Q2

February 9, 2025

0.1 Question 2

[24]:
```
import numpy as np
import pulp
```

[27]:
```
m, n = 10, 10
# i: row (m) , j: column (n)
A = np.zeros((m, n))

for i in range(m) :
    for j in range(n) :
        A[i, j] = (-1)**(i + j) * (i - j)


b = np.zeros((m,1))

for i in range(m) :
    b[i] = (-1)**(i+1)

print(A)
print(b)
```

```
[[ 0.  1. -2.  3. -4.  5. -6.  7. -8.  9.]
 [-1.  0.  1. -2.  3. -4.  5. -6.  7. -8.]
 [ 2. -1.  0.  1. -2.  3. -4.  5. -6.  7.]
 [-3.  2. -1.  0.  1. -2.  3. -4.  5. -6.]
 [ 4. -3.  2. -1.  0.  1. -2.  3. -4.  5.]
 [-5.  4. -3.  2. -1.  0.  1. -2.  3. -4.]
 [ 6. -5.  4. -3.  2. -1.  0.  1. -2.  3.]
 [-7.  6. -5.  4. -3.  2. -1.  0.  1. -2.]
 [ 8. -7.  6. -5.  4. -3.  2. -1.  0.  1.]
 [-9.  8. -7.  6. -5.  4. -3.  2. -1.  0.]]
[[-1.]
 [ 1.]
 [-1.]
 [ 1.]
 [-1.]
 [ 1.]
 [-1.]
```

```
 [ 1.]
 [-1.]
 [ 1.]]
```

[26]:
```python
num_variables = A.shape[1]

lp_problem = pulp.LpProblem("Feasibility Check", pulp.LpMinimize)

x = [pulp.LpVariable(f"x{i}",lowBound=0) for i in range(num_variables)]

lp_problem += 0

for i in range(A.shape[0]) :
    lp_problem += (pulp.lpDot(A[i],x) <= b[i])

lp_problem.solve()

for var in x :
    print(f"{var.name}: {var.varValue}")
```

```
Welcome to the CBC MILP Solver
Version: 2.10.3
Build Date: Dec 15 2019

command line - /Users/mercurymcindoe/Documents/Mercury/UBC/CPEN 4-2/MATH
340/Assignments/.venv/lib/python3.13/site-packages/pulp/solverdir/cbc/osx/64/cbc
/var/folders/py/b14h3jpn1036ckyvg60q2fp40000gn/T/caf7f50dadb043cdb3e831a7bd2c56c
2-pulp.mps -timeMode elapsed -branch -printingOptions all -solution /var/folders
/py/b14h3jpn1036ckyvg60q2fp40000gn/T/caf7f50dadb043cdb3e831a7bd2c56c2-pulp.sol
(default strategy 1)
At line 2 NAME          MODEL
At line 3 ROWS
At line 15 COLUMNS
At line 107 RHS
At line 118 BOUNDS
At line 120 ENDATA
Problem MODEL has 10 rows, 11 columns and 90 elements
Coin0008I MODEL read with 0 errors
Option for timeMode changed from cpu to elapsed
Presolve 10 (0) rows, 10 (-1) columns and 90 (0) elements
0  Obj 0 Primal inf 0.74562992 (5) Dual inf 9.2272281 (4)
2  Obj 0
Optimal - objective value 0
After Postsolve, objective 0, infeasibilities - dual 0 (0), primal 0 (0)
Optimal objective 0 - 2 iterations time 0.002, Presolve 0.00
Option for printingOptions changed from normal to all
Total time (CPU seconds):       0.00   (Wallclock seconds):       0.01
```

```
x0: 0.0
x1: 0.0
x2: 0.0
x3: 0.2
x4: 0.0
x5: 0.0
x6: 0.0
x7: 0.0
x8: 0.2
x9: 0.0
```

```
/Users/mercurymcindoe/Documents/Mercury/UBC/CPEN 4-2/MATH
340/Assignments/.venv/lib/python3.13/site-packages/pulp/pulp.py:1298:
UserWarning: Spaces are not permitted in the name. Converted to '_'
  warnings.warn("Spaces are not permitted in the name. Converted to '_'")
```