

Creative Learning in Calculus

Hongxia Yin

Department of Mathematics and Statistics

MSU

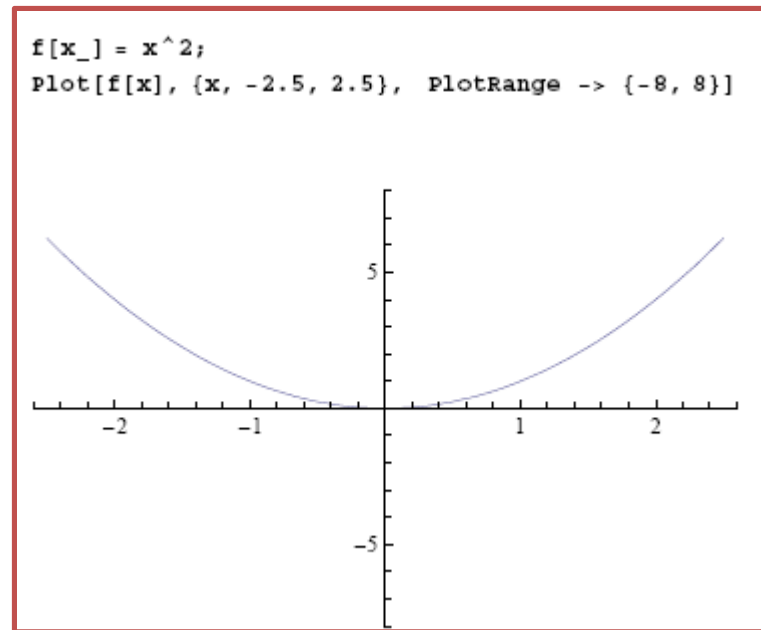
Computer can help us learning

- It make abstract mathematics concept much more easier to be understood by plotting the function and zooming it in or out on computer.
- Encourage student to learn new computer technique, new software.

Example:

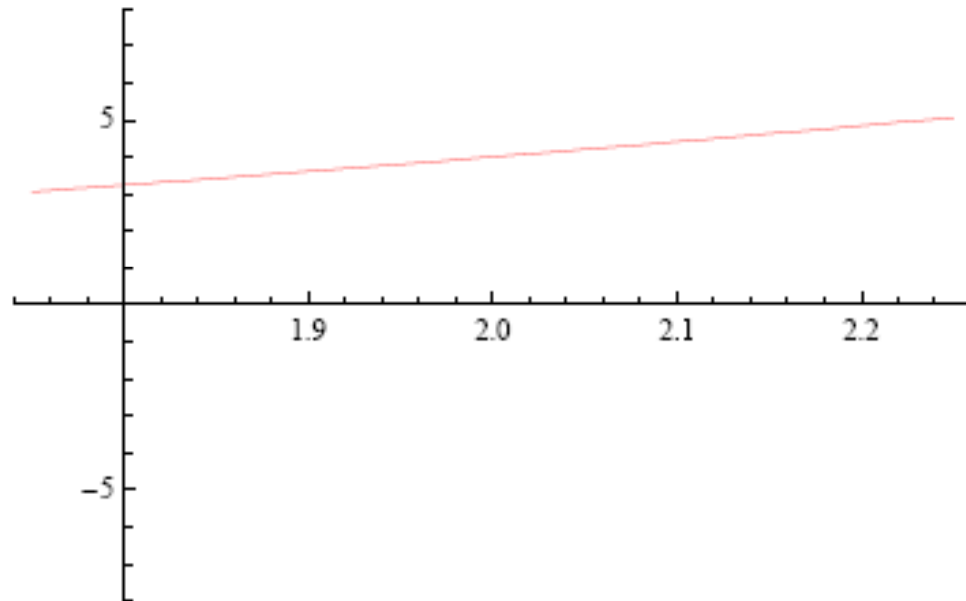
- Definition of limit –the first concept in Calculus.
- Difficult to describe in math.

$$\lim_{x \rightarrow 2} x^2 = 4$$



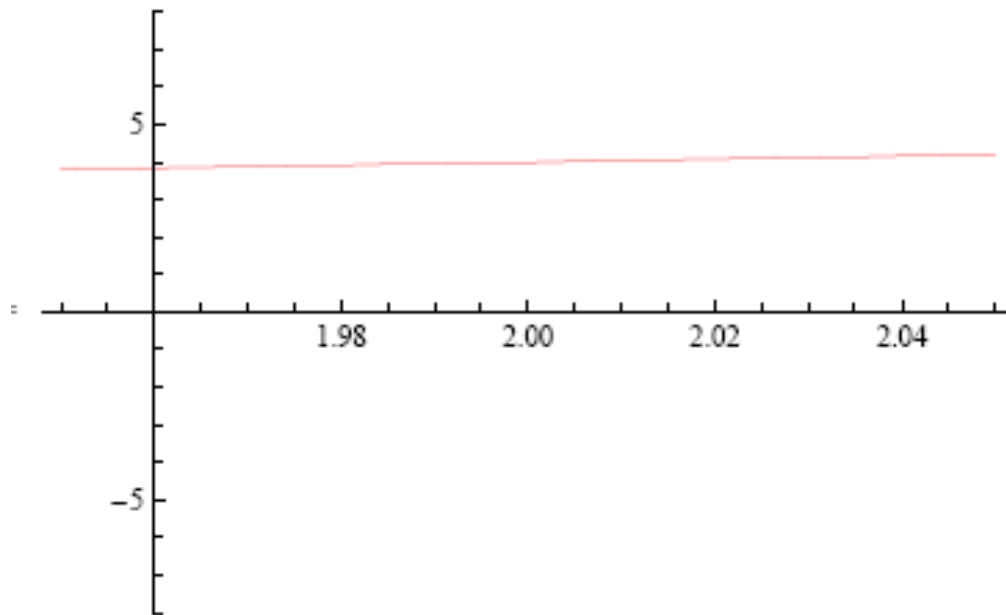
Zooming

```
Plot[f[x], {x, 1.75, 2.25}, PlotStyle -> RGBColor[1, 0, 0], PlotRange -> {-8, 8}]
```



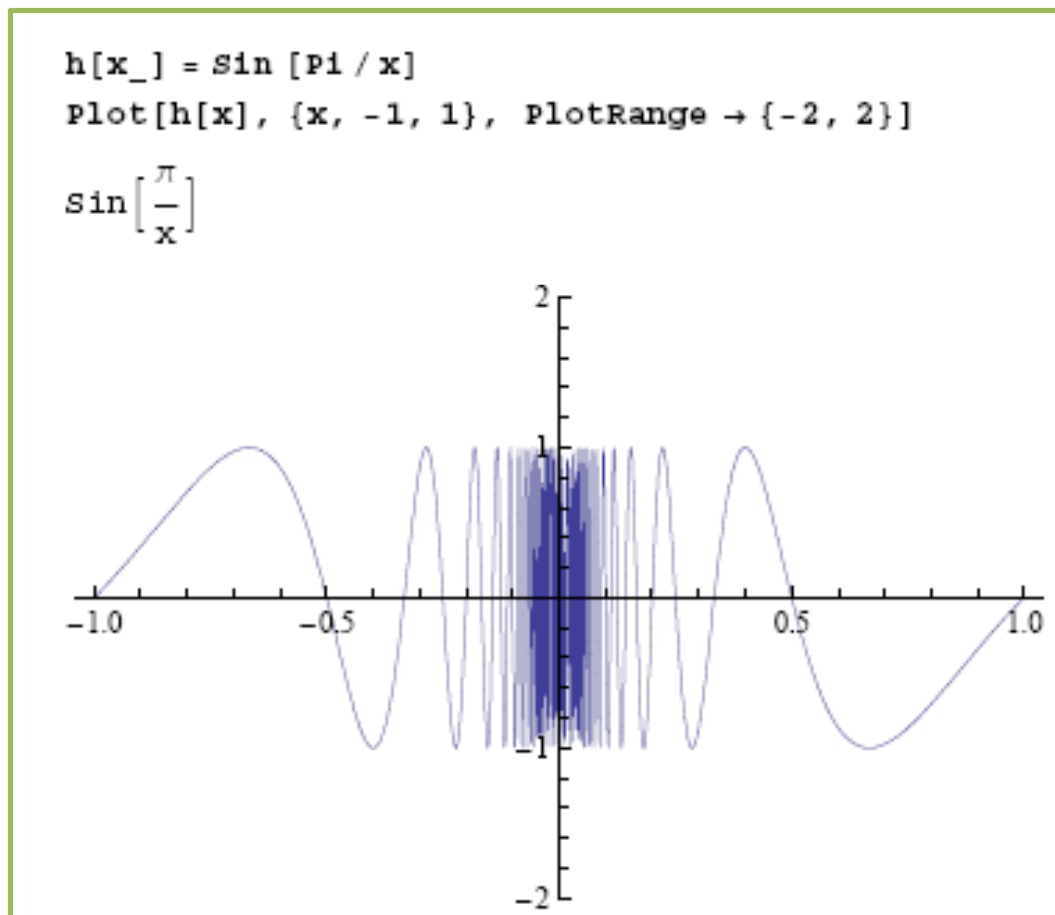
Zooming Again

```
Plot[f[x], {x, 1.95, 2.05}, PlotStyle -> RGBColor[1, 0, 0], PlotRange -> {-8, 8}]
```

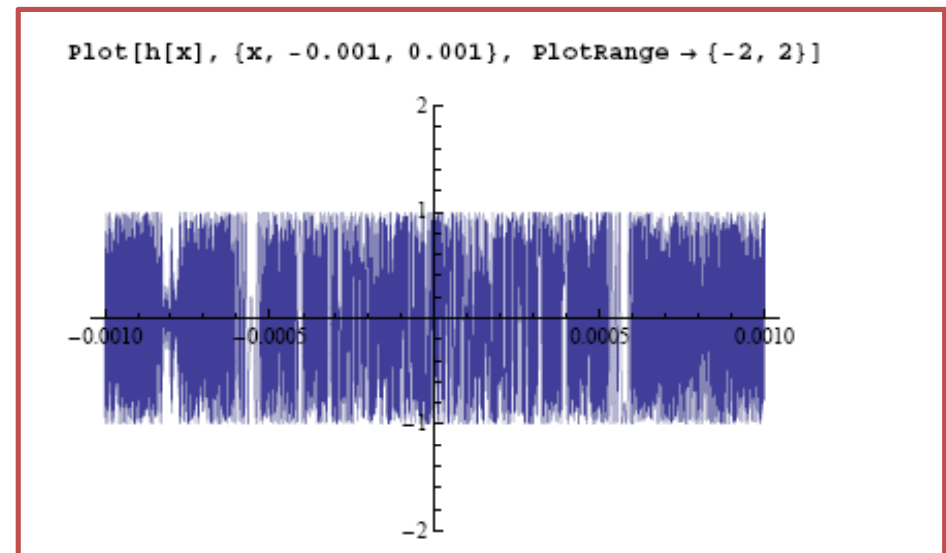
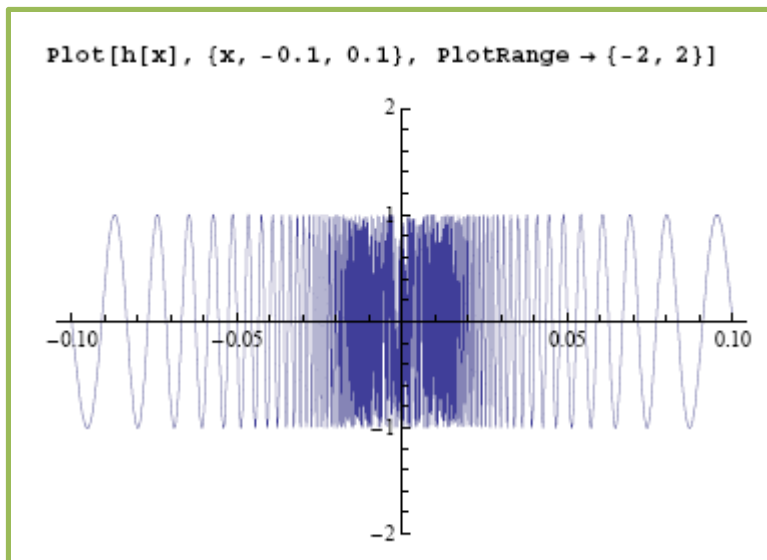


Example 2: $\lim_{x \rightarrow 0} \sin\left(\frac{\pi}{x}\right)$

It is difficult to imagine the result.

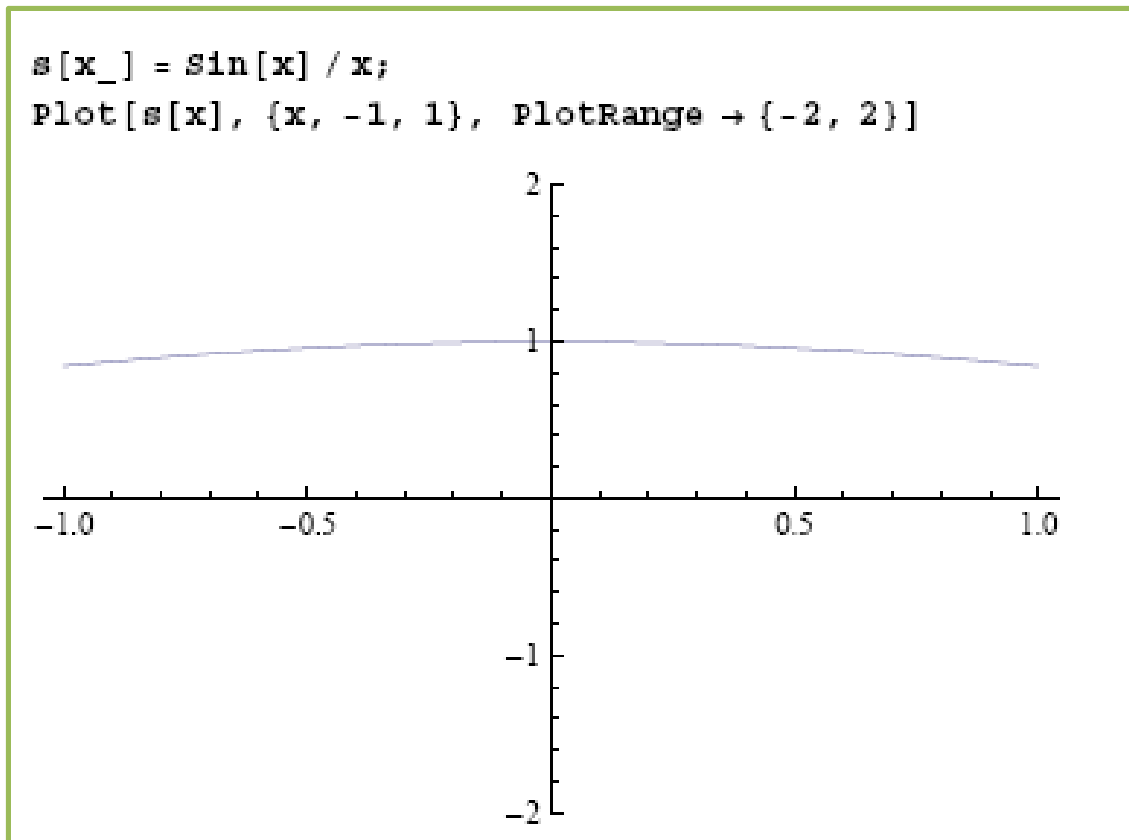


Zooming in



Compare functions

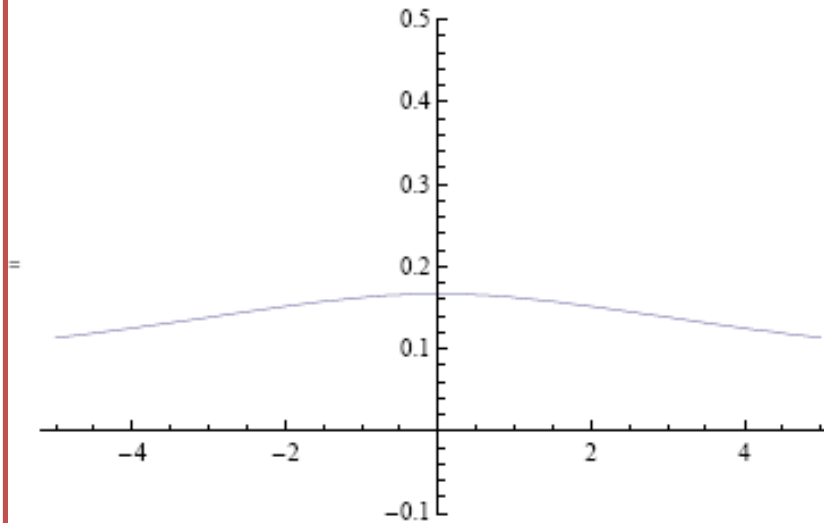
$\sin x$ and x when x close to 0.



Computer does not always good

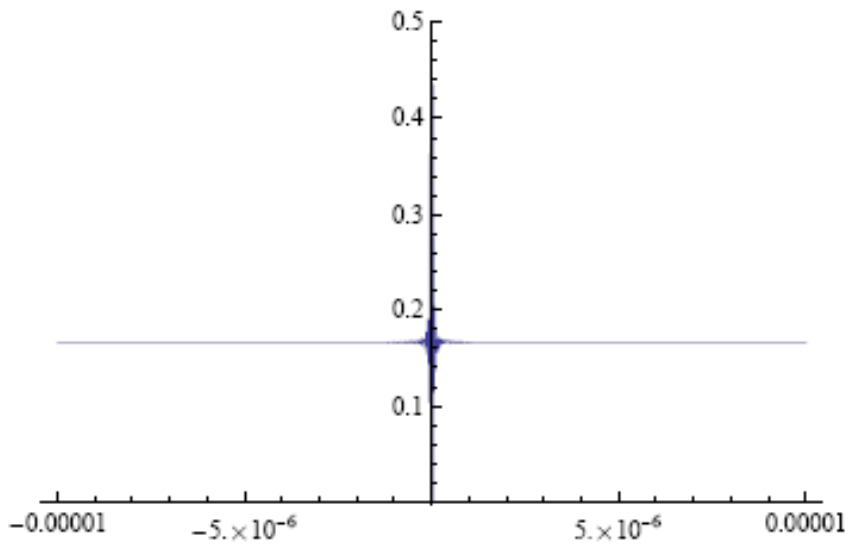
$$\lim_{x \rightarrow 0} \frac{\sqrt{x^2 + 9} - 3}{x^2} = 1/6$$

```
y = (Sqrt[x^2 + 9] - 3) / x^2;  
Plot[y, {x, -5, 5}, PlotRange -> {-0.1, 0.5}]  
Plot[y, {x, -0.000001, 0.000001}, PlotRange -> {-0.001, 0.5}]
```



Zooming in

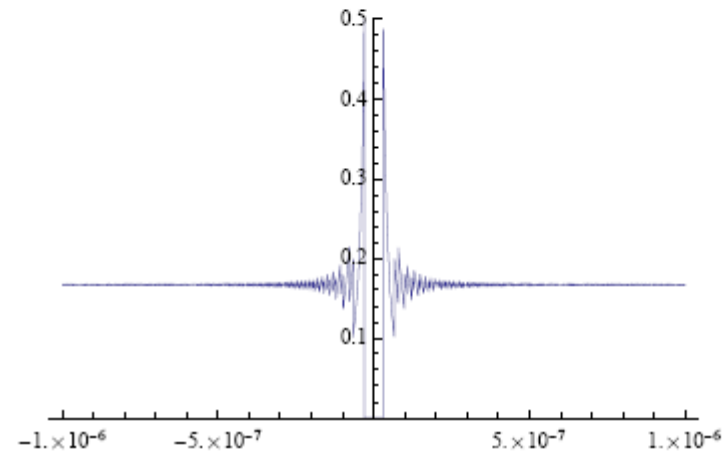
```
Plot[y, {x, -0.00001, 0.00001}, PlotRange -> {-0.001, 0.5}]
```



Confuse!

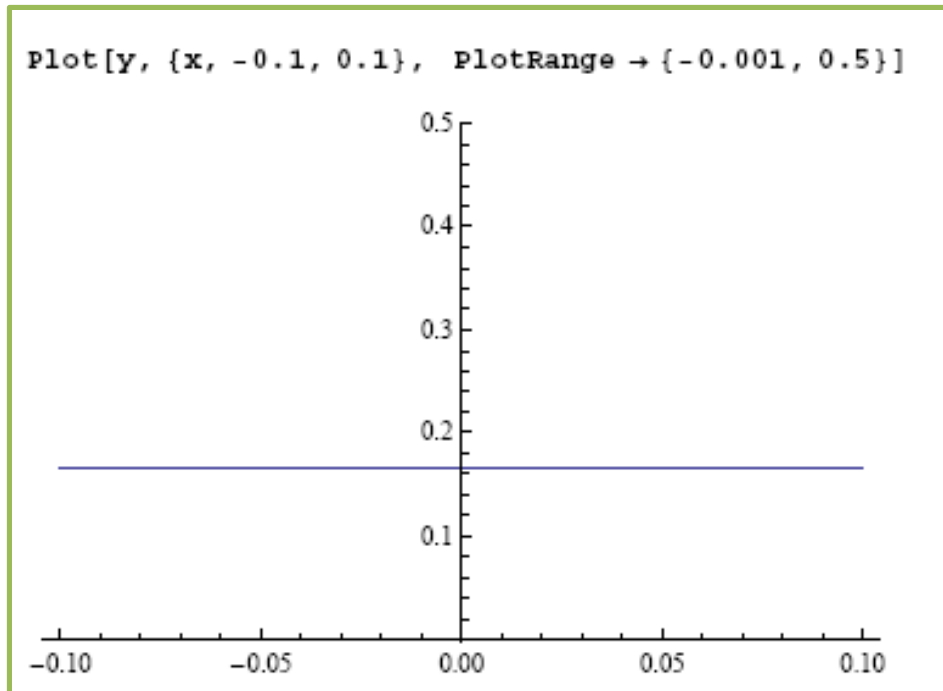
Zooming in again

```
Plot[y, {x, -0.000001, 0.000001}, PlotRange -> {-0.001, 0.5}]
```



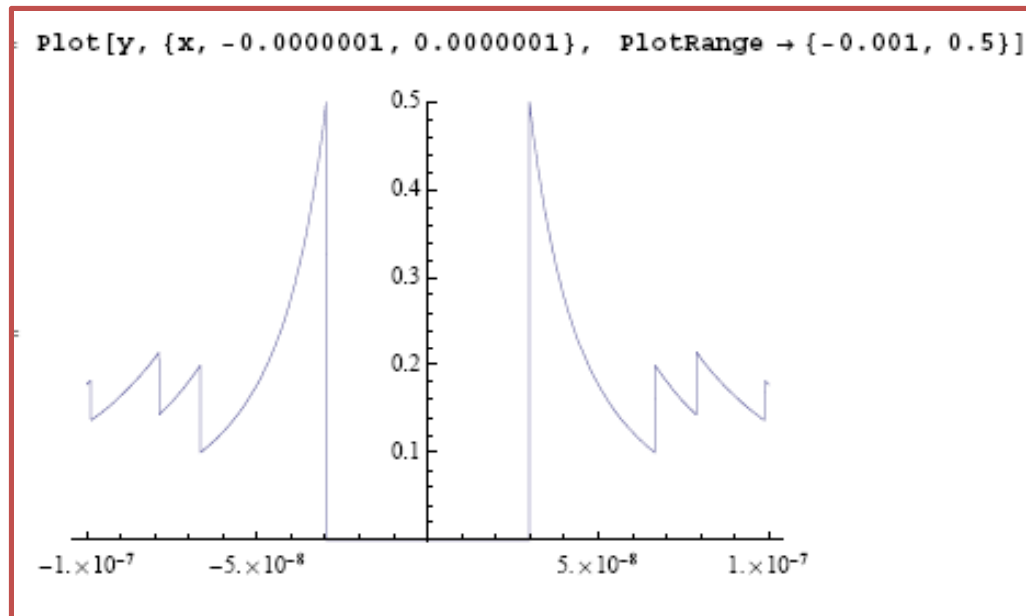
Even confuse!!

Zooming out



Very different!!! Why?

Zooming in again



- It is crazy! What happened???

Mathematics theory VS computer

- We can not trust computer all the time?
- We can not trust what we saw all the time.
- We need to study mathematics theory.
- We need to consider problems logically.
- More and more.....

Thank you.