CS 325: Project 1

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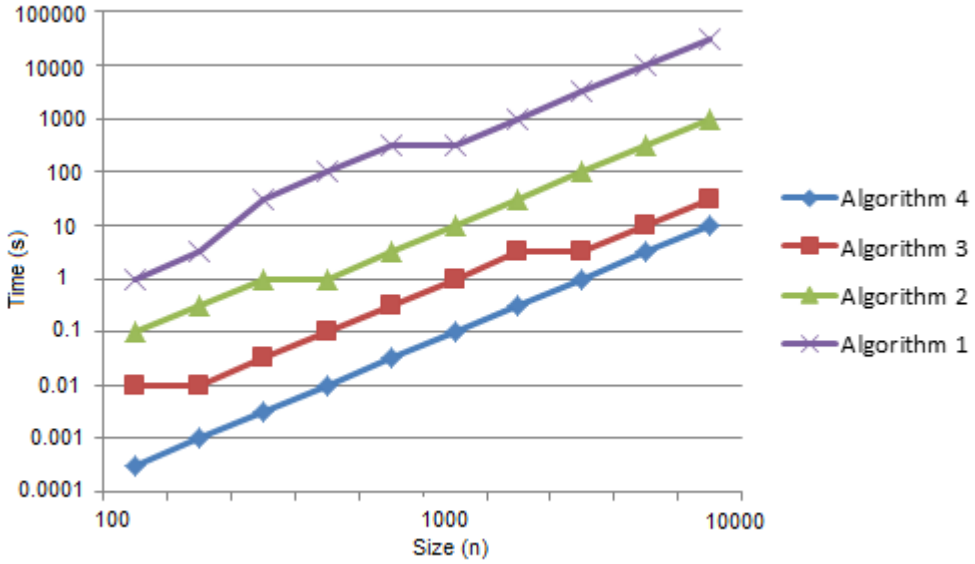
1 Algorithm 1: Enumeration

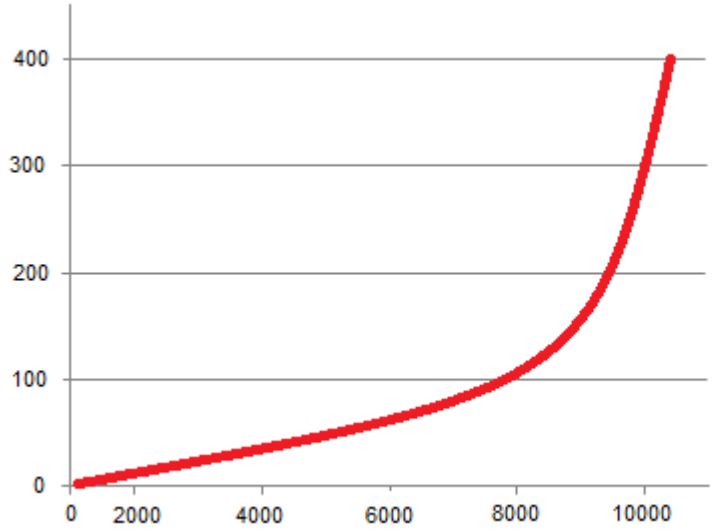
1.1 Theoretical Run-Time Analysis

Enumeration has a running time of $O(n^3)$. Because of the 3 loops, each run n times gives the algorithm a running time of $n * n * n$.

1.2 Experimental Analysis

1.3 Extrapolation and Interpretation





1.3.1 For each algorithm use the experimental data to estimate a function that models the relationship between running times and input sizes (n). Discuss any discrepancies between the experimental and theoretical running times.

1.3.2 For each algorithm, what is the size of the biggest instance that you can solve with your algorithm in one hour?

2 Algorithm 2: Better Enumeration

2.1 Theoretical Run-Time Analysis

2.2 Experimental Analysis

2.3 Extrapolation and Interpretation

2.3.1 For each algorithm use the experimental data to estimate a function that models the relationship between running times and input sizes (n). Discuss any discrepancies between the experimental and theoretical running times.

2.3.2 For each algorithm, what is the size of the biggest instance that you can solve with your algorithm in one hour?

3 Algorithm 3: Divide and Conquer

3.1 Theoretical Run-Time Analysis

3.2 Proof of Correctness

3.3 Experimental Analysis

3.4 Extrapolation and Interpretation

3.4.1 For each algorithm use the experimental data to estimate a function that models the relationship between running times and input sizes (n). Discuss any discrepancies between the experimental and theoretical running times.

3.4.2 For each algorithm, what is the size of the biggest instance that you can solve with your algorithm in one hour?

4 Algorithm 4: Linear-Time

4.1 Theoretical Run-Time Analysis

4.2 Experimental Analysis

4.3 Extrapolation and Interpretation

4.3.1 For each algorithm use the experimental data to estimate a function that models the relationship between running times and input sizes (n). Discuss any discrepancies between the experimental and theoretical running times.

4.3.2 For each algorithm, what is the size of the biggest instance that you can solve with your algorithm in one hour?

5 Appendices

5.1 Code

5.1.1 Algorithm 1

```
def algorithm1(A):
max = 0
for i in range(0, len(A)):
for j in range(i, len(A)):
partial = 0
for k in range(i, j+1):
partial += A[k]

if partial > max:
max = partial

return max
```

5.1.2 Algorithm 2

```
def algorithm2(A):
max = 0
for i in range(0, len(A)):
sum = 0
for j in range(i, len(A)):
sum = sum + A[j]
if max <= sum:
max = sum

return max
```

5.1.3 Algorithm 3

```
def algorithm3(A):
if len(A) < 1:
return 0

m = len(A) / 2

lmax = s = 0
for i in range(len(A)/2, -1, -1):
s += A[i]
```

```
if s > lmax:
lmax = s

rmax = s = 0
for i in range(len(A)/2+1, len(A)):
s += A[i]
if s > rmax:
rmax = s

return max(
algorithm3(A[:len(A)/2]),
algorithm3(A[(len(A)/2)+1:]),
lmax + rmax
)
```

5.1.4 Algorithm 4

```
def algorithm4(A):
m1 = m2 = 0

for x in A:
m1 = max(0, m1 + x)
m2 = max(m2, m1)

return m2
```

5.2 Tests

```
# Algorithm Tests

# Needed Python libraries
import csv
import sys
import random
from timeit import Timer
from multiprocessing import Process

# Import our algorithms
from algorithm1 import *
from algorithm2 import *
from algorithm3 import *
```

```
from algorithm4 import *

# Global Variables
max_time = 2*60 # 2 minutes
min_num = -99
max_num = 99

def run_test(Alg):
f_name = "alg_res{0}.csv".format(Alg)
with open(f_name, 'wb') as csvfile:
writer = csv.writer(csvfile)

for n in range(100, 100001, 100):
# build a random array of len n
A = []
for _ in range(n):
A.append(random.randint(min_num, max_num))

# determine which algorithm to call
# run each set 3 times
if Alg == 1:
t = Timer(lambda: algorithm1(A)).timeit(number=3)
elif Alg == 2:
t = Timer(lambda: algorithm2(A)).timeit(number=3)
elif Alg == 3:
t = Timer(lambda: algorithm3(A)).timeit(number=3)
elif Alg == 4:
t = Timer(lambda: algorithm4(A)).timeit(number=3)

writer.writerow([n, t])

# see if we've gone beyond our max time.
# if we have, break the loop
if t >= max_time:
break;

print 'Algorithm {0} finished'.format(Alg)

def random_tests():
jobs = []
for i in range(1,5):
```

```
p = Process(target=run_test, args=(i,))
jobs.append(p)
p.start()

for p in jobs:
p.join()

def print_fail(alg, a, expected, returned):
print "Algorithm {0} failed test {1}".format(alg, a)
print "  Expected: {0}".format(expected)
print "  Returned: {0}".format(returned)

# Test each of the algorithms against known arrays and their answers
def validate_algorithms():
a = {}
a["a1"] = [1, 4, -9, 8, 1, 3, 3, 1, -1, -4, -6, 2, 8, 19, -10, -11]
a["a1_sub"] = [8, 1, 3, 3, 1, -1, -4, -6, 2, 8, 19]
a["a1_ans"] = 34

a["a2"] = [2, 9, 8, 6, 5, -11, 9, -11, 7, 5, -1, -8, -3, 7 -2]
a["a2_sub"] = [2, 9, 8, 6, 5]
a["a2_ans"] = 30

a["a3"] = [10, -11, -1, -9, 33, -45, 23, 24, -1, -7 -8, 19]
a["a3_sub"] = [23, 24, -1, -7, -8, 19]
a["a3_ans"] = 50

a["a4"] = [31,-41, 59, 26, -53, 58, 97, -93, -23, 84]
a["a4_sub"] = [59, 26, -53, 58, 97]
a["a4_ans"] = 187

a["a5"] = [3, 2, 1, 1, -8, 1, 1, 2, 3]
a["a5_sub"] = [3, 2, 1, 1]
a["a5_ans"] = 7

a["a6"] = [12, 99, 99, -99, -27, 0, 0, 0, -3,10]
a["a6_sub"] = [12, 99, 99]
a["a6_ans"] = 210

a["a7"] = [-2, 1, -3, 4, -1, 2, 1, -5, 4]
a["a7_sub"] = [4, -1, 2, 1]
```

```
a["a7_ans"] = 6

a["a8"] = [-1, -3 -5]
a["a8_sub"] = []
a["a8_ans"] = 0

all_passed = True
for i in range(1,9):
a1 = algorithm1(a["a{0}".format(i)])
a2 = algorithm2(a["a{0}".format(i)])
a3 = algorithm3(a["a{0}".format(i)])
a4 = algorithm4(a["a{0}".format(i)])

if  a1 != a["a{0}_ans".format(i)]:
print_fail(1, i, a["a{0}_ans".format(i)], a1)
all_passed = False

if  a2 != a["a{0}_ans".format(i)]:
print_fail(2, i, a["a{0}_ans".format(i)], a2)
all_passed = False

if  a3 != a["a{0}_ans".format(i)]:
print_fail(3, i, a["a{0}_ans".format(i)], a3)
all_passed = False

if  a4 != a["a{0}_ans".format(i)]:
print_fail(4, i, a["a{0}_ans".format(i)], a4)
all_passed = False

if all_passed == True:
print 'All tests passed! :)'

def MSS_test():
print "MSS_Test stuff goes here"

def print_help():
print "Program argument error!"
print "  Valid arguments include time_test, alg_test, or MSS_test"

if __name__ == "__main__":
if len(sys.argv) < 2 :
```

```
print_help()
sys.exit()

if sys.argv[1] == "time_test":
random_tests()
elif sys.argv[1] == "alg_test":
validate_algorithms()
elif sys.argv[1] == "MSS_test":
MSS_test()
else:
print_help()
```