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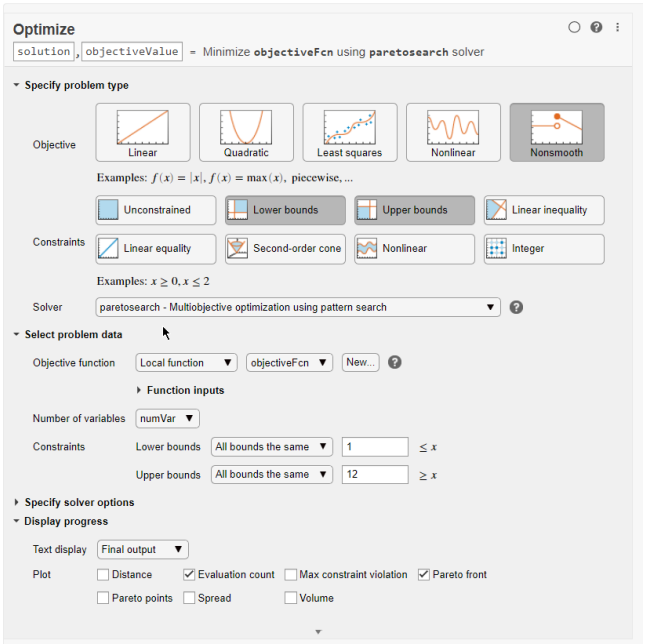
QUICK START GUIDE

Solver-Based Optimization in MATLAB®

Define and solve optimization and least-squares problems and systems of nonlinear equations. Use the *Optimize* Live Editor task to guide you through this workflow.



1. Group the optimization variables into a single vector **x**. Write the objective and constraints in terms of **x**.

Objective Type	Mathematical Form	Example
Linear	$f^T x$	`f = [-1 0 -5];`
Quadratic	$x^T Hx+f^T x$	`H = [5 1 0; 1 3 0; 0 0 0];`

Least Squares	$\|Cx-d\|_2$
	
	$\sum F_i(x)^2$
		`C = [7 8 10; 1 3 4; 2 5 7];`
		`d = [2; 1; 1.5];`
		
		`function F = myF(x)`
		`F(1) = f1(x);`
		`F(2) = f2(x);`
		`end`

General	$f(x)$	`function objval = fobj(x)`
		`objval = 3*(x(1)-x(2))^4;`
		`end`

Constraint Type	Mathematical Form	Example
Bound	$l \le x \le u$	`lb = zeros(n,1);` `ub = 5*ones(n,1);`

Linear	$Ax \le b$
	$A_{eq} x = b_{eq}$
		`A = [1 0 1;`
		`0 -2 1];`
		`b = [4; 2];`
		`Aeq = [1 0 2];`
		`beq = 1;`

Second-Order Cone	$\|\|A_{SC} x - b_{SC}\|\| \le$
	$d_{SC} x$ - gamma
		`A = diag([1,1/2,0]);`
		`b = zeros(3,1);`
		`d = [0;0;1];`
		`gamma = 0;`
		`socConstraints =`
		`secondordercone(A,b,d,gamma);`

General	$c(x) \le 0$
	$c_{eq}(x) = 0$
		`function[c,ceq] = nlcons(x)`
		`c(1) = x(1).^2 + x(2).^2 - 1;`
		`c(2) = x(1)*x(3) - 5;`
		`ceq = [];`
		`end`

Integer	$x_j \in Z^n$	`intcon = [1 2]`

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2. Choose a solver matching the types of objective and constraints.

Solvers in Optimization Toolbox™ use derivatives, are usually faster, and scale to large problems. Solvers in Global Optimization Toolbox (*italic*) and MATLAB (*) do not use derivatives and search for global minima.

Constraint Type	Objective Type					
	Linear	Quadratic	Least Squares	General Smooth	General Nonsmooth	Multiobjective
None		`quadprog`	`lsqcurvefit` `lsqnonlin` `mldivide`	`fminsearch*` `fminunc`	`fminsearch*` `patternsearch` `ga` `particleswarm` `simulannealbnd`	`fgoalattain` `fminimax` `paretosearch` `gamultiobj`
Bound	`linprog`	`quadprog`	`lsqcurvefit` `lsqnonlin` `lsqnonneg` `lsqlin`	`fmincon`	*`surrogateopt`* `patternsearch` `ga` `fminbnd*` `particleswarm` `simulannealbnd`	`fgoalattain` `fminimax` `paretosearch` `gamultiobj`
Linear	`linprog`	`quadprog`	`lsqlin`	`fmincon`	`patternsearch` `ga` *`surrogateopt`*	`fgoalattain` `fminimax` `paretosearch` `gamultiobj`
Second-Order Cone	`coneprog`	`coneprog`				
General Smooth	`fmincon`	`fmincon`	`fmincon`	`fmincon`	`patternsearch` `ga` *`surrogateopt`*	`fgoalattain` `fminimax` `paretosearch` `gamultiobj`
General Nonsmooth	`patternsearch` `ga` *`surrogateopt`*	`patternsearch` `ga` *`surrogateopt`*	`patternsearch` `ga` *`surrogateopt`*	`patternsearch` `ga` *`surrogateopt`*	`patternsearch` `ga` *`surrogateopt`*	`paretosearch` `gamultiobj`
Integer	`intlinprog`				`ga` *`surrogateopt`*	

3. Define initial point if required and options if desired. Call solver and obtain solution.

Initial Point

Examples:

```
x0 = lb + 0.5*(ub-lb)
x0 = zeros(n,1)
```

Options

Use `optimoptions` to set stopping criteria, plot functions, initial population, and more.

Example:

```
opts = optimoptions('fmincon','Display','iter')
```

Solve

Examples:

```
[x,fval] = fmincon(@fobj,x0,A,b,Aeq,beq,lb,ub,@nlcons,opts)
[x,fval,eflag] = ga(@fobj,nvars)
x = lsqlin(C,d,A,b,[],[],lb)
```

Do More

- » *Interpret* and *improve* results
- » *Pass extra parameters to functions*
- » Solver comparison *table* and *example*
- » *Solve systems of nonlinear equations*
- » *Search for global minima on smooth problems*

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