



دل‌سازی‌شناختی

Cognitive Modeling

Presented by: Dr. Maleki,

Semnan University,

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<http://maleki.semnan.ac.ir>

بحث دوم: معادله دیفرانسیل چیست؟

ای نامه‌سی اسرار ایشی که تو بی
وی آپنه‌ی جا لشای که تو بی
پرون زنونیت آنچه در عالم است
از خود بطلب هر چه خواهی که تو بی

فهرست مطالب

دورنما 

- مدل سازی نورون
- معادله دیفرانسیل: روش ریاضی مدل های چکین و هاکسلی
- مفهوم دیفرانسیل در معادله دیفرانسیل
- جمع بندی

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مدل سازی نوردون

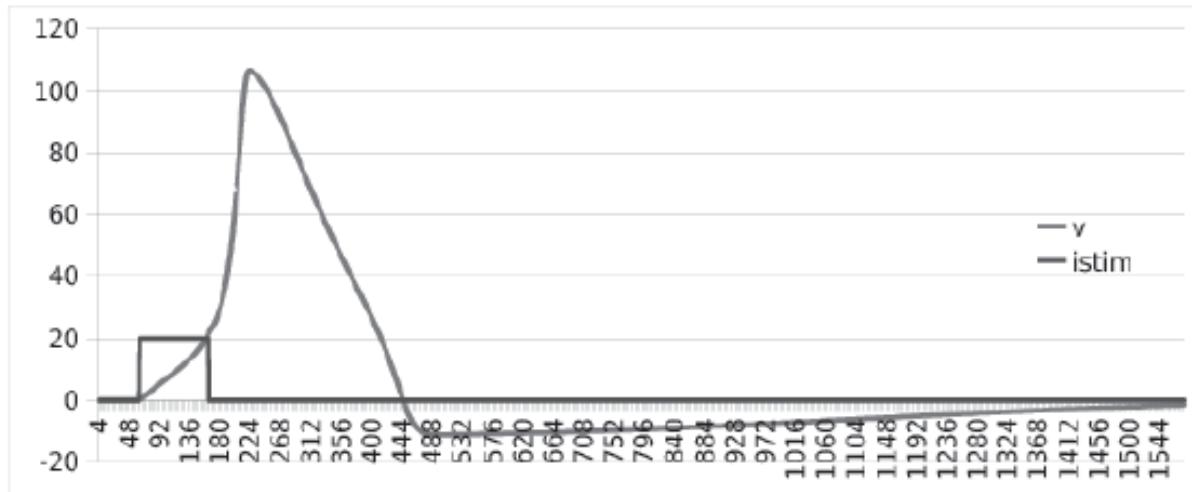


Figure 2.1 A graph of a simulated neuronal action potential produced with a spreadsheet program. In the 1950s generating the data for an image like this might have required a few weeks operating a hand-cranked calculator. The model behind it warranted the 1963 Nobel Prize. You will be able to do Nobel-level work by the end of Chapter 7.

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محل عددی یک معادله!

$$x^2 = 4$$

$$x^2 - 4 = 0$$

$$f(x) = x^2 - 4$$

$$f'(x) = 2x$$

$$f'(x) \cong \frac{f(x_0) - f(x_1)}{x_0 - x_1}$$

در محل برخورد با محور افقی

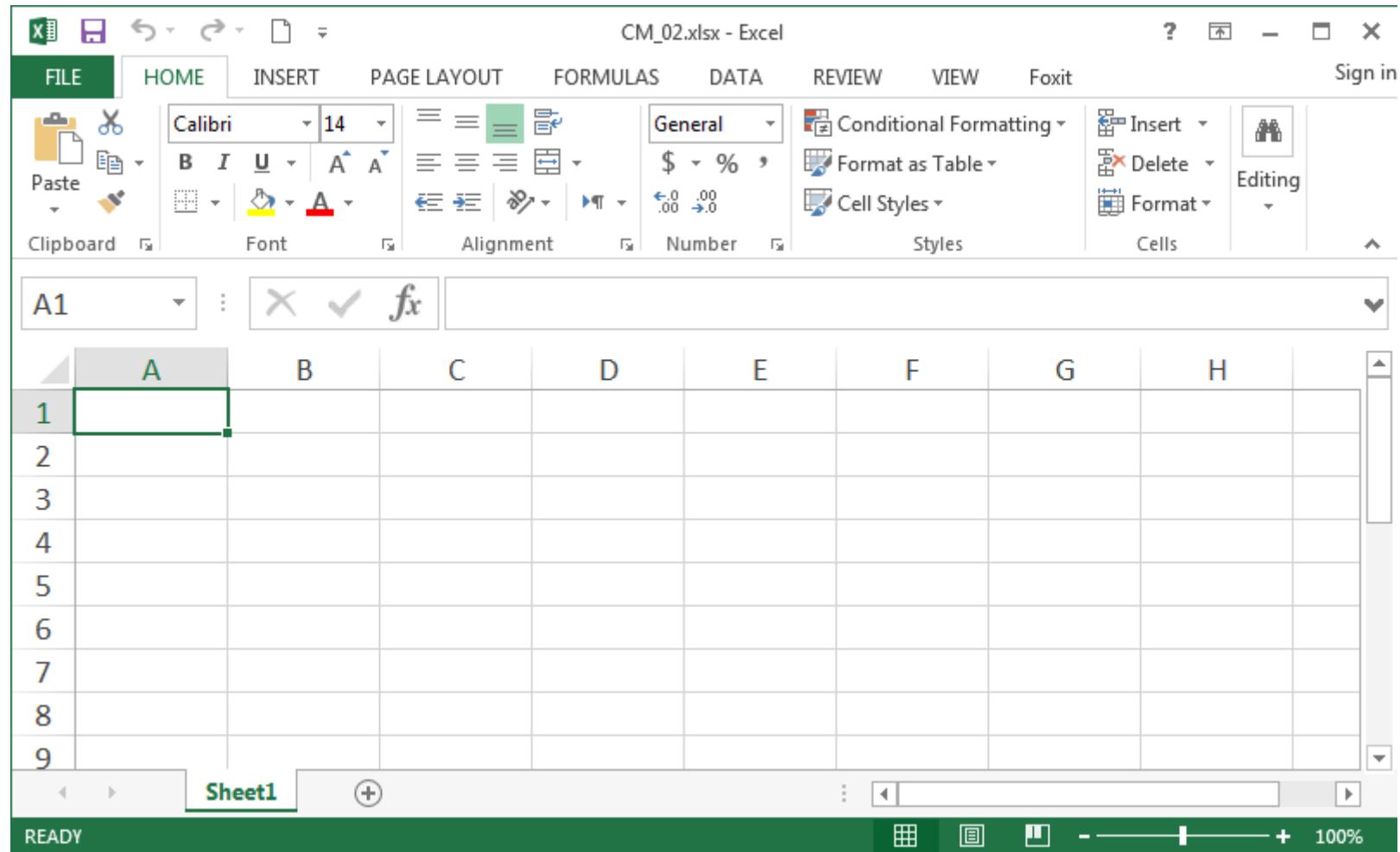
$$f(x_1) = 0 \quad \Rightarrow \quad f'(x) \cong \frac{f(x_0)}{x_0 - x_1}$$

$$x_0 - x_1 \cong \frac{f(x_0)}{f'(x)}$$

$$x_1 \cong x_0 - \frac{f(x_0)}{f'(x)}$$

حل عددی یک معادله دیفرانسیل در نرم افزار اکسل

باز کردن نرم افزار اکسل:



وارد کردن برچسب‌ها:

Screenshot of Microsoft Excel showing a table with headers and a formula in cell E1.

The table has columns labeled A through H. The first row contains headers: A (x), B (y), C ($f(x)$), D ($f'(x)$), and E (empty). The second row contains values: A (1), B (2), C (3), D (4), and E (empty).

The formula $f'(x)$ is entered in cell E1. The formula bar shows "E1" and the formula " $f'(x)$ ".

The ribbon tabs visible are FILE, HOME, INSERT, PAGE LAYOUT, FORMULAS, DATA, REVIEW, and VIEW. The HOME tab is selected.

The status bar at the bottom shows "READY" and "100%".

وارد کردن مقادیر اولیه:

The screenshot shows a Microsoft Excel spreadsheet titled "CM_02.xlsx - Excel". The ribbon menu is visible at the top, with the "HOME" tab selected. The spreadsheet contains the following data:

	A	B	C	D	E	F	G	H
1	x	y	f(x)	f'(x)				
2	3	4						
3								
4								
5								
6								
7								
8								
9								

The cell C2 is currently selected. The formula bar shows the formula $f(x)$. The status bar at the bottom indicates "READY" and "100%".

وارد کردن فرمول تابع :

$$f(x) = x^2 - 4$$

The screenshot shows a Microsoft Excel interface with the following details:

- File:** CM_02.xlsx - Excel
- Home Tab:** Selected.
- Clipboard:** Paste icon is visible.
- Font:** Size 14 is selected.
- Alignment:** General is selected.
- Number:** General is selected.
- Styles:** Conditional Formatting, Format as Table, Cell Styles, Insert, Delete, Format, and Editing buttons.
- Cells:** Cells button.
- Formula Bar:** SUM dropdown, fx button, and the formula $=A2^2-$B2 .
- Worksheet:** Sheet1 tab is selected.
- Data:** A table is present with columns labeled A, B, C, D, E, F, G, H. Row 1 contains labels x, y, f(x), f'(x). Row 2 contains values 3, 4, and the formula 2^2-B2 in cell C2.
- Toolbars:** Standard toolbar (File, Home, Insert, Page Layout, Formulas, Data, Review, View, Foxit) and ribbon tabs (File, Home, Insert, Page Layout, Formulas, Data, Review, View, Foxit).
- Status Bar:** EDIT, zoom level 100%.

وارد کردن فرمول مشتق:

$$f'(x) = 2x$$

The screenshot shows a Microsoft Excel spreadsheet titled "CM_02.xlsx - Excel". The ribbon menu is visible at the top, with the "HOME" tab selected. In the formula bar, the text "=2*A2" is entered. The spreadsheet contains the following data:

	A	B	C	D	E	F	G	H
1	x	y	f(x)	f'(x)				
2	3	4	5	=2*A2				
3								
4								
5								
6								
7								
8								
9								

The cell A2 is highlighted with a blue border. The formula bar shows the formula $=2*A2$. The status bar at the bottom right indicates "100%".

وارد کردن فرمول به روزرسانی متغیر:

$$x_1 \cong x_0 - \frac{f(x_0)}{f'(x)}$$

The screenshot shows a Microsoft Excel spreadsheet titled "CM_02.xlsx". The ribbon menu is visible at the top, with the "HOME" tab selected. The formula bar displays the formula $=A2-C2/D2$. The worksheet contains the following data:

	A	B	C	D	E	F	G	H
1	x	y	f(x)	f'(x)				
2	3	4	5	6				
3	=A2-C2/D2							
4								
5								
6								
7								
8								
9								

The cell A3 contains the formula $=A2-C2/D2$, which is highlighted with a green border. The cells A2, C2, and D2 also have green borders, indicating they are part of the current selection or used in the formula. The formula bar also shows the same formula $=A2-C2/D2$.

تکرار فرمول تابع:

The screenshot shows a Microsoft Excel interface with the following details:

- File:** CM_02.xlsx - Excel
- Home Tab:** Selected.
- Clipboard:** Paste icon is highlighted.
- Font:** Calibri, 14pt.
- Alignment:** Centered alignment is selected.
- Number:** General format.
- Cells:** Editing mode is active.
- Formula Bar:** Cell C2 is selected, displaying the formula $=A2^2-\$B\2 .
- Table Data:** A 3x5 grid of values:

	A	B	C	D
1	x	y	f(x)	f'(x)
2	3	4	5	6
3	2.166667		0.694444	
4				
5				
6				
7				
8				
9				
- Sheet:** Sheet1
- Bottom Status Bar:** READY, AVERAGE: 2.84722222, COUNT: 2, SUM: 5.694444444, 100%.

تكرار فرمول مشتق تابع:

The screenshot shows a Microsoft Excel spreadsheet titled "CM_02.xlsx - Excel". The ribbon menu is visible at the top, with the "HOME" tab selected. The formula bar displays the formula $=2*A2$. The main worksheet contains the following data:

	A	B	C	D	E	F	G	H
1	x	y	f(x)	f'(x)				
2	3	4	5	6				
3	2.166667		0.694444	4.333333				
4								
5								
6								
7								
8								
9								

The cell D3 is highlighted with a green border. The status bar at the bottom of the screen shows "READY", "AVERAGE: 5.166666667", "COUNT: 2", "SUM: 10.33333333", and "100%".

تکرار روند:

CM_02.xlsx - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW Foxit Sign in

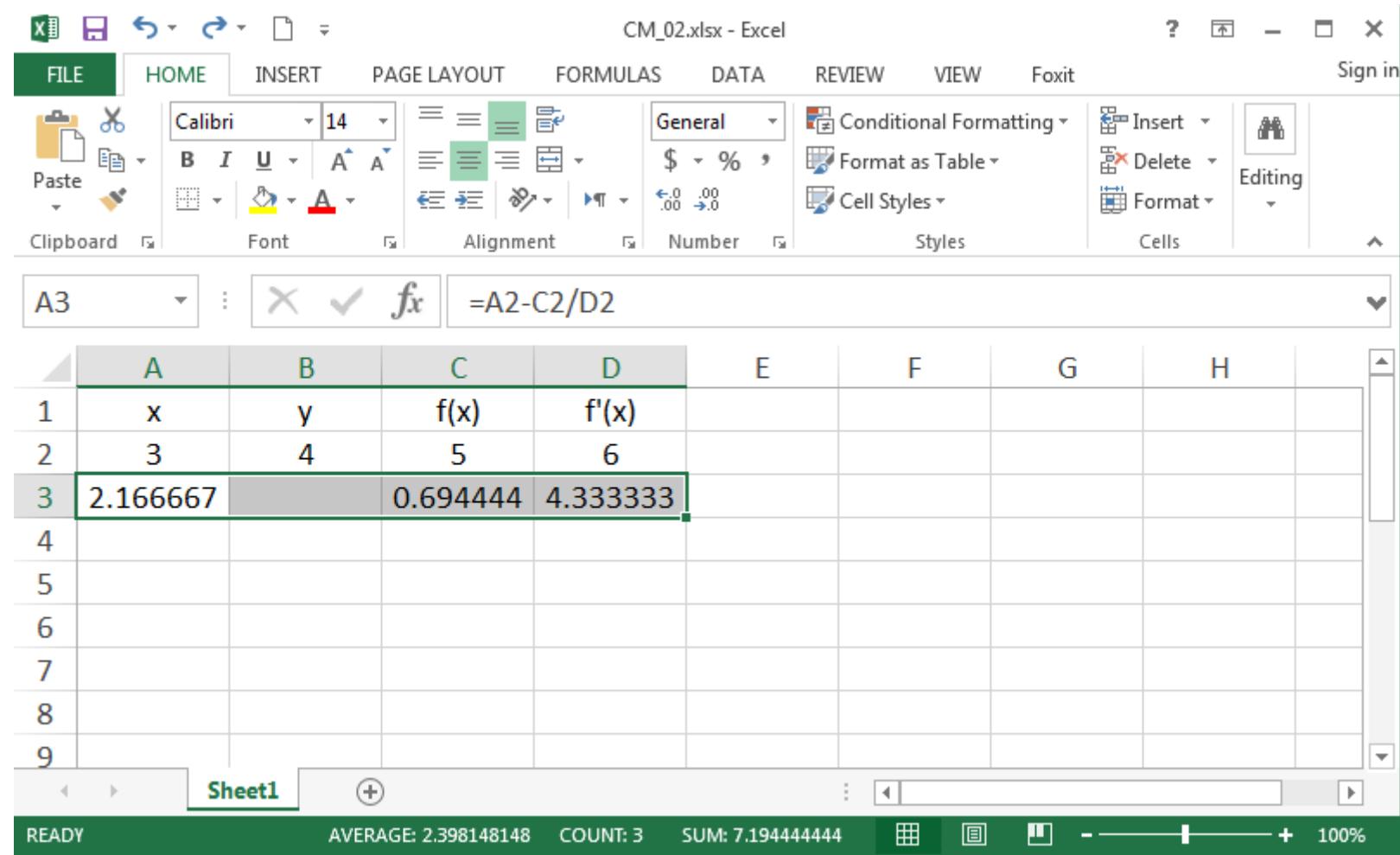
Paste Insert Delete Format Cells Editing

A3 : $=A2-C2/D2$

	A	B	C	D	E	F	G	H
1	x	y	f(x)	f'(x)				
2	3	4	5	6				
3	2.166667		0.694444	4.333333				
4								
5								
6								
7								
8								
9								

Sheet1

READY AVERAGE: 2.398148148 COUNT: 3 SUM: 7.194444444 100%



تکرار روند:

CM_02.xlsx - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW Foxit Sign in

Paste Insert Conditional Formatting Format as Table Cell Styles Cells Editing

D9 : fx =2*A9

	A	B	C	D	E	F	G	H
1	x	y	f(x)	f'(x)				
2	3	4	5	6				
3	2.166667		0.694444	4.333333				
4	2.00641		0.025682	4.012821				
5	2.00001		4.1E-05	4.00002				
6	2		1.05E-10	4				
7	2		0	4				
8	2		0	4				
9	2		0	4				

Sheet1

READY

تغییر حدس اولیه متغیر به 5

	A	B	C	D	E	F	G	H
1	x	y	f(x)	f'(x)				
2	5	4	21	10				
3	2.9		4.41	5.8				
4	2.139655		0.578124	4.27931				
5	2.004558		0.018251	4.009115				
6	2.000005		2.07E-05	4.00001				
7	2		2.68E-11	4				
8	2		0	4				
9	2		0	4				

تغییر حدس اولیه متغیر به $x = 88$

	A	B	C	D	E	F	G	H
1	x	y	f(x)	f'(x)				
2	88	4	7740	176				
3	44.02273		1934.001	88.04545				
4	22.05679		482.5022	44.11359				
5	11.11907		119.6338	22.23814				
6	5.739407		28.9408	11.47881				
7	3.218172		6.356629	6.436343				
8	2.230557		0.975383	4.461113				
9	2.011916		0.047804	4.023831				

تغییر تابع به $f(x) = x^2 - 25$ جهت محاسبه ریشه‌ی

The screenshot shows a Microsoft Excel spreadsheet titled "CM_02.xlsx - Excel". The "HOME" tab is selected. The formula bar shows the cell reference "B2" and the value "25". The table below has columns labeled A through H. The first row contains headers: "x", "y", "f(x)", and "f'(x)". Rows 2 through 9 show iterative calculations for a root-finding algorithm. The values in column C (f(x)) decrease from 7719 to 4.74E-05, while the values in column D (f'(x)) increase from 176 to 10.00001.

	A	B	C	D	E	F	G	H
1	x	y	f(x)	f'(x)				
2	88	25	7719	176				
3	44.14205		1923.52	88.28409				
4	22.3542		474.7102	44.7084				
5	11.73628		112.7402	23.47256				
6	6.933213		23.06944	13.86643				
7	5.269522		2.767866	10.53904				
8	5.006893		0.068974	10.01379				
9	5.000005		4.74E-05	10.00001				

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مفهوم شیب و مشتق

مفهوم شیب:

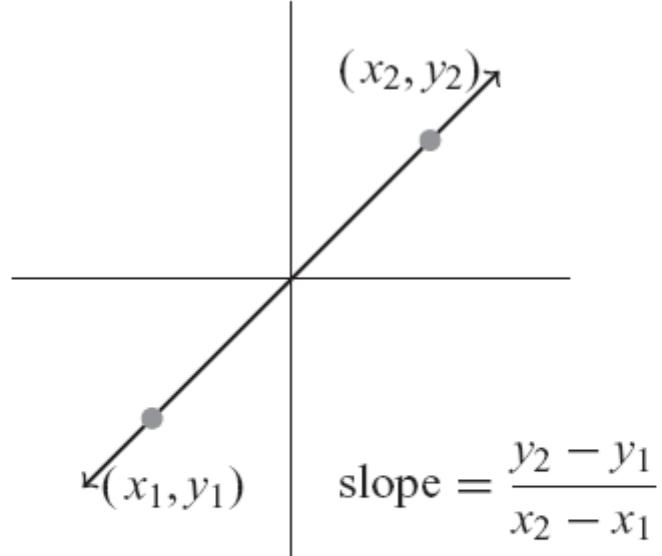


Figure 2.3 Derivatives are instantaneous slopes. For lines this is the familiar formula of “rise over run.” For curves we have to be more careful.

مفهوم مشتق:

$$\frac{df(x)}{dx} = \lim_{\Delta x \rightarrow 0} \frac{f(x + \Delta x) - f(x)}{\Delta x}$$

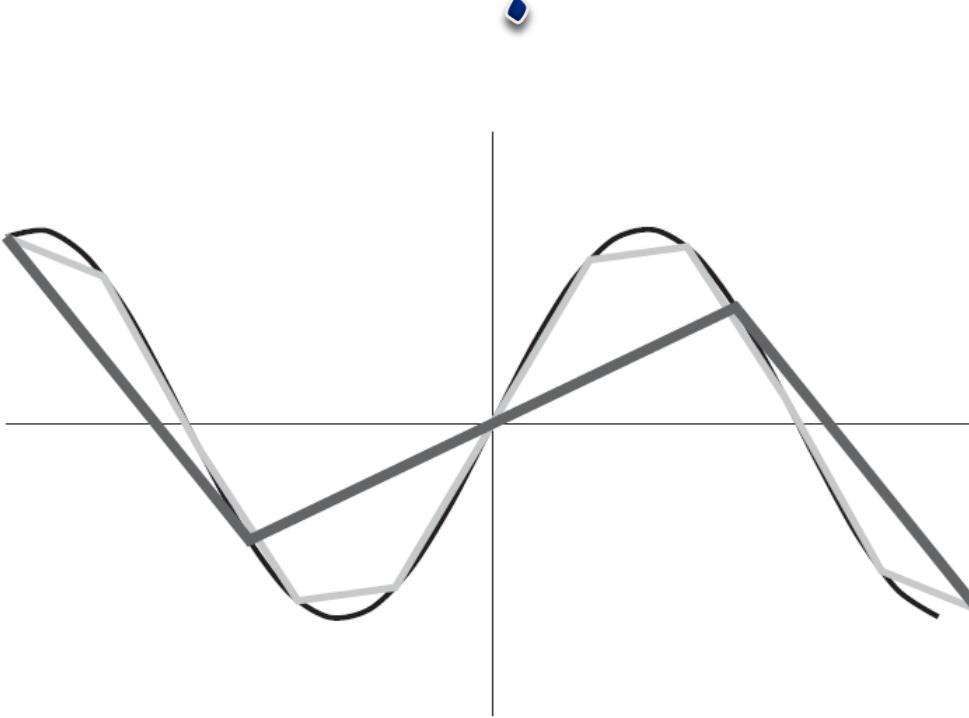


Figure 2.4 Derivatives are instantaneous slopes. We wish to be able to calculate the slope of the black curve at any point, but the curve's slopes change as we move along it. The intuition for how we calculate derivatives is to imagine that we approximate our curve with a sequence of straight lines. Each straight line has a slope that we know how to calculate. As we move our points closer together, the difference between our line segments and the curve decreases. Our line segments begin to more closely approximate the slope of the curve. When our line segments become infinitesimally small, we have approximated the slope of the curve at every point with teeny tiny lines, each of which gives us the slope at a point, the derivative.

اصطلاحات فنی

معادله دیفرانسیل خطی (linear differential equation)

معادله دیفرانسیل معمولی (ordinary differential equation)

معادله دیفرانسیل جزئی (partial differential equation)

معادله دیفرانسیل همگن (homogeneous differential equation)

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شعری مسوب به حضرت علی (ع):

آیا کان می کنی که تو موجود کوچکی هستی در حالی که دنیا ی بزرگی در تو نهفته است!
ای انسان، تو گتاب روشنی هستی که با حروفش ہر پہنانی آشکار می شود.

أَنْزَلْنَاكَ جَرْمًا صَغِيرًا
وَنَحْنُ أَنْطَوْيُونَا عَالَمًا الْأَكْبَرَ
وَإِنْتَ الْكَتَابُ الْمُبِينُ الَّذِي
بِالْحُرْفَةِ يُنْظَرُ الْمُضْمُرُ