MatematiCAL anal for economists

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Preface

This textbook is designed to assist economics students studying the basic course of mathematical analysis. It summarizes the entire mathematical analysis course taught to economists in the best undergraduate economics program in Eastern Europe.

The lectures include only the essential material, ensuring that students who have achieved top honors in national economics Olympiads are not overburdened and can maintain their sense of superiority over the rest of the world. After all, they likely mastered all this material in kindergarten (or at the latest, by first grade). The division of topics into lectures corresponds well to the actual pace of the course, which spans an entire semester. Almost all statements in the course are self-evident, and their proofs are left to the reader as straightforward exercises.

Chapter 1

Numbers

1.1 Basic Classes of Numbers

First, let's introduce the definitions of the basic classes of numbers that we will constantly work with throughout the course.

Definition 1 *Numbers 1, 2, 3, ... are called natural numbers. The notation for the set of all natural numbers is* $\mathbb{N}$.

Definition 2 *A number is called an integer if it is equal to... but you don't need this because everything in economics is positive.*

Definition 3 *A number is called rational if it can be represented as something above a line and something below a line.*

Definition 4 *A number is called irrational if it is not rational.*

Obvious Fact 1 *The sum of all natural numbers equals* $-1/12$.

Kindergarten Example: If Vasya had 2 apples and Petya took 1 apple from him, how many apples does Vasya have left? The answer is obviously $-1/12$, as any advanced mathematician knows.

Chapter 2

Derivative

2.1 Basic derivatives

Definition 5 *The definition of derivative is omitted because it is obvious.*

Everything in this chapter is so obvious that no additional explanations will be provided - we'll immediately proceed to analyze an example from kindergarten.

Let's calculate a simple derivative:

$$cos(sin(x)) + x^{3.00} \tag{2.1}$$

It is common knowledge:

$$(sin(x))' = cos(x) \tag{2.2}$$

As already shown earlier:

$$(cos(sin(x)))' = cos(x) \cdot -1.00 \cdot sin(sin(x)) \tag{2.3}$$

By the obvious theorem:

$$(x^{3.00})' = 3.00 \cdot x^{2.00} \tag{2.4}$$

If you don't understand this obvious transformation, then you need to go into a program where they don't study mathematical analys:

$$(cos(sin(x)) + x^{3.00})' = cos(x) \cdot -1.00 \cdot sin(sin(x)) + 3.00 \cdot x^{2.00} \tag{2.5}$$

Let's calculate a simple derivative:

$$cos(x) \cdot -1.00 \cdot sin(sin(x)) + 3.00 \cdot x^{2.00} \tag{2.6}$$

Should be known from school:

$$(cos(x))' = -1.00 \cdot sin(x) \tag{2.7}$$

A good, solid task?

$$(sin(x))' = cos(x) \tag{2.8}$$

Understanding this transformation is left to the reader as a simple exercise:

$$(sin(sin(x)))' = cos(x) \cdot cos(sin(x)) \tag{2.9}$$

It is common knowledge:

$$(-1.00 \cdot sin(sin(x)))' = -1.00 \cdot cos(x) \cdot cos(sin(x)) \tag{2.10}$$

It is common knowledge:

$$\begin{aligned}(cos(x) \cdot -1.00 \cdot sin(sin(x)))' = -1.00 \cdot sin(x) \cdot -1.00 \cdot sin(sin(x)) \\ + cos(x) \cdot -1.00 \cdot cos(x) \cdot cos(sin(x))\end{aligned} \tag{2.11}$$

By the obvious theorem:

$$(x^{2.00})' = 2.00 \cdot x \tag{2.12}$$

If you don't understand this obvious transformation, then you need to go into a program where they don't study mathematical analys:

$$(3.00 \cdot x^{2.00})' = 3.00 \cdot 2.00 \cdot x \tag{2.13}$$

As already shown earlier:

$$\begin{aligned}&(cos(x) \cdot -1.00 \cdot sin(sin(x)) + 3.00 \cdot x^{2.00})' \\ &= -1.00 \cdot sin(x) \cdot -1.00 \cdot sin(sin(x)) + cos(x) \\ &\cdot -1.00 \cdot cos(x) \cdot cos(sin(x)) + 3.00 \cdot 2.00 \cdot x\end{aligned} \tag{2.14}$$

Chapter 3

Taylor

3.1 Taylor's formula with the remainder term (and why is it needed? Without it, everything is obvious)

Definition 6 *Taylor's formula is obvious, so no additional explanations will be given. Let's start straight with an example.*

At first the derivatives must be calcutated:

Let's calculate a simple derivative:

$$x \cdot sin(x) \tag{3.1}$$

Let's imagine this household as:

$$(sin(x))' = cos(x) \tag{3.2}$$

Should be known from school:

$$(x \cdot sin(x))' = sin(x) + x \cdot cos(x) \tag{3.3}$$

Let's calculate a simple derivative:

$$sin(x) + x \cdot cos(x) \tag{3.4}$$

Should be known from school:

$$(sin(x))' = cos(x) \tag{3.5}$$

Should be known from school:

$$(cos(x))' = -1.00 \cdot sin(x) \tag{3.6}$$

A similar one can be proved:

$$(x \cdot cos(x))' = cos(x) + x \cdot -1.00 \cdot sin(x) \tag{3.7}$$

A similar one can be proved:

$$(sin(x) + x \cdot cos(x))' = cos(x) + cos(x) + x \cdot -1.00 \cdot sin(x) \tag{3.8}$$

Let's calculate a simple derivative:

$$cos(x) + cos(x) + x \cdot -1.00 \cdot sin(x) \tag{3.9}$$

As already shown earlier:

$$(cos(x))' = -1.00 \cdot sin(x) \tag{3.10}$$

A similar one can be proved:

$$(cos(x))' = -1.00 \cdot sin(x) \tag{3.11}$$

Plus a constant:

$$(sin(x))' = cos(x) \tag{3.12}$$

According to the theorem (which number?) from paragraph ??:

$$(-1.00 \cdot sin(x))' = -1.00 \cdot cos(x) \tag{3.13}$$

It is common knowledge:

$$(x \cdot -1.00 \cdot sin(x))' = -1.00 \cdot sin(x) + x \cdot -1.00 \cdot cos(x) \tag{3.14}$$

It is easy to see:

$$(cos(x) + x \cdot -1.00 \cdot sin(x))' = -1.00 \cdot sin(x) + -1.00 \cdot sin(x) + x \cdot -1.00 \cdot cos(x) \tag{3.15}$$

As already shown earlier:

$$\begin{split}(cos(x) + cos(x) + x \cdot -1.00 \cdot sin(x))' = -1.00 \cdot sin(x) + -1.00 \cdot sin(x) + \\ -1.00 \cdot sin(x) + x \cdot -1.00 \cdot cos(x)\end{split} \tag{3.16}$$

Let's calculate a simple derivative:

$$-1.00 \cdot sin(x) + -1.00 \cdot sin(x) + -1.00 \cdot sin(x) + x \cdot -1.00 \cdot cos(x) \tag{3.17}$$

A similar one can be proved:

$$(sin(x))' = cos(x) \tag{3.18}$$

As already shown earlier:

$$(-1.00 \cdot sin(x))' = -1.00 \cdot cos(x) \tag{3.19}$$

It is common knowledge:

$$(sin(x))' = cos(x) \tag{3.20}$$

Should be known from school:

$$(-1.00 \cdot sin(x))' = -1.00 \cdot cos(x) \tag{3.21}$$

As already shown earlier:

$$(sin(x))' = cos(x) \tag{3.22}$$

It is obvious that:

$$(-1.00 \cdot sin(x))' = -1.00 \cdot cos(x) \tag{3.23}$$

It is easy to see:

$$(cos(x))' = -1.00 \cdot sin(x) \tag{3.24}$$

A good, solid task?

$$(-1.00 \cdot cos(x))' = -1.00 \cdot -1.00 \cdot sin(x) \tag{3.25}$$

If this is not obvious to you, try attending a lecture for a change:

$$(x \cdot -1.00 \cdot cos(x))' = -1.00 \cdot cos(x) + x \cdot -1.00 \cdot -1.00 \cdot sin(x) \tag{3.26}$$

Plus a constant:

$$\begin{aligned}(-1.00 \cdot sin(x) + x \cdot -1.00 \cdot cos(x))' = -1.00 \cdot cos(x) + -1.00 \cdot cos(x)\\ + x \cdot -1.00 \cdot -1.00 \cdot sin(x)\end{aligned} \tag{3.27}$$

It is easy to see:

$$\begin{aligned}&(-1.00 \cdot sin(x) + -1.00 \cdot sin(x) + x \cdot -1.00 \cdot cos(x))'\\ &= -1.00 \cdot cos(x) + -1.00 \cdot cos(x) + -1.00 \cdot cos(x) + x \cdot -1.00 \cdot -1.00 \cdot sin(x)\end{aligned} \tag{3.28}$$

It is easy to see:

$$\begin{aligned}&(-1.00 \cdot sin(x) + -1.00 \cdot sin(x) + -1.00 \cdot sin(x) + x \cdot -1.00 \cdot cos(x))'\\ &= -1.00 \cdot cos(x) + -1.00 \cdot cos(x) + -1.00 \cdot cos(x)\\ &\quad + -1.00 \cdot cos(x) + x \cdot -1.00 \cdot -1.00 \cdot sin(x)\end{aligned} \tag{3.29}$$

Let's calculate a simple derivative:

$$\begin{aligned}-1.00 \cdot cos(x) + -1.00 \cdot cos(x) + -1.00 \cdot cos(x)\\ + -1.00 \cdot cos(x) + x \cdot -1.00 \cdot -1.00 \cdot sin(x)\end{aligned} \tag{3.30}$$

According to the theorem (which number?) from paragraph ??:

$$(cos(x))' = -1.00 \cdot sin(x) \tag{3.31}$$

According to the theorem (which number?) from paragraph ??:

$$(-1.00 \cdot cos(x))' = -1.00 \cdot -1.00 \cdot sin(x) \tag{3.32}$$

A good, solid task?

$$(cos(x))' = -1.00 \cdot sin(x) \tag{3.33}$$

A good, solid task?

$$(-1.00 \cdot cos(x))' = -1.00 \cdot -1.00 \cdot sin(x) \tag{3.34}$$

If you don't understand this obvious transformation, then you need to go into a program where they don't study mathematical analys:

$$(cos(x))' = -1.00 \cdot sin(x) \tag{3.35}$$

It is easy to see:

$$(-1.00 \cdot cos(x))' = -1.00 \cdot -1.00 \cdot sin(x) \tag{3.36}$$

Let's imagine this household as:

$$(cos(x))' = -1.00 \cdot sin(x) \tag{3.37}$$

A similar one can be proved:

$$(-1.00 \cdot cos(x))' = -1.00 \cdot -1.00 \cdot sin(x) \tag{3.38}$$

Plus a constant:

$$(sin(x))' = cos(x) \tag{3.39}$$

It is easy to see:

$$(-1.00 \cdot sin(x))' = -1.00 \cdot cos(x) \tag{3.40}$$

According to the theorem (which number?) from paragraph ??:

$$(-1.00 \cdot -1.00 \cdot sin(x))' = -1.00 \cdot -1.00 \cdot cos(x) \tag{3.41}$$

As already shown earlier:

$$(x \cdot -1.00 \cdot -1.00 \cdot sin(x))' = -1.00 \cdot -1.00 \cdot sin(x) + x \cdot -1.00 \cdot -1.00 \cdot cos(x) \tag{3.42}$$

It is common knowledge:

$$(-1.00 \cdot cos(x) + x \cdot -1.00 \cdot -1.00 \cdot sin(x))' \\ = -1.00 \cdot -1.00 \cdot sin(x) + -1.00 \cdot -1.00 \cdot sin(x) + x \cdot -1.00 \cdot -1.00 \cdot cos(x) \tag{3.43}$$

A good, solid task?

$$(-1.00 \cdot cos(x) + -1.00 \cdot cos(x) + x \cdot -1.00 \cdot -1.00 \cdot sin(x))' \\ = -1.00 \cdot -1.00 \cdot sin(x) + -1.00 \cdot -1.00 \cdot sin(x) + \\ -1.00 \cdot -1.00 \cdot sin(x) + x \cdot -1.00 \cdot -1.00 \cdot cos(x) \tag{3.44}$$

It is common knowledge:

$$(-1.00 \cdot cos(x) + -1.00 \cdot cos(x) + -1.00 \cdot cos(x) + x \cdot -1.00 \cdot -1.00 \cdot sin(x))' \\ = -1.00 \cdot -1.00 \cdot sin(x) + -1.00 \cdot -1.00 \cdot sin(x) + -1.00 \cdot -1.00 \\ \cdot sin(x) + -1.00 \cdot -1.00 \cdot sin(x) + x \cdot -1.00 \cdot -1.00 \cdot cos(x) \tag{3.45}$$

A good, solid task?

$$(-1.00 \cdot cos(x) + -1.00 \cdot cos(x) + -1.00 \cdot cos(x) + -1.00 \cdot cos(x) + x \cdot -1.00 \cdot -1.00 \\ \cdot sin(x))' = -1.00 \cdot -1.00 \cdot sin(x) + -1.00 \cdot -1.00 \cdot sin(x) + -1.00 \cdot -1.00 \cdot sin(x) \\ + -1.00 \cdot -1.00 \cdot sin(x) + -1.00 \cdot -1.00 \cdot sin(x) + x \cdot -1.00 \cdot -1.00 \cdot cos(x) \tag{3.46}$$

Taylor Series:

$$T(x \cdot sin(x)) = x^{2.00} - 0.17 \cdot x^{4.00}... \tag{3.47}$$