

# Introductory Mathematics for Economists with Matlab

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2023-01-22



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# Preface

This is a work-in-progress [course website](#) for Mathematics for Economists. Course covers a limited subset of topics from [Mathematics for Economists](#) (Simon and Blume, 1994), and uses various definitions from the book. Applications focus on two period borrowing and savings problems. Matlab's symbolic toolbox is used throughout.

Materials are written in [matlab](#) (The MathWorks Inc, 2019) livescript files and shown as HTML files. To obtain matlab codes, see [here](#) and [here](#) for github set up. For HTML files, click on the links below.

From other repositories: For dynamic borrowing and savings problems, see [Dynamic Asset Repository](#); For code examples, see also [R Example Code](#), [Matlab Example Code](#), and [Stata Example Code](#); For intro stat with R, see [Intro Statistics for Undergraduates](#).

The site is built using [Bookdown](#) (Xie, 2020).

Please contact [Piruz Saboury](#) or [Fan Wang](#) for issues or problems.



# Chapter 1

## Notations and Functions

### 1.1 Local and Global Maximum

Back to [Intro Math for Econ](#), [Matlab Definition\*\*

- **Global Maximum:** Function  $f$  defined on domain  $X$  has a **global** maximum at  $x^* \in X$  if for all  $x \in X$ ,  $f(x) \leq f(x^*)$
- **Local Maximum:** Function  $f$  defined on domain  $X$  has a **local** maximum at  $x^* \in X$  if there exists an open interval  $(a, b)$ , such that  $x^* \in (a, b)$ , and for all  $x \in (a, b)$ ,  $f(x) \leq f(x^*)$

**Many functions do not have maximum**

We have utility function, production function, and budget constraints in economic models.

When households make choices, they are picking the bundle of goods that gives them the highest level of utility.

Most of the production and utility functions that we use do not have local or global maximum.

For example, a cobb-douglas production function will produce ever higher output with more labor and capital input.

And a log utility function will give higher utility with higher levels of consumption.

**Note:** When we combine preference and budget together, like we did in our two goods model, we could think about the optimal bundle of choices that achieves the highest level of utility given fixed budget in a household maximization problem.

#### Quadratic Utility

A special utility function, quadratic utility, however, does have a single maximum.

$$U(x) = x - \alpha \cdot x^2$$

We can write down the equation using matlab's symbolic package

```
% Parameter
a = 0.20;
% Create symbolic equation in matlab
syms x
f(x) = x - a*x^2

f(x) =
x - \frac{x^2}{5}
```

**Matlab Analytical Global Maximum for Quadratic Utility**

Matlab can find the  $x$  value that maximizes the function by:

- **diff** function: taking the derivative of  $f$  with respect to  $x$
- **solve** function: finding where the derivative crosses 0

```
% Solve
maxofx = solve(diff(f, x), x)
```

```
maxofx =
```

```
5
2
```

```
% Convert symbolic to double precision
maxofx = double(maxofx)

maxofx = 2.5000
```

We have found the global maximum for the function.

A household will try to consume exactly this optimal amount of good if their budget allows.

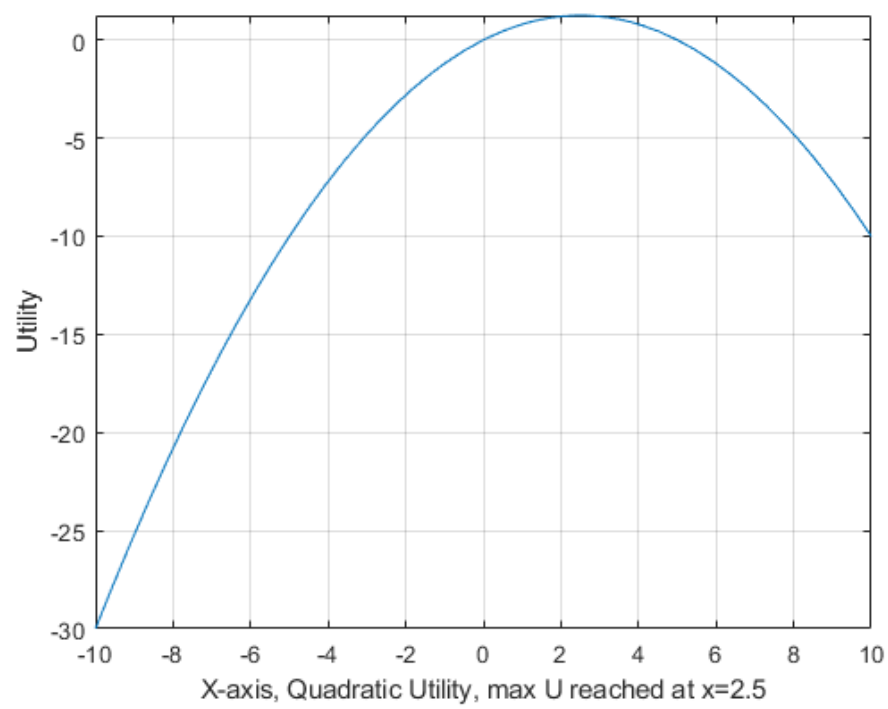
With quadratic utility over one good, even if the household can afford to buy more goods than the maximum amount, they will not.

This could be used to approximate consumption of say how much rice a consumer wants for example.

### Matlab Graphical Solution

```
% Graph equation
close all;
figure();
% Create minimum x and maximum x point where to draw the graph
x_lower_bd = min(-10, maxofx-abs(maxofx)/2);
x_upper_bd = max(10, maxofx+abs(maxofx)/2);
% Draw the function
fplot(f, [x_lower_bd, x_upper_bd]);
% Label
xlabel(['X-axis, Quadratic Utility, max U reached at x=', num2str(maxofx)])
ylabel(['Utility'])
grid on
```







# Appendix A

## Index and Code Links

### A.1 Notations and Functions links

1. [Local and Global Maximum: \*\*mlx\*\* | \*\*m\*\* | \*\*pdf\*\* | \*\*html\*\*](#)
  - local and global maximum.
  - **m**: `syms + solve() + diff() + double() + double(solve(diff(f,x),x)), fplot(f,[x_low, x_high])`



# Bibliography

Simon, C. P. and Blume, L. (1994). *Mathematics for Economists*. W. W. Norton & Company, New York City, New York, 2nd edition. ISBN 978-0393117523.

The MathWorks Inc (2019). *MATLAB*. Matlab package version 2019b.

Xie, Y. (2020). *bookdown: Authoring Books and Technical Documents with R Markdown*. R package version 0.18.