

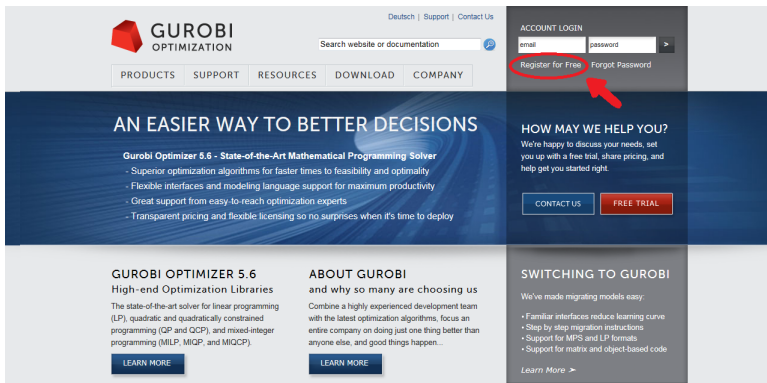
GUROBI

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Roberta Nunes

- 1 Introdução
- 2 Instalação
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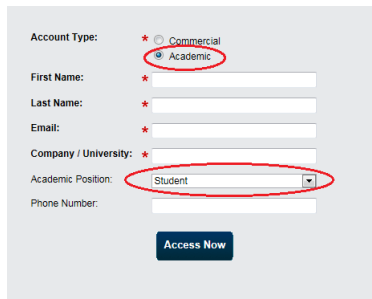
- Fundada por Zonghau **Gu**, Ed **Rothberg** e Bob **Bixby** em 2008;
- Outubro/2009: edição limitada até novembro de 2010 (150e.c.—25a.v.);
- Focos da empresa:
 - ① Melhores solucionadores de programação matemática;
 - ② Parceria flexível em termos de licenciamento e preços;
 - ③ Liderança em tecnologia (programação matemática).
- Programação inteira, mista, quadrática;
- Conjunto de APIs: Python, C, C++, Java, .Net;
- Parcerias: Matlab, Frontline Solvers, AMPL, GAMS;
- Resultados Interessantes:
 - ① Paralelismo multi-core;
 - ② Licenças livres;
 - ③ Programa acadêmico com download automatizado;
 - ④ Evolução para melhoria de desempenho e ampliação da plataforma e suporte API.

- Acesse www.gurobi.com [2];
- Faça o cadastro clicando em *Register for Free*;



The screenshot displays the Gurobi Optimization website. At the top left is the Gurobi logo and navigation links for 'Deutsch', 'Support', and 'Contact Us'. A search bar is located in the top center. Below the search bar are navigation tabs for 'PRODUCTS', 'SUPPORT', 'RESOURCES', 'DOWNLOAD', and 'COMPANY'. The main banner features the headline 'AN EASIER WAY TO BETTER DECISIONS' and lists key features of Gurobi Optimizer 5.6. On the right side, there is an 'ACCOUNT LOGIN' section with input fields for 'email' and 'password'. Below these fields, the 'Register for Free' link is highlighted with a red circle and a red arrow pointing to it. Other links in this section include 'Forgot Password', 'CONTACT US', and 'FREE TRIAL'. The bottom of the page contains three columns of text: 'GUROBI OPTIMIZER 5.6 High-end Optimization Libraries', 'ABOUT GUROBI and why so many are choosing us', and 'SWITCHING TO GUROBI We've made migrating models easy.' Each column has a 'LEARN MORE' button.

Figura : Cadastro



The image shows a registration form with the following fields and options:

- Account Type:** Radio buttons for Commercial and Academic. The 'Academic' option is circled in red.
- First Name:** Text input field with a red asterisk.
- Last Name:** Text input field with a red asterisk.
- Email:** Text input field with a red asterisk.
- Company / University:** Text input field with a red asterisk.
- Academic Position:** Dropdown menu with 'Student' selected. The dropdown is circled in red.
- Phone Number:** Text input field.
- Access Now:** A dark blue button with white text.

Figura : Cadastro

- Você receberá um e-mail para cadastrar a senha;
- Clique no primeiro link do e-mail e cadastre sua senha;

Instalação

- No site do Gurobi, na aba *Download*, selecione *Gurobi Optimizer*;
- Escolha a versão desejada, seu sistema operacional e faça o download;
- Execute e siga os seguintes passos:

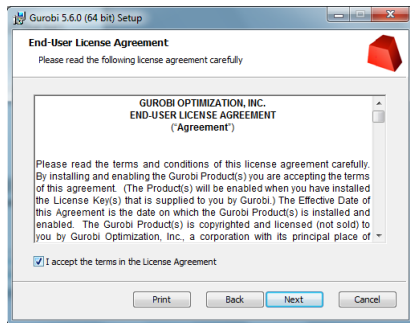
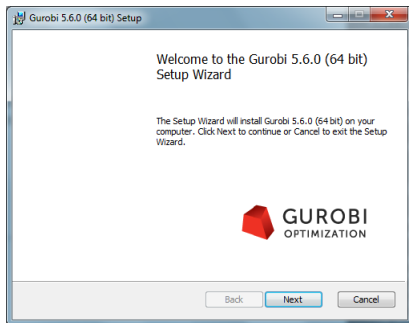


Figura : Instalação

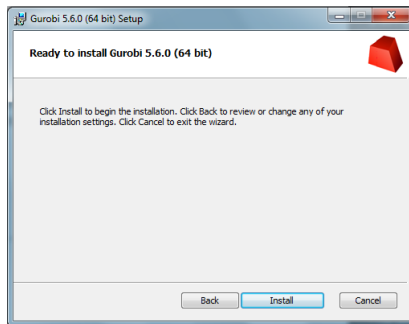
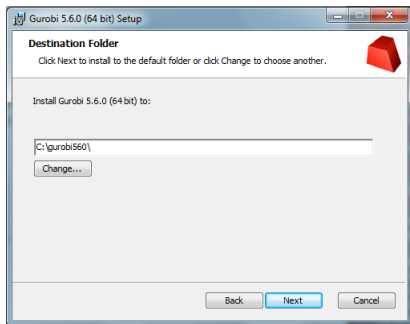


Figura : Instalação

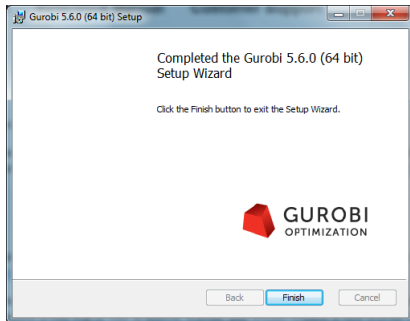
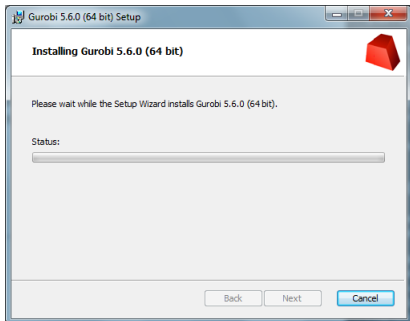
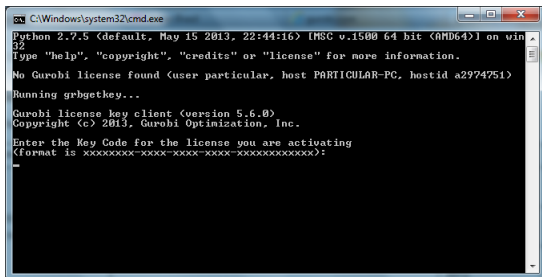


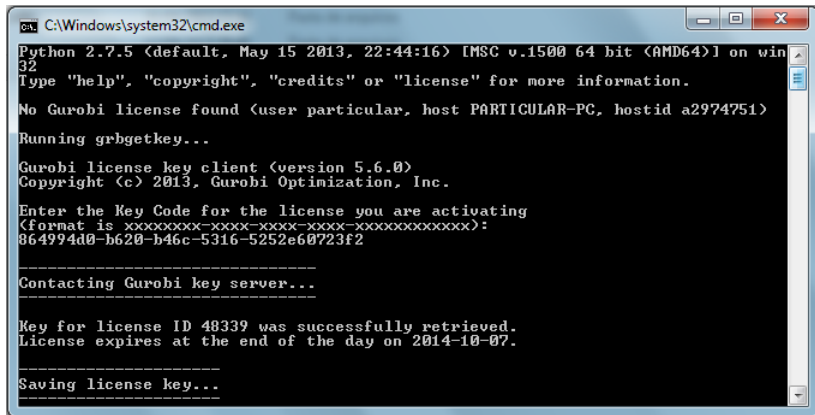
Figura : Instalação

- Faça o login no site, entre em *Download, Licenses, Free Academic*;
- Aceite as condições da licença e clique em *Request License*;
- Abra o Gurobi e digite a licença, mostrado a seguir:



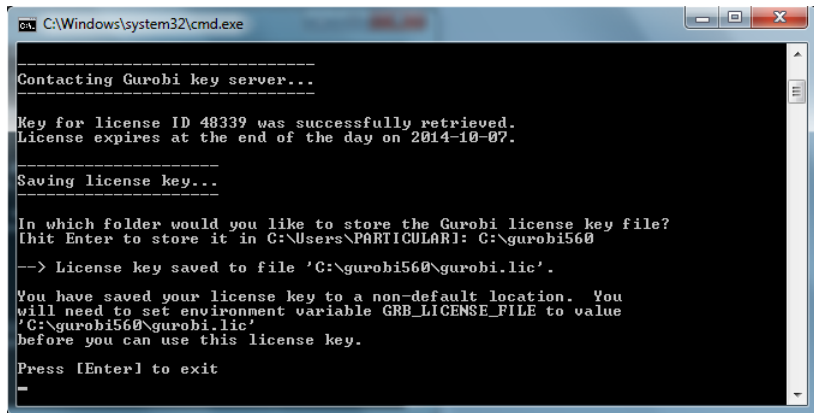
```
C:\Windows\system32\cmd.exe
Python 2.7.5 (default, May 15 2013, 22:44:16) [MSC v.1500 64 bit (AMD64)] on win
32
Type "help", "copyright", "credits" or "license" for more information.
No Gurobi license found (user particular, host PARTICULAR-PC, hostid a2974751)
Running grbgetkey...
Gurobi license key client (version 5.6.0)
Copyright (c) 2013, Gurobi Optimization, Inc.
Enter the Key Code for the license you are activating
(format is xxxxxxxx-xxxx-xxxx-xxxxxxxxxxxx):
```

Figura : Licença



```
ca. C:\Windows\system32\cmd.exe
Python 2.7.5 (default, May 15 2013, 22:44:16) [MSC v.1500 64 bit (AMD64)] on win
32
Type "help", "copyright", "credits" or "license" for more information.
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Running grbgetkey...
Gurobi license key client (version 5.6.0)
Copyright (c) 2013, Gurobi Optimization, Inc.
Enter the Key Code for the license you are activating
(format is xxxxxxxx-xxxx-xxxx-xxxx-xxxxxxxxxxxx):
864994d0-b620-b46c-5316-5252e60723f2
-----
Contacting Gurobi key server...
-----
Key for license ID 48339 was successfully retrieved.
License expires at the end of the day on 2014-10-07.
-----
Saving license key...
```

Figura : Licença



```
C:\Windows\system32\cmd.exe

-----
Contacting Gurobi key server...
-----

Key for license ID 48339 was successfully retrieved.
License expires at the end of the day on 2014-10-07.

-----
Saving license key...
-----

In which folder would you like to store the Gurobi license key file?
[hit Enter to store it in C:\Users\PARTICULAR]: C:\gurobi560

--> License key saved to file 'C:\gurobi560\gurobi.lic'.

You have saved your license key to a non-default location. You
will need to set environment variable GRB_LICENSE_FILE to value
'C:\gurobi560\gurobi.lic'
before you can use this license key.

Press [Enter] to exit
_
```

Figura : Licença

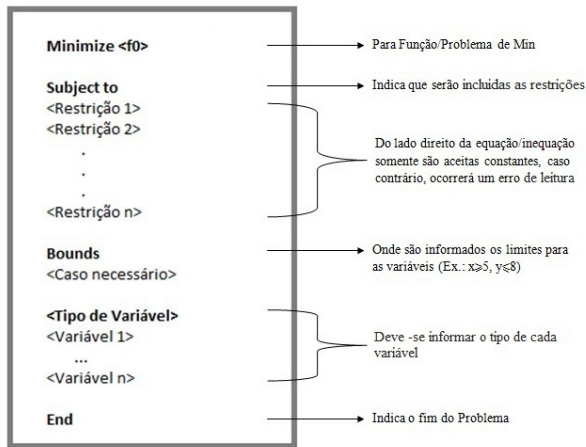


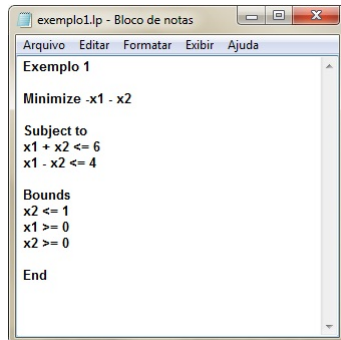
Figura : Modelo

- `<modelo>=read(" <arquivo.lp ou .mps>")`
- `<modelo>.optimize()`
- `<modelo>.printAttr('X')`
- `<modelo>.write(" <nome>.sol")`
- `<variável> = <modelo>.getVars()`
- `<modelo>.setParam(" TimeLimit" , tempo)`
- `print <variável>[número].VarName, <variável>[número].X`
- `print len(variável)`

- $\langle \text{modelo} \rangle = \text{Model}()$
- $\langle \text{variável} \rangle = \langle \text{modelo} \rangle.\text{addVar}(\text{lb}, \text{ub}, \text{obj}, \langle \text{tipo} \rangle, " \langle \text{nome} \rangle ")$
GRB.BINARY, GRB.CONTINUOUS, GRB.INTEGER
- $\langle \text{modelo} \rangle.\text{addConstr}(\langle \text{operação} \rangle, \langle \text{senal} \rangle, \alpha, " \langle \text{nome} \rangle ")$
LinExpr([a, b, c], [x, y, z])
GRB.LESS_EQUAL, GRB.GREATER_EQUAL, GRB.EQUAL
- $\langle \text{modelo} \rangle.\text{update}()$
- $\langle \text{modelo} \rangle.\text{numVars}$

Exemplo 1

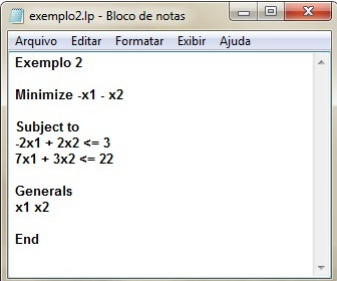
$$\begin{array}{l} \text{Minimizar } z = -x_1 - x_2 \\ \text{Sujeito a } \left\{ \begin{array}{l} x_1 + x_2 \leq 6 \\ x_1 - x_2 \leq 4 \\ x_1 \geq 0 \\ 0 \leq x_2 \leq 1 \\ x_1, x_2 \in \mathbb{R} \end{array} \right. \end{array}$$



```
exemplo1.lp - Bloco de notas
Arquivo  Editar  Formatar  Exibir  Ajuda
Exemplo 1
Minimize -x1 - x2
Subject to
x1 + x2 <= 6
x1 - x2 <= 4
Bounds
x2 <= 1
x1 >= 0
x2 >= 0
End
```

Exemplo 2

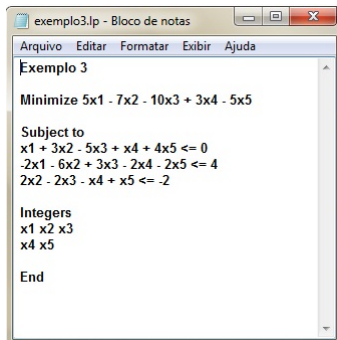
$$\begin{array}{l} \text{Minimizar } z = -x_1 - x_2 \\ \text{Sujeito a } \begin{cases} -2x_1 + 2x_2 \leq 3 \\ 7x_1 + 3x_2 \leq 22 \\ x_1, x_2 \in \mathbb{Z} \end{cases} \end{array}$$



```
exemplo2.lp - Bloco de notas
Arquivo  Editar  Formatar  Exibir  Ajuda
Exemplo 2
Minimize -x1 - x2
Subject to
-2x1 + 2x2 <= 3
7x1 + 3x2 <= 22
Generals
x1 x2
End
```


Exemplo 3

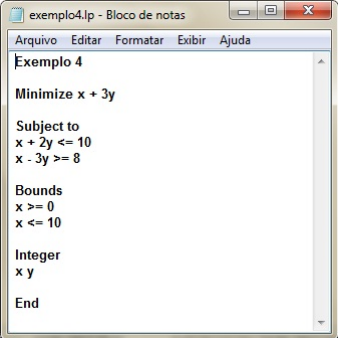
$$\begin{array}{l} \text{Minimizar } z = 5x_1 - 7x_2 - 10x_3 + 3x_4 - 5x_5 \\ \text{Sujeito a } \left\{ \begin{array}{l} x_1 + 3x_2 - 5x_3 + x_4 + 4x_5 \leq 0 \\ -2x_1 - 6x_2 + 3x_3 - 2x_4 - 2x_5 \leq 4 \\ 2x_2 - 2x_3 - x_4 + x_5 \leq -2 \\ x_1, x_2, x_3, x_4, x_5 \in \mathbb{B} \end{array} \right. \end{array}$$



```
exemplo3.lp - Bloco de notas
Arquivo  Editar  Formatar  Exibir  Ajuda
Exemplo 3
Minimize 5x1 - 7x2 - 10x3 + 3x4 - 5x5
Subject to
x1 + 3x2 - 5x3 + x4 + 4x5 <= 0
-2x1 - 6x2 + 3x3 - 2x4 - 2x5 <= 4
2x2 - 2x3 - x4 + x5 <= -2
Integers
x1 x2 x3
x4 x5
End
```

Exemplo 4

$$\begin{array}{l} \text{Minimizar } z = x + 3y \\ \text{Sujeito a } \left\{ \begin{array}{l} x + 2y \leq 10 \\ 8 \leq x - 3y \\ 0 \leq x \leq 10 \\ x \in \mathbb{Z} \\ y \in \mathbb{B} \end{array} \right. \end{array}$$



```
exemplo4.lp - Bloco de notas
Arquivo  Editar  Formatar  Exibir  Ajuda
Exemplo 4
Minimize x + 3y
Subject to
x + 2y <= 10
x - 3y >= 8
Bounds
x >= 0
x <= 10
Integer
x y
End
```



$$\begin{array}{l} \text{Maximizar } z = 2,16x_T + 1,26x_A + 0,812x_M \\ \text{Sujeito a } \left\{ \begin{array}{l} x_T \geq 400 \\ x_A \geq 800 \\ x_M \geq 10000 \\ x_T + x_A + x_M \leq 200000 \\ 0,2x_T + 0,3x_A + 0,4x_M \leq 60000 \\ x_T \geq 0 \\ x_A \geq 0 \\ x_M \geq 0 \end{array} \right. \end{array}$$



```
C:\Windows\system32\cmd.exe
gurobi> m=read('C:\Users\PARTICULAR\Desktop\exercicio.lp')
Read LP format model from file C:\Users\PARTICULAR\Desktop\exercicio.lp
Reading time = 0.00 seconds
<null>: 5 rows, 3 columns, 9 nonzeros
gurobi> m.optimize()
Optimize a model with 5 rows, 3 columns and 9 nonzeros
Presolve removed 3 rows and 0 columns
Presolve time: 0.00s
Presolved: 2 rows, 3 columns, 6 nonzeros

Iteration   Objective          Primal Inf.    Dual Inf.      Time
           0    7.6545109e+05   5.125117e+05   0.000000e+00   0s
           1    4.1780000e+05   0.000000e+00   0.000000e+00   0s

Solved in 1 iterations and 0.04 seconds
Optimal objective 4.17800000e+05
gurobi> m.printAttr('x')

  Variable          x
-----
      X_t          189200
      X_a           800
      X_m           10000
gurobi>
gurobi>
```

Figura : Resolução

-  <http://jtonedm.com/>, 2013.
-  Inc. Gurobi Optimization.
Gurobi optimizer reference manual, 2013.
-  Henrique Pacca L. Luna Marco Cesar Goldberg.
Otimizacao Combinatoria e Programacao Linear.
ELSEVIER, Rio de Janeiro, 2005.
-  Reinaldo Morabito e Horacio Yanasse Marcos Arenales,
Vinicius Armentano.
Pesquisa Operacional.
ELSEVIER, Rio de Janeiro, 2007.