

CTA200H1 – Problem Set #1
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Question 1.

Location – p1/q1/q1.sh

Bash script that creates a copy of all txt files in the same directory in the folder “replace” with the first arg replaced by the arg.

./q1.sh tomato potato //(instances of tomato replaced by potato)

Source -

```
#!/bin/bash
find=$1
replace=$2
mkdir replace
cp *.*.txt ./replace
sed -i -e "s/$find/$replace/g" ./replace/*.txt
```

Question 2.

a.

Routine found in p1/q2.sh

```
def NChooseK(n, k):
    if (k == 0):
        return 1
    numerator = n
    for i in range(n - k + 1, n):
        numerator *= i
    denominator = k
    for i in range(2, k):
        denominator *= i
    return int(numerator/denominator)
```

b.

Routine found in p1/q2.sh

Run python p1/pascals.py to run method

Output:

```
1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1
1 8 28 56 70 56 28 8 1
1 9 36 84 126 126 84 36 9 1
1 10 45 120 210 252 210 120 45 10 1
1 11 55 165 330 462 462 330 165 55 11 1
1 12 66 220 495 792 924 792 495 220 66 12 1
1 13 78 286 715 1287 1716 1716 1287 715 286 78 13 1
1 14 91 364 1001 2002 3003 3432 3003 2002 1001 364 91 14 1
1 15 105 455 1365 3003 5005 6435 6435 5005 3003 1365 455 105 15 1
1 16 120 560 1820 4368 8008 11440 12870 11440 8008 4368 1820 560 120 16 1
1 17 136 680 2380 6188 12376 19448 24310 24310 19448 12376 6188 2380 680 136 17 1
1 18 153 816 3060 8568 18564 31824 43758 48620 43758 31824 18564 8568 3060 816 153 18 1
1 19 171 969 3876 11628 27132 50388 75582 92378 92378 75582 50388 27132 11628 3876 969 171 19 1
1 20 190 1140 4845 15504 38760 77520 125970 167960 184756 167960 125970 77520 38760 15504 4845 1140 190 20 1
```

c.

Routine found in p1/q2/q2.sh

Run python p1/q2/hitter.py to run routine

68.359375% of the time the hitter will get at least one hit.

```
def biasedCoin(p, k, n):
    return NChooseK(n, k) * math.pow(p, k) * math.pow(1 - p, n - k)
```

d.

Routine found in p1/q2.sh

Run python p1/experiment.py to run experiment

Output -

Karans-MacBook:q2 karan\$ python experiment.py

N = 10.0, Fraction of success = 0.2

N = 100.0, Fraction of success = 0.41

N = 1000.0, Fraction of success = 0.324

```
Karans-MacBook:q2 karan$ python experiment.py
N = 10.0, Fraction of success = 0.5
N = 100.0, Fraction of success = 0.37
N = 1000.0, Fraction of success = 0.329
Karans-MacBook:q2 karan$ python experiment.py
N = 10.0, Fraction of success = 0.3
N = 100.0, Fraction of success = 0.31
N = 1000.0, Fraction of success = 0.326
```

```
def runExperiment(N, p, k, n):
    random.seed()
    successCount = 0
    probability = biasedCoin(p, k, n)
    for i in range(1, N):
        if random.random() > probability:
            successCount += 1
    return successCount

def experiment():
    for i in range(1, 4):
        print runExperiment(int(math.pow(10, i)), 0.250, 1, 4) / math.pow(10, i)
```

Question 3.

a. I used an approximation algorithm as well as a recurrence algorithm. The recurrence algorithm lost accuracy as m increased but it ran quicker.

Table of results -

M, X	Result
(1, 1)	0.440050585745
(2, 1)	0.114903484932
(3, 1)	0.0195633539827
(4, 1)	0.00247663896411
(5, 1)	0.000249757730211

This recurrence is quicker but loses accuracy dramatically when $v > 9$

```
def bessellRecurrence(v, x):
```

```

if v == 0 or v == 1:
    return bessellApprox(v, x)
else:
    return (2 * (v - 1) / x) * bessellRecurrence(v - 1, x) - bessellRecurrence(v - 2, x)

```

#Slower calculation but more accurate than recurrence

```

def bessellApprox(v, x):
    sum = 0.0
    for k in range(0, 10):
        numerator = math.pow(-1, k) * math.pow(x / 2, v + (2 * k))
        denominator = math.factorial(k) * math.factorial(v + k)
        sum += (numerator / denominator)
    return sum

```

b.

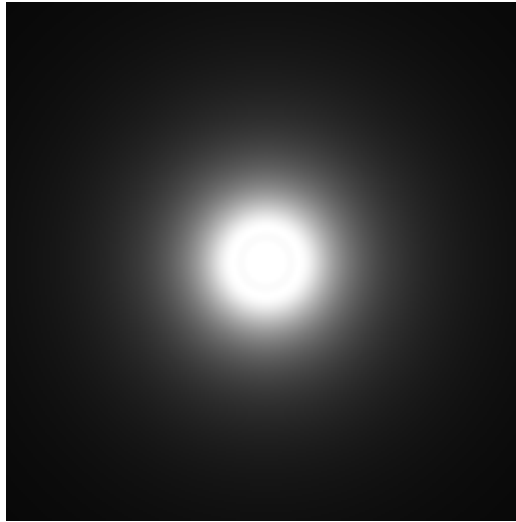
Routine in p1/q3/q3.py

Can be run using p1/q3/createPointSpread.py outputFile

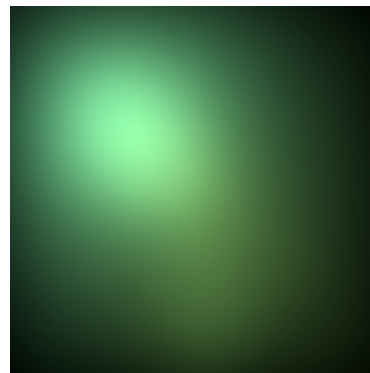
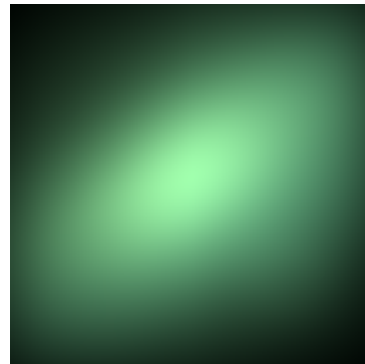
I.e python createPointSpread.py test.png

will create the point spread image as test.png in the current directory

Created Image -



c. Routine in p1/q3/q3.py
Can be run using p1/convolve.py imageToConvolve outputFile
I.e python convolve.py space.jpg testSpace.jpg



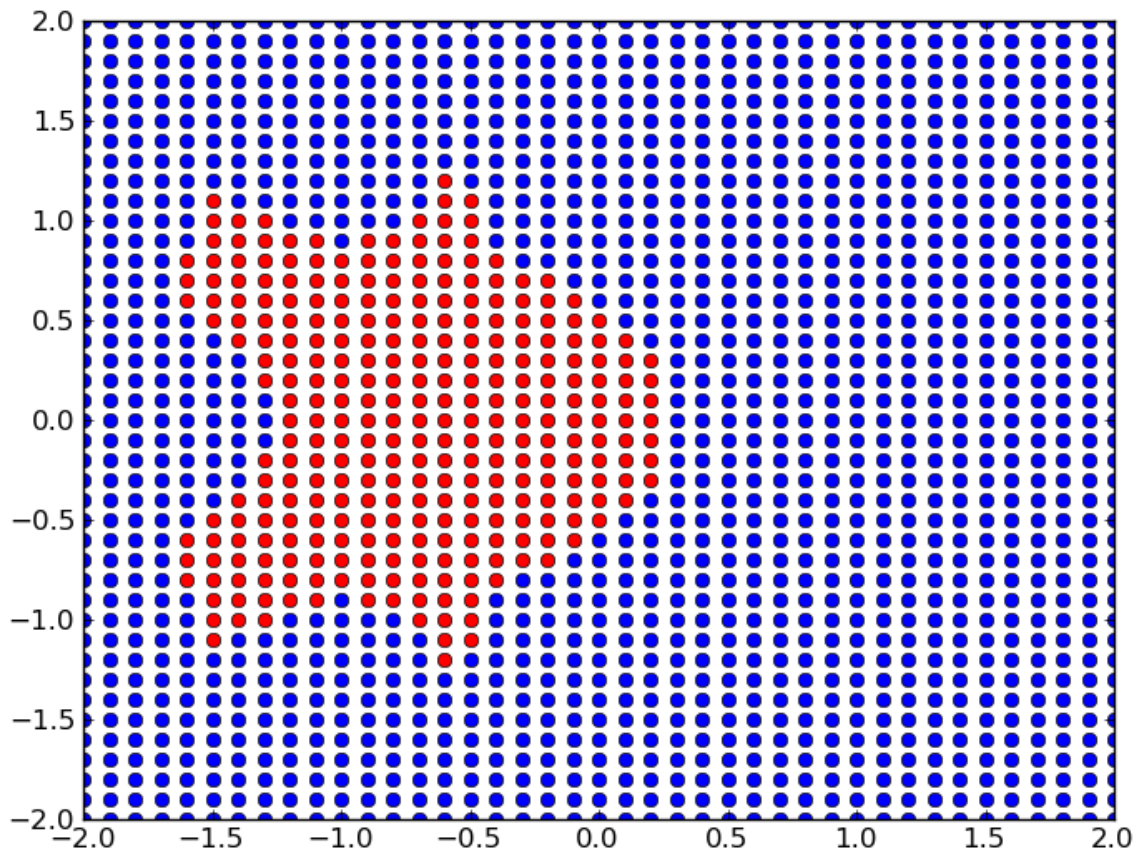
Question 4.

Routines in p1/q4/q4.py

Running will generate a plot indicating divergence for all x, y values in increments of 0.1.

Output on next page -

Blue = Diverts, Red = Does not divert



Question 5

Routines in q1/q5/q5.py

Derivative, $f'(x) = 2x - 1$

$f'(1) = 1$

What do you find?

The smaller the delta the more accurate the answer we get, however after 10^{-13} the answers remain the same. (10^{-13} is also more inaccurate than 10^{-12})

Output:

Delta	Output
10^{-4}	1.0001
10^{-5}	1.000010000001
10^{-6}	1.000000999992
10^{-7}	1.000000010058
10^{-8}	1.000000000392
10^{-9}	1.000000008374
10^{-10}	1.000000008284
10^{-11}	1.000000008275
10^{-12}	1.00008890058
10^{-13}	0.999200722163
10^{-14}	0.999200722163

Q6.

Routines in p1/q6/q6.py
Run it to simulate a battle.

Sample output:

```
python q6.py
```

Warship fired a missile at Speeder!
Speeder dodged Warship's attack!
Speeder fired a laser at Standard Ship!
Standard Ship took 50 shield damage from Speeder! Shield is now at 50
Standard Ship fired a laser at Warship!
Warship took 50 shield damage from Standard Ship! Shield is now at 50
Standard Ship fired a laser at Speeder!
Speeder took 50 shield damage from Standard Ship! Shield is now at 50
Speeder fired a laser at Warship!

Warship took 50 shield damage from Speeder! Shield is now at 0
Warship fired a missile at Standard Ship!
Standard Ship took 100 shield damage from Warship! Shield is now at -50
Standard Ship took 25 hull damage from Warship! Hull Strength is now at 75.0
Speeder fired a laser at Warship!
Warship took 25 hull damage from Speeder! Hull Strength is now at 75.0
Warship fired a laser at Speeder!
Speeder dodged Warship's attack!
Standard Ship fired a laser at Speeder!
Speeder took 50 shield damage from Standard Ship! Shield is now at 0
Speeder fired a laser at Standard Ship!
Standard Ship took 25 hull damage from Speeder! Hull Strength is now at 50.0
Warship fired a laser at Speeder!
Speeder took 25 hull damage from Warship! Hull Strength is now at 75.0
Standard Ship fired a laser at Warship!
Warship took 25 hull damage from Standard Ship! Hull Strength is now at 50.0
Speeder fired a laser at Warship!
Warship took 25 hull damage from Speeder! Hull Strength is now at 25.0
Standard Ship fired a laser at Speeder!
Speeder took 25 hull damage from Standard Ship! Hull Strength is now at 50.0
Warship fired a missile at Speeder!
Speeder took 50 hull damage from Warship! Hull Strength is now at 0.0
Speeder was destroyed!
Standard Ship fired a laser at Warship!
Warship took 25 hull damage from Standard Ship! Hull Strength is now at 0.0
Warship was destroyed!
Standard Ship is the victor!

#2

python q6.py

Speeder fired a laser at Standard Ship!
Standard Ship took 50 shield damage from Speeder! Shield is now at 50
Warship fired a missile at Standard Ship!
Standard Ship took 100 shield damage from Warship! Shield is now at -50
Standard Ship took 25 hull damage from Warship! Hull Strength is now at 75.0
Standard Ship fired a laser at Warship!
Warship took 50 shield damage from Standard Ship! Shield is now at 50
Speeder fired a laser at Standard Ship!
Standard Ship took 25 hull damage from Speeder! Hull Strength is now at 50.0

Warship fired a missile at Speeder!
Speeder dodged Warship's attack!
Standard Ship fired a laser at Warship!
Warship took 50 shield damage from Standard Ship! Shield is now at 0
Standard Ship fired a laser at Warship!
Warship took 25 hull damage from Standard Ship! Hull Strength is now at 75.0
Warship fired a laser at Speeder!
Speeder took 50 shield damage from Warship! Shield is now at 50
Speeder fired a laser at Standard Ship!
Standard Ship took 25 hull damage from Speeder! Hull Strength is now at 25.0
Speeder fired a laser at Warship!
Warship took 25 hull damage from Speeder! Hull Strength is now at 50.0
Warship fired a missile at Speeder!
Speeder dodged Warship's attack!
Standard Ship fired a laser at Warship!
Warship took 25 hull damage from Standard Ship! Hull Strength is now at 25.0
Standard Ship fired a laser at Warship!
Warship took 25 hull damage from Standard Ship! Hull Strength is now at 0.0
Warship was destroyed!
Standard Ship fired a laser at Speeder!
Speeder dodged Standard Ship's attack!
Speeder fired a laser at Standard Ship!
Standard Ship took 25 hull damage from Speeder! Hull Strength is now at 0.0
Standard Ship was destroyed!
Speeder is the victor!