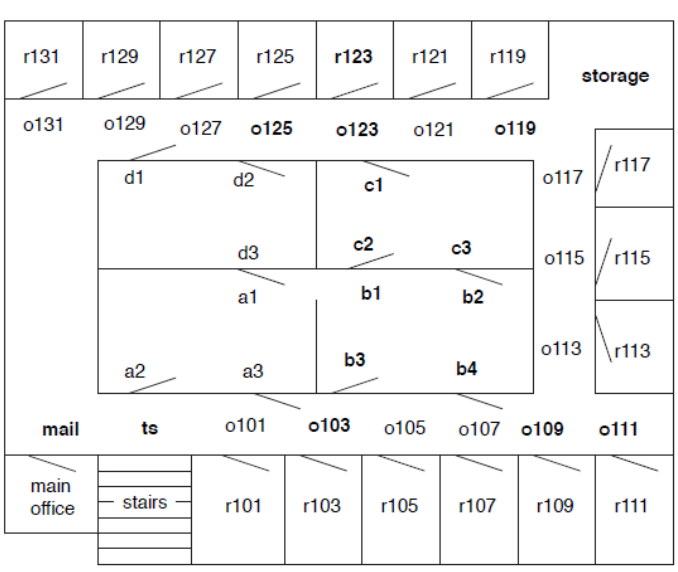
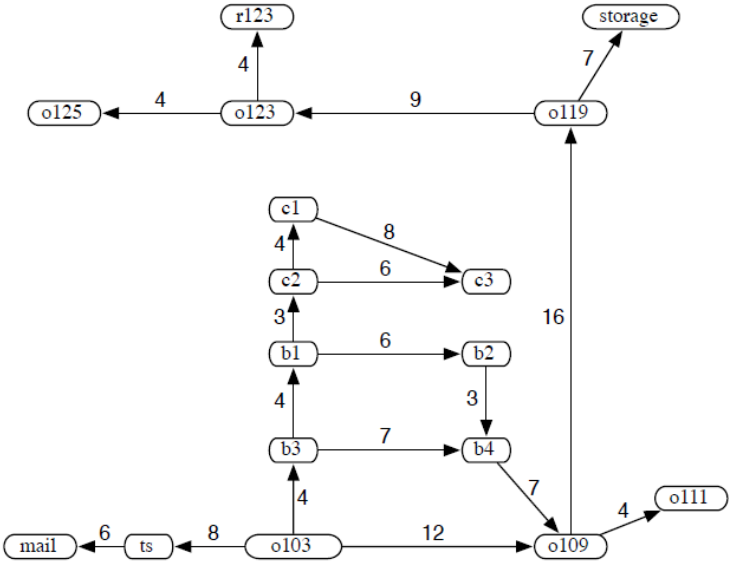
Homework 2

(Due by 09/16)

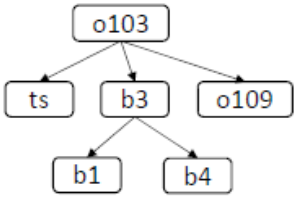
Considering a robot outside room r103, at position o103, and the goal is to get to room r123. The floor map and the simplified state-space graph are shown below.





Problem 1:

a) Finish the following search tree (assuming the left node has a higher priority than the right node if they are at the same depth)



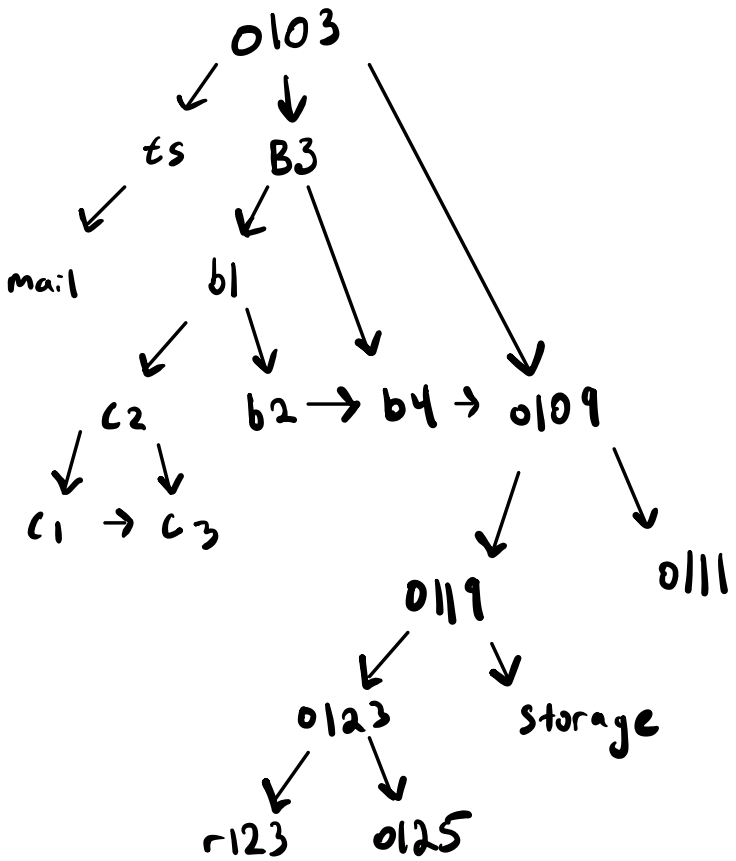
b) Using BFS to find the first solution path (**hand calculation**)

c) Using DFS to find the first solution path (**hand calculation**)

d) Complete "hw2.py" code and run the code to obtain three solution paths from BFS and three solution paths from DFS (Submit the output, don't attach the code)

Aidan Schulze Hw 2 AI

1) a) Finish the following search tree.

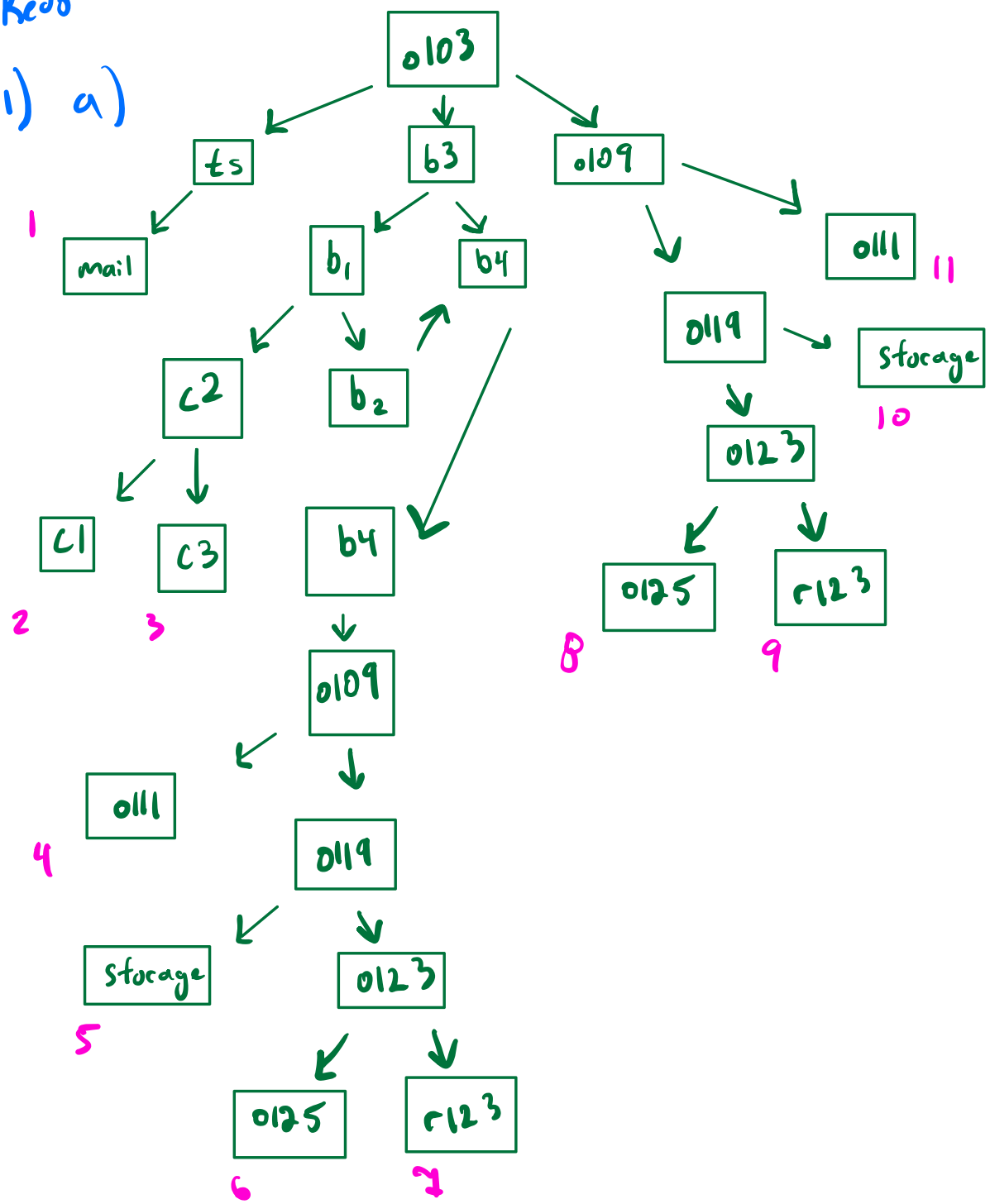


✓

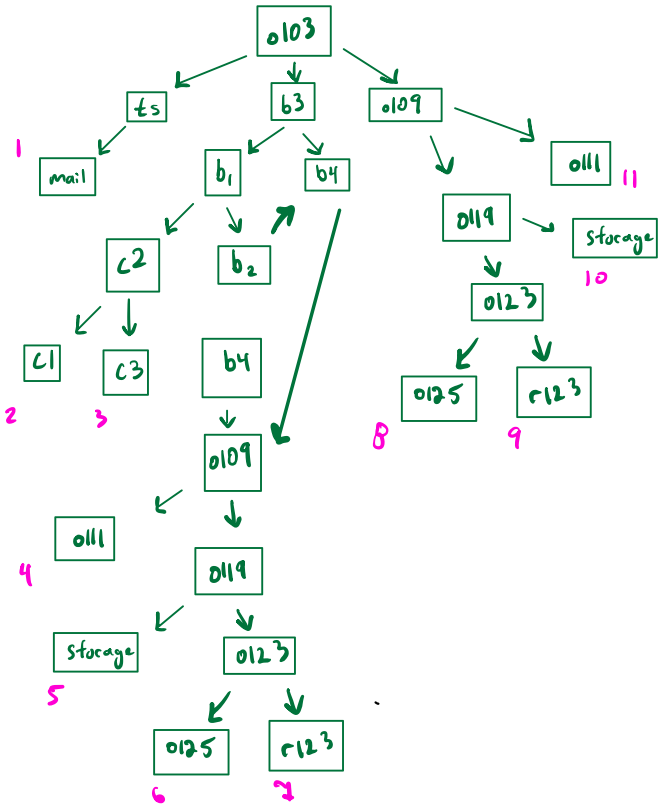
OR

Redo

1) a)


0103
ts
b3
0109
mail
b1
b4
0111
0119
c2
b2
storage
0123
c1
c3
b4
0125
r123
0109
0111
0119
storage
0123
0125
r123
1
2
3
4
5
6
7
8
9
10
11

1 b) BFS



Queue	New path
~~<0103>~~	<0103, t3>, <0103, b3> <0103, 0109
~~<0103, t3>~~, <0103, b3> <0103, 0109	<0103, t3, mail>
<0103, t3, mail> ~~<0103, b3>~~ <0103, 0109>	<0103, b3, b1> <0103, b3, b4>
<0103, b3, b1> <0103, b3, b4> ~~<0103, t3, mail>~~ ~~<0103, 0109>~~	<0103, 0109, 0111>, <0103, 0109, 0119>
~~<0103, b3, b1>~~ <0103, b3, b4> <0103, 0109, 0111>	<0103, b3, b1, c2> <0103, b3, b1, b2>

⟨o103, o109, o119⟩	
~~⟨o103, b3, b4⟩~~ ~~⟨o103, o109, o111⟩~~ ⟨o103, o109, o119⟩ ⟨o103, b3, b1, c2⟩ ⟨o103, b3, b1, b2⟩	skip
~~⟨o103, o109, o111⟩~~ ~~⟨o103, o109, o119⟩~~ ⟨o103, b3, b1, c2⟩ ⟨o103, b3, b1, b2⟩	⟨o103, o109, o119, storage⟩ ⟨o103, o109, o119, o123⟩
~~⟨o103, b3, b1, c2⟩~~ ⟨o103, b3, b1, b2⟩ ⟨o103, o109, o119, storage⟩ ⟨o103, o109, o119, o123⟩	⟨o103, b3, b1, c2, c_1⟩ ⟨o103, b3, b1, c2, c3⟩
~~⟨o103, b3, b1, b2⟩~~ ⟨o103, o109, o119, storage⟩ ⟨o103, o109, o119, o123⟩ ⟨o103, b3, b1, c2, c_1⟩ ⟨o103, b3, b1, c2, c3⟩	⟨o103, b3, b1, b2, b4⟩

~~<o103, o109, o119, storage>~~

<o103, o109, o119, o123>

<o103, b3, b1, c2, c1>

<o103, b3, b1, c2, c3>

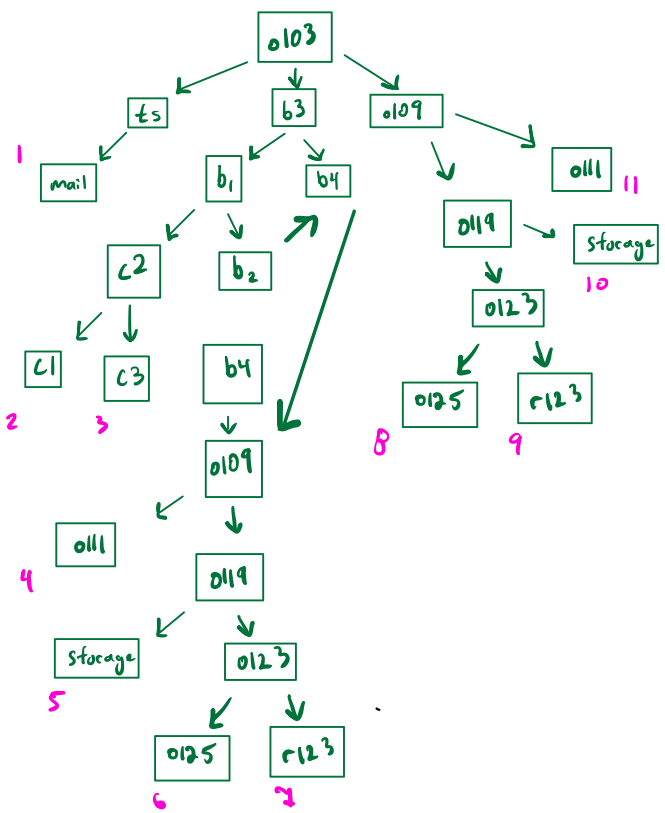
<o103, b3, b1, b2, b4>

<o103, o109, o119, o123, o125>

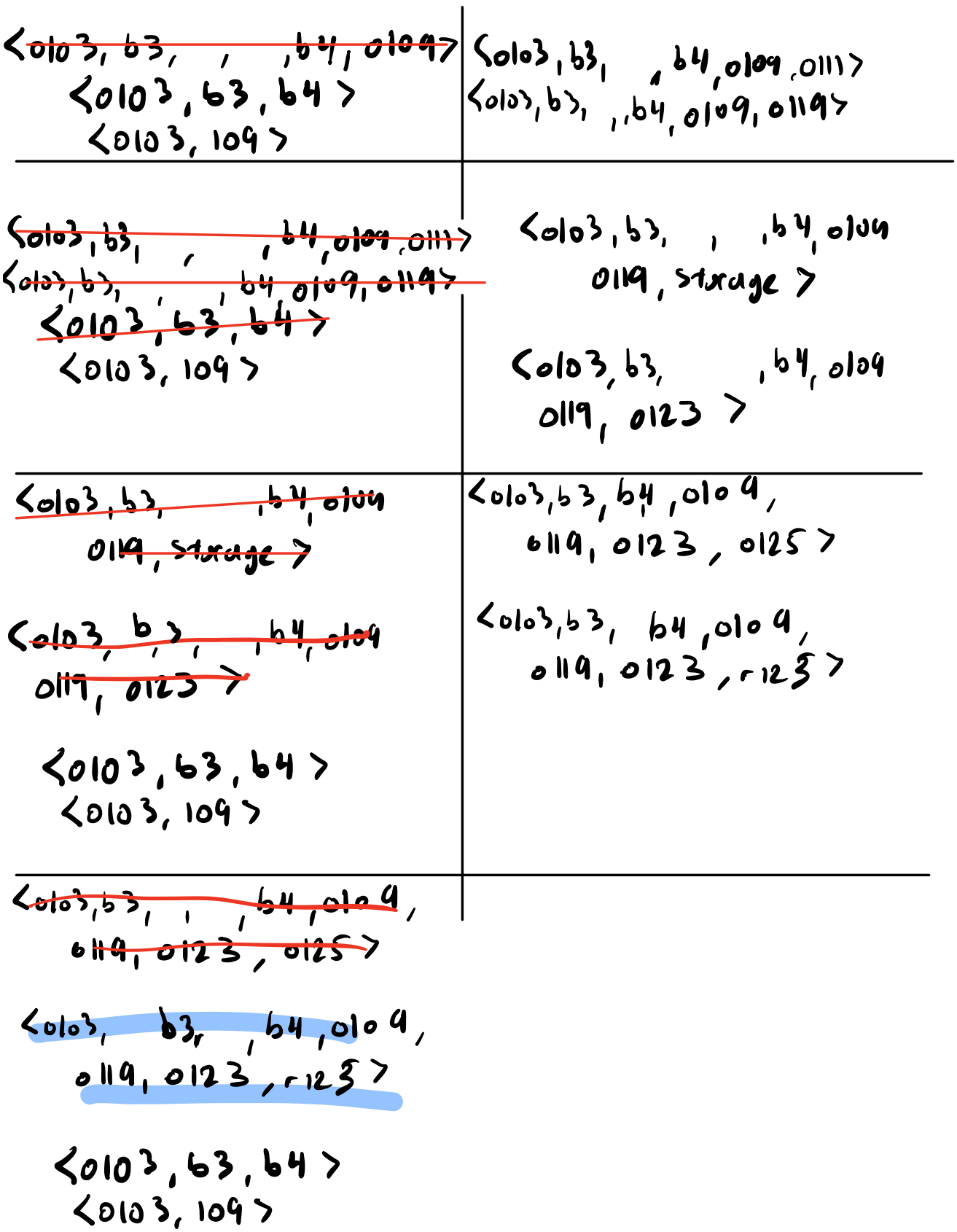
<o103, o109, o119, o123, r123>

Solution: <o103, o109, o119, o123, r123>

1c) DFS



Queue	New Paths
~~<0103>~~	<0103, ts> <0103, b3> <0103, 109>
~~<0103, ts>~~ <0103, b3> <0103, 109>	<0103, ts, mail>
~~<0103, ts, mail>~~ ~~<0103, b3>~~ <0103, 109>	<0103, b3, b1> <0103, b3, b4>
~~<0103, b3, b1>~~ <0103, b3, b4> <0103, 109>	<0103, b3, b1, c2> <0103, b3, b1, b2>
~~<0103, b3, b1, c2>~~ <0103, b3, b1, b2> <0103, b3, b4> <0103, 109>	<0103, b3, b1, c2, c1> <0103, b3, b1, c2, c3>
~~<0103, b3, b1, c2, c1>~~ ~~<0103, b3, b1, c2, c3>~~ ~~<0103, b3, b1, b2>~~ <0103, b3, b4> <0103, 109>	<0103, b3, b4>
~~<0103, b3, b4>~~ <0103, b3, b4> <0103, 109>	<0103, b3, b4, 0109>


<0103, b3, , b4, 0109>
<0103, b3, , b4, 0109, 0111>
<0103, b3, , b4, 0109, 0119>
<0103, b3, , b4, 0109
0119, storage>
<0103, b3, , b4, 0109
0119, 0123>
<0103, b3, b4, 0109,
0119, 0123, 0125>
<0103, b3, b4, 0109,
0119, 0123, 0125>
<0103, 63, 64>
<0103, 109>

Solution: <o103, b3, b4, o109, o119
o123, r125 >

2)

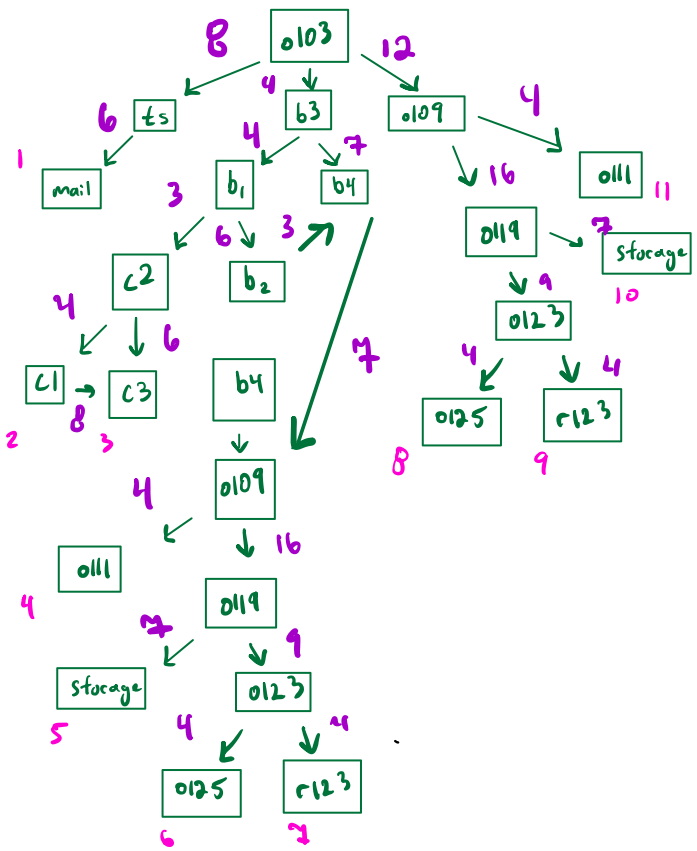
```
aidanschulze@wireless-nat-inside AI % /usr/local/bin/python3 /Users/aida
=============BFS============
20 paths have been expanded and 5 paths remain in the frontier
o103 --> o109 --> o119 --> o123 --> r123
26 paths have been expanded and 3 paths remain in the frontier
o103 --> b3 --> b4 --> o109 --> o119 --> o123 --> r123
32 paths have been expanded and 1 paths remain in the frontier
o103 --> b3 --> b1 --> b2 --> b4 --> o109 --> o119 --> o123 --> r123
==========DFS==========
10 paths have been expanded and 4 paths remain in the frontier
o103 --> b3 --> b4 --> o109 --> o119 --> o123 --> r123
24 paths have been expanded and 3 paths remain in the frontier
o103 --> b3 --> b1 --> b2 --> b4 --> o109 --> o119 --> o123 --> r123
31 paths have been expanded and 2 paths remain in the frontier
o103 --> o109 --> o119 --> o123 --> r123
aidanschulze@wireless-nat-inside AI %
```

2) A* Search

h(mail) = 26
h(o109) = 24
h(o123) = 4
h(b1) = 13
h(b4) = 18
h(c3) = 12

h(ts) = 23
h(o111) = 27
h(o125) = 6
h(b2) = 15
h(c1) = 6
h(storage) = 12

h(o103) = 21
h(o119) = 11
h(r123) = 0
h(b3) = 17
h(c2) = 10



Queue	Next
~~<o103>~~	<o103, ts(31)> <o103, b3(21)> <o103, o109(36)>
~~<o103, b3(21)>~~ <o103, ts(31)> <o103, o109(36)>	<o103, b3, b1(21)> <o103, b3, b4(29)>
~~<o103, b3, b1(21)>~~ <o103, b3, b4(29)> <o103, ts(31)> <o103, o109(36)>	<o103, b3, b1, b2(29)> <o103, b3, b1, c2(21)>
~~<o103, b3, b1, c2(21)>~~ <o103, b3, b1, b2(29)> <o103, b3, b4(29)> <o103, ts(31)> <o103, o109(36)>	<o103, b3, b1, c2, c1(21)> <o103, b3, b1, c2, c3(29)>
~~<o103, b3, b1, c2, c1(21)>~~ ~~<o103, b3, b1, c2, c3(29)>~~ ~~<o103, b3, b1, b2(29)>~~ <o103, b3, b4(29)> <o103, ts(31)> <o103, o109(36)>	<o103, b3, b1, b2, b4(35)>

~~<o103, b3, b4 (29)>~~
<o103, ts(31)>
<o103, b3, b1, b2, b4 (35)>
<o103, o109(36)>
<o103, b3, b4, o109 (42)>

~~<o103, ts(31)>~~
<o103, b3, b1, b2, b4 (35)>
<o103, o109(36)>
<o103, b3, b4, o109 (42)>
<o103, ts, mail (40)

~~<o103, b3, b1, b2, b4 (35)>~~
<o103, o109(36)>
<o103, ts, mail (40)
<o103, b3, b4, o109 (42)>
<o103, b3, b1, b2, b4, o109(48)>

~~<o103, o109(36)>~~
<o103, ts, mail (40)
<o103, b3, b4, o109 (42)>
<o103, b3, b1, b2, b4, o109(48)>
<o103, o109, o111 (43)
<o103, o104, o119 (39)

~~<o103, o104, o119 (39)~~
<o103, ts, mail (40)
<o103, b3, b4, o109 (42)>
<o103, o109, o111 (43)
<o103, b3, b1, b2, b4, o109(48)>
<o103, o109, o119, o123 (41)>
<o103, o109, o119, Storage (47)>

~~<0103, ts, mail (40)~~

~~<0103, 0109, 0119, 0123 (41)~~

<0103, b3, by, 0109 (42)>

<0103, 0109, 0111 (43)

<0103, 0109, 0119, Struyc (47)>

<0103, b3, b1, b2, by, 0109 (48)>

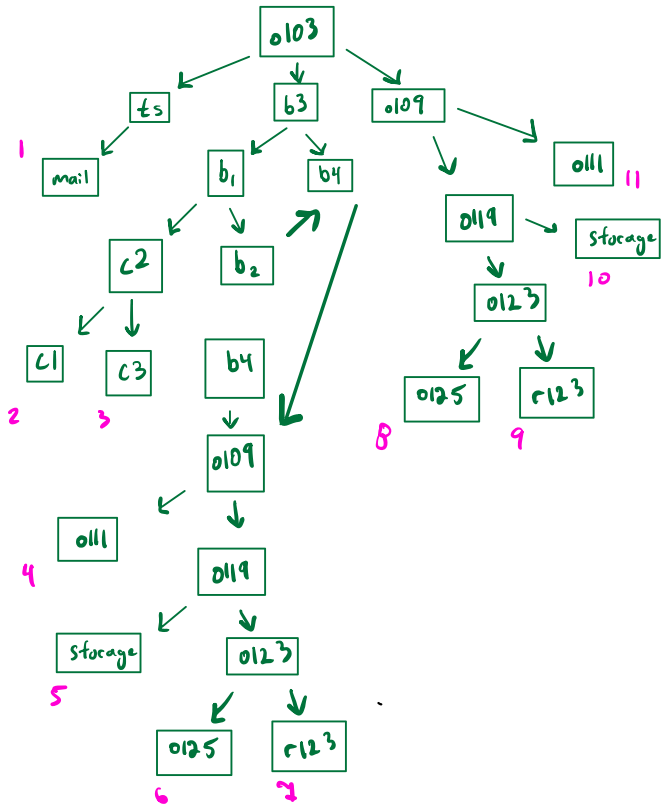
<0103, 0109, 0119, 0123, 0125 (47)>

<0103, 0109, 0119, 0123, r123 (41)>

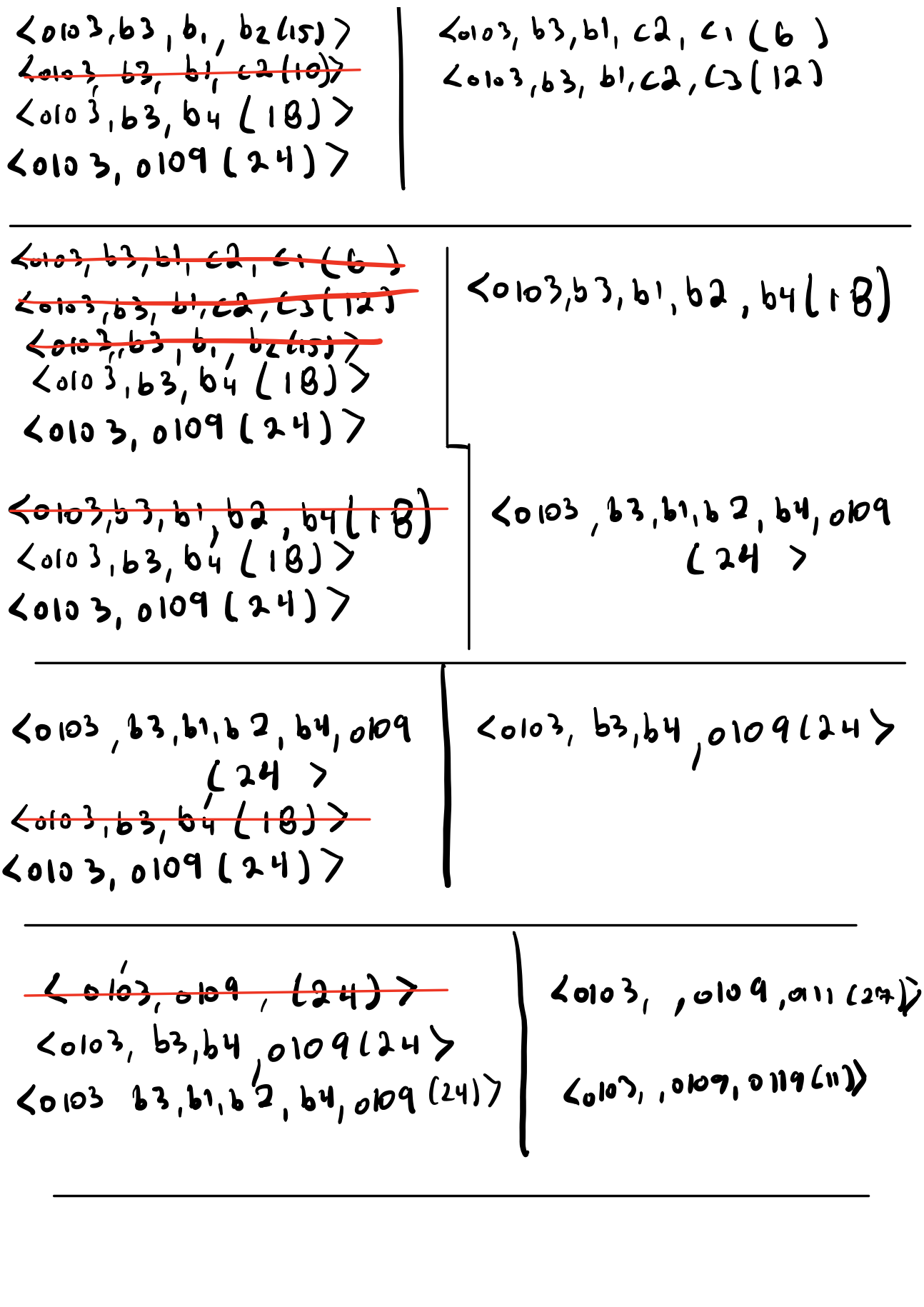
Solution: <0103, 0109, 0119, 0123, r123 (41)>

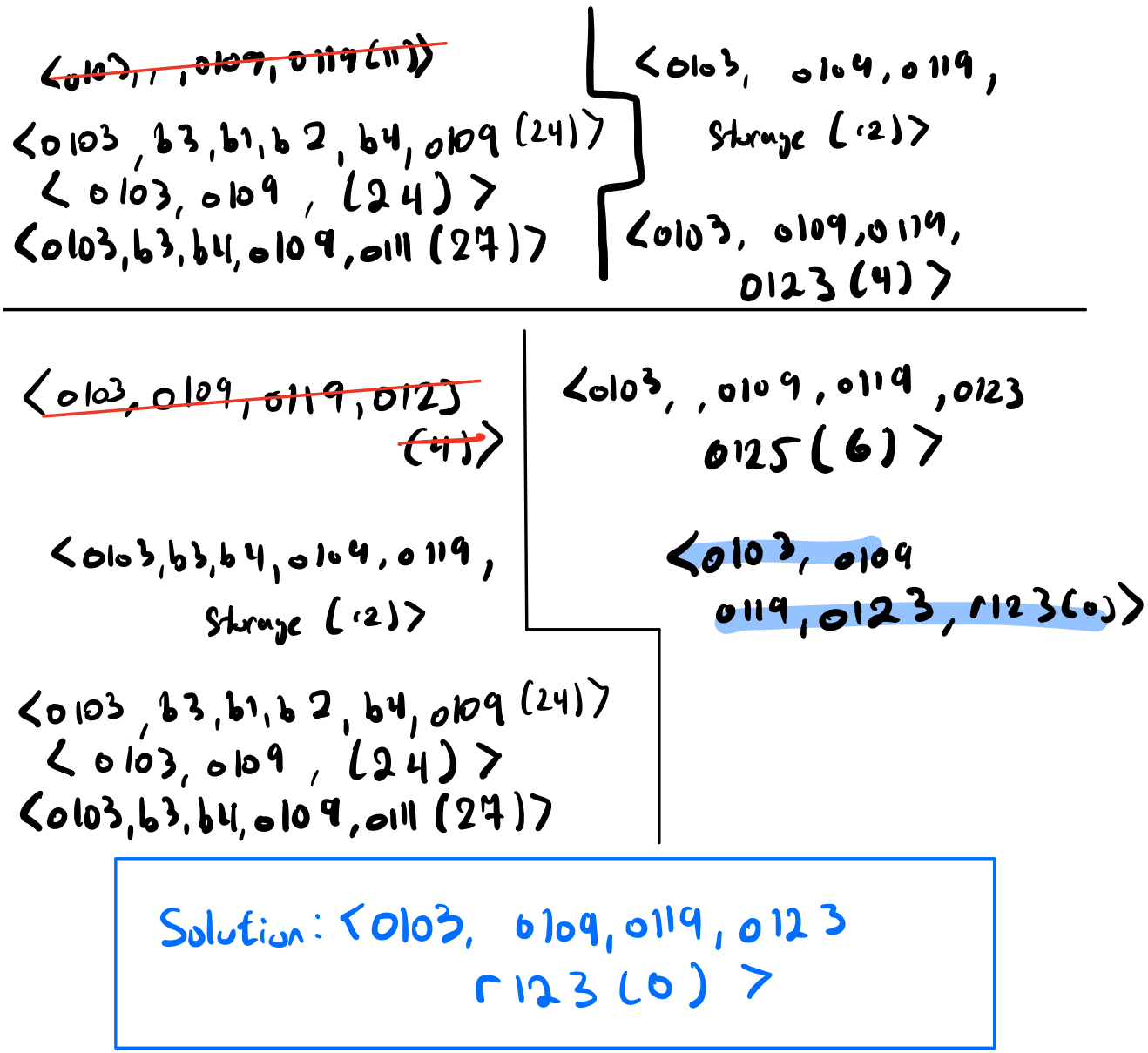
2 b) Greedy

h(mail) = 26
h(0109) = 24
h(0123) = 4
h(b1) = 13
h(b4) = 18
h(c3) = 12
h(ts) = 23
h(0111) = 27
h(0125) = 6
h(b2) = 15
h(c1) = 6
h(storage) = 12
h(0103) = 21
h(0119) = 11
h(r123) = 0
h(b3) = 17
h(c2) = 10



Queue	Next Phase
~~<0103>~~ (21)	<0103, ts (23)> <0103, b3 (17)> <0103, 0109 (24)>
<0103, ts (23)> ~~<0103, b3 (17)>~~ <0103, 0109 (24)>	<0103, b3, b1 (13)> <0103, b3, b4 (18)>
~~<0103, b3, b1 (13)>~~ <0103, b3, b4 (18)> <0103, 0109 (24)>	<0103, b3, b1, b2 (15)> <0103, b3, b1, c2 (10)>


<0103, b3, b1, b2 (15)>
<0103, b3, b1, c2 (10)>
<0103, b3, b4 (18)>
<0103, 0109 (24)>
<0103, b3, b1, c2, c1 (6)
<0103, b3, b1, c2, c3 (12)
<0103, b3, b1, c2, c1 (6)
<0103, b3, b1, c2, c3 (12)
<0103, b3, b1, b2, b4 (18)
<0103, b3, b1, b2 (15)>
<0103, b3, b4 (18)>
<0103, 0109 (24)>
<0103, b3, b1, b2, b4 (18)
<0103, b3, b1, b2, b4, 0109 (24)>
<0103, b3, b4 (18)>
<0103, 0109 (24)>
<0103, b3, b1, b2, b4, 0109 (24)>
<0103, b3, b4, 0109 (24)>
<0103, b3, b4 (18)>
<0103, 0109 (24)>
<0103, 0109 (24)>
<0103, 0109, 0111 (27)>
<0103, b3, b4, 0109 (24)>
<0103, b3, b1, b2, b4, 0109 (24)>
<0103, 0109, 0119 (11)>



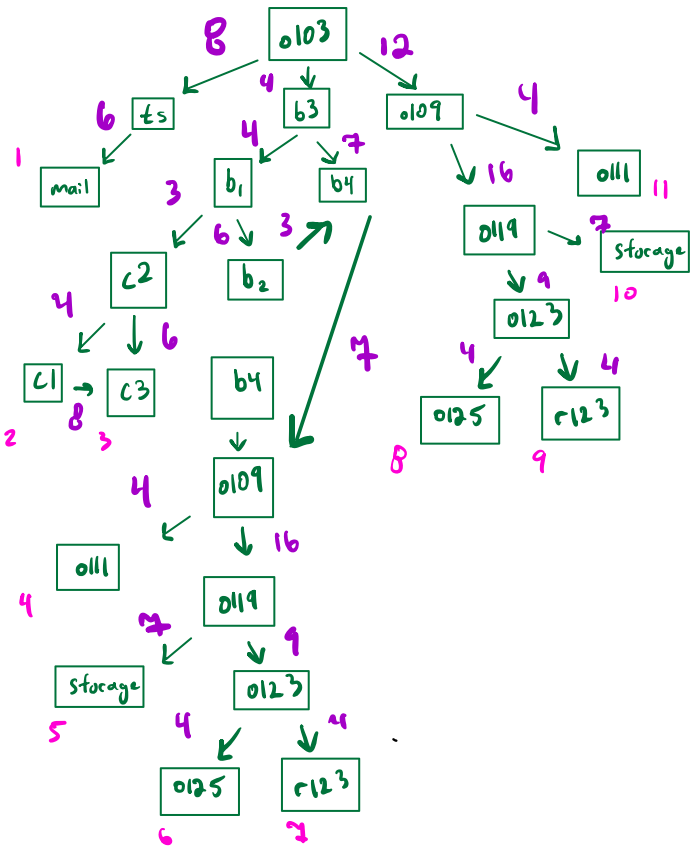
Solution: <0103, 0109, 0119, 0123 r123 (0)>

2c) uniform

h(mail) = 26
h(0109) = 24
h(0123) = 4
h(b1) = 13
h(b4) = 18
h(c3) = 12

h(ts) = 23
h(0111) = 27
h(0125) = 6
h(b2) = 15
h(c1) = 6
h(storage) = 12

h(0103) = 21
h(0119) = 11
h(r123) = 0
h(b3) = 17
h(c2) = 10



Queue	Next
~~<0103>~~	<0103, ts(8)> <0103, b3(4)> <0103, 0109(12)>
~~<0103, b3(4)>~~ <0103, ts(8)> <0103, 0109(12)>	<0103, b3, b1(8)> <0103, b3, b4(11)>
~~<0103, b3 b1(8)>~~ <0103, ts(8)> <0103 b3, b4(11)> <0103, 0109(12)>	<0103, b3, b1, b2(14)> <0103, b3, b1, c2(11)>

~~<o103, t5(8)>~~
<o103, b3, b1, c2(11)>
<o103, b3, b4 (11)>
<o103, o109 (12)>

<o103, t5, mail(14)>

~~<o103, b3, b1, c2(11)>~~
<o103, b3, b4 (11)>
<o103, o109 (12)>
<o103, t5, mail(14)>

<o103, b3, b1, c2, c1 (15)
<o103, b3, b1, c2, c3 (17)

~~<o103, b3, b4 (11)>~~
<o103, o109 (12)>
<o103, t5, mail(14)>
<o103, b3, b1, c2, c1 (15)
<o103, b3, b1, c2, c3 (17)

<o103, b3, b4, o109 (18)

~~<o103, o109 (12)>~~
<o103, t5, mail(14)>
<o103, b3, b1, c2, c1 (15)
<o103, b3, b1, c2, c3 (17)

<o103, o109, o111 (16)>
<o103, o109, o119 (28)>

<o103, b3, b4, o109 (18)

~~<o103, t5, mail(14)>~~
~~<o103, b3, b1, c2, c1 (15)~~
~~<o103, o109, o111 (16)>~~
~~<o103, b3, b1, c2, c3 (17)~~

<o103, b3, b4, o109, o111 (22)
<o103, b3, b4, o109, o119 (34)

~~<o103, b3, b4, o109 (18)~~

<o103, o109, o119 (2B) >

~~<o103, b3, b4, o109, o111 (22)~~
~~<o103, o109, o119 (2B) >~~
<o103, b3, b4, o109, o119 (34)

<o103, 109, o119, o123 (37)>
<o103, 104, o119, storage (35) >

~~<o103, b3, b4, o109, o119 (34)~~
<o103, 104, o119, storage (35) >
<o103, 109, o119, o123 (37)>

<o103, b3, b4, 109, o119, o123 (43) >

<o103, b3, b4, 109, o119, storage (41) >

~~<o103, 104, o119, storage (35) >~~
~~<o103, 109, o119, o123 (37)>~~

<o103, b3, b4, 109, o119, storage (41) >

<o103, b3, b4, 104, o119, o123 (43) >

<o103, 109, o119, o123, o125 (41)

<o103, o109, o119, o123, r123 (41)

Solution: <o103, o109, o119, o123, r123 (41) >

h(mail) = 26
h(0109) = 24
h(0123) = 4
h(b1) = 13
h(b4) = 18
h(c3) = 12

h(ts) = 23
h(0111) = 27
h(0125) = 6
h(b2) = 15
h(c1) = 6
h(storage) = 12

h(0103) = 21
h(0119) = 11
h(r123) = 0
h(b3) = 17
h(c2) = 10

Problem 2: Considering the following heuristic function:

$h(mail) = 26$	$h(ts) = 23$	$h(o103) = 21$
$h(o109) = 24$	$h(o111) = 27$	$h(o119) = 11$
$h(o123) = 4$	$h(o125) = 6$	$h(r123) = 0$
$h(b1) = 13$	$h(b2) = 15$	$h(b3) = 17$
$h(b4) = 18$	$h(c1) = 6$	$h(c2) = 10$
$h(c3) = 12$	$h(storage) = 12$	

Using A* search to find the first solution path (**hand calculation**)

(**Optional**) Modify the code and use the following algorithms to find the solution paths.

a) Using A* search to find the first solution path
b) Using Greedy best-first search to find the first solution path
c) Using Uniform-cost search (lowest-cost-first search) to find the first solution path