Příloha 1 – Zdrojový kód pro výpočty modelu pomocí metodu STEM

Načtení dat:

```
from pulp import *

import pandas as pd

import numpy as np

#Vstupní data

obaly_data = pd.read_excel('Plocha1.xlsx', index_col = 0, sheet_name = 0)

zony_data = pd.read_excel('Plocha1.xlsx', index_col = 0, sheet_name = 1)

obaly = obaly_data.index.to_list()

zony = zony_data.index.to_list()

w = obaly_data['Sirka'].to_dict()

o = obaly_data['Obratkovost'].to_dict()

p = zony_data['Pristup'].to_dict()

l = obaly_data['Delka'].to_dict()

D = zony_data['Hloubka'].to_dict()

L = zony_data['Delka'].to_dict()
```

Model pro první výpočtovou fázi:

```
#Model Stem1

model = LpProblem('Vazena_odchylka', LpMinimize)

umisteni = [(i,j) for i in obaly for j in zony]

M = {0, 1}

N = {0, 1}

#Promenne modelu

x = LpVariable.dicts('x', (obaly, zony), lowBound = 0)

y = LpVariable.dicts('y', (obaly, zony), lowBound = 0, cat = 'Integer')

z = LpVariable.dicts('z', (obaly, zony), cat = 'Binary')

k = LpVariable.dicts('k', (obaly), cat = 'Binary')

d = pulp.LpVariable('d', lowBound=0)

#Kriterialni funkce

model += d

#Za podminek

model += d >= 0.9998 * (25 - lpSum(k[i] for i in obaly))

model += d >= 0.0002 * (44856- lpSum(z[i][j] * o[i] * p[j] for (i,j) in umisteni))

for i in obaly:

    model += k[i]*l[i] == lpSum(x[i][j] for j in zony)

for i in obaly:

    model += lpSum(z[i][j] for j in zony) <= 1

for j in zony:

    model += lpSum(y[i][j]*w[i] for i in obaly) <= L[j]

for (i,j) in umisteni:

    model += x[i][j] <= y[i][j]*D[j]

    model += x[i][j] <= 1000000*z[i][j]
```

```
    model += y[i][j] <= 1000000*z[i][j]

    model += z[i][j] <= 1000000*k[i]

for (i,j) in umisteni:

    model += x[i][j] >= 0

#Vystupy

model.solve(PULP_CBC_CMD(msg = 1, timeLimit = 120))

print("Status:", LpStatus[model.status])

for v in model.variables():

    if v.varValue > 0:

        print(v.name, "=", v.varValue)

print("Hodnota ucelove funkce je: ", value(model.objective))

print('Hodnota prvni ucelove funkce je: ',value(lpSum(k[i] for i in obaly)))

print('Hodnota druhe ucelove funkce je: ',value(lpSum(z[i][j]*o[i]*p[j] for (i,j) in umisteni)))
```

Výsledky první výpočtové fáze:

```
Status: Optimal
d = 0.9998
k_1 = 1.0
k_10 = 1.0
k_11 = 1.0
k_13 = 1.0
k_14 = 1.0
k_15 = 1.0
k_16 = 1.0
k_17 = 1.0
k_19 = 1.0
k_22 = 1.0
k_23 = 1.0
k_24 = 1.0
k_25 = 1.0
k_26 = 1.0
k_27 = 1.0
k_28 = 1.0
k_29 = 1.0
k_3 = 1.0
k_30 = 1.0
k_31 = 1.0
k_4 = 1.0
k_5 = 1.0
k_6 = 1.0
k_8 = 1.0
x_10_3 = 92.0
```

x_11_3 = 90.0
x_13_2 = 67.0
x_14_4 = 64.0
x_15_4 = 62.0
x_16_3 = 60.0
x_17_3 = 88.0
x_19_4 = 58.0
x_1_2 = 138.0
x_22_4 = 46.0
x_23_3 = 45.0
x_24_4 = 38.0
x_25_4 = 32.0
x_26_4 = 30.0
x_27_1 = 24.0
x_28_4 = 23.0
x_29_4 = 22.0
x_30_4 = 15.0
x_31_1 = 12.0
x_3_2 = 122.0
x_4_2 = 118.0
x_5_3 = 113.0
x_6_2 = 112.0
x_8_3 = 102.0
y_10_3 = 4.0
y_11_3 = 4.0
y_13_2 = 3.0
y_14_4 = 3.0
y_15_4 = 3.0
y_16_3 = 3.0
y_17_3 = 4.0
y_19_4 = 3.0
y_1_2 = 6.0
y_22_4 = 2.0
y_23_3 = 2.0
y_24_4 = 2.0
y_25_4 = 2.0
y_26_4 = 2.0
y_27_1 = 2.0
y_28_4 = 1.0
y_29_4 = 1.0
y_30_4 = 1.0
y_31_1 = 1.0
y_3_2 = 6.0
y_4_2 = 6.0
y_5_3 = 5.0
y_6_2 = 5.0
y_8_3 = 5.0
z_10_3 = 1.0
z_11_3 = 1.0
z_13_2 = 1.0
z_14_4 = 1.0
z_15_4 = 1.0
z_16_3 = 1.0
z_17_3 = 1.0
z_19_4 = 1.0
z_1_2 = 1.0
z_22_4 = 1.0
z_23_3 = 1.0

```
z_24_4 = 1.0
z_25_4 = 1.0
z_26_4 = 1.0
z_27_1 = 1.0
z_28_4 = 1.0
z_29_4 = 1.0
z_30_4 = 1.0
z_31_1 = 1.0
z_3_2 = 1.0
z_4_2 = 1.0
z_5_3 = 1.0
z_6_2 = 1.0
z_8_3 = 1.0
Hodnota ucelove funkce je:  0.9998
Hodnota prvni ucelove funkce je:  24.0
Hodnota druhe ucelove funkce je:  39937.0
```

Model pro druhou výpočtovou fázi:

```
#Model Stem 2

model = LpProblem('Vazena_odchylka', LpMinimize)

umisteni = [(i,j) for i in obaly for j in zony]

M = {0, 1}

N = {0, 1}

#Promenne modelu

x = LpVariable.dicts('x', (obaly, zony), lowBound = 0)

y = LpVariable.dicts('y', (obaly, zony), lowBound = 0, cat = 'Integer')

z = LpVariable.dicts('z', (obaly, zony), cat = 'Binary')

k = LpVariable.dicts('k', (obaly), cat = 'Binary')

d = pulp.LpVariable('d', lowBound=0)

#Kriterialni funkce

model += d

#Za podminek

model += d >= 0 * (25 - lpSum(k[i] for i in obaly))

model += d >= 1 * (44856 - lpSum(z[i][j] * o[i] * p[j] for (i,j) in umisteni))

model += (lpSum(k[i] for i in obaly)) >= 22

for i in obaly:

    model += k[i]*l[i] == lpSum(x[i][j] for j in zony)

for i in obaly:

    model += lpSum(z[i][j] for j in zony) <= 1

for j in zony:

    model += lpSum(y[i][j]*w[i] for i in obaly) <= L[j]

for (i,j) in umisteni:

    model += x[i][j] <= y[i][j]*D[j]#4
```

```
    model += x[i][j] <= 1000000*z[i][j]
    model += y[i][j] <= 1000000*z[i][j]
    model += z[i][j] <= 1000000*k[i]
for (i,j) in umisteni:
    model += x[i][j] >= 0
#Vystupy
model.solve(PULP_CBC_CMD(msg = 1, timeLimit = 120))
print("Status:", LpStatus[model.status])
for v in model.variables():
    if v.varValue > 0:
        print(v.name, "=", v.varValue)
print("Hodnota ucelove funkce je: ", value(model.objective))
print('Hodnota prvni ucelove funkce je: ',value(lpSum(k[i] for i in obaly)))
print('Hodnota druhe ucelove funkce je: ',value(lpSum(z[i][j]*o[i]*p[j] for (i,j) in umisteni)))
```

Výsledky druhé výpočtové fáze:

```
Status: Optimal
d = 635.0
k_1 = 1.0
k_10 = 1.0
k_11 = 1.0
k_12 = 1.0
k_13 = 1.0
k_14 = 1.0
k_15 = 1.0
k_2 = 1.0
k_22 = 1.0
k_23 = 1.0
k_24 = 1.0
k_25 = 1.0
k_28 = 1.0
k_29 = 1.0
k_3 = 1.0
k_30 = 1.0
k_31 = 1.0
k_4 = 1.0
k_5 = 1.0
k_6 = 1.0
k_7 = 1.0
k_8 = 1.0
```

x_10_3 = 92.0
x_11_3 = 90.0
x_12_3 = 88.0
x_13_2 = 67.0
x_14_4 = 64.0
x_15_4 = 62.0
x_1_2 = 138.0
x_22_4 = 46.0
x_23_4 = 45.0
x_24_1 = 38.0
x_25_4 = 32.0
x_28_4 = 23.0
x_29_4 = 22.0
x_2_2 = 125.0
x_30_1 = 15.0
x_31_4 = 12.0
x_3_2 = 122.0
x_4_3 = 118.0
x_5_3 = 113.0
x_6_2 = 112.0
x_7_4 = 105.0
x_8_3 = 102.0
y_10_3 = 4.0
y_11_3 = 4.0
y_12_3 = 4.0
y_13_2 = 3.0
y_14_4 = 3.0
y_15_4 = 3.0
y_1_2 = 6.0
y_22_4 = 2.0
y_23_4 = 2.0
y_24_1 = 2.0
y_25_4 = 2.0
y_28_4 = 1.0
y_29_4 = 1.0
y_2_2 = 6.0
y_30_1 = 1.0
y_31_4 = 1.0
y_3_2 = 6.0
y_4_3 = 6.0
y_5_3 = 5.0
y_6_2 = 5.0
y_7_4 = 5.0
y_8_3 = 5.0
z_10_3 = 1.0
z_11_3 = 1.0
z_12_3 = 1.0
z_13_2 = 1.0
z_14_4 = 1.0
z_15_4 = 1.0
z_1_2 = 1.0
z_22_4 = 1.0
z_23_4 = 1.0
z_24_1 = 1.0
z_25_4 = 1.0
z_28_4 = 1.0
z_29_4 = 1.0
z_2_2 = 1.0

```
z_30_1 = 1.0
z_31_4 = 1.0
z_3_2 = 1.0
z_4_3 = 1.0
z_5_3 = 1.0
z_6_2 = 1.0
z_7_4 = 1.0
z_8_3 = 1.0
Hodnota ucelove funkce je:  635.0
Hodnota prvni ucelove funkce je:  22.0
Hodnota druhe ucelove funkce je:  44221.0
```