

1)

a) To have maximum height, we need to have maximum number of red nodes and maximum number of black nodes. So,

$$= \log_2(n+1) + \log_2(n+1)$$

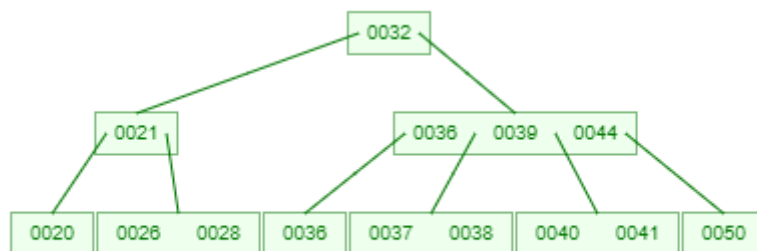
$$= 2 * \log_2(n+1)$$

b) Red-Black Tree uses more memory. Because it has an additional boolean to represent color of the node.

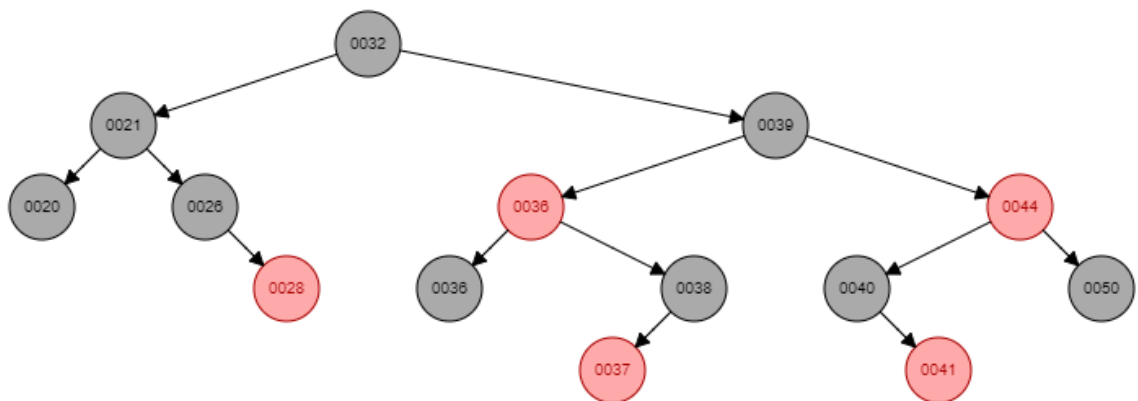
c) Algorithm stops when there are no more unvisited vertices.

2)

a)



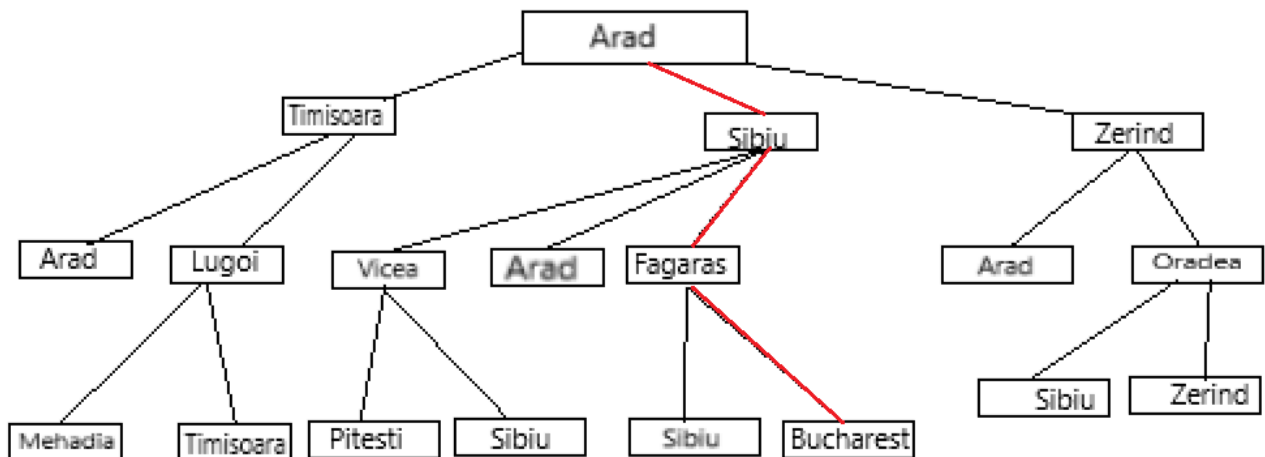
b)



c)

Shortest path is 5,14,3 since length : 3 + 1 + 2 = 6							
Step	v	vertexSet	5	1	2	3	4
1	-	5	0	3	infinity	infinity	infinity
2	1	5,1	0	3	4		4
3	4	5,1,4	0	3	4	6	4
4	2	5,1,4,2	0	3	4	6	4
5	3	5,1,4,2,3	0	3	4	6	4

d)



So our path is Arad -> Sibiu -> Fagaras->Bucharest, length of the path is  $140 + 99 + 211 = 450$

3)

My code runs perfectly on my windows computer with CodeBlocks. But when i try it on Dijkstra it doesn't. When I manually insert items to table, it runs correctly. However if I try to do it by reading from txt, items in txt file corrupts. Because of the corrupted strings program does not work properly on Dijkstra. When I asked before about conversions from Unix to Windows to TA Alihan Okka, he said it might be possible to corrupt txt file so try to create it on Unix. I couldn't manage it to make it.

I drop screenshots from my working code, I can come by and show it with different inputs as well.

1)

-----Printing table Open-----

```
0: mango = 4051
1: chile jalapeño = 4693
2: onions green = 4068
3: avocado large hass = 4225
4: banana leaf = 4234
5: beans red = 3177
6: beets bunch = 4539
7: beans peruano = 3170
8: chile anaheim = 4696
9: banana macho = 4235
10: apple granny smith = 4017
11: chile hungaro = 4692
12: chile pasilla = 4701
13: alfalfa sprouts = 4514
14: asparagus = 4525
15: avocado small = 4227
16: beans green = 4066
17: basil = 4885
18: cabbage red = 4554
19: banana baby = 4232
20: bell pepper red = 4088
21: apricots = 4218
22: apple fuji = 4131
23: banana = 4011
24: beets loose = 4540
25: beans garbanzo = 3174
26: bean sprouts = 4536
27: chile habanero = 3125
28: cherries red = 4045
29: bok choy = 4545
30: beans haba fresh = 4528
31: beans haba dry = 3175
32: beans pinto = 3172
33: banana burro = 4229
34: chile dry arbol = 3185
35: black berries = 4239
36: beans black = 3176
37: beans black eye = 3196
38: beans lentils = 3173
39: bell pepper green = 4065
40: brussel sprouts = 4550
41: cauliflower = 4079
42: chile dry pasilla = 3184
```

2)

```
42: chile dry pasilla = 3184
43: chile serrano = 4709
44: carrots = 4562
45: corn white = 4077
46: cabbage green = 4069
47: apple gala = 4133
48: broccoli = 4060
49: celery = 4583
50: chile dry california = 3188
51: cabbage Napa = 4556
52: chile dry guajillo = 3186
53: chile de arbol fresco = 4822
54: corn yellow = 4078
55: durositos = 4874
56: camote de cerro = 4820
57: grapefruit = 4282
58: coconut white = 4260
59: green collard = 4614
60: chile yellow = 4680
61: eggplant = 4081
62: chile dry japanese = 3181
63: cucumber persian = 4593
64: oregano = 4897
65: mint = 4896
66: mamey = 4310
67: grapes green = 4022
68: green kale = 4627
69: garlic = 4608
70: parsley = 4899
71: guayabas = 4299
72: guasanas = 3189
73: jamaica = 4870
74: limes = 4048
75: cucumber = 4062
76: lettuce romaine = 4640
77: grapes globe = 4273
78: ginger root = 4612
79: green turnip = 4619
80: lemons yellow = 4053
81: onions boiling = 4658
82: grapes red seedless = 4023
83: melon honeydew = 4034
84: guajes = 4821
85: malanga = 4644
```

3)

```
85: malanga = 4644
86: jicama = 4626
87: lettuce = 4061
88: onions brown = 4093
89: nuts brazil = 4926
90: nuts peanuts = 4931
91: cilantro = 4889
92: lettuce green leaf = 4076
93: lettuce red leaf = 4075
94: limes mex key = 4305
95: limes sweet = 4306
96: squash kabocha = 4769
97: melon cantaloupe = 4050
98: mushroom bulk = 4645
99: epazote = 4909
100: squash spaghetti = 4776
101: onions white = 4663
102: potato white = 4083
103: leaks = 4629
104: papaya = 4395
105: pear bartlett = 4409
106: pear bosc = 4026
107: piloncillo = 4873
108: pear anjou = 4416
109: nuts pecans = 4936
110: mushroom pack = 4646
111: nuts walnuts = 4943
112: nectarines = 4036
113: turnips = 4813
114: plums red = 4041
115: spinach = 4090
116: peaches yellow = 4038
117: potato russet loose = 4072
118: tangerine mineola = 4055
119: squash chayote = 4827
120: tangerine clementine = 4450
121: watermelon seedless = 4032
122: tomatoes roma = 3145
123: persimmon = 4427
124: pineapple = 4430
125: tomatoes reg = 4063
126: pomegranate = 4445
127: plums black = 4039
128: yucca = 4819
```

4)

```
128: yucca = 4819
129: nectarines white = 4188
130: potato red = 4073
131: orange navel = 4012
132: tuna = 4471
133: yams jumbo = 4817
134: onions red = 4082
135: squash mexican = 4786
136: tomatoes cherry = 3146
137: tangerine honey = 4453
138: tomatillo = 4801
139: watermelon reg = 4031
140: squash butternut = 4759
141: tejocote = 4472
142: squash acorn = 4750
143: yams medium = 4818
144: strawberry basket = 4028
145: watercress = 4815
146: radish red bunch = 4089
147: squash yellow = 4784
150: nuts pistachios = 4939
-----Retrieved Items-----
23 : banana = 4011
75 : cucumber = 4062
121 : watermelon seedless = 4032
-----Printing table Open-----
0: mango = 4051
1: chile jalapeño = 4693
2: onions green = 4068
3: avocado large hass = 4225
4: banana leaf = 4234
6: beets bunch = 4539
7: beans peruano = 3170
8: chile anaheim = 4696
9: banana macho = 4235
10: apple granny smith = 4017
11: chile hungaro = 4602
12: chile pasilla = 4701
13: alfalfa sprouts = 4514
14: asparagus = 4525
15: avocado small = 4227
16: beans green = 4066
17: basil = 4885
18: cabbage red = 4554
```

5)

```
C:\Users\erens\OneDrive\Belgeler\CS201\202HW41\bin\Debug\202HW41.exe
18: cabbage red = 4554
19: banana baby = 4232
20: bell pepper red = 4088
21: apricots = 4218
22: apple fuji = 4131
23: banana = 4011
24: beets loose = 4540
25: beans garbanzo = 3174
26: bean sprouts = 4536
27: chile habanero = 3125
28: cherries red = 4045
29: bok choy = 4545
30: beans haba fresh = 4528
31: beans haba dry = 3175
32: beans pinto = 3172
33: banana burro = 4229
34: chile dry arbol = 3185
35: black berries = 4239
36: beans black = 3176
37: beans black eye = 3196
38: beans lentils = 3173
39: bell pepper green = 4065
40: brussel sprouts = 4550
41: cauliflower = 4079
42: chile dry pasilla = 3184
43: chile serrano = 4709
44: carrots = 4562
45: corn white = 4077
46: cabbage green = 4069
47: apple gala = 4133
49: celery = 4583
50: chile dry california = 3188
51: cabbage Napa = 4556
52: chile dry guajillo = 3186
53: chile de arbol fresco = 4822
54: corn yellow = 4078
55: duritos = 4874
56: camote de cerro = 4820
57: grapefruit = 4282
58: coconut white = 4260
59: green collard = 4614
60: chile yellow = 4680
61: eggplant = 4081
62: chile dry japanese = 3181
```

6)

```
62: chile dry japanese = 3181
63: cucumber persian = 4593
64: oregano = 4897
65: mint = 4896
66: mamey = 4310
67: grapes green = 4022
68: green kale = 4627
69: garlic = 4608
70: parsley = 4899
71: guayabas = 4299
72: guasanas = 3189
73: jamaica = 4870
74: limes = 4048
75: cucumber = 4062
76: lettuce romaine = 4640
77: grapes globe = 4273
78: green turnip = 4619
80: lemons yellow = 4053
81: onions boiling = 4658
82: grapes red seedless = 4023
83: melon honeydew = 4034
84: guajes = 4821
85: malanga = 4644
86: jicama = 4626
87: lettuce = 4061
88: onions brown = 4093
89: nuts brazil = 4926
90: nuts peanuts = 4931
91: cilantro = 4889
92: lettuce green leaf = 4076
93: lettuce red leaf = 4075
94: limes mex key = 4305
95: limes sweet = 4306
96: squash kabocha = 4769
97: melon cantaloupe = 4050
98: mushroom bulk = 4645
99: epazote = 4909
100: squash spaghetti = 4776
101: onions white = 4663
102: potato white = 4083
103: leaks = 4629
104: papaya = 4395
105: pear bartlett = 4409
106: pear bosc = 4026
```

7)

```
108: pear anjou = 4416
109: nuts pecans = 4926
110: mushroom pack = 4646
111: nuts walnuts = 4943
112: nectarines = 4036
113: turnips = 4813
114: plums red = 4041
115: spinach = 4090
116: peaches yellow = 4038
117: potato russet loose = 4072
118: tangerine mineola = 4055
119: squash chayote = 4827
120: tangerine clementine = 4450
121: watermelon seedless = 4032
122: tomatoes roma = 3145
123: persimmon = 4427
124: pineapple = 4430
125: tomatoes reg = 4063
126: pomegranate = 4445
127: plums black = 4039
128: yucca = 4819
129: nectarines white = 4188
130: potato red = 4073
131: orange navel = 4012
132: tuna = 4471
133: yams jumbo = 4817
134: onions red = 4082
135: squash mexican = 4786
136: tomatoes cherry = 3146
137: tangerine honey = 4453
138: tomatillo = 4801
139: watermelon reg = 4031
140: squash butternut = 4759
141: tejocote = 4472
142: squash acorn = 4750
143: yams medium = 4818
144: strawberry basket = 4028
145: watercress = 4815
146: radish red bunch = 4089
147: squash yellow = 4784
150: nuts pistachios = 4939
-----Printing table Chain-----
0: mango = 4051, onions boiling = 4658,
1: chile jalapeño = 4693, onions green = 4068, tomatoes roma = 3145, watercress = 4815,
2: squash butternut = 4759, watermelon reg = 4031,
3: avocado large hass = 4205, banana leaf = 4234, chile pasilla = 4701, chile dry guajillo = 3186, guajes = 4821, squash yellow = 4784, tejocote = 4472, yucca = 4819,
4: beans red = 3177, chile anasheim = 4696, green kale = 4627,
5: beets bunch = 4539, cauliflower = 4079,
6: chile dry pasilla = 3184, parsley = 4899, lettuce = 4061,
7: beans perrano = 3170, chile hungaro = 4692, guayabas = 4299, piconcillo = 4873,
8: nuts brazil = 4926,
9: banana macho = 4235,
10: apple granny smith = 4017, green collard = 4614, orange navel = 4012, spinach = 4090,
11: lettuce green leaf = 4076,
12: eggplant = 4081,
13: alfalfa sprouts = 4514, asparagus = 4525, basil = 4885, grapes globe = 4273, limes mex key = 4305,
14: avocado small = 4227, cabbage red = 4554, chile dry california = 3188, cucumber persian = 4593, ginger root = 4612, plums red = 4041,
15: oregano = 4897,
16: beans green = 4066, bell pepper red = 4088, mint = 4896, lemons yellow = 4053, tangerine honey = 4453, tuna = 4471,
17: mamey = 4310, potato russet loose = 4072, tomatillo = 4801,
18: epazote = 4909, tangerine mineola = 4055,
19: banana baby = 4232, yams medium = 4818,
20: garlic = 4608,
21: apricots = 4218, beans garbanzo = 3174, beans haba fresh = 4528, grapefruit = 4282,
22: apple fuji = 4131, beans haba dry = 3175, leeks = 4629,
23: banana = 4011, beets loose = 4540, guasanas = 3189, strawberry basket = 4028,
24: onions brown = 4093, pear bartlett = 4409, pineapple = 4430,
25: bok choy = 4545, pear bosc = 4026,
26: bean sprouts = 4536, cucumber = 4062, nuts peanuts = 4931,
27: chile habanero = 3125, lettuce romaine = 4640, pear anjou = 4416,
28: cherries red = 4045, chile de arbol fresco = 4822, nuts pecans = 4936,
29: lettuce red leaf = 4075, mushroom pack = 4646, nectarines white = 4188, nuts pistachios = 4939, onions red = 4082,
30: nuts walnuts = 4943, potato red = 4073, squash mexican = 4786,
31: beans pinto = 3172, black berries = 4239, grapes green = 4022, tomatoes cherry = 3146,
32: squash kabocha = 4769,
33: banana burro = 4229, grapes red seedless = 4023, melon cantaloupe = 4050,
34: chile dry arbol = 3185, melon honeydew = 4034, mushroom bulk = 4645,
35: chile yellow = 4680, peaches yellow = 4038, yams jumbo = 4817,
36: beans black = 3176, squash spaghetti = 4776,
37: beans black eye = 3196, chile dry japanese = 3181, jicama = 4626, onions white = 4663, turnips = 4813,
38: beans lentils = 3173, bell pepper green = 4065, corn yellow = 4078, limes = 4048, potato white = 4083, squash chayote = 4827,
39: tangerine clementine = 4450,
40: brussel sprouts = 4550, papaya = 4395, watermelon seedless = 4032,
41: corn white = 4077,
42: coconut white = 4260, cilantro = 4889, persimmon = 4427, squash acorn = 4750,
```

8)

```
-----Printing table Chain-----
0: mango = 4051, onions boiling = 4658,
1: chile jalapeño = 4693, onions green = 4068, tomatoes roma = 3145, watercress = 4815,
2: squash butternut = 4759, watermelon reg = 4031,
3: avocado large hass = 4205, banana leaf = 4234, chile pasilla = 4701, chile dry guajillo = 3186, guajes = 4821, squash yellow = 4784, tejocote = 4472, yucca = 4819,
4: beans red = 3177, chile anasheim = 4696, green kale = 4627,
5: beets bunch = 4539, cauliflower = 4079,
6: chile dry pasilla = 3184, parsley = 4899, lettuce = 4061,
7: beans perrano = 3170, chile hungaro = 4692, guayabas = 4299, piconcillo = 4873,
8: nuts brazil = 4926,
9: banana macho = 4235,
10: apple granny smith = 4017, green collard = 4614, orange navel = 4012, spinach = 4090,
11: lettuce green leaf = 4076,
12: eggplant = 4081,
13: alfalfa sprouts = 4514, asparagus = 4525, basil = 4885, grapes globe = 4273, limes mex key = 4305,
14: avocado small = 4227, cabbage red = 4554, chile dry california = 3188, cucumber persian = 4593, ginger root = 4612, plums red = 4041,
15: oregano = 4897,
16: beans green = 4066, bell pepper red = 4088, mint = 4896, lemons yellow = 4053, tangerine honey = 4453, tuna = 4471,
17: mamey = 4310, potato russet loose = 4072, tomatillo = 4801,
18: epazote = 4909, tangerine mineola = 4055,
19: banana baby = 4232, yams medium = 4818,
20: garlic = 4608,
21: apricots = 4218, beans garbanzo = 3174, beans haba fresh = 4528, grapefruit = 4282,
22: apple fuji = 4131, beans haba dry = 3175, leeks = 4629,
23: banana = 4011, beets loose = 4540, guasanas = 3189, strawberry basket = 4028,
24: onions brown = 4093, pear bartlett = 4409, pineapple = 4430,
25: bok choy = 4545, pear bosc = 4026,
26: bean sprouts = 4536, cucumber = 4062, nuts peanuts = 4931,
27: chile habanero = 3125, lettuce romaine = 4640, pear anjou = 4416,
28: cherries red = 4045, chile de arbol fresco = 4822, nuts pecans = 4936,
29: lettuce red leaf = 4075, mushroom pack = 4646, nectarines white = 4188, nuts pistachios = 4939, onions red = 4082,
30: nuts walnuts = 4943, potato red = 4073, squash mexican = 4786,
31: beans pinto = 3172, black berries = 4239, grapes green = 4022, tomatoes cherry = 3146,
32: squash kabocha = 4769,
33: banana burro = 4229, grapes red seedless = 4023, melon cantaloupe = 4050,
34: chile dry arbol = 3185, melon honeydew = 4034, mushroom bulk = 4645,
35: chile yellow = 4680, peaches yellow = 4038, yams jumbo = 4817,
36: beans black = 3176, squash spaghetti = 4776,
37: beans black eye = 3196, chile dry japanese = 3181, jicama = 4626, onions white = 4663, turnips = 4813,
38: beans lentils = 3173, bell pepper green = 4065, corn yellow = 4078, limes = 4048, potato white = 4083, squash chayote = 4827,
39: tangerine clementine = 4450,
40: brussel sprouts = 4550, papaya = 4395, watermelon seedless = 4032,
41: corn white = 4077,
42: coconut white = 4260, cilantro = 4889, persimmon = 4427, squash acorn = 4750,
```

9)

```
C:\Users\erens\OneDrive\Belgeler\CS201\202HW41\bin\Debug\202HW41.exe
41: corn white = 4077,
42: coconut white = 4260, cilantro = 4889, persimmon = 4427, squash acorn = 4750,
43: chile serrano = 4709, green turnip = 4619,
44: carrots = 4562, tomatoes reg = 4063,
45: pomegranate = 4445,
46: cabbage green = 4069, duritos = 4874, limes sweet = 4306, plums black = 4039, radish red bunch = 4089,
47: apple gala = 4133, broccoli = 4060, cabbage Napa = 4556, camote de cerro = 4820,
48: celery = 4583, jamaica = 4870, nectarines = 4036,
49: malanga = 4644,
-----Retrieved Items-----
23: banana = 4011,
26: cucumber = 4062,
-----Printing table Chain-----
0: mango = 4051, onions boiling = 4658,
1: chile jalapeño = 4693, onions green = 4068, tomatoes roma = 3145, watercress = 4815,
2: squash butternut = 4759, watermelon reg = 4031,
3: avocado large hass = 4225, banana leaf = 4234, chile pasilla = 4701, chile dry guajillo = 3186, guajes = 4821, squash yellow = 4784, tejocote = 4472, yucca = 4819,
4: chile anaheim = 4696, green kale = 4627,
5: beets bunch = 4539, cauliflower = 4079,
6: chile dry pasilla = 3184, parsley = 4899, lettuce = 4061,
7: beans peruano = 3170, chile hungaro = 4692, guayabas = 4299, piconcillo = 4873,
8: nuts brazil = 4926,
9: banana macho = 4235,
10: apple granny smith = 4017, green collard = 4614, orange navel = 4012, spinach = 4090,
11: lettuce green leaf = 4076,
12: eggplant = 4081,
13: alfalfa sprouts = 4514, asparagus = 4525, basil = 4885, grapes globe = 4273, limes mex key = 4305,
14: avocado small = 4227, cabbage red = 4554, chile dry california = 3188, cucumber persian = 4593, plums red = 4041,
15: oregano = 4897,
16: beans green = 4066, bell pepper red = 4088, mint = 4896, lemons yellow = 4053, tangerine honey = 4453, tuna = 4471,
17: mamey = 4310, potato russet loose = 4072, tomatillo = 4801,
18: epazote = 4909, tangerine mineola = 4055,
19: banana baby = 4232, yams medium = 4818,
20: garlic = 4608,
21: apricots = 4218, beans garbanzo = 3174, beans haba fresh = 4528, grapefruit = 4282,
22: apple fuji = 4131, beans haba dry = 3175, leeks = 4629,
23: banana = 4011, beets loose = 4540, guasanas = 3189, strawberry basket = 4028,
24: onions brown = 4093, pear bartlett = 4409, pineapple = 4430,
25: bok choy = 4545, pear bosc = 4026,
26: bean sprouts = 4536, cucumber = 4062, nuts peanuts = 4931,
27: chile habanero = 3125, lettuce romaine = 4640, pear anjou = 4416,
28: cherries red = 4045, chile de arbol fresco = 4822, nuts pecans = 4936,
29: lettuce red leaf = 4075, mushroom pack = 4646, nectarines white = 4188, nuts pistachios = 4939, onions red = 4082,
```

10)

```
C:\Users\erens\OneDrive\Belgeler\CS201\202HW41\bin\Debug\202HW41.exe
28: cherries red = 4045, chile de arbol fresco = 4822, nuts pecans = 4936,
29: lettuce red leaf = 4075, mushroom pack = 4646, nectarines white = 4188, nuts pistachios = 4939, onions red = 4082,
30: nuts walnuts = 4943, potato red = 4073, squash mexican = 4786,
31: beans pinto = 3172, black berries = 4239, grapes green = 4022, tomatoes cherry = 3146,
32: squash kabocha = 4769,
33: banana burro = 4229, grapes red seedless = 4023, melon cantaloupe = 4050,
34: chile dry arbol = 3185, melon honeydew = 4034, mushroom bulk = 4645,
35: chile yellow = 4680, peaches yellow = 4038, yams jumbo = 4817,
36: beans black = 3176, squash spaghetti = 4776,
37: beans black eye = 3196, chile dry japanese = 3181, jicama = 4626, onions white = 4663, turnips = 4813,
38: beans lentils = 3173, bell pepper green = 4065, corn yellow = 4078, limes = 4048, potato white = 4083, squash chayote = 4827,
39: tangerine clementine = 4450,
40: brussel sprouts = 4550, papaya = 4395, watermelon seedless = 4032,
41: corn white = 4077,
42: coconut white = 4260, cilantro = 4889, persimmon = 4427, squash acorn = 4750,
43: chile serrano = 4709, green turnip = 4619,
44: carrots = 4562, tomatoes reg = 4063,
45: pomegranate = 4445,
46: cabbage green = 4069, duritos = 4874, limes sweet = 4306, plums black = 4039, radish red bunch = 4089,
47: apple gala = 4133, cabbage Napa = 4556, camote de cerro = 4820,
48: celery = 4583, jamaica = 4870, nectarines = 4036,
49: malanga = 4644,
51: cauliflower = 4079
45: corn white = 4077
143: yams medium = 4818
75: cucumber = 4062
143: yams medium = 4818
20: bell pepper red = 4088
2: onions green = 4068
64: oregano = 4897
84: guajes = 4821
2: onions green = 4068
118: tangerine mineola = 4055
59: green collard = 4614
27: chile habanero = 3125
66: mamey = 4310
146: radish red bunch = 4089
98: beans lentils = 3173
126: pomegranate = 4445
13: alfalfa sprouts = 4514
146: radish red bunch = 4089
0: mango = 4051
77: grapes globe = 4273
108: pear anjou = 4416
```

11)

C:\Users\erens\OneDrive\Belgeler\CS201\202HW41\bin\Debug\202HW41.exe

```
108 : pear anjou = 4416
127 : plums black = 4039
2 : onions green = 4068
141 : tejocote = 4472
0 : mango = 4051
56 : camote de cerro = 4820
143 : yams medium = 4818
88 : onions brown = 4093
114 : plums red = 4041
11 : chile hungaro = 4692
133 : yams jumbo = 4817
124 : pineapple = 4430
62 : chile dry japanese = 3181
57 : grapefruit = 4282
131 : orange navel = 4012
25 : beans garbanzo = 3174
123 : persimmon = 4427
79 : green turnip = 4619
13 : alfalfa sprouts = 4514
104 : papaya = 4395
65 : mint = 4896
133 : yams jumbo = 4817
6 : beets bunch = 4539
134 : onions red = 4082
41 : cauliflower = 4079
10 : apple granny smith = 4017
16 : beans green = 4066
73 : jamaica = 4870
28 : cherries red = 4045
11 : chile hungaro = 4692
46 : cabbage green = 4069
141 : tejocote = 4472
105 : pear bartlett = 4409
24 : beets loose = 4540
116 : peaches yellow = 4038
77 : grapes globe = 4273
47 : apple gala = 4133
23 : banana = 4011
85 : malanga = 4644
15 : avocado small = 4227
144 : strawberry basket = 4028
30 : beans haba fresh = 4528
137 : tangerine honey = 4453
57 : grapefruit = 4282
```

12)

```
59 : green collard = 4614
99 : epazote = 4909
57 : grapefruit = 4282
146 : radish red bunch = 4089
82 : grapes red seedless = 4023
75 : cucumber = 4062
150 : nuts pistachios = 4939
90 : nuts peanuts = 4931
75 : cucumber = 4062
22 : apple fuji = 4131
32 : beans pinto = 3172
62 : chile dry japanese = 3181
134 : onions red = 4082
128 : yucca = 4819
39 : bell pepper green = 4065
34 : chile dry arbol = 3185
32 : beans pinto = 3172
125 : tomatoes reg = 4063
13 : alfalfa sprouts = 4514
101 : onions white = 4663
96 : squash kabocha = 4769
112 : nectarines = 4036
119 : squash chayote = 4827
128 : yucca = 4819
82 : grapes red seedless = 4023
1 : chile jalapeno = 4693
9 : banana macho = 4235
109 : nuts pecans = 4936
```

Part a - Analysis of Open Addressing Hash Table

Parameter	Time Elapsed
Average insertion time:	1 ms
Average retrieval time:	1 ms
Average deletion time:	0 ms
Number of comparisons in Retrieval	= 1626
Number of collision in Retrieval	= 763

```
4: beans red = 3177,
28: cherries red = 4045,
0: chile dry pasilla = 3184,
15: oregano = 4897,
14: avocado small = 4227,
9: banana macho = 4235,
40: brussel sprouts = 4550,
```



13)

```
9: banana macho = 4235,
40: brussel sprouts = 4550,
6: chile dry pasilla = 3184,
3: avocado large hass = 4225,
19: banana baby = 4232,
15: oregano = 4897,
0: mango = 4051,
7: beans peruano = 3170,
45: pomegranate = 4445,
37: beans black eye = 3196,
44: carrots = 4562,
46: cabbage green = 4069,
20: garlic = 4608,
38: beans lentils = 3173,
14: avocado small = 4227,
3: avocado large hass = 4225,
5: beets bunch = 4539,
13: alfalfa sprouts = 4514,
27: chile habanero = 3125,
33: banana burro = 4229,
35: chile yellow = 4680,
34: chile dry arbol = 3185,
16: beans green = 4066,
17: manay = 4310,
48: celery = 4583,
6: chile dry pasilla = 3184,
36: beans black = 3176,
19: banana baby = 4232,
13: alfalfa sprouts = 4514,
8: nuts brazil = 4926,
42: coconut white = 4260,
13: alfalfa sprouts = 4514,
21: apricots = 4218,
25: bok choy = 4545,
41: corn white = 4077,
40: brussel sprouts = 4550,
41: corn white = 4077,
43: chile serrano = 4709,
27: chile habanero = 3125,
21: apricots = 4218,
8: nuts brazil = 4926,
26: bean sprouts = 4536,
45: pomegranate = 4445,
21: apricots = 4218,
```

14)

```
20: garlic = 4608,
20: garlic = 4608,
28: cherries red = 4045,
21: apricots = 4218,
19: banana baby = 4232,
11: lettuce green leaf = 4076,
49: malanga = 4644,
30: nuts walnuts = 4943,
10: apple granny smith = 4017,
20: garlic = 4608,
37: beans black eye = 3196,
19: banana baby = 4232,
1: chile jalapeño = 4693,
8: nuts brazil = 4926,
4: beans red = 3177,
10: apple granny smith = 4017,
35: chile yellow = 4680,
29: lettuce red leaf = 4075,
27: chile habanero = 3125,
41: corn white = 4077,
23: banana = 4011,
45: pomegranate = 4445,
43: chile serrano = 4709,
25: bok choy = 4545,
13: alfalfa sprouts = 4514,
35: chile yellow = 4680,
4: beans red = 3177,
45: pomegranate = 4445,
28: cherries red = 4045,
43: chile serrano = 4709,
25: bok choy = 4545,
42: coconut white = 4260,
1: .....
Part a - Analysis of Chain Hash Table
Parameter      Time Elapsed
Average insertion time:      0 ms
Average retrieval time:      1 ms
Average deletion time:       0 ms
Number of comparisons in Retrieval = 290
1: .....
Process returned 0 (0x0)   execution time : 1.076 s
Press any key to continue.
```

Bar Chart

