International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 3 Issue 5, August 2019 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Easy Finding Extreme Values of a Function

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How to cite this paper: Nyein Min Oo "Easy Finding Extreme Values of a Function" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-5, August 2019, pp.1983-1984, **https://doi.org/10.31142/ijtsrd26746**

IJTSRD26746

ABSTRACT

We want to introduce a new and effective method to find the maximum value and minimum value of a function in this paper. The proposed method is very short in calculation and easy compared with existing methods. The proposed method is illustrated by the examples.

KEYWORDS: *Differentiation, Homogenous functions, and variables*

INTRODUCTION

Absolute Maximum and Absolute Minimum: The most important applications of differential calculus are optimization problems. We are needed to find the optimal way of doing something. By using this method, in many cases these problems can be reduced to finding the maximum or minimum values of a function.

Definition

- Maximum and minimum values are called **extreme values** of the function f. Absolute maximum or minimum are also referred to as global maxima or minima.
- Let f be a function with domain D. Then f has an **absolute maximum value** on D at a point c if $f(x) \le f(c)$ for all x in D.
- Let f be a function with domain D. Then f has an **absolute minimum value** on D at a point c if $f(x) \ge f(c)$ for all x in D.

Local Maximum and Local Minimum: We now consider one of the most important applications of the derivative, here we use the first derivative as an aid in determining the high points or the low points on a curve. These points are called Local Maximum and Local Minimum.

MAIN RESULTS

Absolute Maximum and Minimum

To find the absolute maximum and minimum values of a continuous function f on a closed interval [a, b];

1. Find all of the critical points of function in the interval [a, b].
2. Compute f at all of the critical numbers in the interval [a, b].
3. Compute f at the endpoints of the interval, [calculate f(a) and f(b)].
4. The largest of the values from steps 2 and 3 is the absolute maximum of the function on the interval [a, b] and the smallest of the values from Steps 2 and 3 is the absolute maximum of the function on the interval [a, b]. or we proceed with following algorithm.

Calculation Rule to find absolute maximum and minimum

Step I : Let y = f (x), a ≤ x ≤ b, f (a) = a, f (b) = b. Find $\frac{dy}{dx}$.

Step II : Find $\frac{dy}{dx}$ = 0, and also find critical numbers.

Step III : Substituting f (a), f (b) and critical numbers in y=f(x).

Step IV : To find absolute maximum. Take the largest value of f(x)=y . This value is called absolute maximum.

Step V : To find absolute minimum. Take the smallest value of f(x)=y. this value is called absolute minimum.

Example1. Find the absolute maximum and minimum values of the function y=10x(2-lnx) on the interval [1,e^2].

Step I: Find $\frac{dy}{dx}$

$\frac{dy}{dx}$=10(2-lnx)-10x(1/x)

=10(1-lnx)

$\frac{dy}{dx}$=0

10-10lnx=0

lnx=1
lnx=lne
x=e

The critical point is e.

Sep II : x=e substituting in y=f(x)=10x(2-lnx), we get f(e)=10e ≈ 27.2

Step III : Endpoint values: f(1)=10(2-ln1)=20
$f(e^2)=10e^2(2-2\ln e)=0$.

Step IV : To find absolute maximum, select the largest value of f(x). Then the value from f(e), f(1) and $f(e^2)$. Therefore the absolute maximum value of f(e) ≈ 27.2

Step V : To find absolute minimum, select the smallest value of f(x). then the value from f(e), f(1) and $f(e^2)$. Therefore the absolute minimum value is $f(e^2)$= 0.

Local Maximum and Local Minimum

Working Rule to find local maximum and local minimum

Step 1 :y = f (x). Find $\frac{dy}{dx}$

Step 2 : put $\frac{dy}{dx}$ =0, find critical numbers.

Step 3 : Find $\frac{d^2y}{dx^2}$.

Step 4 : Substituting critical numbers in $\frac{d^2y}{dx^2}$.

1. $\frac{d^2y}{dx^2}$ <0, the critical number is Local Maximum
2. $\frac{d^2y}{dx^2}$ >0, the critical number is Local Minimum.
3. $\frac{d^2y}{dx^2}$ =0, $\frac{d^2y}{dx^2}$ ≠0, the given conditions are points of inflection.

Step 5 : Substitute local maximum, local minimum values

Example 2. Find the local maximum of using second order derivative for $y=\frac{1}{2}x\sqrt{25-x^2}$.

$$\frac{dy}{dx}=\frac{1}{2}\left[x\frac{1}{2}(25-x^2)^{-\frac{1}{2}}(-2x)+\sqrt{25-x^2}\right]$$

$$=\frac{1}{2}\left[\frac{-x^2}{\sqrt{25-x^2}}+\sqrt{25-x^2}\right]$$

$$=\frac{1}{2}\left[\frac{25-2x^2}{\sqrt{25-x^2}}\right]$$

$$\frac{dy}{dx}=0$$

$$\frac{1}{2}\frac{25-2x^2}{\sqrt{25-x^2}}=0$$

$$x^2=\frac{25}{2}$$

$$x=\frac{5}{\sqrt{2}}$$

$$\frac{d^2y}{dx^2}=\frac{1}{2}\left[\frac{\sqrt{25-x^2}(-4x)-(25-x^2)\frac{1}{2}(25-x^2)^{-\frac{1}{2}}(-2x)}{25-x^2}\right]$$

$$=\frac{1}{2}\left[\frac{(-4x)(25-x^2)+(25-2x^2)x}{(25-x^2)^{3/2}}\right]$$

$$=\frac{1}{2}\left[\frac{2x^3-75x}{(25-x^2)^{3/2}}\right]$$

At $x=\frac{5}{\sqrt{2}}$, $\frac{d^2y}{dx^2}=\frac{1}{2}\left[\frac{\frac{125}{\sqrt{2}}-\frac{375}{\sqrt{2}}}{\left(\frac{125}{2}\right)^{3/2}}\right]$ <0

Therefore y is local maximum when $x=\frac{5}{\sqrt{2}}$.

The local maximum value of $y=\frac{1}{2}\times\frac{5}{\sqrt{2}}\sqrt{25-\frac{25}{2}}$ =6.25

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