Problemas de Programação Linear

```
#define TRABALHO "Trabalho - Problemas de Programação Linear"
#define PROFESSOR "Guilherme Pena"
#define DISCIPLINA "Pesquisa Operacional"
#define ESTUDANTES ["Gabriel de Paula", "Henrique Azevedo"]
```

📃 Lista de Problemas

1. Problema do Fluxo de Custo Mínimo
2. Problema de Transporte
3. Problema da Designação
4. Problema do Caminho Mínimo
5. Problema do Fluxo Máximo

💻 Como executar

> Instale a biblioteca CPLEX

Vá para a pasta do problema:

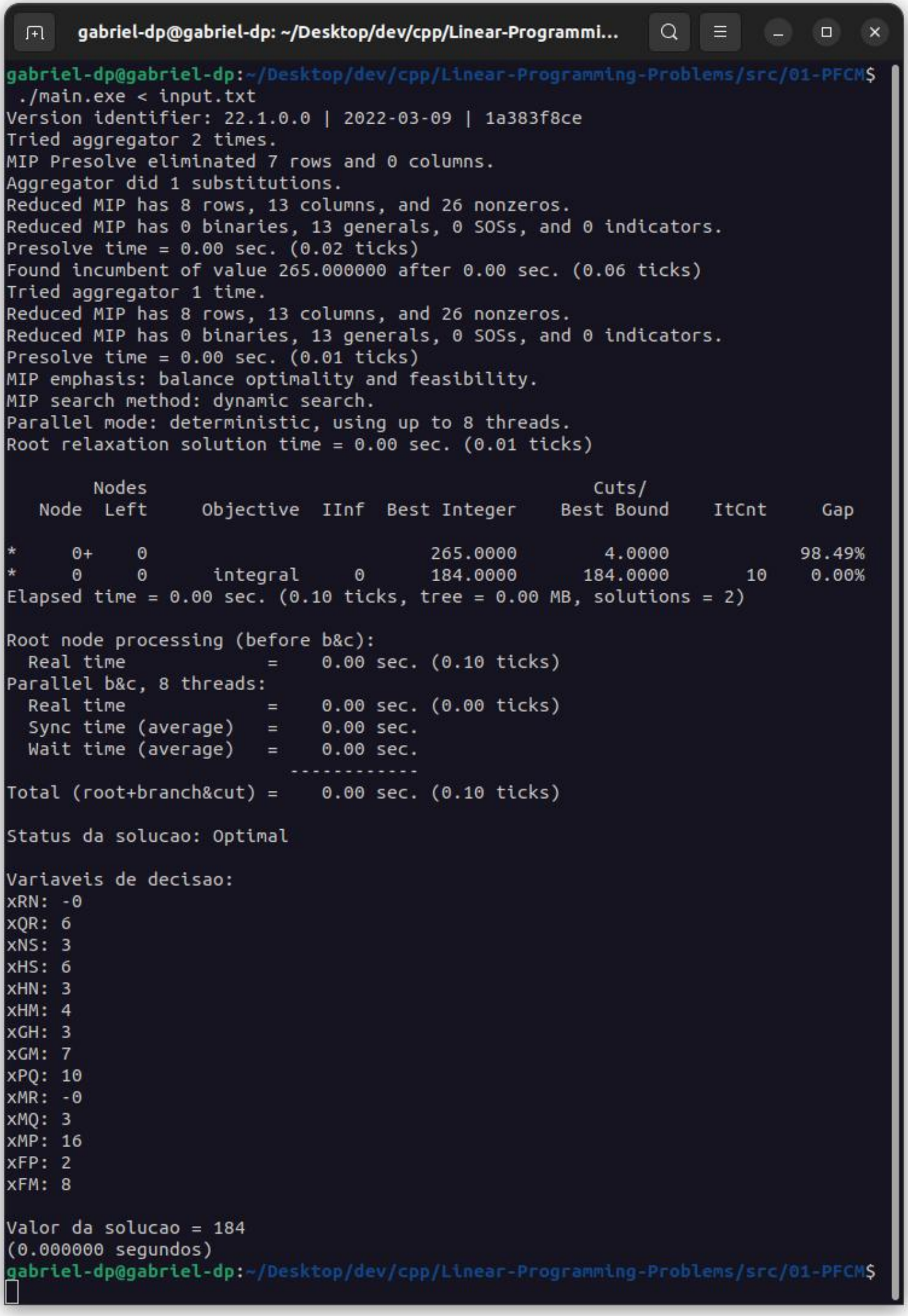
```
cd src/xx-xxxxx
```

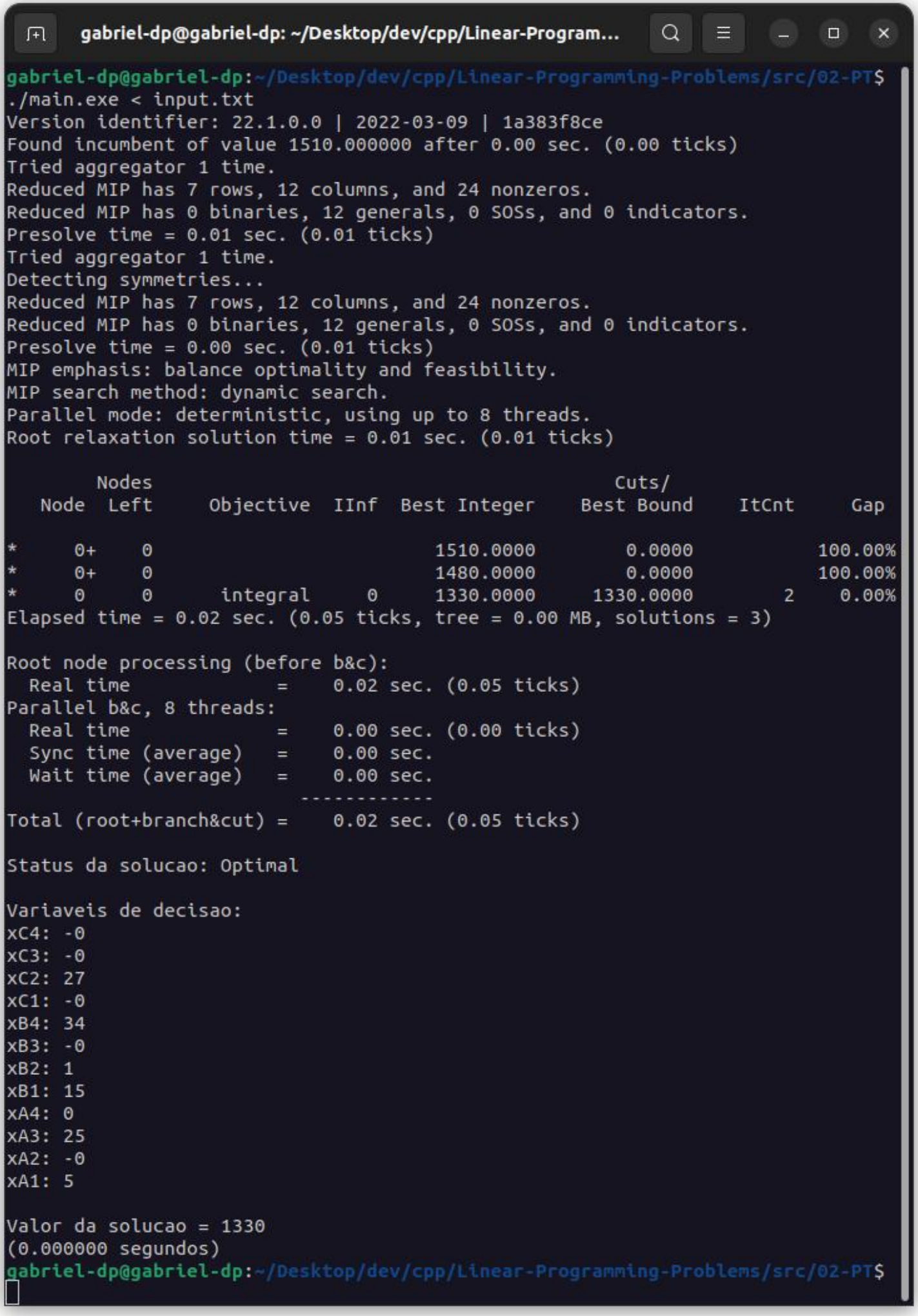
Compile o executável:

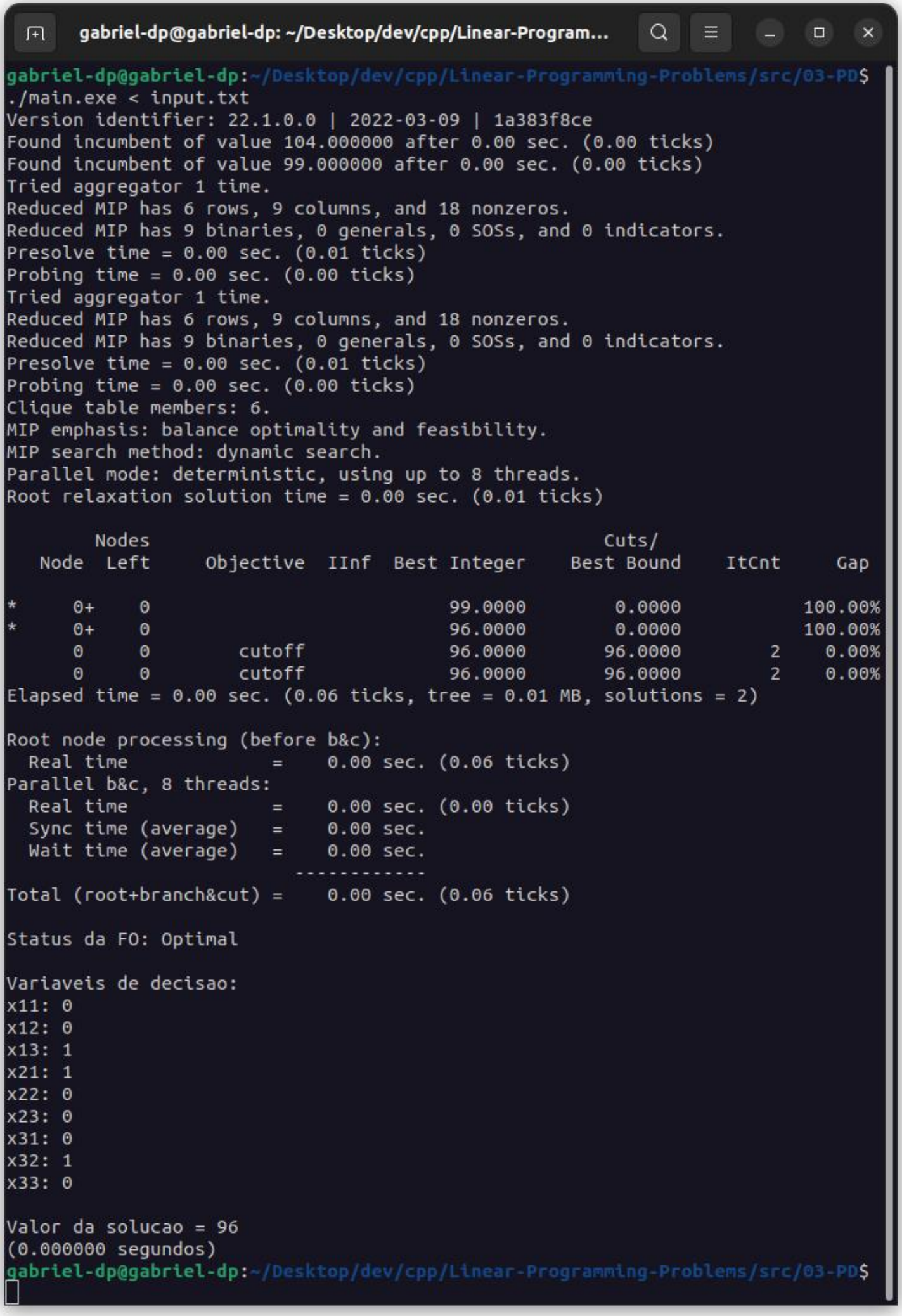
```
make
```

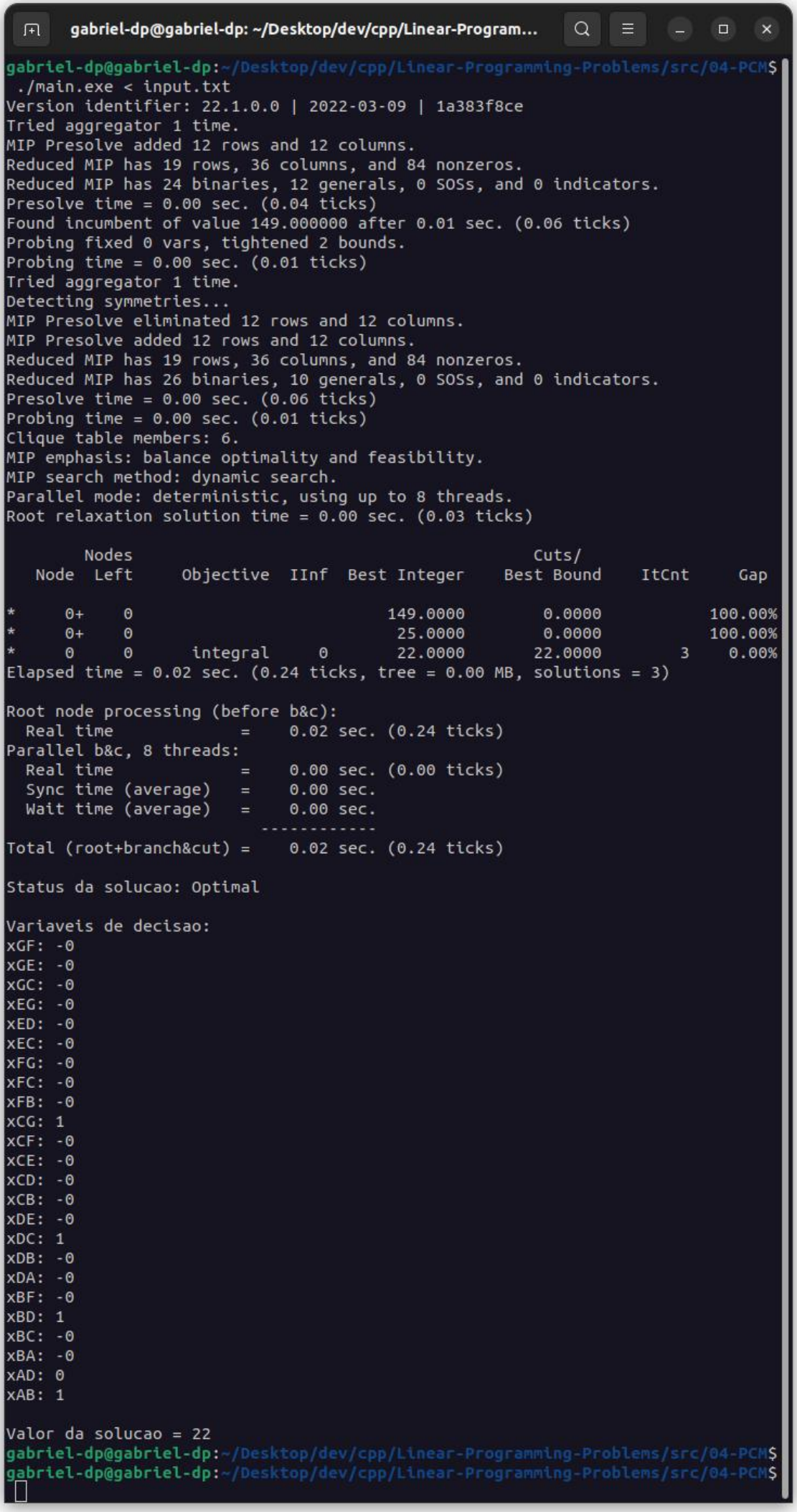
Execute o programa com a entrada:

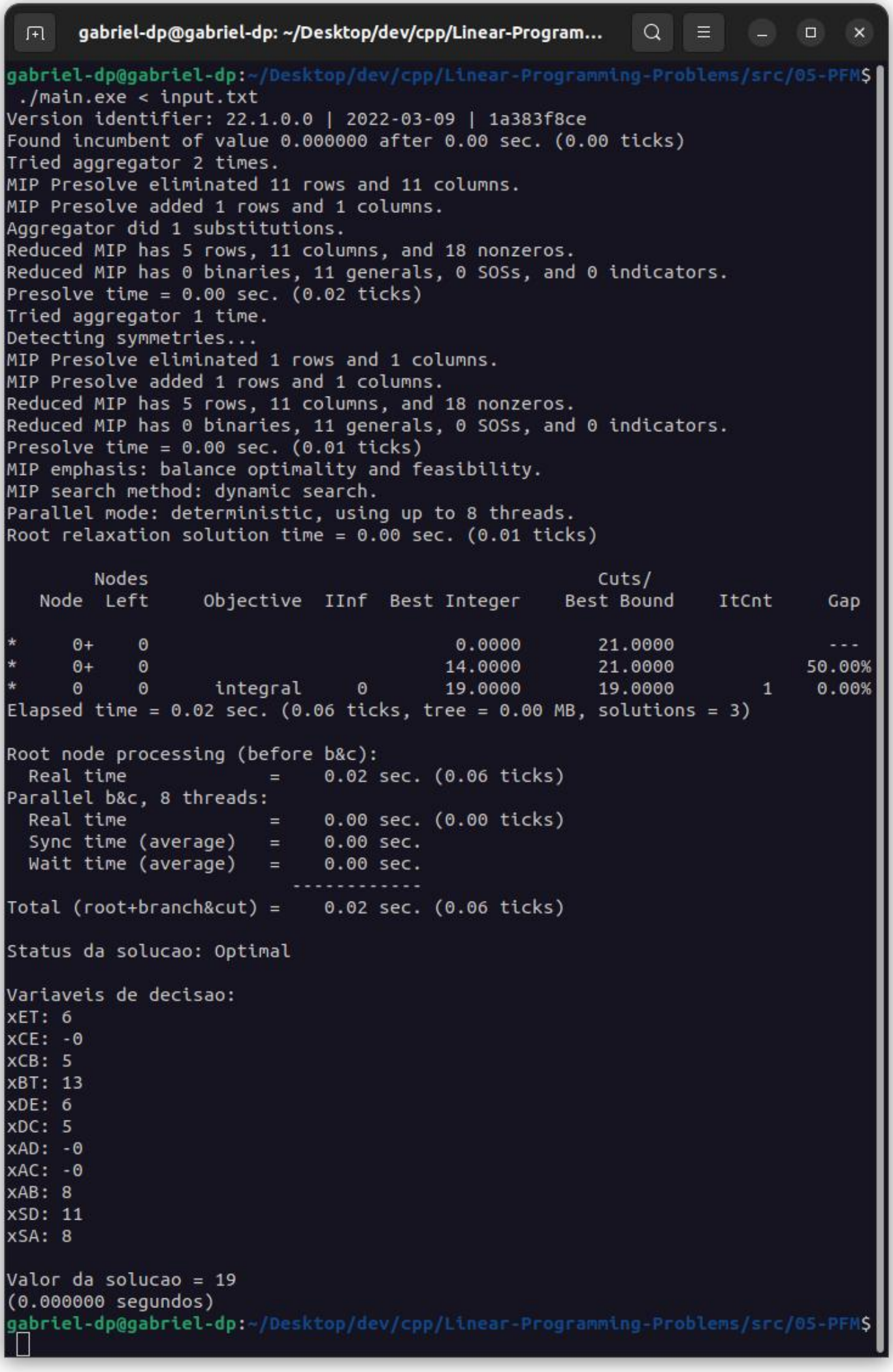
```
./main.exe < input.txt
```


gabriel-dp@gabriel-dp: ~/Desktop/dev/cpp/Linear-Programmi...
gabriel-dp@gabriel-dp:~/Desktop/dev/cpp/Linear-Programming-Problems/src/01-PFCM$ ./main.exe < input.txt
Version identifier: 22.1.0.0 | 2022-03-09 | 1a383f8ce
Tried aggregator 2 times.
MIP Presolve eliminated 7 rows and 0 columns.
Aggregator did 1 substitutions.
Reduced MIP has 8 rows, 13 columns, and 26 nonzeros.
Reduced MIP has 0 binaries, 13 generals, 0 SOSs, and 0 indicators.
Presolve time = 0.00 sec. (0.02 ticks)
Found incumbent of value 265.000000 after 0.00 sec. (0.06 ticks)
Tried aggregator 1 time.
Reduced MIP has 8 rows, 13 columns, and 26 nonzeros.
Reduced MIP has 0 binaries, 13 generals, 0 SOSs, and 0 indicators.
Presolve time = 0.00 sec. (0.01 ticks)
MIP emphasis: balance optimality and feasibility.
MIP search method: dynamic search.
Parallel mode: deterministic, using up to 8 threads.
Root relaxation solution time = 0.00 sec. (0.01 ticks)
Nodes
Node Left Objective IInf Best Integer Cuts/ Best Bound ItCnt Gap
* 0+ 0 265.0000 4.0000 98.49%
* 0 0 integral 0 184.0000 184.0000 10 0.00%
Elapsed time = 0.00 sec. (0.10 ticks, tree = 0.00 MB, solutions = 2)
Root node processing (before b&c):
Real time = 0.00 sec. (0.10 ticks)
Parallel b&c, 8 threads:
Real time = 0.00 sec. (0.00 ticks)
Sync time (average) = 0.00 sec.
Wait time (average) = 0.00 sec.
Total (root+branch&cut) = 0.00 sec. (0.10 ticks)
Status da solucao: Optimal
Variaveis de decisao:
xRN: -0
xQR: 6
xNS: 3
xHS: 6
xHN: 3
xHM: 4
xGH: 3
xGM: 7
xPQ: 10
xMR: -0
xMQ: 3
xMP: 16
xFP: 2
xFM: 8
Valor da solucao = 184
(0.000000 segundos)
gabriel-dp@gabriel-dp:~/Desktop/dev/cpp/Linear-Programming-Problems/src/01-PFCM$


gabriel-dp@gabriel-dp: ~/Desktop/dev/cpp/Linear-Program...
gabriel-dp@gabriel-dp:~/Desktop/dev/cpp/Linear-Programming-Problems/src/02-PT$
./main.exe < input.txt
Version identifier: 22.1.0.0 | 2022-03-09 | 1a383f8ce
Found incumbent of value 1510.000000 after 0.00 sec. (0.00 ticks)
Tried aggregator 1 time.
Reduced MIP has 7 rows, 12 columns, and 24 nonzeros.
Reduced MIP has 0 binaries, 12 generals, 0 SOSs, and 0 indicators.
Presolve time = 0.01 sec. (0.01 ticks)
Tried aggregator 1 time.
Detecting symmetries...
Reduced MIP has 7 rows, 12 columns, and 24 nonzeros.
Reduced MIP has 0 binaries, 12 generals, 0 SOSs, and 0 indicators.
Presolve time = 0.00 sec. (0.01 ticks)
MIP emphasis: balance optimality and feasibility.
MIP search method: dynamic search.
Parallel mode: deterministic, using up to 8 threads.
Root relaxation solution time = 0.01 sec. (0.01 ticks)
Nodes
Node Left Objective IInf Best Integer Best Bound Cuts/ ItCnt Gap
* 0+ 0 1510.0000 0.0000 100.00%
* 0+ 0 1480.0000 0.0000 100.00%
* 0 0 integral 0 1330.0000 1330.0000 2 0.00%
Elapsed time = 0.02 sec. (0.05 ticks, tree = 0.00 MB, solutions = 3)
Root node processing (before b&c):
Real time = 0.02 sec. (0.05 ticks)
Parallel b&c, 8 threads:
Real time = 0.00 sec. (0.00 ticks)
Sync time (average) = 0.00 sec.
Wait time (average) = 0.00 sec.
Total (root+branch&cut) = 0.02 sec. (0.05 ticks)
Status da solucao: Optimal
Variaveis de decisao:
xC4: -0
xC3: -0
xC2: 27
xC1: -0
xB4: 34
xB3: -0
xB2: 1
xB1: 15
xA4: 0
xA3: 25
xA2: -0
xA1: 5
Valor da solucao = 1330
(0.000000 segundos)
gabriel-dp@gabriel-dp:~/Desktop/dev/cpp/Linear-Programming-Problems/src/02-PT$


gabriel-dp@gabriel-dp: ~/Desktop/dev/cpp/Linear-Program...
gabriel-dp@gabriel-dp:~/Desktop/dev/cpp/Linear-Programming-Problems/src/03-PD$
./main.exe < input.txt
Version identifier: 22.1.0.0 | 2022-03-09 | 1a383f8ce
Found incumbent of value 104.000000 after 0.00 sec. (0.00 ticks)
Found incumbent of value 99.000000 after 0.00 sec. (0.00 ticks)
Tried aggregator 1 time.
Reduced MIP has 6 rows, 9 columns, and 18 nonzeros.
Reduced MIP has 9 binaries, 0 generals, 0 SOSs, and 0 indicators.
Presolve time = 0.00 sec. (0.01 ticks)
Probing time = 0.00 sec. (0.00 ticks)
Tried aggregator 1 time.
Reduced MIP has 6 rows, 9 columns, and 18 nonzeros.
Reduced MIP has 9 binaries, 0 generals, 0 SOSs, and 0 indicators.
Presolve time = 0.00 sec. (0.01 ticks)
Probing time = 0.00 sec. (0.00 ticks)
Clique table members: 6.
MIP emphasis: balance optimality and feasibility.
MIP search method: dynamic search.
Parallel mode: deterministic, using up to 8 threads.
Root relaxation solution time = 0.00 sec. (0.01 ticks)
Nodes
Node Left Objective IInf Best Integer Cuts/ Best Bound ItCnt Gap
* 0+ 0 99.0000 0.0000 100.00%
* 0+ 0 96.0000 0.0000 100.00%
0 0 cutoff 96.0000 96.0000 2 0.00%
0 0 cutoff 96.0000 96.0000 2 0.00%
Elapsed time = 0.00 sec. (0.06 ticks, tree = 0.01 MB, solutions = 2)
Root node processing (before b&c):
Real time = 0.00 sec. (0.06 ticks)
Parallel b&c, 8 threads:
Real time = 0.00 sec. (0.00 ticks)
Sync time (average) = 0.00 sec.
Wait time (average) = 0.00 sec.
Total (root+branch&cut) = 0.00 sec. (0.06 ticks)
Status da FO: Optimal
Variaveis de decisao:
x11: 0
x12: 0
x13: 1
x21: 1
x22: 0
x23: 0
x31: 0
x32: 1
x33: 0
Valor da solucao = 96
(0.000000 segundos)
gabriel-dp@gabriel-dp:~/Desktop/dev/cpp/Linear-Programming-Problems/src/03-PD$


gabriel-dp@gabriel-dp: ~/Desktop/dev/cpp/Linear-Program...
gabriel-dp@gabriel-dp:~/Desktop/dev/cpp/Linear-Programming-Problems/src/04-PCM$
./main.exe < input.txt
Version identifier: 22.1.0.0 | 2022-03-09 | 1a383f8ce
Tried aggregator 1 time.
MIP Presolve added 12 rows and 12 columns.
Reduced MIP has 19 rows, 36 columns, and 84 nonzeros.
Reduced MIP has 24 binaries, 12 generals, 0 SOSs, and 0 indicators.
Presolve time = 0.00 sec. (0.04 ticks)
Found incumbent of value 149.000000 after 0.01 sec. (0.06 ticks)
Probing fixed 0 vars, tightened 2 bounds.
Probing time = 0.00 sec. (0.01 ticks)
Tried aggregator 1 time.
Detecting symmetries...
MIP Presolve eliminated 12 rows and 12 columns.
MIP Presolve added 12 rows and 12 columns.
Reduced MIP has 19 rows, 36 columns, and 84 nonzeros.
Reduced MIP has 26 binaries, 10 generals, 0 SOSs, and 0 indicators.
Presolve time = 0.00 sec. (0.06 ticks)
Probing time = 0.00 sec. (0.01 ticks)
Clique table members: 6.
MIP emphasis: balance optimality and feasibility.
MIP search method: dynamic search.
Parallel mode: deterministic, using up to 8 threads.
Root relaxation solution time = 0.00 sec. (0.03 ticks)
Nodes
Node Left Objective IInf Best Integer Cuts/ Best Bound ItCnt Gap
* 0+ 0 149.0000 0.0000 100.00%
* 0+ 0 25.0000 0.0000 100.00%
* 0 0 integral 0 22.0000 22.0000 3 0.00%
Elapsed time = 0.02 sec. (0.24 ticks, tree = 0.00 MB, solutions = 3)
Root node processing (before b&c):
Real time = 0.02 sec. (0.24 ticks)
Parallel b&c, 8 threads:
Real time = 0.00 sec. (0.00 ticks)
Sync time (average) = 0.00 sec.
Wait time (average) = 0.00 sec.
Total (root+branch&cut) = 0.02 sec. (0.24 ticks)
Status da solucao: Optimal
Variaveis de decisao:
xGF: -0
xGE: -0
xGC: -0
xEG: -0
xED: -0
xEC: -0
xFG: -0
xFC: -0
xFB: -0
xCG: 1
xCF: -0
xCE: -0
xCD: -0
xCB: -0
xDE: -0
xDC: 1
xDB: -0
xDA: -0
xBF: -0
xBD: 1
xBC: -0
xBA: -0
xAD: 0
xAB: 1
Valor da solucao = 22
gabriel-dp@gabriel-dp:~/Desktop/dev/cpp/Linear-Programming-Problems/src/04-PCM$
gabriel-dp@gabriel-dp:~/Desktop/dev/cpp/Linear-Programming-Problems/src/04-PCM$


gabriel-dp@gabriel-dp: ~/Desktop/dev/cpp/Linear-Program...
gabriel-dp@gabriel-dp:~/Desktop/dev/cpp/Linear-Programming-Problems/src/05-PFM$
./main.exe < input.txt
Version identifier: 22.1.0.0 | 2022-03-09 | 1a383f8ce
Found incumbent of value 0.000000 after 0.00 sec. (0.00 ticks)
Tried aggregator 2 times.
MIP Presolve eliminated 11 rows and 11 columns.
MIP Presolve added 1 rows and 1 columns.
Aggregator did 1 substitutions.
Reduced MIP has 5 rows, 11 columns, and 18 nonzeros.
Reduced MIP has 0 binaries, 11 generals, 0 SOSs, and 0 indicators.
Presolve time = 0.00 sec. (0.02 ticks)
Tried aggregator 1 time.
Detecting symmetries...
MIP Presolve eliminated 1 rows and 1 columns.
MIP Presolve added 1 rows and 1 columns.
Reduced MIP has 5 rows, 11 columns, and 18 nonzeros.
Reduced MIP has 0 binaries, 11 generals, 0 SOSs, and 0 indicators.
Presolve time = 0.00 sec. (0.01 ticks)
MIP emphasis: balance optimality and feasibility.
MIP search method: dynamic search.
Parallel mode: deterministic, using up to 8 threads.
Root relaxation solution time = 0.00 sec. (0.01 ticks)
Nodes
Node Left Objective IInf Best Integer Cuts/ Best Bound ItCnt Gap
* 0+ 0 0.0000 21.0000 ---
* 0+ 0 14.0000 21.0000 50.00%
* 0 0 integral 0 19.0000 19.0000 1 0.00%
Elapsed time = 0.02 sec. (0.06 ticks, tree = 0.00 MB, solutions = 3)
Root node processing (before b&c):
Real time = 0.02 sec. (0.06 ticks)
Parallel b&c, 8 threads:
Real time = 0.00 sec. (0.00 ticks)
Sync time (average) = 0.00 sec.
Wait time (average) = 0.00 sec.
Total (root+branch&cut) = 0.02 sec. (0.06 ticks)
Status da solucao: Optimal
Variaveis de decisao:
xET: 6
xCE: -0
xCB: 5
xBT: 13
xDE: 6
xDC: 5
xAD: -0
xAC: -0
xAB: 8
xSD: 11
xSA: 8
Valor da solucao = 19
(0.000000 segundos)
gabriel-dp@gabriel-dp:~/Desktop/dev/cpp/Linear-Programming-Problems/src/05-PFM$