

Johns Hopkins Engineering

Applied Machine Learning for Mechanical Engineers

Optimization, Part 2, E



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of ENGINEERING

Introduction to Genetic Programming in MATLAB

- By the end of this lecture you will be able to:
 - Describe “ga” package in MATLAB
 - Implement “ga” in MATLAB

Introduction to Genetic Programming in MATLAB

- Formal linear/nonlinear optimization problem with one objective function

$$\begin{array}{ll} \text{minimize} & f(\mathbf{x}) \\ \text{subject to} & \begin{cases} g_j(\mathbf{x}) \leq 0 & j \in \{1, 2, \dots, J\} \\ h_k(\mathbf{x}) = 0 & k \in \{1, 2, \dots, K\} \end{cases} \end{array} \quad (2-5)$$

Introduction to Genetic Programming in MATLAB

- Genetic programming (linear/nonlinear)

$$\begin{array}{ll} \text{minimize} & f(\mathbf{x}) \\ \text{subject to} & \left\{ \begin{array}{l} g_j(\mathbf{x}) \leq 0 \\ h_k(\mathbf{x}) = 0 \\ \mathbf{G} \cdot \mathbf{x} \leq \mathbf{A} \\ \mathbf{H} \cdot \mathbf{x} = \mathbf{B} \\ \mathbf{L} \leq \mathbf{x} \leq \mathbf{U} \\ \hat{\mathbf{x}}: \hat{x}_l \in \mathbf{x} \end{array} \right. \end{array} \quad (2-6)$$

where $\hat{\mathbf{x}}$ is a list of integer variables

Introduction to Genetic Programming in MATLAB

- MATLAB genetic programming

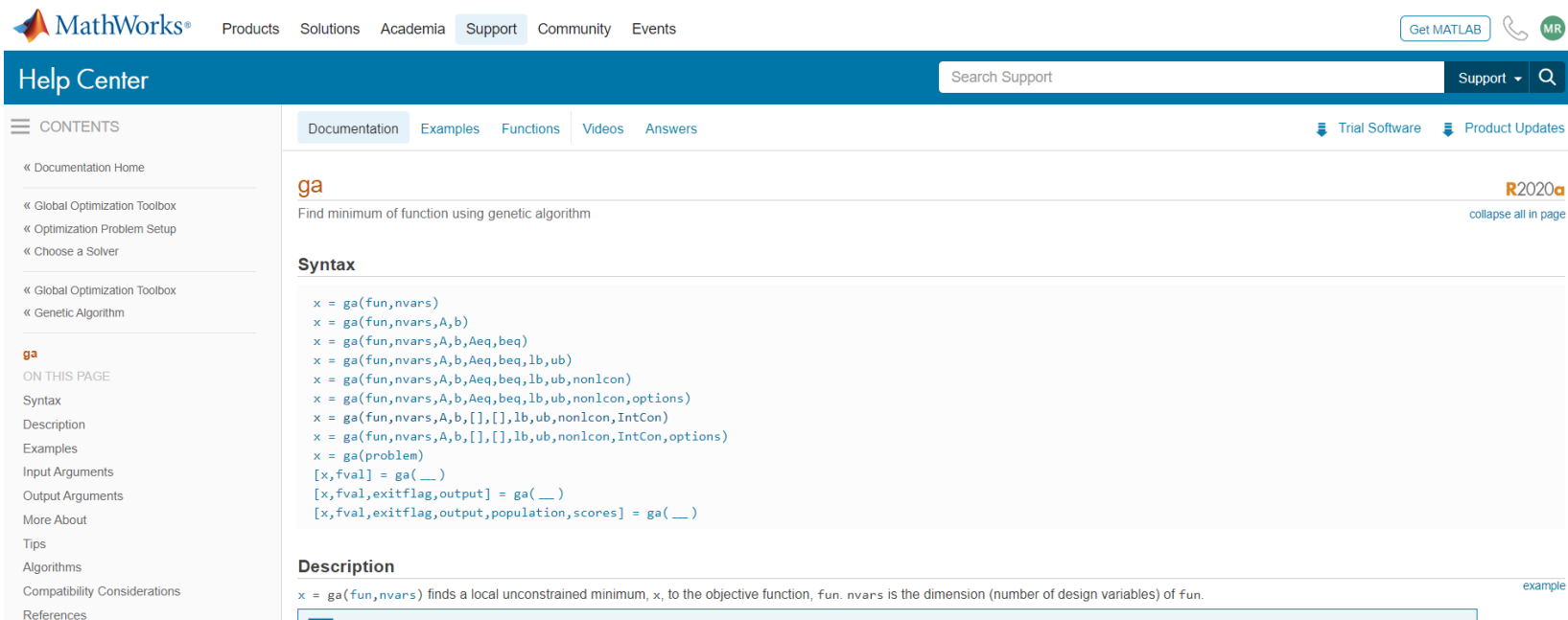
- Different annotations

$$\min f(x) \text{ such that } \left\{ \begin{array}{l} c(x) \leq 0 \\ ceq \leq 0 \\ A \cdot x \leq 0 \\ Aeq \cdot x = beq \\ lb \leq x \leq ub \\ IntCon \end{array} \right.$$

Figure 2-3 Annotations used to address genetic optimization problems at <https://www.mathworks.com/help/gads/ga.html>

Introduction to Genetic Programming in MATLAB

■ MATLAB genetic programming ('ga' function)



The screenshot shows the MATLAB Help Center interface. At the top, there's a navigation bar with links for Products, Solutions, Academia, Support, Community, and Events. A search bar is also present. The main content area is titled 'Help Center' and features a sidebar with a 'CONTENTS' menu. The 'ga' function page is displayed, showing its purpose: 'Find minimum of function using genetic algorithm'. The 'Syntax' section lists various function calls for 'ga', including options for constraints and output. The 'Description' section begins with the text: 'x = ga(fun,nvars) finds a local unconstrained minimum, x, to the objective function, fun. nvars is the dimension (number of design variables) of fun.'

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ga

Find minimum of function using genetic algorithm

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Syntax

```
x = ga(fun,nvars)
x = ga(fun,nvars,A,b)
x = ga(fun,nvars,A,b,Aeq,beq)
x = ga(fun,nvars,A,b,Aeq,beq,lb,ub)
x = ga(fun,nvars,A,b,Aeq,beq,lb,ub,nonlcon)
x = ga(fun,nvars,A,b,Aeq,beq,lb,ub,nonlcon,options)
x = ga(fun,nvars,A,b,[],[],lb,ub,nonlcon,IntCon)
x = ga(fun,nvars,A,b,[],[],lb,ub,nonlcon,IntCon,options)
x = ga(problem)
[x,fval] = ga(___)
[x,fval,exitflag,output] = ga(___)
[x,fval,exitflag,output,population,scores] = ga(___)

```

Description

x = ga(fun,nvars) finds a local unconstrained minimum, x, to the objective function, fun. nvars is the dimension (number of design variables) of fun.

example

Introduction to Genetic Programming in MATLAB

Let's jump to Module02_E.mlx

Introduction to Genetic Programming in MATLAB

- In this lecture, you learned about:
 - “ga” package in MATLAB
 - Implementation of “ga” package in MATLAB
- In the next lecture, we will overview other optimization algorithms available in Python and MATLAB.



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