validForCC middleOfMountain)

    (personAt p0 bigLedge) (personAt p1 cliffEdge) (personAt p2 topOfMountain)
    (personAt p3 smallRock) (personAt p4 smallLedge) (personAt p5 bigLedge) (personAt p6 bigRock)
    (personAt p7 bigLedge) (personAt p8 bigRock) (personAt p9 cliffEdge)
    (personAt p10 middleOfMountain) (personAt p11 cliffEdge)

    (personAt d1 baseOfMountain) (personAt d0 medCen)
    (personAt res0 topOfMountain) (personAt res1 middleOfMountain)
    (personAt res2 baseOfMountain)

    (= (fuelLeft h0) 750) (= (fuelMax h0) 750) (= (fuelLeft h1) 750) (= (fuelMax h1) 750)
    (= (fuelLeft amb0) 750) (= (fuelMax amb0) 750) (= (fuelLeft amb1) 750) (= (fuelMax amb1) 750)

    (vehicleAt cc0 baseOfMountain) (vehicleAt cc1 topOfMountain)
    (vehicleAt h0 topOfMountain) (vehicleAt h1 medCen)
    (vehicleAt amb0 baseOfMountain) (vehicleAt amb1 medCen)

    (= (passengers h0) 0) (= (capacity h0) 2) (= (passengers h1) 0) (= (capacity h1) 2)
    (= (passengers cc0) 0) (= (capacity cc0) 6) (= (passengers cc1) 0) (= (capacity cc1) 6)
    (= (passengers amb0) 0) (= (capacity amb0) 1) (= (passengers amb1) 0) (= (capacity amb1) 1)

    (= (withRescuer res0) 0) (= (maxWithRescuer res0) 1) (= (withRescuer res1) 0)
```

(= (maxWithRescuer res1) 2) (= (withRescuer res2) 0) (= (maxWithRescuer res2) 1)

(= (distance topOfMountain bigRock) 145) (= (distance bigRock bigLedge) 105)
 (= (distance bigLedge middleOfMountain) 36) (= (distance middleOfMountain cliffEdge) 75)
 (= (distance cliffEdge smallRock) 145) (= (distance smallRock smallLedge) 51)
 (= (distance smallLedge baseOfMountain) 15) (= (distance baseOfMountain medCen) 145)
 (= (distance medCen baseOfMountain) 145) (= (distance medCen morgue) 100)
 (= (distance morgue medCen) 100) (= (distance baseOfMountain morgue) 15)
 (= (distance morgue baseOfMountain) 15) (= (distance middleOfMountain baseOfMountain) 200)
 (= (distance baseOfMountain middleOfMountain) 200)
 (= (distance middleOfMountain topOfMountain) 200)
 (= (distance topOfMountain middleOfMountain) 200)
 (= (distance topOfMountain baseOfMountain) 400)
 (= (distance baseOfMountain topOfMountain) 400)

(= (timeForVehicle amb0 baseOfMountain medCen) 60)
 (= (timeForVehicle amb0 medCen baseOfMountain) 60)
 (= (timeForVehicle amb0 medCen morgue) 8) (= (timeForVehicle amb0 morgue medCen) 8)
 (= (timeForVehicle amb0 baseOfMountain morgue) 3)
 (= (timeForVehicle amb0 morgue baseOfMountain) 3)
 (= (timeForVehicle amb1 baseOfMountain medCen) 60)
 (= (timeForVehicle amb1 medCen baseOfMountain) 60)
 (= (timeForVehicle amb1 medCen morgue) 8) (= (timeForVehicle amb1 morgue medCen) 8)
 (= (timeForVehicle amb1 baseOfMountain morgue) 3)
 (= (timeForVehicle amb1 morgue baseOfMountain) 3)

(= (timeForVehicle h0 baseOfMountain medCen) 50)
 (= (timeForVehicle h0 medCen baseOfMountain) 50)
 (= (timeForVehicle h0 baseOfMountain topOfMountain) 150)
 (= (timeForVehicle h0 topOfMountain baseOfMountain) 150)
 (= (timeForVehicle h0 topOfMountain medCen) 180)
 (= (timeForVehicle h0 medCen topOfMountain) 180)

(= (timeForVehicle cc0 middleOfMountain baseOfMountain) 100)
 (= (timeForVehicle cc0 baseOfMountain middleOfMountain) 100)
 (= (timeForVehicle cc0 middleOfMountain topOfMountain) 100)
 (= (timeForVehicle cc0 topOfMountain middleOfMountain) 100)
 (= (timeForVehicle cc0 baseOfMountain topOfMountain) 200)
 (= (timeForVehicle cc0 topOfMountain baseOfMountain) 200)
 (= (timeForVehicle cc1 middleOfMountain baseOfMountain) 100)
 (= (timeForVehicle cc1 baseOfMountain middleOfMountain) 100)
 (= (timeForVehicle cc1 middleOfMountain topOfMountain) 100)
 (= (timeForVehicle cc1 topOfMountain middleOfMountain) 100)
 (= (timeForVehicle cc1 baseOfMountain topOfMountain) 200)
 (= (timeForVehicle cc1 topOfMountain baseOfMountain) 200)

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( = (timeForRescuer res0 baseOfMountain medCen) 300)
( = (timeForRescuer res0 medCen baseOfMountain) 300)
( = (timeForRescuer res0 baseOfMountain morgue) 30)
( = (timeForRescuer res0 morgue baseOfMountain) 30)
( = (timeForRescuer res0 baseOfMountain middleOfMountain) 400)
( = (timeForRescuer res0 middleOfMountain baseOfMountain) 400)
( = (timeForRescuer res0 baseOfMountain topOfMountain) 800)
( = (timeForRescuer res0 topOfMountain baseOfMountain) 800)
( = (timeForRescuer res0 topOfMountain middleOfMountain) 400)
( = (timeForRescuer res0 middleOfMountain topOfMountain) 400)
( = (timeForRescuer res0 topOfMountain morgue) 900)
( = (timeForRescuer res0 morgue topOfMountain) 900)
( = (timeForRescuer res0 topOfMountain medCen) 1000)
( = (timeForRescuer res0 medCen topOfMountain) 1000)
( = (timeForRescuer res0 morgue medCen) 160) ( = (timeForRescuer res0 medCen morgue) 160)
( = (timeForRescuer res0 morgue middleOfMountain) 460)
( = (timeForRescuer res0 middleOfMountain morgue) 460)
( = (timeForRescuer res0 middleOfMountain medCen) 560)
( = (timeForRescuer res0 medCen middleOfMountain) 560)
( = (timeForRescuer res0 topOfMountain bigRock) 1450)
( = (timeForRescuer res0 bigRock bigLedge) 1050)
( = (timeForRescuer res0 bigLedge middleOfMountain) 360)
( = (timeForRescuer res0 middleOfMountain cliffEdge) 750)
( = (timeForRescuer res0 cliffEdge smallRock) 1450)
( = (timeForRescuer res0 smallRock smallLedge) 510)
( = (timeForRescuer res0 smallLedge baseOfMountain) 150)
( = (timeForRescuer res0 baseOfMountain medCen) 1450)
( = (timeForRescuer res0 medCen baseOfMountain) 1450)
( = (timeForRescuer res0 medCen morgue) 1000)
( = (timeForRescuer res0 morgue medCen) 1000)
( = (timeForRescuer res0 baseOfMountain morgue) 150)
( = (timeForRescuer res0 morgue baseOfMountain) 150)
( = (timeForRescuer res0 middleOfMountain baseOfMountain) 2000)
( = (timeForRescuer res0 baseOfMountain middleOfMountain) 2000)
( = (timeForRescuer res0 middleOfMountain topOfMountain) 2000)
( = (timeForRescuer res0 topOfMountain middleOfMountain) 2000)
( = (timeForRescuer res0 topOfMountain baseOfMountain) 4000)
( = (timeForRescuer res0 baseOfMountain topOfMountain) 4000)

( = (timeForRescuer res1 baseOfMountain medCen) 300)
( = (timeForRescuer res1 medCen baseOfMountain) 300)
( = (timeForRescuer res1 baseOfMountain morgue) 30)
( = (timeForRescuer res1 morgue baseOfMountain) 30)
( = (timeForRescuer res1 baseOfMountain middleOfMountain) 400)

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( = (timeForRescuer res1 middleOfMountain baseOfMountain) 400)
( = (timeForRescuer res1 baseOfMountain topOfMountain) 800)
( = (timeForRescuer res1 topOfMountain baseOfMountain) 800)
( = (timeForRescuer res1 topOfMountain middleOfMountain) 400)
( = (timeForRescuer res1 middleOfMountain topOfMountain) 400)
( = (timeForRescuer res1 topOfMountain morgue) 900)
( = (timeForRescuer res1 morgue topOfMountain) 900)
( = (timeForRescuer res1 topOfMountain medCen) 1000)
( = (timeForRescuer res1 medCen topOfMountain) 1000)
( = (timeForRescuer res1 morgue medCen) 160) ( = (timeForRescuer res1 medCen morgue) 160)
( = (timeForRescuer res1 morgue middleOfMountain) 460)
( = (timeForRescuer res1 middleOfMountain morgue) 460)
( = (timeForRescuer res1 middleOfMountain medCen) 560)
( = (timeForRescuer res1 medCen middleOfMountain) 560)
( = (timeForRescuer res1 topOfMountain bigRock) 1450)
( = (timeForRescuer res1 bigRock bigLedge) 1050)
( = (timeForRescuer res1 bigLedge middleOfMountain) 360)
( = (timeForRescuer res1 middleOfMountain cliffEdge) 750)
( = (timeForRescuer res1 cliffEdge smallRock) 1450)
( = (timeForRescuer res1 smallRock smallLedge) 510)
( = (timeForRescuer res1 smallLedge baseOfMountain) 150)
( = (timeForRescuer res1 baseOfMountain medCen) 1450)
( = (timeForRescuer res1 medCen baseOfMountain) 1450)
( = (timeForRescuer res1 medCen morgue) 1000)
( = (timeForRescuer res1 morgue medCen) 1000)
( = (timeForRescuer res1 baseOfMountain morgue) 150)
( = (timeForRescuer res1 morgue baseOfMountain) 150)
( = (timeForRescuer res1 middleOfMountain baseOfMountain) 2000)
( = (timeForRescuer res1 baseOfMountain middleOfMountain) 2000)
( = (timeForRescuer res1 middleOfMountain topOfMountain) 2000)
( = (timeForRescuer res1 topOfMountain middleOfMountain) 2000)
( = (timeForRescuer res1 topOfMountain baseOfMountain) 4000)
( = (timeForRescuer res1 baseOfMountain topOfMountain) 4000)

( = (timeForRescuer res2 baseOfMountain medCen) 300)
( = (timeForRescuer res2 medCen baseOfMountain) 300)
( = (timeForRescuer res2 baseOfMountain morgue) 30)
( = (timeForRescuer res2 morgue baseOfMountain) 30)
( = (timeForRescuer res2 baseOfMountain middleOfMountain) 400)
( = (timeForRescuer res2 middleOfMountain baseOfMountain) 400)
( = (timeForRescuer res2 baseOfMountain topOfMountain) 800)
( = (timeForRescuer res2 topOfMountain baseOfMountain) 800)
( = (timeForRescuer res2 topOfMountain middleOfMountain) 400)
( = (timeForRescuer res2 middleOfMountain topOfMountain) 400)
( = (timeForRescuer res2 topOfMountain morgue) 900)

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( = (timeForRescuer res2 morgue topOfMountain) 900)
( = (timeForRescuer res2 topOfMountain medCen) 1000)
( = (timeForRescuer res2 medCen topOfMountain) 1000)
( = (timeForRescuer res2 morgue medCen) 160) ( = (timeForRescuer res2 medCen morgue) 160)
( = (timeForRescuer res2 morgue middleOfMountain) 460)
( = (timeForRescuer res2 middleOfMountain morgue) 460)
( = (timeForRescuer res2 middleOfMountain medCen) 560)
( = (timeForRescuer res2 medCen middleOfMountain) 560)
( = (timeForRescuer res2 topOfMountain bigRock) 1450)
( = (timeForRescuer res2 bigRock bigLedge) 1050)
( = (timeForRescuer res2 bigLedge middleOfMountain) 360)
( = (timeForRescuer res2 middleOfMountain cliffEdge) 750)
( = (timeForRescuer res2 cliffEdge smallRock) 1450)
( = (timeForRescuer res2 smallRock smallLedge) 510)
( = (timeForRescuer res2 smallLedge baseOfMountain) 150)
( = (timeForRescuer res2 baseOfMountain medCen) 1450)
( = (timeForRescuer res2 medCen baseOfMountain) 1450)
( = (timeForRescuer res2 medCen morgue) 1000)
( = (timeForRescuer res2 morgue medCen) 1000)
( = (timeForRescuer res2 baseOfMountain morgue) 150)
( = (timeForRescuer res2 morgue baseOfMountain) 150)
( = (timeForRescuer res2 middleOfMountain baseOfMountain) 2000)
( = (timeForRescuer res2 baseOfMountain middleOfMountain) 2000)
( = (timeForRescuer res2 middleOfMountain topOfMountain) 2000)
( = (timeForRescuer res2 topOfMountain middleOfMountain) 2000)
( = (timeForRescuer res2 topOfMountain baseOfMountain) 4000)
( = (timeForRescuer res2 baseOfMountain topOfMountain) 4000)

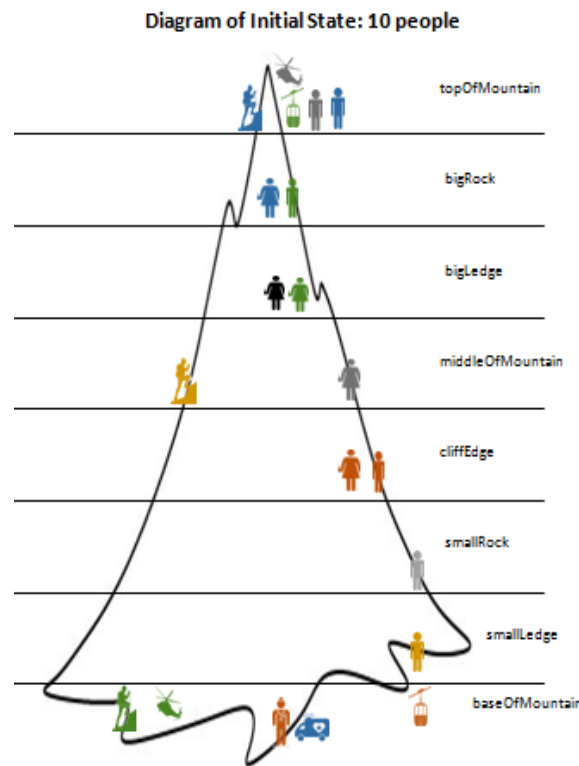
( notInjured p0) ( notInjured p1) ( notInjured p2) ( notInjured p3) ( notInjured p4) ( notInjured p5)
( injured p6) ( injured p7) ( injured p8) ( injured p9) ( injured p10) ( injured p11)
( conscious p0) ( conscious p1) ( conscious p2) ( conscious p3) ( conscious p4) ( conscious p5)
( notConscious p6) ( notConscious p7) ( notConscious p8) ( notConscious p9) ( notConscious p10)
( notConscious p11)
( alive p0) ( alive p1) ( alive p2) ( alive p3) ( alive p4) ( alive p5)
)
(:goal
( and
( personAt p0 medCen) ( personAt p1 medCen) ( personAt p2 medCen) ( personAt p3 medCen)
( personAt p4 medCen) ( personAt p5 medCen)
( personAt p6 morgue) ( personAt p7 morgue) ( personAt p8 morgue) ( personAt p9 morgue)
( personAt p10 morgue)( personAt p11 morgue)
)
)
(:metric minimize (total-time))
)

```

2.1b –Problems Files Properties

10x People to be rescued:

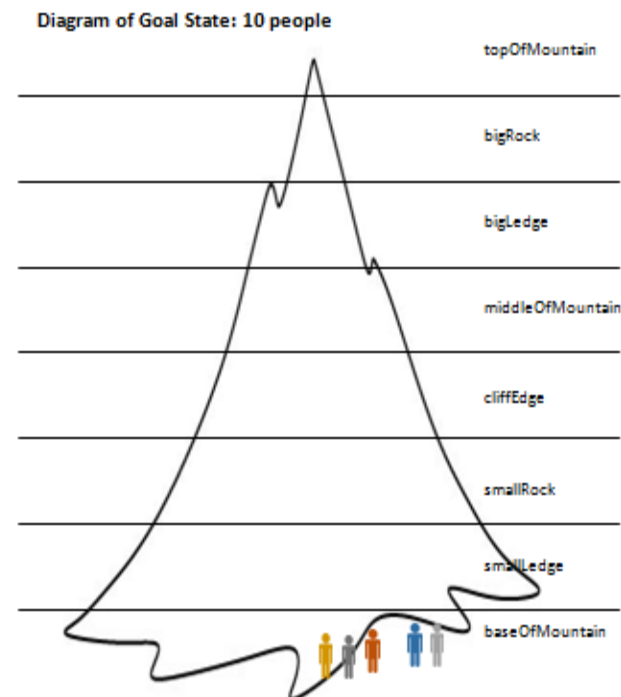
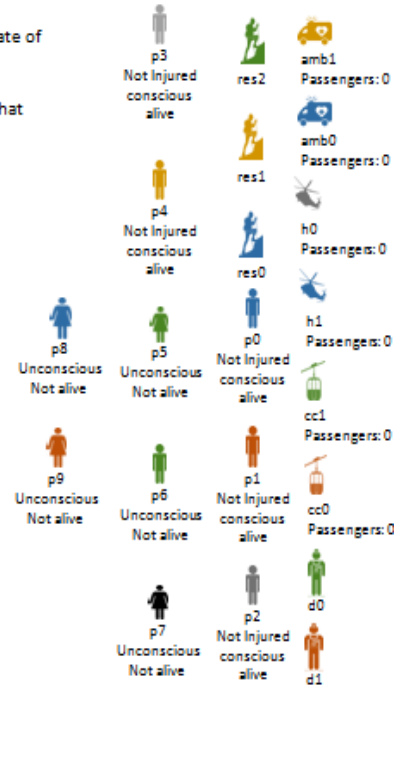
Initial & Goal State Image.



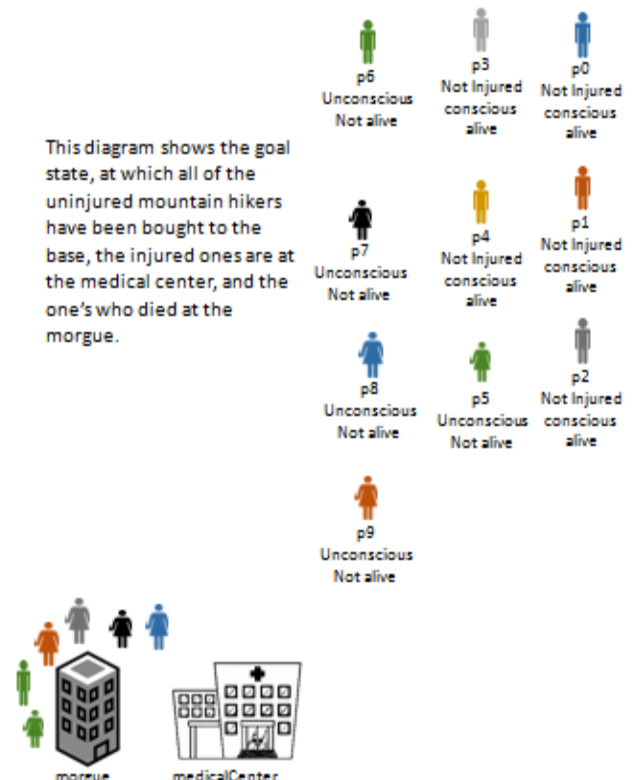
This diagram shows the initial state of each object as declared in our problem file. This is the a visual representation of the problem that we are solving in our code.

Please note:

- Each instance of an object is shown by a different colour, and each object is placed at it's initial location.
- At this state h0, h1, amb0 and amb1 has the maximum amount of fuel
- There is not predicate for dead, if a person is not alive, we assume that they are dead.



This diagram shows the goal state, at which all of the uninjured mountain hikers have been brought to the base, the injured ones are at the medical center, and the one's who died at the morgue.



11x People to be rescued:
Initial & Goal State Image.

- Each instance of an object is shown by a different colour, and each object is placed at its initial location.
- At this state h_0 , h_1 , amb_0 and amb_1 has the maximum amount of fuel
- There is not predicate for dead, if a person is not alive, we assume that they are dead.

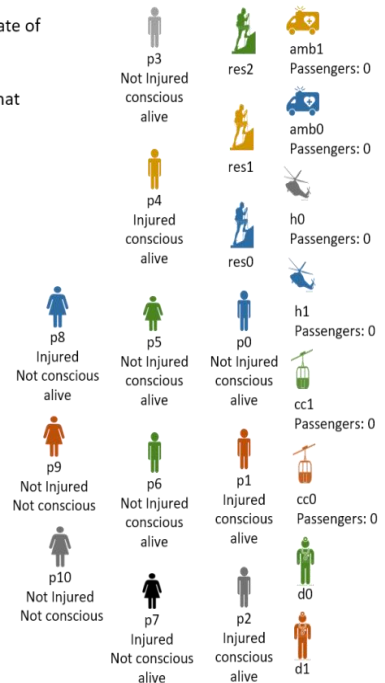


Diagram illustrating a mountain with various locations labeled on its right side:

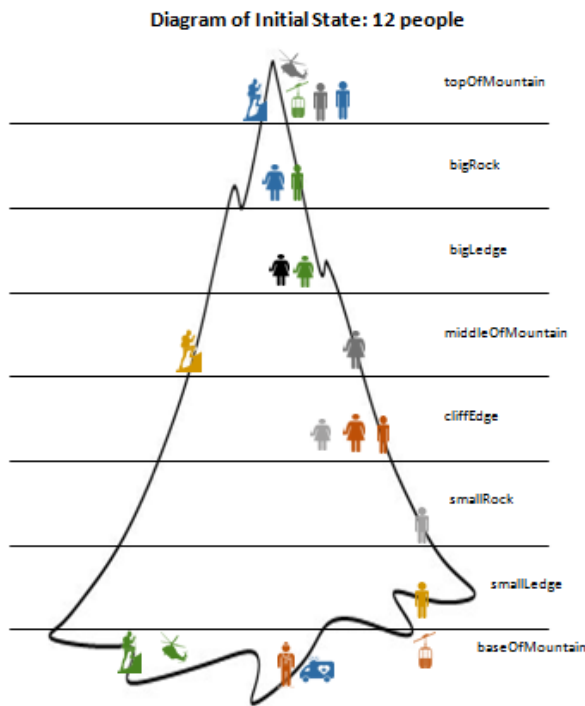
- topOfMountain
- bigRock
- bigLedge
- middleOfMountain
- cliffEdge
- smallRock
- smallLedge
- baseOfMountain

At the base of the mountain, there are four stylized human figures: two green, one blue, and one grey.

2.1d –Problems Files Properties

12x People to be rescued:

Initial & Goal State Image.



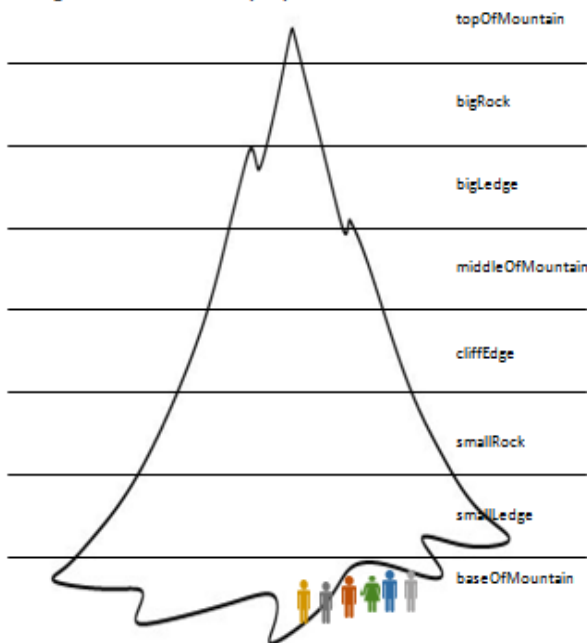
This diagram shows the initial state of each object as declared in our problem file. This is the a visual representation of the problem that we are solving in our code.

Please note:

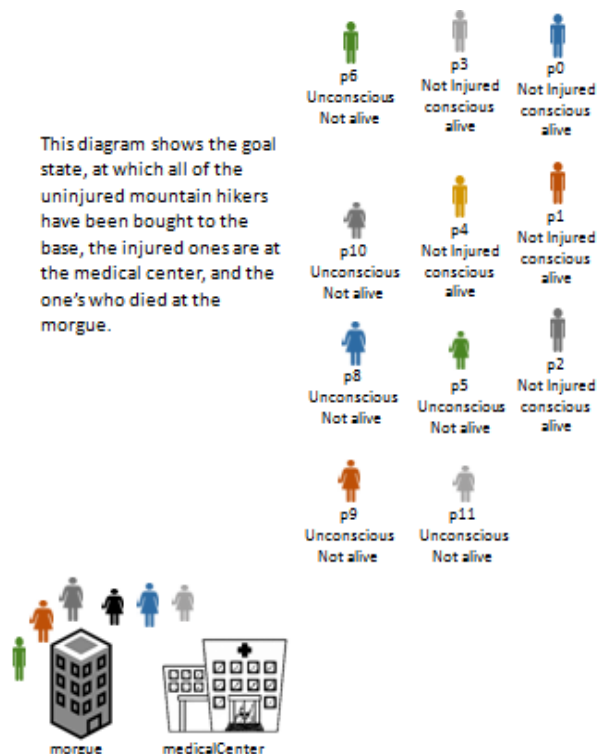
- Each instance of an object is shown by a different colour, and each object is placed at it's initial location.
- At this state h0, h1, amb0 and amb1 has the maximum amount of fuel
- There is not predicate for dead, if a person is not alive, we assume that they are dead.



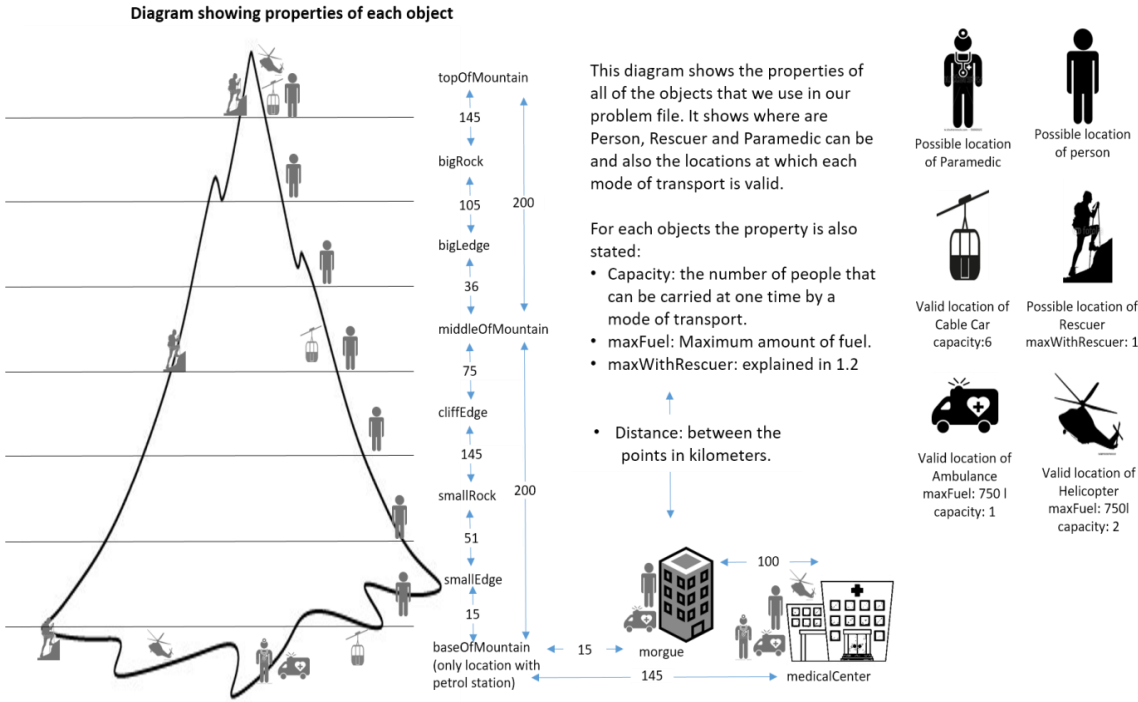
Diagram of Goal State: 12 people



This diagram shows the goal state, at which all of the uninjured mountain hikers have been brought to the base, the injured ones are at the medical center, and the one's who died at the morgue.



2.1e Valid Object Locations, Object Properties



2.2a –

i. 10x People to be rescued: Order OPTIC Solves Problem

| | PersonToBe Rescued | Initial Location | Uninjured? (i.e.no scars) | Conscious? | Alive? | Goal Location |
|------------------|--------------------|------------------|---------------------------|------------|--------|---------------|
| 1 st | p2 | TopOfMountain | ✓ | ✓ | ✓ | Med-Cen |
| 2 nd | p4 | SmallLedge | ✓ | ✓ | ✓ | Med-Cen |
| 3 rd | p3 | SmallRock | ✓ | ✓ | ✓ | Med-Cen |
| 4 th | p9 | CliffEdge | | | | Morgue |
| 5 th | p1 | CliffEdge | ✓ | ✓ | ✓ | Med-Cen |
| 6 th | p0 | BigLedge | ✓ | ✓ | ✓ | Med-Cen |
| 7 th | p7 | BigLedge | | | | Morgue |
| 8 th | p5 | BigLedge | | | | Morgue |
| 9 th | p8 | BigRock | | | | Morgue |
| 10 th | p6 | BigRock | | | | Morgue |

ii. 11x People to be rescued: Order OPTIC Solves Problem

| | PersonToBe Rescued | Initial Location | Uninjured? (i.e.no scars) | Conscious? | Alive? | Goal Location |
|------------------|--------------------|------------------|---------------------------|------------|--------|----------------|
| 1 st | p10 | MiddleOfMountain | | | | Morgue |
| 2 nd | p2 | TopOfMountain | | ✓ | ✓ | Med-Cen |
| 3 rd | p3 | SmallRock | ✓ | ✓ | ✓ | BaseOfMountain |
| 4 th | p4 | SmallLedge | | ✓ | ✓ | Med-Cen |
| 5 th | p9 | CliffEdge | | | | Morgue |
| 6 th | p1 | CliffEdge | | ✓ | ✓ | Med-Cen |
| 7 th | p7 | BigLedge | | | ✓ | Med-Cen |
| 8 th | p5 | BigLedge | ✓ | ✓ | ✓ | BaseOfMountain |
| 9 th | p8 | BigRock | | | ✓ | Med-Cen |
| 10 th | p6 | BigRock | ✓ | ✓ | ✓ | BaseOfMountain |
| 11 th | p0 | BigLedge | ✓ | ✓ | ✓ | BaseOfMountain |

iii. 12x People to be rescued: Order OPTIC Solves Problem

| | PersonToBe Rescued | Initial Location | Uninjured? (i.e.no scars) | Conscious? | Alive? | Goal Location |
|------------------|--------------------|------------------|---------------------------|------------|--------|---------------|
| 1 st | p2 | TopOfMountain | ✓ | ✓ | ✓ | Med-Cen |
| 2 nd | p10 | MiddleOfMountain | | | | Morgue |
| 3 rd | p4 | SmallLedge | ✓ | ✓ | ✓ | Med-Cen |
| 4 th | p3 | SmallRock | ✓ | ✓ | ✓ | Med-Cen |
| 5 th | p9 | CliffEdge | | | | Morgue |
| 6 th | p11 | CliffEdge | | | | Morgue |
| 7 th | p1 | CliffEdge | ✓ | ✓ | ✓ | Med-Cen |
| 8 th | p5 | BigLedge | ✓ | ✓ | ✓ | Med-Cen |
| 9 th | p0 | BigLedge | ✓ | ✓ | ✓ | Med-Cen |
| 10 th | p7 | BigLedge | | | | Morgue |
| 11 th | p8 | BigRock | | | | Morgue |
| 12 th | p6 | BigRock | | | | Morgue |

2.2b –

i. 10x People to be rescued: OPTIC SOLUTION

- 0.000: (moveablecar cc1 topofmountain middleofmountain) [100.000]
- 0.000: (moverescuer res0 topofmountain middleofmountain) [400.000]
- 0.000: (moverescuer res1 middleofmountain medcen) [560.000]
- 0.000: (moveablecar cc0 baseofmountain topofmountain) [200.000]
- 100.001: (moveablecar cc1 middleofmountain topofmountain) [100.000]
- 200.001: (boardablecar p2 cc0 topofmountain) [2.000]
- 200.002: (moveablecar cc0 topofmountain baseofmountain) [200.000]
- 400.001: (moverescuer res0 middleofmountain medcen) [560.000]
- 400.003: (disembarkfromvehicle p2 cc0 baseofmountain) [5.000]
- 405.004: (checkperson p2 d1 baseofmountain) [10.000]
- 415.005: (boardambulance p2 amb0 baseofmountain) [5.000]
- 415.006: (moveambulance amb0 baseofmountain morgue) [3.000]
- 418.007: (moveambulance amb0 morgue medcen) [8.000]
- 426.008: (disembarkfromvehicle p2 amb0 medcen) [5.000]
- 426.009: (moveambulance amb0 medcen morgue) [8.000]
- 434.010: (moveambulance amb0 morgue baseofmountain) [3.000]
- 560.001: (moverescuer res1 medcen middleofmountain) [560.000]
- 960.002: (moverescuer res0 medcen morgue) [160.000]
- 1120.002: (moverescuer res1 middleofmountain cliffedge) [750.000]
- 1120.003: (moverescuer res0 morgue baseofmountain) [30.000]
- 1870.003: (moverescuer res1 cliffedge smallrock) [1450.000]
- 3320.004: (moverescuer res1 smallrock smallledge) [510.000]
- 3830.005: (secureuninjuredtorescuer p4 res1 smallledge) [3.000]
- 3830.006: (moverescuer res1 smallledge baseofmountain) [150.000]
- 3980.007: (disembarkfromrescuer p4 res1 baseofmountain) [4.000]
- 3980.008: (moverescuer res1 baseofmountain morgue) [30.000]
- 3984.008: (secureuninjuredtorescuer p4 res0 baseofmountain) [3.000]
- 3984.009: (moverescuer res0 baseofmountain morgue) [30.000]
- 4010.009: (moverescuer res1 morgue medcen) [160.000]
- 4014.010: (moverescuer res0 morgue medcen) [160.000]
- 4170.010: (moverescuer res1 medcen middleofmountain) [560.000]
- 4174.011: (disembarkfromrescuer p4 res0 medcen) [4.000]
- 4174.012: (moverescuer res0 medcen middleofmountain) [560.000]
- 4730.011: (moverescuer res1 middleofmountain baseofmountain) [400.000]
- 4734.013: (moverescuer res0 middleofmountain cliffedge) [750.000]
- 5484.014: (moverescuer res0 cliffedge smallrock) [1450.000]
- 6934.015: (secureuninjuredtorescuer p3 res0 smallrock) [3.000]
- 6934.016: (moverescuer res0 smallrock smallledge) [510.000]
- 7444.017: (moverescuer res0 smallledge baseofmountain) [150.000]
- 7594.018: (disembarkfromrescuer p3 res0 baseofmountain) [4.000]
- 7594.019: (moverescuer res0 baseofmountain morgue) [30.000]
- 7598.019: (secureuninjuredtorescuer p3 res1 baseofmountain) [3.000]
- 7598.020: (moverescuer res1 baseofmountain morgue) [30.000]
- 7624.020: (moverescuer res0 morgue medcen) [160.000]
- 7628.021: (moverescuer res1 morgue medcen) [160.000]
- 7784.021: (moverescuer res0 medcen middleofmountain) [560.000]
- 7788.022: (disembarkfromrescuer p3 res1 medcen) [4.000]

- 7788.023: (moverescuer res1 medcen middleofmountain) [560.000]
- 8344.022: (moverescuer res0 middleofmountain cliffedge) [750.000]
- 8348.024: (moverescuer res1 middleofmountain cliffedge) [750.000]
- 9094.023: (secureinjuredtorescuer p9 res0 cliffedge) [5.000]
- 9094.024: (moverescuer res0 cliffedge smallrock) [1450.000]
- 9098.025: (moverescuer res1 cliffedge smallrock) [1450.000]
- 10544.025: (moverescuer res0 smallrock smallledge) [510.000]
- 10548.026: (moverescuer res1 smallrock smallledge) [510.000]
- 11054.026: (moverescuer res0 smallledge baseofmountain) [150.000]
- 11058.027: (moverescuer res1 smallledge baseofmountain) [150.000]
- 11204.027: (moverescuer res0 baseofmountain morgue) [30.000]
- 11208.028: (moverescuer res1 baseofmountain morgue) [30.000]
- 11234.028: (disembarkfromrescuer p9 res0 morgue) [4.000]
- 11234.029: (moverescuer res0 morgue medcen) [160.000]
- 11238.029: (moverescuer res1 morgue medcen) [160.000]
- 11394.030: (moverescuer res0 medcen middleofmountain) [560.000]
- 11398.030: (moverescuer res1 medcen middleofmountain) [560.000]
- 11954.031: (moverescuer res0 middleofmountain cliffedge) [750.000]
- 11958.031: (moverescuer res1 middleofmountain topofmountain) [400.000]
- 12358.032: (moverescuer res1 topofmountain bigrock) [1450.000]
- 12704.032: (secureuninjuredtorescuer p1 res0 cliffedge) [3.000]
- 12704.033: (moverescuer res0 cliffedge smallrock) [1450.000]
- 13808.033: (moverescuer res1 bigrock bigledge) [1050.000]
- 14154.034: (moverescuer res0 smallrock smallledge) [510.000]
- 14664.035: (moverescuer res0 smallledge baseofmountain) [150.000]
- 14814.036: (moverescuer res0 baseofmountain morgue) [30.000]
- 14844.037: (moverescuer res0 morgue medcen) [160.000]
- 14858.034: (moverescuer res1 bigledge middleofmountain) [360.000]
- 15004.038: (disembarkfromrescuer p1 res0 medcen) [4.000]
- 15004.039: (moverescuer res0 medcen middleofmountain) [560.000]
- 15218.035: (moverescuer res1 middleofmountain medcen) [560.000]
- 15564.040: (moverescuer res0 middleofmountain topofmountain) [400.000]
- 15778.036: (moverescuer res1 medcen middleofmountain) [560.000]
- 15964.041: (moverescuer res0 topofmountain bigrock) [1450.000]
- 17414.042: (moverescuer res0 bigrock bigledge) [1050.000]
- 18464.043: (secureuninjuredtorescuer p0 res0 bigledge) [3.000]
- 18464.044: (moverescuer res0 bigledge middleofmountain) [360.000]
- 18824.045: (disembarkfromrescuer p0 res0 middleofmountain) [4.000]
- 18824.046: (moverescuer res0 middleofmountain topofmountain) [400.000]
- 18828.046: (secureuninjuredtorescuer p0 res1 middleofmountain) [3.000]
- 18828.047: (moverescuer res1 middleofmountain medcen) [560.000]
- 19224.047: (moverescuer res0 topofmountain bigrock) [1450.000]
- 19388.048: (disembarkfromrescuer p0 res1 medcen) [4.000]
- 19388.049: (moverescuer res1 medcen middleofmountain) [560.000]
- 20674.048: (moverescuer res0 bigrock bigledge) [1050.000]
- 21724.049: (secureinjuredtorescuer p7 res0 bigledge) [5.000]
- 21724.049: (secureinjuredtorescuer p5 res0 bigledge) [5.000]
- 21724.050: (moverescuer res0 bigledge middleofmountain) [360.000]
- 22084.051: (disembarkfromrescuer p7 res0 middleofmountain) [4.000]

- 22084.052: (disembarkfromrescuer p5 res0 middleofmountain) [4.000]
- 22084.053: (moverescuer res0 middleofmountain baseofmountain) [400.000]
- 22088.052: (secureinjuredtorescuer p7 res1 middleofmountain) [5.000]
- 22088.053: (secureinjuredtorescuer p5 res1 middleofmountain) [5.000]
- 22088.054: (moverescuer res1 middleofmountain baseofmountain) [400.000]
- 22484.054: (moverescuer res0 baseofmountain morgue) [30.000]
- 22488.055: (moverescuer res1 baseofmountain morgue) [30.000]
- 22514.055: (moverescuer res0 morgue baseofmountain) [30.000]
- 22518.056: (disembarkfromrescuer p7 res1 morgue) [4.000]
- 22518.057: (disembarkfromrescuer p5 res1 morgue) [4.000]
- 22518.058: (moverescuer res1 morgue baseofmountain) [30.000]
- 22544.056: (moverescuer res0 baseofmountain topofmountain) [800.000]
- 22548.059: (moverescuer res1 baseofmountain topofmountain) [800.000]
- 23344.057: (moverescuer res0 topofmountain bigrock) [1450.000]
- 23348.060: (moverescuer res1 topofmountain bigrock) [1450.000]
- 24794.058: (secureinjuredtorescuer p8 res0 bigrock) [5.000]
- 24794.059: (moverescuer res0 bigrock bigledge) [1050.000]
- 24798.061: (moverescuer res1 bigrock bigledge) [1050.000]
- 25844.060: (moverescuer res0 bigledge middleofmountain) [360.000]
- 25848.062: (moverescuer res1 bigledge middleofmountain) [360.000]
- 26204.061: (moverescuer res0 middleofmountain baseofmountain) [400.000]
- 26208.063: (moverescuer res1 middleofmountain baseofmountain) [400.000]
- 26604.062: (moverescuer res0 baseofmountain morgue) [30.000]
- 26608.064: (moverescuer res1 baseofmountain topofmountain) [800.000]
- 26634.063: (disembarkfromrescuer p8 res0 morgue) [4.000]
- 26634.064: (moverescuer res0 morgue baseofmountain) [30.000]
- 26664.065: (moverescuer res0 baseofmountain topofmountain) [800.000]
- 27408.065: (moverescuer res1 topofmountain bigrock) [1450.000]
- 27464.066: (moverescuer res0 topofmountain bigrock) [1450.000]
- 28858.066: (secureinjuredtorescuer p6 res1 bigrock) [5.000]
- 28858.067: (moverescuer res1 bigrock bigledge) [1050.000]
- 29908.068: (moverescuer res1 bigledge middleofmountain) [360.000]
- 30268.069: (moverescuer res1 middleofmountain baseofmountain) [400.000]
- 30668.070: (disembarkfromrescuer p6 res1 baseofmountain) [4.000]
- 30672.071: (checkperson p6 d1 baseofmountain) [10.000]
- 30682.072: (boardambulance p6 amb0 baseofmountain) [5.000]
- 30682.073: (moveambulance amb0 baseofmountain morgue) [3.000]
- 30687.073: (disembarkfromvehicle p6 amb0 morgue) [5.000]

2.2b –

ii. 11x People to be rescueD: OPTIC SOLUTION

- 0.000: (moverescuer res0 topofmountain middleofmountain) [400.000]
- 0.000: (moverescuer res1 middleofmountain medcen) [560.000]
- 0.000: (movecablecar cc0 baseofmountain middleofmountain) [100.000]
- 400.001: (moverescuer res0 middleofmountain topofmountain) [400.000]
- 560.001: (moverescuer res1 medcen middleofmountain) [560.000]
- 800.002: (moverescuer res0 topofmountain baseofmountain) [800.000]
- 1120.002: (secureuninjuredtorescuer p10 res1 middleofmountain) [3.000]
- 1120.003: (moverescuer res1 middleofmountain baseofmountain) [400.000]

1520.004: (moverescuer res1 baseofmountain morgue) [30.000]
 1550.005: (disembarkfromrescuer p10 res1 morgue) [4.000]
 1550.006: (moverescuer res1 morgue baseofmountain) [30.000]
 1580.007: (moverescuer res1 baseofmountain topofmountain) [800.000]
 1600.003: (moverescuer res0 baseofmountain topofmountain) [800.000]
 2380.008: (secureinjuredtorescuer p2 res1 topofmountain) [5.000]
 2380.009: (moverescuer res1 topofmountain middleofmountain) [400.000]
 2400.004: (moverescuer res0 topofmountain middleofmountain) [400.000]
 2780.010: (moverescuer res1 middleofmountain medcen) [560.000]
 2800.005: (moverescuer res0 middleofmountain cliffedge) [750.000]
 3340.011: (disembarkfromrescuer p2 res1 medcen) [4.000]
 3340.012: (moverescuer res1 medcen middleofmountain) [560.000]
 3550.006: (moverescuer res0 cliffedge smallrock) [1450.000]
 3900.013: (moverescuer res1 middleofmountain cliffedge) [750.000]
 4650.014: (moverescuer res1 cliffedge smallrock) [1450.000]
 5000.007: (secureuninjuredtorescuer p3 res0 smallrock) [3.000]
 5000.008: (moverescuer res0 smallrock smallledge) [510.000]
 5510.009: (moverescuer res0 smallledge baseofmountain) [150.000]
 5660.010: (disembarkfromrescuer p3 res0 baseofmountain) [4.000]
 6100.015: (moverescuer res1 smallrock smallledge) [510.000]
 6610.016: (secureinjuredtorescuer p4 res1 smallledge) [5.000]
 6610.017: (moverescuer res1 smallledge baseofmountain) [150.000]
 6760.018: (disembarkfromrescuer p4 res1 baseofmountain) [4.000]
 6760.019: (moverescuer res1 baseofmountain morgue) [30.000]
 6764.019: (secureinjuredtorescuer p4 res0 baseofmountain) [5.000]
 6764.020: (moverescuer res0 baseofmountain middleofmountain) [400.000]
 6790.020: (moverescuer res1 morgue medcen) [160.000]
 6950.021: (moverescuer res1 medcen middleofmountain) [560.000]
 7164.021: (moverescuer res0 middleofmountain medcen) [560.000]
 7510.022: (moverescuer res1 middleofmountain cliffedge) [750.000]
 7724.022: (disembarkfromrescuer p4 res0 medcen) [4.000]
 7724.023: (moverescuer res0 medcen middleofmountain) [560.000]
 8260.023: (secureuninjuredtorescuer p9 res1 cliffedge) [3.000]
 8260.024: (moverescuer res1 cliffedge smallrock) [1450.000]
 8284.024: (moverescuer res0 middleofmountain cliffedge) [750.000]
 9034.025: (moverescuer res0 cliffedge smallrock) [1450.000]
 9710.025: (moverescuer res1 smallrock smallledge) [510.000]
 10220.026: (moverescuer res1 smallledge baseofmountain) [150.000]
 10370.027: (moverescuer res1 baseofmountain morgue) [30.000]
 10400.028: (disembarkfromrescuer p9 res1 morgue) [4.000]
 10400.029: (moverescuer res1 morgue baseofmountain) [30.000]
 10430.030: (moverescuer res1 baseofmountain middleofmountain) [400.000]
 10484.026: (moverescuer res0 smallrock smallledge) [510.000]
 10830.031: (moverescuer res1 middleofmountain cliffedge) [750.000]
 10994.027: (moverescuer res0 smallledge baseofmountain) [150.000]
 11144.028: (moverescuer res0 baseofmountain middleofmountain) [400.000]
 11544.029: (moverescuer res0 middleofmountain cliffedge) [750.000]
 11580.032: (secureinjuredtorescuer p1 res1 cliffedge) [5.000]
 11580.033: (moverescuer res1 cliffedge smallrock) [1450.000]
 12294.030: (moverescuer res0 cliffedge smallrock) [1450.000]
 13030.034: (moverescuer res1 smallrock smallledge) [510.000]

13540.035: (moverescuer res1 smallledge baseofmountain) [150.000]
 13690.036: (moverescuer res1 baseofmountain morgue) [30.000]
 13720.037: (moverescuer res1 morgue medcen) [160.000]
 13744.031: (moverescuer res0 smallrock smallledge) [510.000]
 13880.038: (disembarkfromrescuer p1 res1 medcen) [4.000]
 13880.039: (moverescuer res1 medcen morgue) [160.000]
 14040.040: (moverescuer res1 morgue baseofmountain) [30.000]
 14070.041: (moverescuer res1 baseofmountain topofmountain) [800.000]
 14254.032: (moverescuer res0 smallledge baseofmountain) [150.000]
 14404.033: (moverescuer res0 baseofmountain topofmountain) [800.000]
 14870.042: (moverescuer res1 topofmountain bigrock) [1450.000]
 15204.034: (moverescuer res0 topofmountain middleofmountain) [400.000]
 16320.043: (moverescuer res1 bigrock bigledge) [1050.000]
 17370.044: (secureuninjuredtorescuer p7 res1 bigledge) [3.000]
 17370.045: (moverescuer res1 bigledge middleofmountain) [360.000]
 17730.046: (disembarkfromrescuer p7 res1 middleofmountain) [4.000]
 17730.047: (moverescuer res1 middleofmountain topofmountain) [400.000]
 17734.047: (secureuninjuredtorescuer p7 res0 middleofmountain) [3.000]
 17734.048: (moverescuer res0 middleofmountain medcen) [560.000]
 18130.048: (moverescuer res1 topofmountain bigrock) [1450.000]
 18294.049: (disembarkfromrescuer p7 res0 medcen) [4.000]
 18294.050: (moverescuer res0 medcen morgue) [160.000]
 18454.051: (moverescuer res0 morgue baseofmountain) [30.000]
 18484.052: (moverescuer res0 baseofmountain topofmountain) [800.000]
 19284.053: (moverescuer res0 topofmountain bigrock) [1450.000]
 19580.049: (moverescuer res1 bigrock bigledge) [1050.000]
 20630.050: (secureuninjuredtorescuer p5 res1 bigledge) [3.000]
 20630.051: (moverescuer res1 bigledge middleofmountain) [360.000]
 20734.054: (secureinjuredtorescuer p8 res0 bigrock) [5.000]
 20734.055: (moverescuer res0 bigrock bigledge) [1050.000]
 20990.052: (disembarkfromrescuer p5 res1 middleofmountain) [4.000]
 20994.053: (boardcablecar p5 cc0 middleofmountain) [2.000]
 20994.054: (movecablecar cc0 middleofmountain baseofmountain) [100.000]
 21094.055: (disembarkfromvehicle p5 cc0 baseofmountain) [5.000]
 21094.056: (movecablecar cc0 baseofmountain middleofmountain) [100.000]
 21784.056: (moverescuer res0 bigledge middleofmountain) [360.000]
 22144.057: (disembarkfromrescuer p8 res0 middleofmountain) [4.000]
 22144.058: (moverescuer res0 middleofmountain topofmountain) [400.000]
 22148.058: (secureinjuredtorescuer p8 res1 middleofmountain) [5.000]
 22148.059: (moverescuer res1 middleofmountain medcen) [560.000]
 22544.059: (moverescuer res0 topofmountain bigrock) [1450.000]
 22708.060: (disembarkfromrescuer p8 res1 medcen) [4.000]
 22708.061: (moverescuer res1 medcen middleofmountain) [560.000]
 23268.062: (moverescuer res1 middleofmountain topofmountain) [400.000]
 23668.063: (moverescuer res1 topofmountain bigrock) [1450.000]
 23994.060: (secureuninjuredtorescuer p6 res0 bigrock) [3.000]
 23994.061: (moverescuer res0 bigrock bigledge) [1050.000]
 25044.062: (secureuninjuredtorescuer p0 res0 bigledge) [3.000]
 25044.063: (moverescuer res0 bigledge middleofmountain) [360.000]
 25404.064: (disembarkfromrescuer p6 res0 middleofmountain) [4.000]
 25404.065: (disembarkfromrescuer p0 res0 middleofmountain) [4.000]

25408.065: (boardcablecar p6 cc0 middleofmountain) [2.000]
 25408.066: (boardcablecar p0 cc0 middleofmountain) [2.000]
 25408.067: (movecablecar cc0 middleofmountain baseofmountain) [100.000]
 25508.068: (disembarkfromvehicle p6 cc0 baseofmountain) [5.000]
 25508.069: (disembarkfromvehicle p0 cc0 baseofmountain) [5.000]

2.2b --**iii. 12x People to be rescued: OPTIC SOLUTION**

- 0.000: (movecablecar cc1 topofmountain middleofmountain) [100.000]
- 0.000: (moverescuer res0 topofmountain middleofmountain) [400.000]
- 0.000: (moverescuer res1 middleofmountain baseofmountain) [400.000]
- 0.000: (movecablecar cc0 baseofmountain topofmountain) [200.000]
- 100.001: (movecablecar cc1 middleofmountain topofmountain) [100.000]
- 200.001: (boardcablecar p2 cc0 topofmountain) [2.000]
- 200.002: (movecablecar cc0 topofmountain baseofmountain) [200.000]
- 400.001: (moverescuer res0 middleofmountain medcen) [560.000]
- 400.001: (moverescuer res1 baseofmountain morgue) [30.000]
- 400.003: (disembarkfromvehicle p2 cc0 baseofmountain) [5.000]
- 405.004: (checkperson p2 d1 baseofmountain) [10.000]
- 415.005: (boardambulance p2 amb0 baseofmountain) [5.000]
- 415.006: (moveambulance amb0 baseofmountain morgue) [3.000]
- 418.007: (moveambulance amb0 morgue medcen) [8.000]
- 426.008: (disembarkfromvehicle p2 amb0 medcen) [5.000]
- 430.002: (moverescuer res1 morgue medcen) [160.000]
- 590.003: (moverescuer res1 medcen middleofmountain) [560.000]
- 960.002: (moverescuer res0 medcen middleofmountain) [560.000]
- 1150.004: (secureinjuredtorescuer p10 res1 middleofmountain) [5.000]
- 1150.005: (moverescuer res1 middleofmountain baseofmountain) [400.000]
- 1520.003: (moverescuer res0 middleofmountain baseofmountain) [400.000]
- 1550.006: (moverescuer res1 baseofmountain morgue) [30.000]
- 1580.007: (disembarkfromrescuer p10 res1 morgue) [4.000]
- 1580.008: (moverescuer res1 morgue medcen) [160.000]
- 1740.009: (moverescuer res1 medcen middleofmountain) [560.000]
- 1920.004: (moverescuer res0 baseofmountain topofmountain) [800.000]
- 2300.010: (moverescuer res1 middleofmountain cliffedge) [750.000]
- 2720.005: (moverescuer res0 topofmountain baseofmountain) [800.000]
- 3050.011: (moverescuer res1 cliffedge smallrock) [1450.000]
- 4500.012: (moverescuer res1 smallrock smallledge) [510.000]
- 5010.013: (secureuninjuredtorescuer p4 res1 smallledge) [3.000]
- 5010.014: (moverescuer res1 smallledge baseofmountain) [150.000]
- 5160.015: (disembarkfromrescuer p4 res1 baseofmountain) [4.000]
- 5160.016: (moverescuer res1 baseofmountain morgue) [30.000]
- 5164.016: (secureuninjuredtorescuer p4 res0 baseofmountain) [3.000]
- 5164.017: (moverescuer res0 baseofmountain morgue) [30.000]
- 5190.017: (moverescuer res1 morgue medcen) [160.000]
- 5194.018: (moverescuer res0 morgue medcen) [160.000]
- 5350.018: (moverescuer res1 medcen middleofmountain) [560.000]
- 5354.019: (disembarkfromrescuer p4 res0 medcen) [4.000]
- 5354.020: (moverescuer res0 medcen middleofmountain) [560.000]

- 5910.019: (moverescuer res1 middleofmountain baseofmountain) [400.000]
- 5914.021: (moverescuer res0 middleofmountain cliffedge) [750.000]
- 6664.022: (moverescuer res0 cliffedge smallrock) [1450.000]
- 8114.023: (secureuninjuredtorescuer p3 res0 smallrock) [3.000]
- 8114.024: (moverescuer res0 smallrock smallledge) [510.000]
- 8624.025: (moverescuer res0 smallledge baseofmountain) [150.000]
- 8774.026: (disembarkfromrescuer p3 res0 baseofmountain) [4.000]
- 8774.027: (moverescuer res0 baseofmountain morgue) [30.000]
- 8778.027: (secureuninjuredtorescuer p3 res1 baseofmountain) [3.000]
- 8778.028: (moverescuer res1 baseofmountain morgue) [30.000]
- 8804.028: (moverescuer res0 morgue medcen) [160.000]
- 8808.029: (moverescuer res1 morgue medcen) [160.000]
- 8964.029: (moverescuer res0 medcen middleofmountain) [560.000]
- 8968.030: (disembarkfromrescuer p3 res1 medcen) [4.000]
- 8968.031: (moverescuer res1 medcen middleofmountain) [560.000]
- 9524.030: (moverescuer res0 middleofmountain cliffedge) [750.000]
- 9528.032: (moverescuer res1 middleofmountain cliffedge) [750.000]
- 10274.031: (secureinjuredtorescuer p9 res0 cliffedge) [5.000]
- 10274.031: (secureinjuredtorescuer p11 res0 cliffedge) [5.000]
- 10274.032: (moverescuer res0 cliffedge smallrock) [1450.000]
- 10278.033: (moverescuer res1 cliffedge smallrock) [1450.000]
- 11724.033: (moverescuer res0 smallrock smallledge) [510.000]
- 11728.034: (moverescuer res1 smallrock smallledge) [510.000]
- 12234.034: (moverescuer res0 smallledge baseofmountain) [150.000]
- 12238.035: (moverescuer res1 smallledge baseofmountain) [150.000]
- 12384.035: (moverescuer res0 baseofmountain morgue) [30.000]
- 12388.036: (moverescuer res1 baseofmountain morgue) [30.000]
- 12414.036: (disembarkfromrescuer p9 res0 morgue) [4.000]
- 12414.037: (disembarkfromrescuer p11 res0 morgue) [4.000]
- 12414.038: (moverescuer res0 morgue medcen) [160.000]
- 12418.037: (moverescuer res1 morgue medcen) [160.000]
- 12574.039: (moverescuer res0 medcen middleofmountain) [560.000]
- 12578.038: (moverescuer res1 medcen middleofmountain) [560.000]
- 13134.040: (moverescuer res0 middleofmountain cliffedge) [750.000]
- 13138.039: (moverescuer res1 middleofmountain topofmountain) [400.000]
- 13538.040: (moverescuer res1 topofmountain bigrock) [1450.000]
- 13884.041: (secureuninjuredtorescuer p1 res0 cliffedge) [3.000]
- 13884.042: (moverescuer res0 cliffedge smallrock) [1450.000]
- 14988.041: (moverescuer res1 bigrock bigledge) [1050.000]
- 15334.043: (moverescuer res0 smallrock smallledge) [510.000]
- 15844.044: (moverescuer res0 smallledge baseofmountain) [150.000]
- 15994.045: (moverescuer res0 baseofmountain morgue) [30.000]
- 16024.046: (moverescuer res0 morgue medcen) [160.000]
- 16038.042: (moverescuer res1 bigledge middleofmountain) [360.000]
- 16184.047: (disembarkfromrescuer p1 res0 medcen) [4.000]
- 16184.048: (moverescuer res0 medcen middleofmountain) [560.000]
- 16398.043: (moverescuer res1 middleofmountain medcen) [560.000]
- 16744.049: (moverescuer res0 middleofmountain topofmountain) [400.000]
- 16958.044: (moverescuer res1 medcen middleofmountain) [560.000]

- 17144.050: (moverescuer res0 topofmountain bigrock) [1450.000]
- 18594.051: (moverescuer res0 bigrock bigledge) [1050.000]
- 19644.052: (secureuninjuredtorescuer p5 res0 bigledge) [3.000]
- 19644.052: (secureuninjuredtorescuer p0 res0 bigledge) [3.000]
- 19644.052: (secureinjuredtorescuer p7 res0 bigledge) [5.000]
- 19644.053: (moverescuer res0 bigledge middleofmountain) [360.000]
- 20004.054: (disembarkfromrescuer p7 res0 middleofmountain) [4.000]
- 20004.055: (disembarkfromrescuer p5 res0 middleofmountain) [4.000]
- 20004.056: (disembarkfromrescuer p0 res0 middleofmountain) [4.000]
- 20004.057: (moverescuer res0 middleofmountain topofmountain) [400.000]
- 20008.055: (secureinjuredtorescuer p7 res1 middleofmountain) [5.000]
- 20008.056: (secureuninjuredtorescuer p5 res1 middleofmountain) [3.000]
- 20008.057: (secureuninjuredtorescuer p0 res1 middleofmountain) [3.000]
- 20008.058: (moverescuer res1 middleofmountain medcen) [560.000]
- 20404.058: (moverescuer res0 topofmountain bigrock) [1450.000]
- 20568.059: (disembarkfromrescuer p7 res1 medcen) [4.000]
- 20568.060: (disembarkfromrescuer p5 res1 medcen) [4.000]
- 20568.061: (disembarkfromrescuer p0 res1 medcen) [4.000]
- 20568.062: (moverescuer res1 medcen middleofmountain) [560.000]
- 20572.060: (checkperson p7 d0 medcen) [10.000]
- 20582.061: (boardambulance p7 amb0 medcen) [5.000]
- 20582.062: (moveambulance amb0 medcen morgue) [8.000]
- 20590.063: (disembarkfromvehicle p7 amb0 morgue) [5.000]
- 20590.064: (moveambulance amb0 morgue baseofmountain) [3.000]
- 21128.063: (moverescuer res1 middleofmountain topofmountain) [400.000]
- 21528.064: (moverescuer res1 topofmountain bigrock) [1450.000]
- 21854.059: (secureinjuredtorescuer p8 res0 bigrock) [5.000]
- 21854.060: (moverescuer res0 bigrock bigledge) [1050.000]
- 22904.061: (moverescuer res0 bigledge middleofmountain) [360.000]
- 22978.065: (moverescuer res1 bigrock bigledge) [1050.000]
- 23264.062: (moverescuer res0 middleofmountain baseofmountain) [400.000]
- 23664.063: (moverescuer res0 baseofmountain morgue) [30.000]
- 23694.064: (disembarkfromrescuer p8 res0 morgue) [4.000]
- 23694.065: (moverescuer res0 morgue baseofmountain) [30.000]
- 23724.066: (moverescuer res0 baseofmountain topofmountain) [800.000]
- 24028.066: (moverescuer res1 bigledge middleofmountain) [360.000]
- 24388.067: (moverescuer res1 middleofmountain topofmountain) [400.000]
- 24524.067: (moverescuer res0 topofmountain bigrock) [1450.000]
- 24788.068: (moverescuer res1 topofmountain bigrock) [1450.000]
- 25974.068: (secureinjuredtorescuer p6 res0 bigrock) [5.000]
- 25974.069: (moverescuer res0 bigrock bigledge) [1050.000]
- 27024.070: (moverescuer res0 bigledge middleofmountain) [360.000]
- 27384.071: (moverescuer res0 middleofmountain baseofmountain) [400.000]
- 27784.072: (disembarkfromrescuer p6 res0 baseofmountain) [4.000]
- 27788.073: (checkperson p6 d1 baseofmountain) [10.000]
- 27798.074: (boardambulance p6 amb0 baseofmountain) [5.000]
- 27798.075: (moveambulance amb0 baseofmountain morgue) [3.000]
- 27803.075: (disembarkfromvehicle p6 amb0 morgue) [5.000]

2.3a –

Experimental Analysis Properties

2 Hiker Problem

| | <u>Initial Location</u> | <u>Uninjured?</u> | <u>Conscious?</u> | <u>Alive?</u> | <u>Goal Location</u> |
|-----------|-------------------------|-------------------|-------------------|---------------|----------------------|
| p0 | BigLedge | ✓ | ✓ | ✓ | BaseOfMountain |
| p1 | CliffEdge | | | | Morgue |

4 Hiker Problem

| | <u>Initial Location</u> | <u>Uninjured?</u> | <u>Conscious?</u> | <u>Alive?</u> | <u>Goal Location</u> |
|-----------|-------------------------|-------------------|-------------------|---------------|----------------------|
| p0 | BigLedge | ✓ | ✓ | ✓ | BaseOfMountain |
| p1 | CliffEdge | ✓ | ✓ | ✓ | BaseOfMountain |
| p2 | TopOfMountain | | | | Morgue |
| p3 | SmallRock | | | | Morgue |

6 Hiker Problem

| | <u>Initial Location</u> | <u>Uninjured?</u> | <u>Conscious?</u> | <u>Alive?</u> | <u>Goal Location</u> |
|-----------|-------------------------|-------------------|-------------------|---------------|----------------------|
| p0 | BigLedge | ✓ | ✓ | ✓ | BaseOfMountain |
| p1 | CliffEdge | ✓ | ✓ | ✓ | BaseOfMountain |
| p2 | TopOfMountain | ✓ | ✓ | ✓ | BaseOfMountain |
| p3 | SmallRock | | | | Morgue |
| p4 | SmallLedge | | | | Morgue |
| p5 | BigLedge | | | | Morgue |

8 Hiker Problem

| | <u>Initial Location</u> | <u>Uninjured?</u> | <u>Conscious?</u> | <u>Alive?</u> | <u>Goal Location</u> |
|-----------|-------------------------|-------------------|-------------------|---------------|----------------------|
| p0 | BigLedge | ✓ | ✓ | ✓ | BaseOfMountain |
| p1 | CliffEdge | ✓ | ✓ | ✓ | BaseOfMountain |
| p2 | TopOfMountain | ✓ | ✓ | ✓ | BaseOfMountain |
| p3 | SmallRock | ✓ | ✓ | ✓ | BaseOfMountain |
| p4 | SmallLedge | | | | Morgue |
| p5 | BigLedge | | | | Morgue |
| p6 | BigRock | | | | Morgue |
| p7 | BigLedge | | | | Morgue |

10 Hiker Problem

| | <u>Initial Location</u> | <u>Uninjured?</u> | <u>Conscious?</u> | <u>Alive?</u> | <u>Goal Location</u> |
|-----------|-------------------------|-------------------|-------------------|---------------|----------------------|
| p0 | BigLedge | ✓ | ✓ | ✓ | BaseOfMountain |
| p1 | CliffEdge | ✓ | ✓ | ✓ | BaseOfMountain |
| p2 | TopOfMountain | ✓ | ✓ | ✓ | BaseOfMountain |
| p3 | SmallRock | ✓ | ✓ | ✓ | BaseOfMountain |
| p4 | SmallLedge | ✓ | ✓ | ✓ | BaseOfMountain |
| p5 | BigLedge | | | | Morgue |
| p6 | BigRock | | | | Morgue |
| p7 | BigLedge | | | | Morgue |
| p8 | BigRock | | | | Morgue |
| p9 | CliffEdge | | | | Morgue |

12 Hiker Problem

| | <u>Initial Location</u> | <u>Uninjured?</u> | <u>Conscious?</u> | <u>Alive?</u> | <u>Goal Location</u> |
|------------|-------------------------|-------------------|-------------------|---------------|----------------------|
| p0 | BigLedge | ✓ | ✓ | ✓ | BaseOfMountain |
| p1 | CliffEdge | ✓ | ✓ | ✓ | BaseOfMountain |
| p2 | TopOfMountain | ✓ | ✓ | ✓ | BaseOfMountain |
| p3 | SmallRock | ✓ | ✓ | ✓ | BaseOfMountain |
| p4 | SmallLedge | ✓ | ✓ | ✓ | BaseOfMountain |
| p5 | BigLedge | ✓ | ✓ | ✓ | BaseOfMountain |
| p6 | BigRock | | | | Morgue |
| p7 | BigLedge | | | | Morgue |
| p8 | BigRock | | | | Morgue |
| p9 | CliffEdge | | | | Morgue |
| p10 | MiddleOfMountain | | | | Morgue |
| p11 | CliffEdge | | | | Morgue |

2.3b –

Graph Data

| ½ Hikers, Uninjured, Conscious, Alive – (Other half Injured, Unconscious, Dead) | | | |
|------------------------------------------------------------------------------------|------------------|-----------|----------------|
| Number of Hikers | STATES EVALUATED | COST | TIME (seconds) |
| 2 | 130 | 7264.016 | 0.95 |
| 4 | 1106 | 10880.027 | 4.28 |
| 6 | 1828 | 11684.031 | 8.01 |
| 8 | 12906 | 23014.054 | 72.79 |
| 10 | 39432 | 30692.073 | 291.60 |
| 12 | 54734 | 27808.075 | 453.07 |