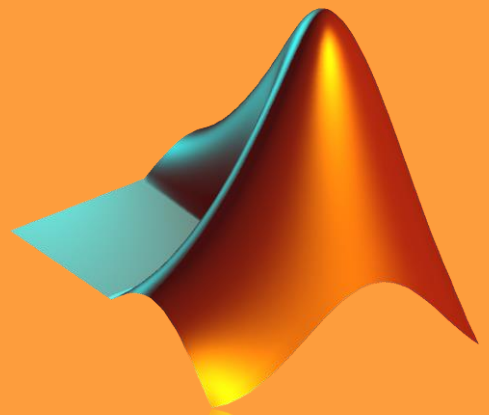

MATLAB

Linear Programing Problems
(LP)

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1 What you'll learn

Function Names'

Syntax

Output Arguments

Input Arguments

2 Function Name

linprog

Solve linear programming problems

Linear programing

Finds the minimum of a problem.

$$\min f^{T}x \text{ such that } \begin{cases} Ax \leq b \\ A_{eq} \cdot x = b_{eq} \\ L\,b_i \leq x_i \leq U\,b_i \end{cases}$$

3 Syntax

X=linprog(f, A, b)

X=linprog(f, A, b, A_{eq}, b_{eq}, lb, ub)

X= linprog(f, A, b, A_{eq}, b_{eq}, lb, ub, options)

[X, fval]=linprog(__)

[X, fval, exitflag, output] = linprog(__)

[X, fval , exitflag , output , lambda] = linprog(__)

input

output

Objective Function & Constraints

$$\min Z = \sum_{i=1}^{n} f_i x_i \xrightarrow{\text{vector notation}} f^T x$$ Objective Function

$$Ax \leq b$$

$$A_{eq} = b_{eq}$$

$$L\, b_i \leq x_i \leq U\, b_i$$

Example

$$\min \; Z = -5x_1 - 4x_2 - 6x_3$$

S . t .

$$x_1 - x_2 + x_3 \le 20$$
$$3x_1 + 2x_2 + 4x_3 \le 42$$
$$3x_1 + 2x_2 \le 30$$
$$x_1, x_2, x_3 \ge 0$$

X=linprog(**f A b** $\mathbf{A_{eq}}$ $\mathbf{b_{eq}}$ **lb ub**)

6

f

$$\min\ Z = -5x_1 - 4x_2 - 6x_3$$

$$\underbrace{[\,-5\ ,\ -4\ ,\ -6\,]}_{f^T} \cdot \underbrace{\begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}}_{x} \longrightarrow f = \begin{pmatrix} -5 \\ -4 \\ -6 \end{pmatrix}$$

A & b

S . t .

$$x_1 - x_2 + x_3 \le 20$$
$$3x_1 + 2x_2 + 4x_3 \le 42$$
$$3x_1 + 2x_2 \le 30$$

$$A \quad X \quad \ge \quad b$$

$$\begin{pmatrix} 1 & -1 & 1 \\ 3 & 2 & 4 \\ 3 & 2 & 0 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} \ge \begin{pmatrix} 20 \\ 42 \\ 30 \end{pmatrix}$$

lb & ub

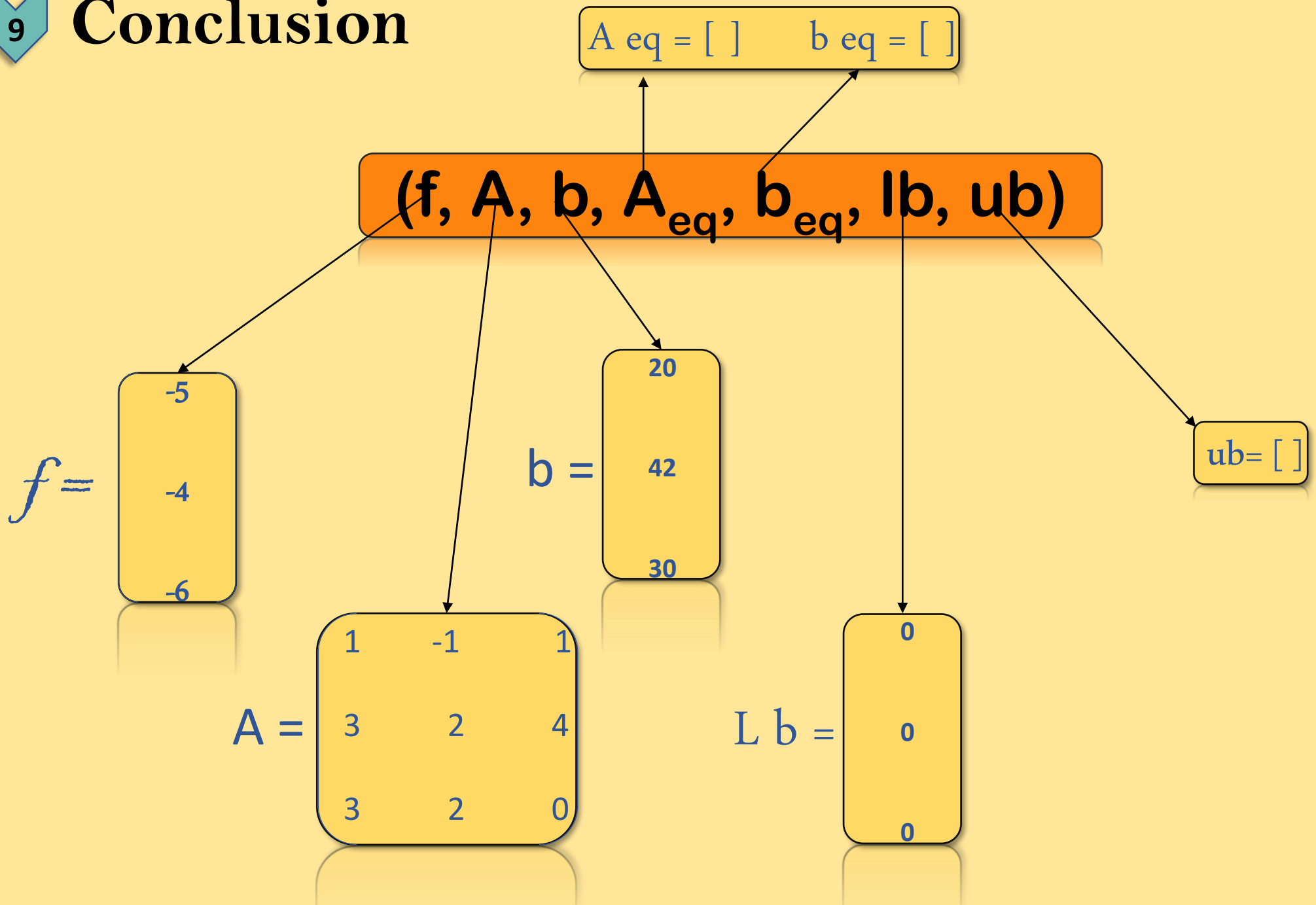
$$x_1 , x_2 , x_3 \geq 0$$

$X_1 \geq 0$ $\quad$ $Lb_1 \geq 0$

$X_2 \geq 0$ $\Rightarrow$ $Lb_2 \geq 0$ $\Rightarrow$ $Lb = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$ $\Rightarrow$ Zeros (n,1)

$X_3 \geq 0$ $\quad$ $Lb_3 \geq 0$

9 Conclusion



exitflag

exitflag — Reason linprog stopped
integer

Reason `linprog` stopped, returned as an integer.

3	The solution is feasible with respect to the relative `ConstraintTolerance` tolerance, but is not feasible with respect to the absolute tolerance.
1	Function converged to a solution `x`.
0	Number of iterations exceeded `options.MaxIterations` or solution time in seconds exceeded `options.MaxTime`.
-2	No feasible point was found.
-3	Problem is unbounded.
-4	`NaN` value was encountered during execution of the algorithm.
-5	Both primal and dual problems are infeasible.
-7	Search direction became too small. No further progress could be made.
-9	Solver lost feasibility.

Exitflags `3` and `-9` relate to solutions that have large infeasibilities. These usually arise from linear constraint matrices that have large condition number, or problems that have large solution components. To correct these issues, try to scale the coefficient matrices, eliminate redundant linear constraints, or give tighter bounds on the variables.

output

output — Information about the optimization process

structure

Information about the optimization process, returned as a structure with these fields.

`iterations`	Number of iterations
`algorithm`	Optimization algorithm used
`cgiterations`	0 (interior-point algorithm only, included for backward compatibility)
`message`	Exit message
`constrviolation`	Maximum of constraint functions
`firstorderopt`	First-order optimality measure

lambda

lambda — Lagrange multipliers at the solution

structure

Lagrange multipliers at the solution, returned as a structure with these fields.

lower	Lower bounds corresponding to lb
upper	Upper bounds corresponding to ub
ineqlin	Linear inequalities corresponding to A and b
eqlin	Linear equalities corresponding to Aeq and beq

Options

options — Optimization options
output of `optimoptions` | structure as `optimset` returns

Optimization options, specified as the output of `optimoptions` or a structure as `optimset` returns.

Some options apply to all algorithms, and others are relevant for particular algorithms. See Optimization Options Reference for detailed information.

Some options are absent from the `optimoptions` display. These options appear in italics in the following table. For details, see View Options.

All Algorithms

`Algorithm`	Choose the optimization algorithm: • `'dual-simplex'` (default) • `'interior-point-legacy'` • `'interior-point'` For information on choosing the algorithm, see Linear Programming Algorithms.
Diagnostics	Display diagnostic information about the function to be minimized or solved. Choose `'off'` (default) or `'on'`.
`Display`	Level of display (see Iterative Display): • `'final'` (default) displays just the final output. • `'off'` or `'none'` displays no output. • `'iter'` displays output at each iteration.
`MaxIterations`	Maximum number of iterations allowed, a positive integer. The default is: • `85` for the `'interior-point-legacy'` algorithm • `200` for the `'interior-point'` algorithm • `10*(numberOfEqualities + numberOfInequalities + numberOfVariables)` for the `'dual-simplex'` algorithm See Tolerances and Stopping Criteria and Iterations and Function Counts. For `optimset`, the name is `MaxIter`. See Current and Legacy Option Name Tables.

Example of the feasible region

max Z = 143x+60y

S . t .

$x+y \leq 75$

$110x+30y \leq 4000$

$120x+210y \leq 15000$

$x,y \geq 0$

$$f = \begin{pmatrix} 143 \\ 60 \end{pmatrix}$$

$$A = \begin{pmatrix} 1 & 1 \\ 110 & 30 \\ 120 & 210 \end{pmatrix}$$

$$b = \begin{pmatrix} 75 \\ 4000 \\ 15000 \end{pmatrix}$$

$$Lb = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$$


OPTIMIZATION
PROCESS
70%
PROFIT
25%
75%