LaTeX: What? Why? and How?

CSCE 595 Presentation

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1. Overview
2. Examples
3. Powerful Techniques
4. Questions

Outline

Procedural Markup Language

```
$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
```

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

- NOT WYSIWIG, "What You See Is What You Get"
- Steep Learning Curve
- Open Source, Free
  "Free as in Free Speech and Free Beer"
- Lots of user-created libraries and packages
- Programming Language Stuff

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History

- Donald Knuth, TEX, 1978
- Leslie Lamport, LATEX, 1983
- Last Stable Release, LATEX2ϵ, 1994
- MathType (WYSIWIG GUI for Word), 1987

Why make TEX? Appendices to The TEXBook

A. Answers to All the Exercises
B. Basic Control Structures
C. Character Codes
D. Dirty Tricks
E. Example Formats
F. Font Tables
G. Generating Boxes from Formulas
H. Hyphenation
I. Index
J. Joining the TEXCommunity

Writing Beautifully

From Donald Knuth's *Mathematical Writing*, 1989

"I look forward to the day when a Pulitzer Prize will be given for the best computer program of the year."

"I'm thinking of running a contest for the best Pascal program that is also a sonnet."

Examples in GitHub Repo

- This Presentation
- Paper in ACL Format
- Poster
- Book

Outline

Equations

```
$$\int_a^b f(x) dx = \lim_{n \to \infty}
    \sum_{i=1}^n f(x^*_i) \Delta x$$
```

$$\int_a^b f(x)dx = \lim_{n\to\infty} \sum_{i=1}^{n} f(x_i^*)\Delta x$$

```
$\int_a^b f(x) dx = \lim_{n \to \infty}
    \sum_{i=1}^n f(x^*_i) \Delta x$
```

$\int_a^b f(x)dx = \lim_{n\to\infty} \sum_{i=1}^{n} f(x_i^*)\Delta x$

Aligned Equations

$$
\begin{aligned}
e^{3x+4} &= 2 \\
3x + 4 &= \ln 2 \\
3x &= \ln 2 - 4 \\
x &= \frac{\ln 2 - 4}{3}
\end{aligned}
$$

```
\begin{align*}
    e^{3x+4} &= 2 \cr
    3x+4 &= \ln 2 \cr
    3x &= \ln 2 - 4 \cr
    x &= \frac{\ln 2 - 4}{3} \cr
\end{align*}
```

Tabular Environment

Teacher		Course	Period	Course	Period
Emily	Allen	EN300.1	13	EN300.3	14
Scott	Atkins	PH240L.1	12	PH120.2	13
Robert	Dalling	PH320.1	13	PH350.1	14
Leo	Eisenlohr	FL170.1	13	FL270.1	14
Victor	Feske	EH122.1	13	EH122.2	14

```
\begin{tabular}{ll|lclc}
\multicolumn{2}{c}{Teacher}
    & Course & Period & Course & Period \cr\hline
Emily & Allen & EN300.1 & 13 &  EN300.3 & 14 \cr
...
\end{tabular}
```

Tables with Math

$$\begin{aligned} 2x + 15y &= 6 \\ 3x - 4y &< 12 \end{aligned}$$

```
\begin{tabular}{*5{@{\hspace{4pt}}>{$}r<{$}}}
    2x &+& 15y &=& 6 \cr
    3x &-& 4y &<& 12 \cr
\end{tabular}
```

Code

Listing 1: Default Style

```
import math
# Comment
def stuff():
    for a in range (10):
        for b in range (10):
            if math.gcd(a,b)==1:
                print (a, b)
stuff()
```

Code

Listing 2: Formatted No Color

```
1 import math
2 # Comment
3 def stuff():
4     for a in range (10):
5         for b in range (10):
6             if math.gcd(a,b)==1:
7                 print (a, b)
8 stuff()
```

Code

Listing 3: Typical Colors

```
1 import math
2 # Comment
3 def stuff():
4     for a in range (10):
5         for b in range (10):
6             if math.gcd(a,b)==1:
7                 print (a, b)
8 stuff()
```

Code

Listing 4: UL Colors

```
1 import math
2 # Comment
3 def stuff():
4     for a in range (10):
5         for b in range (10):
6             if math.gcd(a,b)==1:
7                 print (a, b)
8 stuff()
```

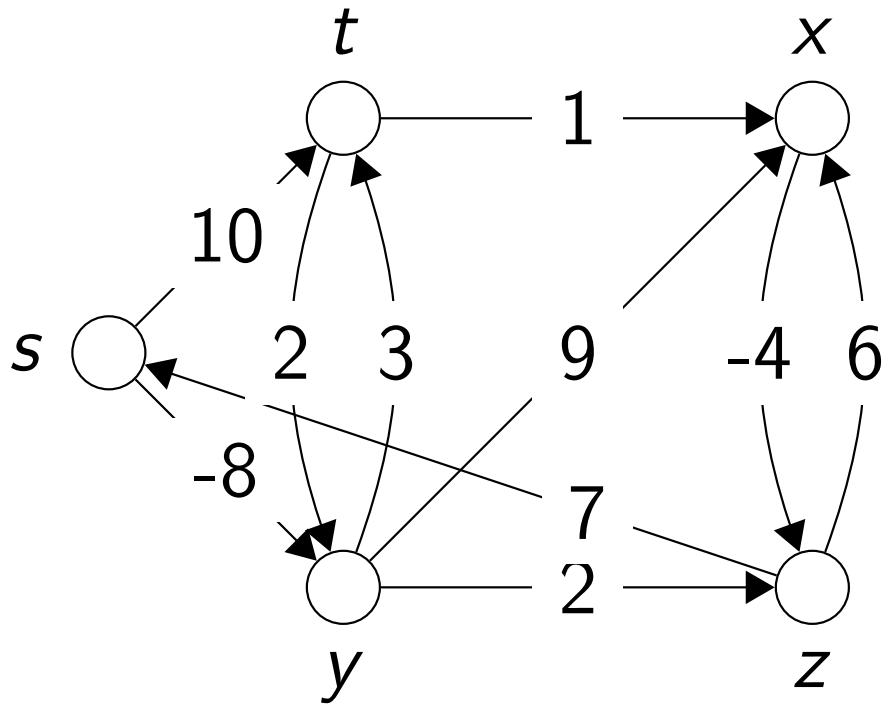
TikZ

Graphics Package for LaTeX

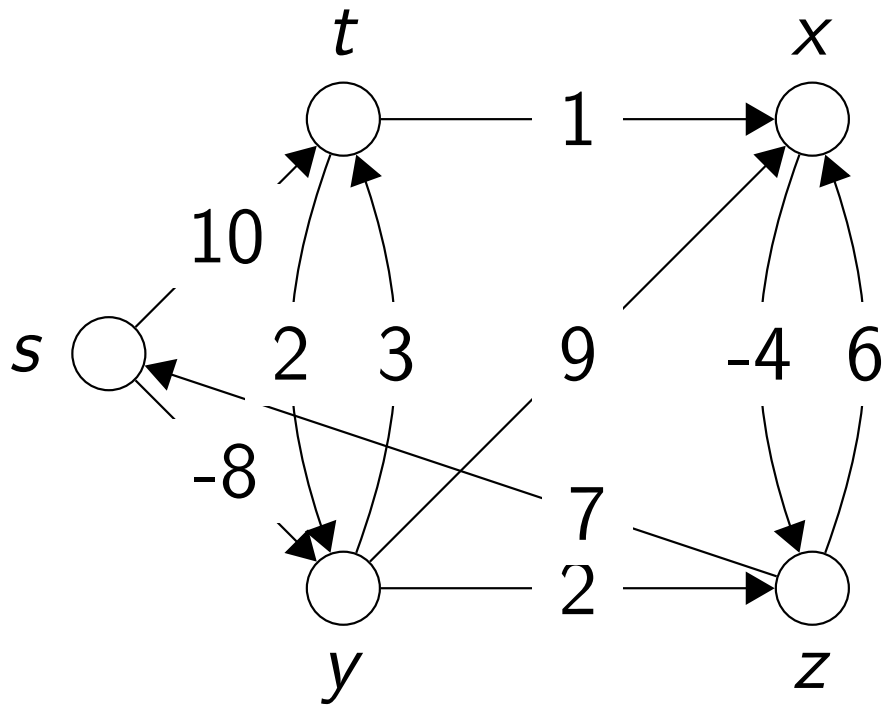
TikZ *ist kein Zeichenprogramm*

"TikZ is not a graphing program."

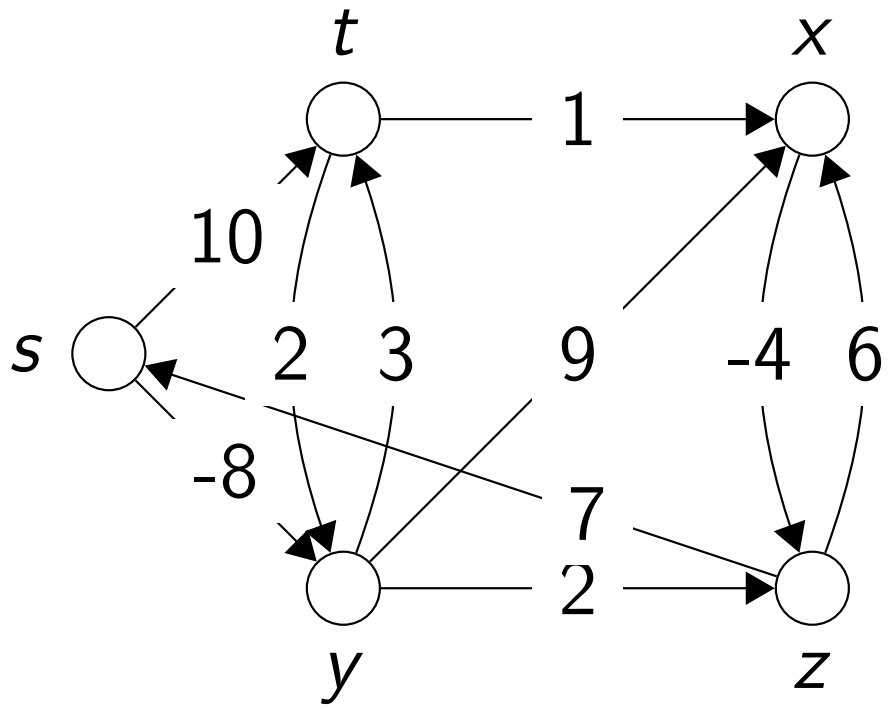
Graphs: Fall 2018 #L3




```
\begin{tikzpicture}[x=15mm, y=15mm]
  \node [circle, draw, label=left:$s$]
    (s) at (0,0) {};
```




```
\foreach \from/\to/\weight in {s/t/10, s/y/-8, t/x/1, y/x/9, y/z/2}
  \draw [-triangle 60] (\from) -- (\to) node [midway, rectangle, fill=white] {\weight};
```




```
\foreach \from/\to/\weight in {t/y/2, y/t/3, x/z/-4, z/x/6}
  \draw [bend right=20, -triangle 60] (\from) to node [midway, rectangle, fill=white] {\weight} (\to);
```

Harmonic Series

$$1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\cdots=\lim_{n\to\infty}\sum_{r=1}^{n}\frac{1}{r}$$

This series does not converge.

Harmonic Series

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This series does not converge.

Source of my confusion: In our work, n is finite.

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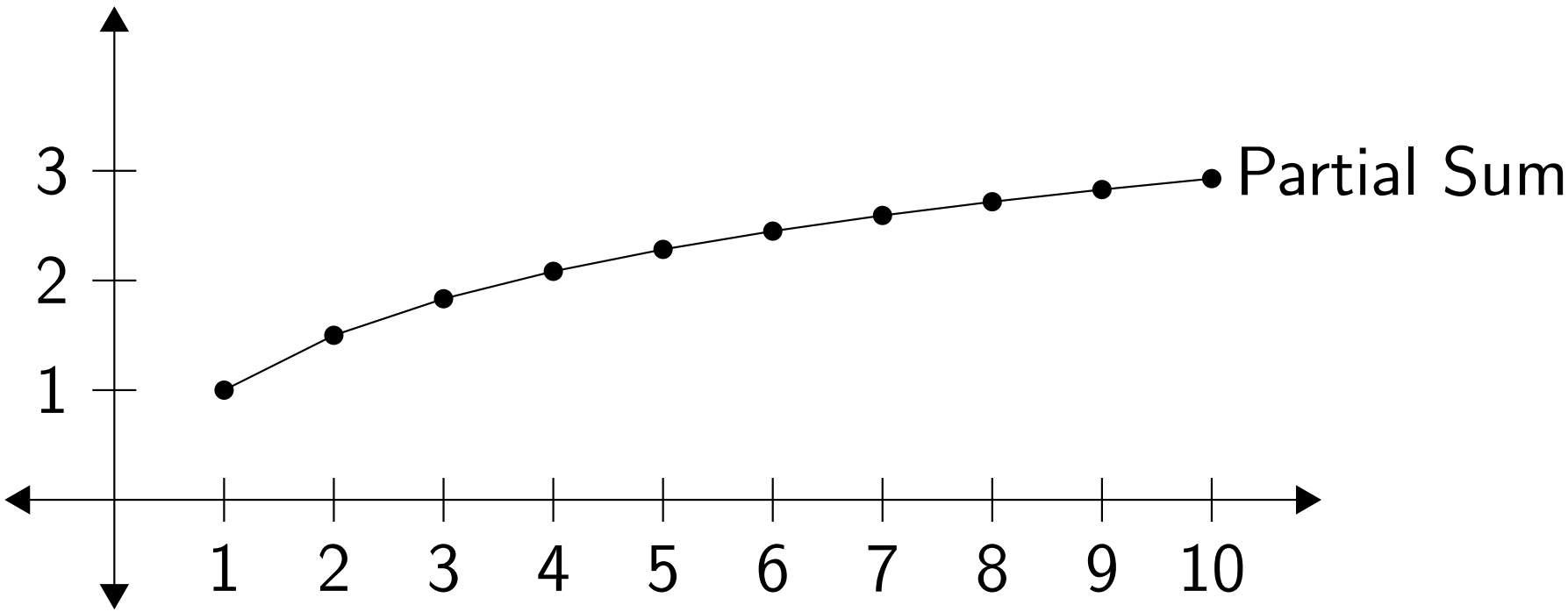

Harmonic Series

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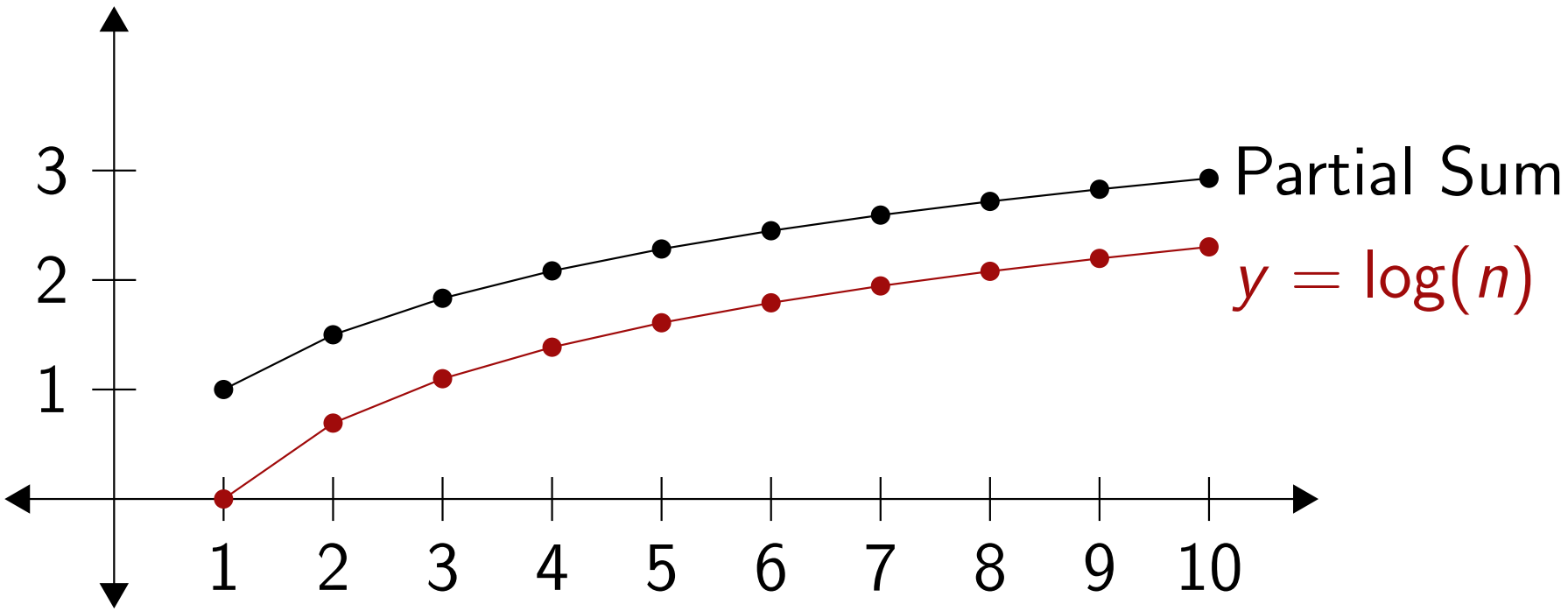
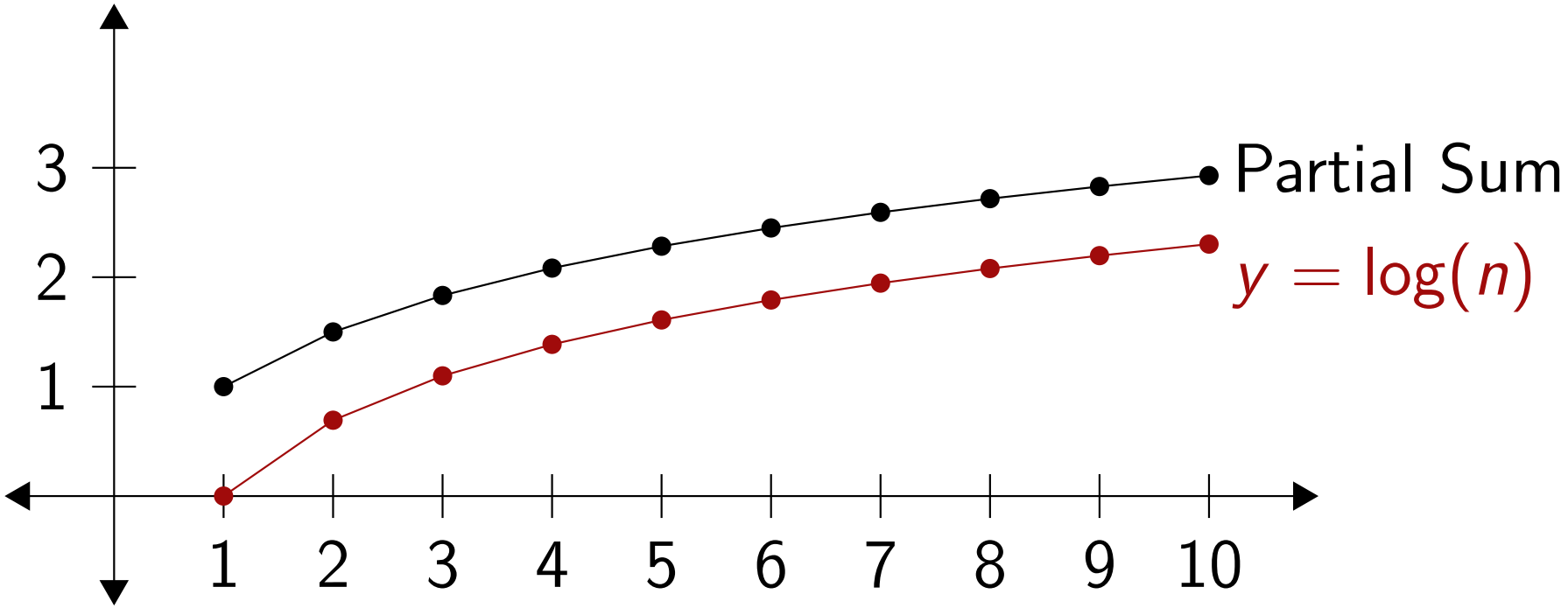


Harmonic Series

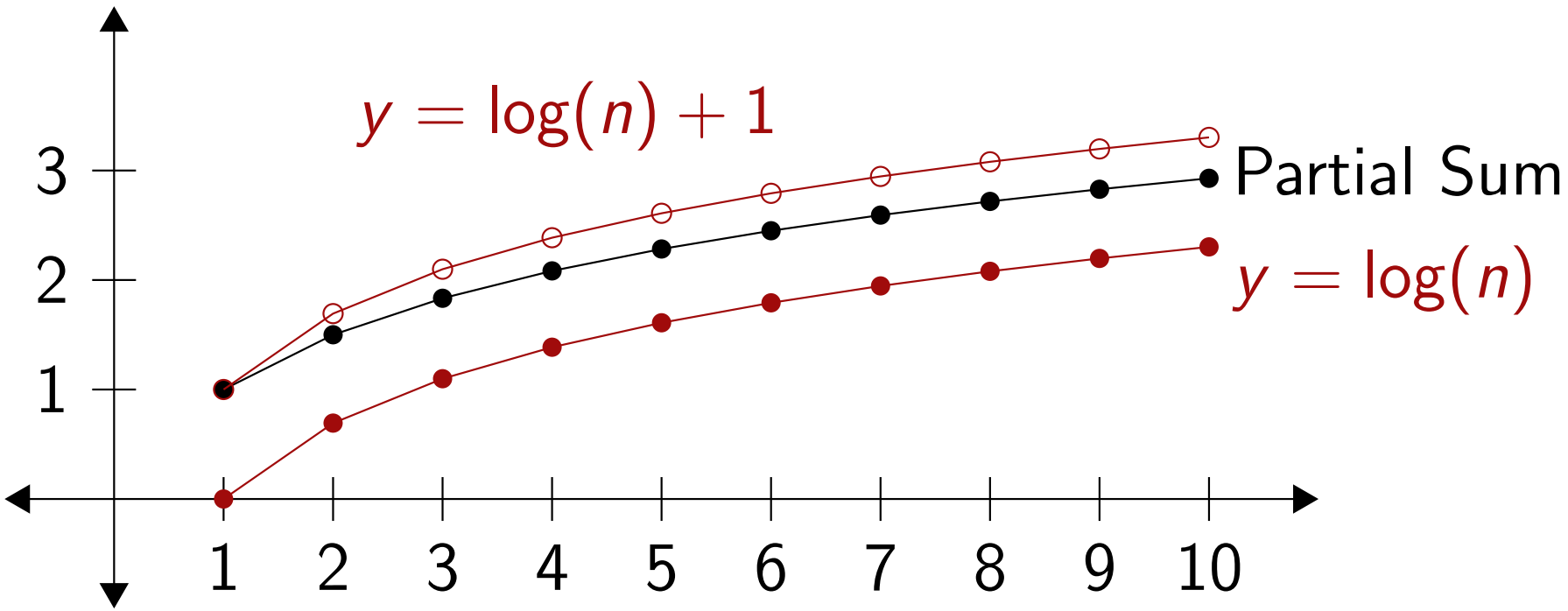
$$1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\cdots+\frac{1}{n}=\sum_{r=1}^{n}\frac{1}{r}$$



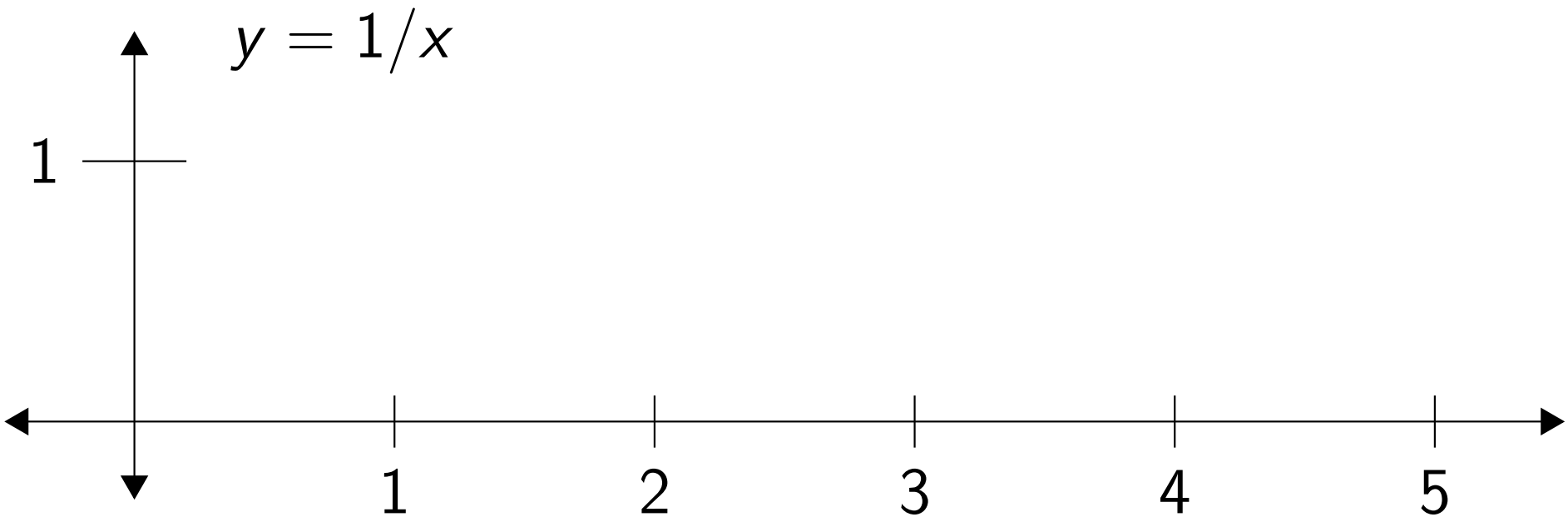
$$\frac{dy}{dx}=y,\ (0,1) \qquad \frac{dy}{dx}=\frac{1}{x},\ (1,0)$$

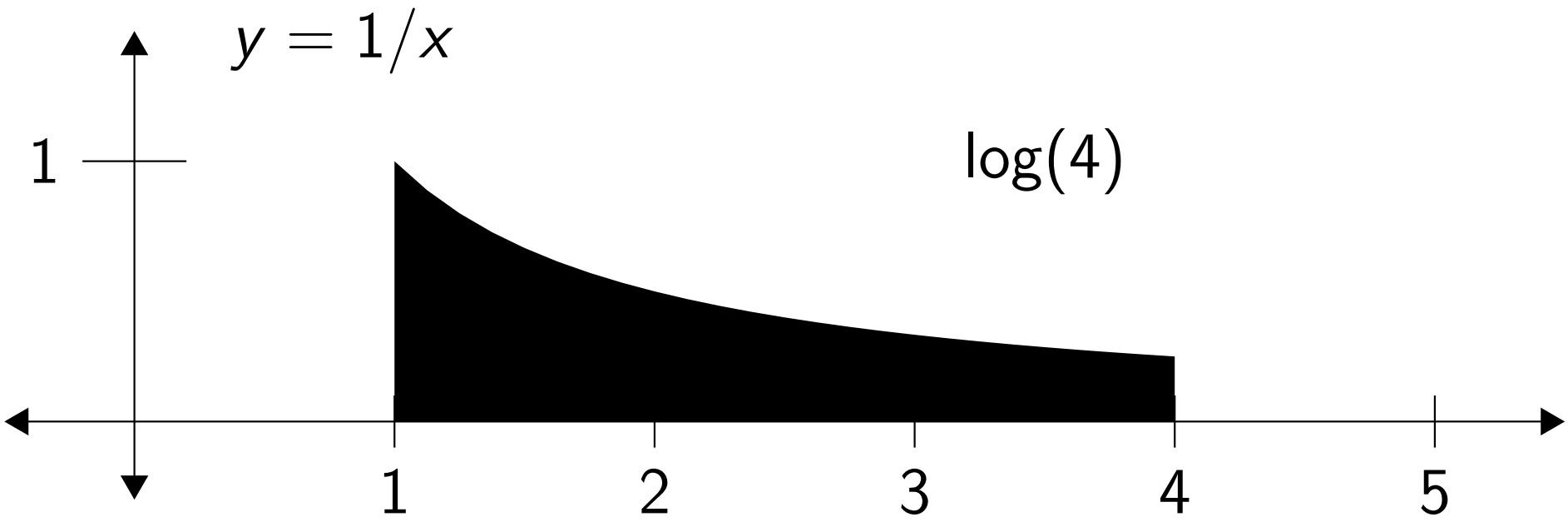
Harmonic Series

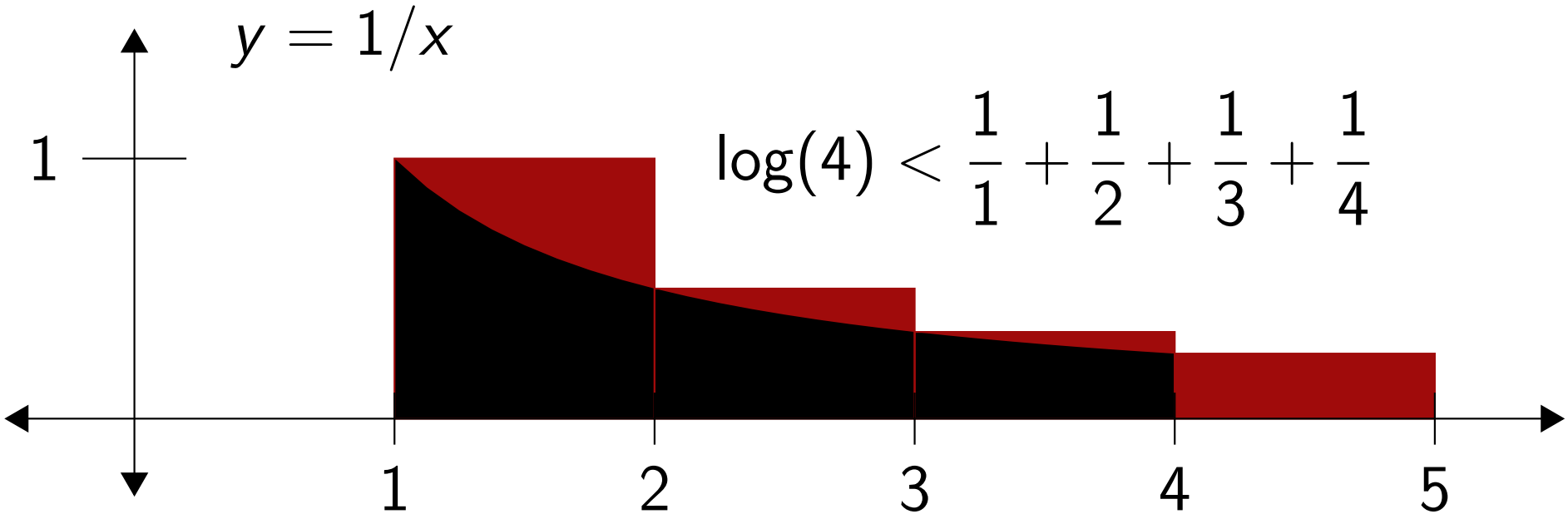
$$1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\cdots+\frac{1}{n}=\sum_{r=1}^{n}\frac{1}{r}$$



$\frac{dy}{dx} = y,\ (0,1)$ $\frac{dy}{dx} = \frac{1}{x},\ (1,0)\ (1,1)$

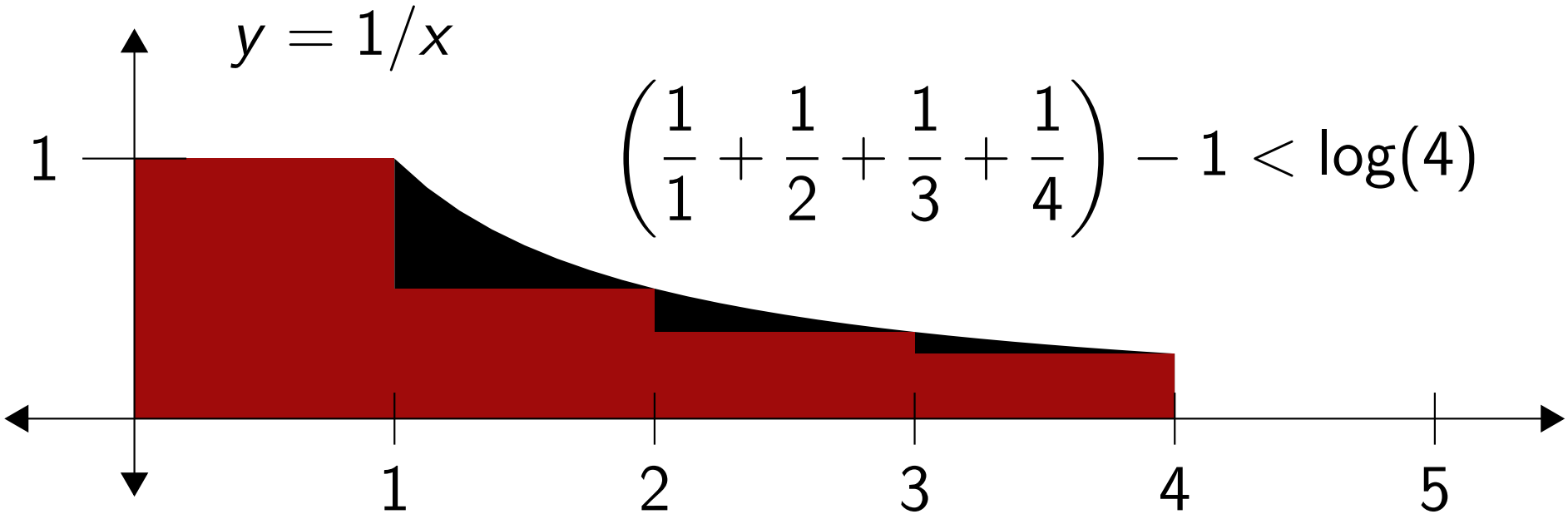

$y = 1/x$
1
1
2
3
4
5


$y = 1/x$
1
log(4)
1
2
3
4
5



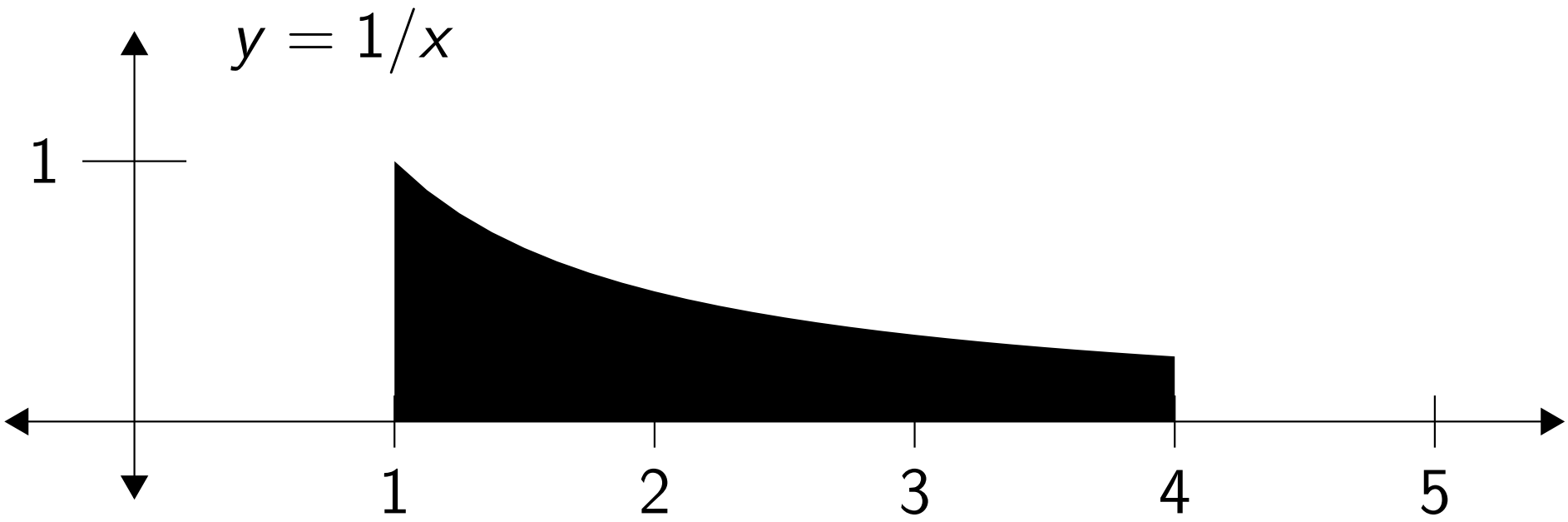
$$\log(4) < \frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \frac{1}{4}$$

$$\log(n) < \sum_{r=1}^{n} \frac{1}{r}$$

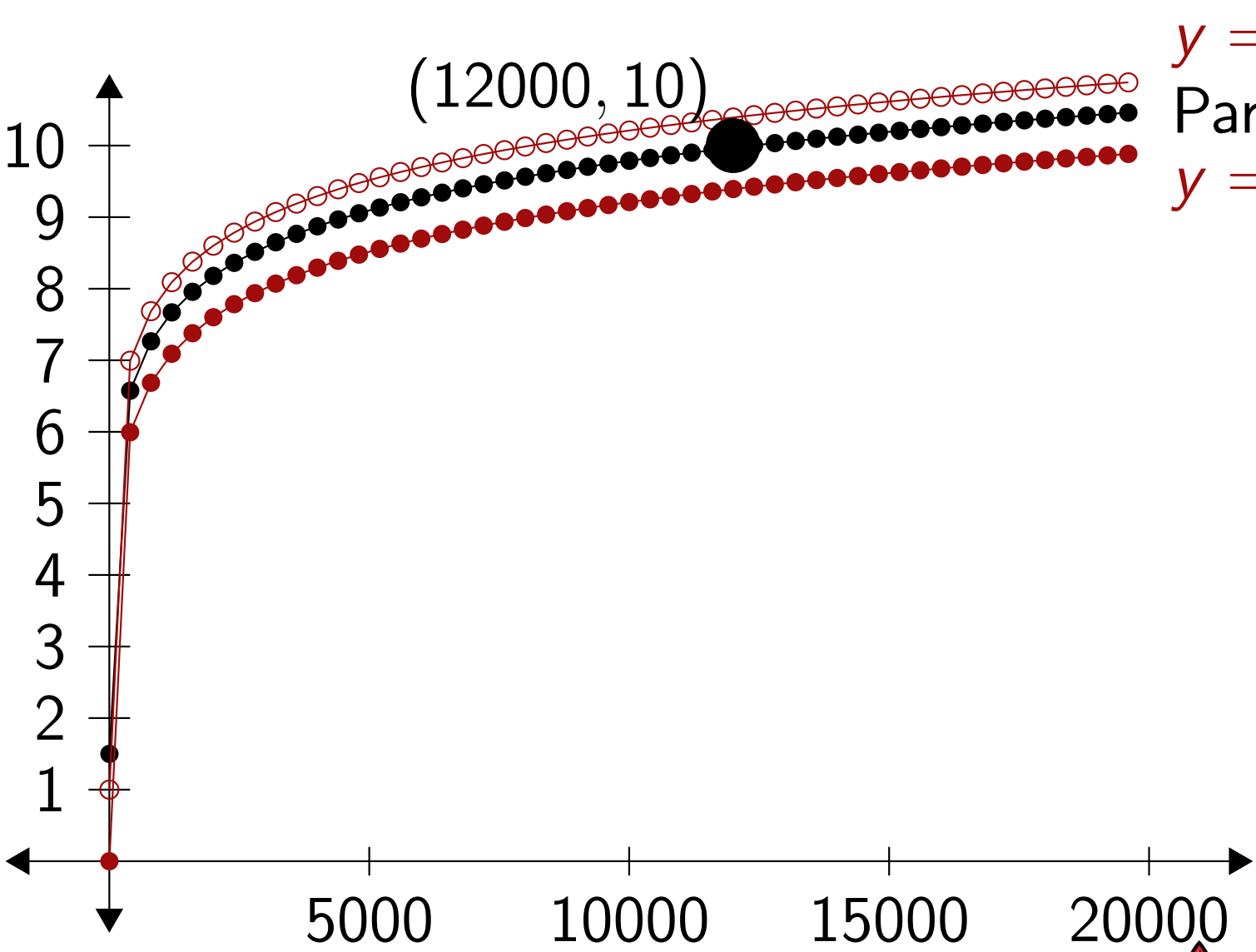


$$\left(\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}\right)-1<\log(4)$$

$$\sum_{r=1}^{n}\frac{1}{r}-1 \;<\; \log(n)$$



$$\log(n) < \sum_{r=1}^{n} \frac{1}{r} < \log(n) + 1$$



$y = \log(n) + 1$

Partial Sum

$y = \log(n)$

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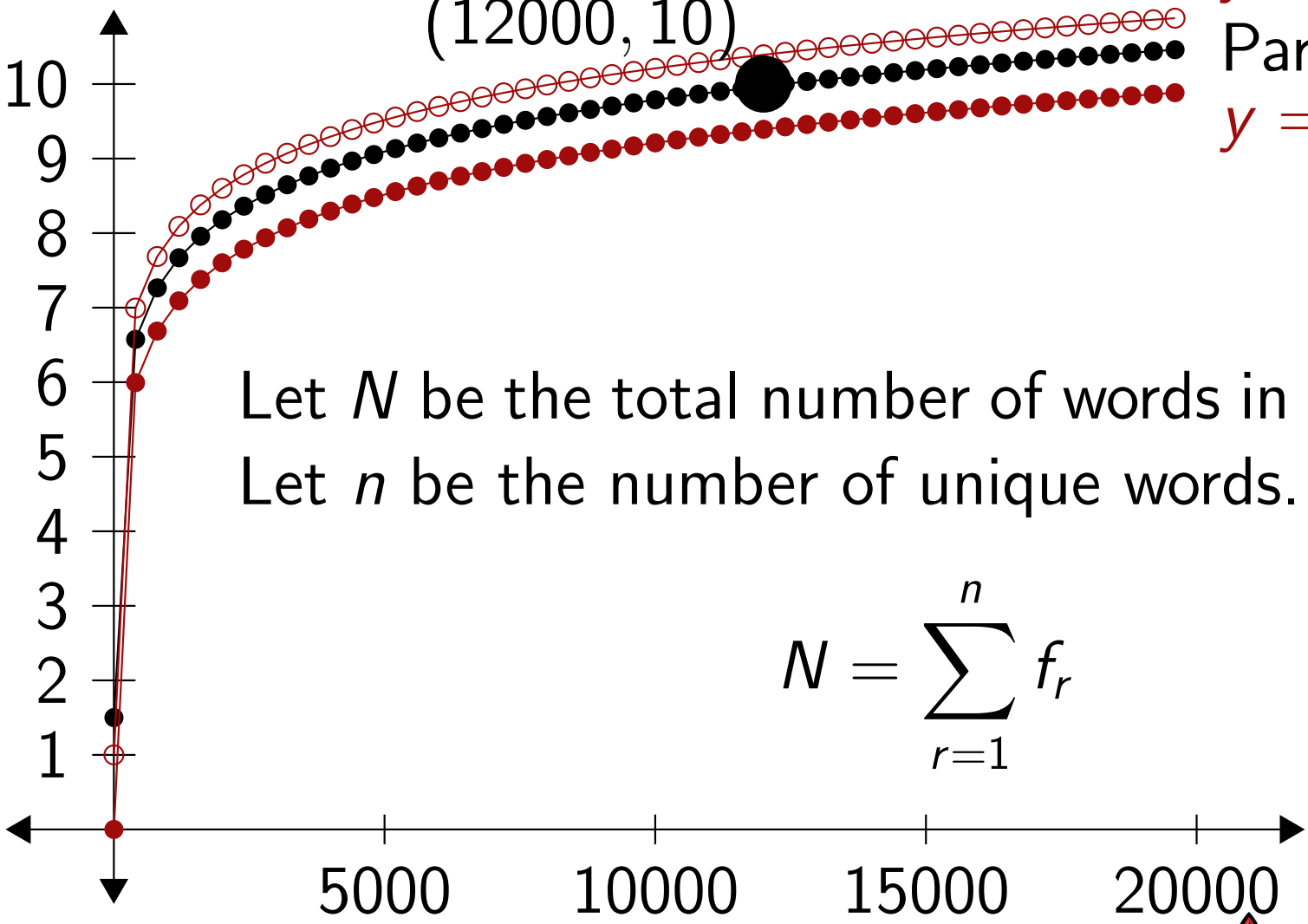
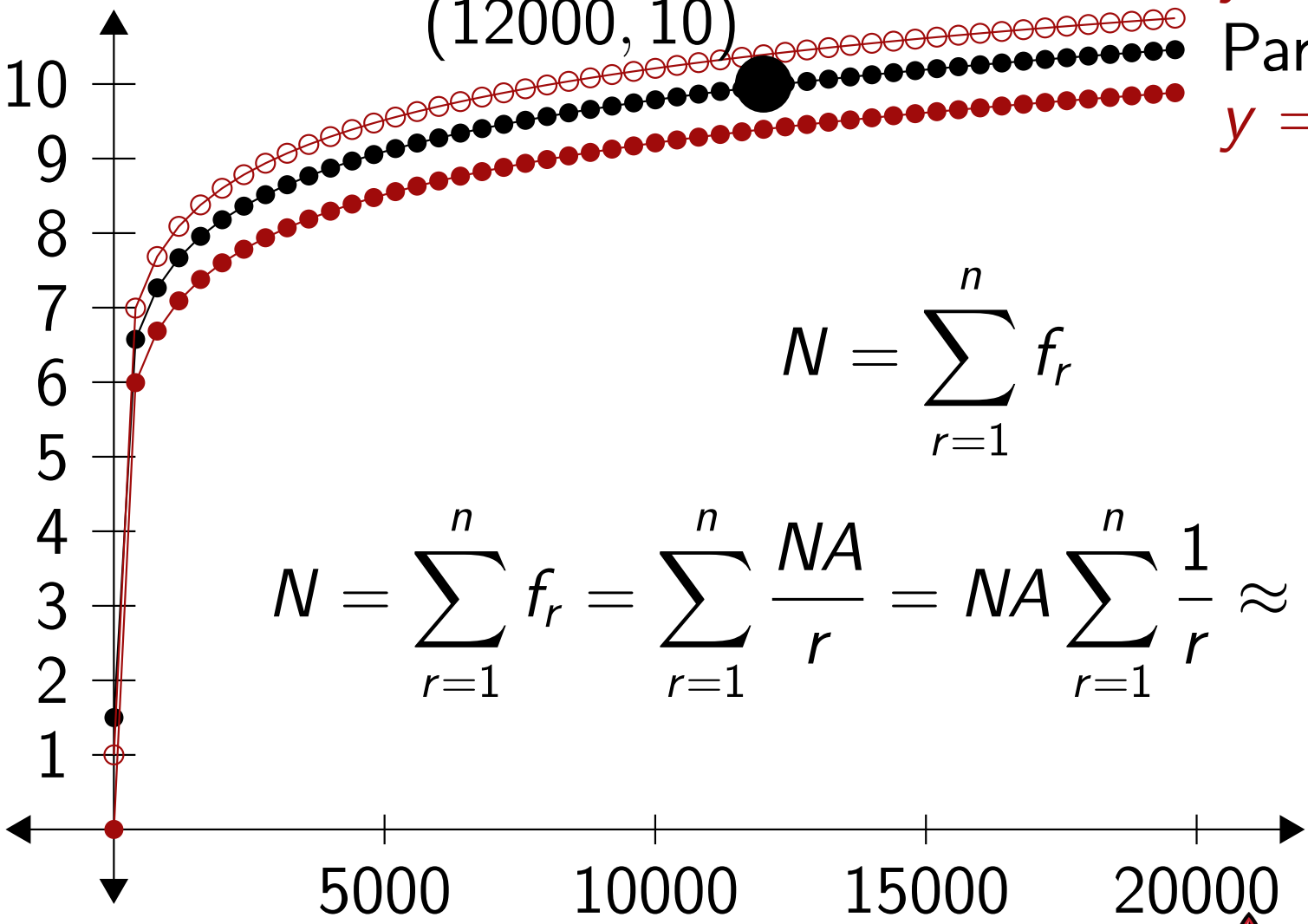


$y = \log(n) + 1$
Partial Sum
$y = \log(n)$

Let N be the total number of words in the corpus.
Let n be the number of unique words.

$$N = \sum_{r=1}^{n} f_r$$



$y = \log(n) + 1$

Partial Sum

$y = \log(n)$

$$N = \sum_{r=1}^{n} f_r$$

$$N = \sum_{r=1}^{n} f_r = \sum_{r=1}^{n} \frac{NA}{r} = NA \sum_{r=1}^{n} \frac{1}{r} \approx NA \log(n)$$

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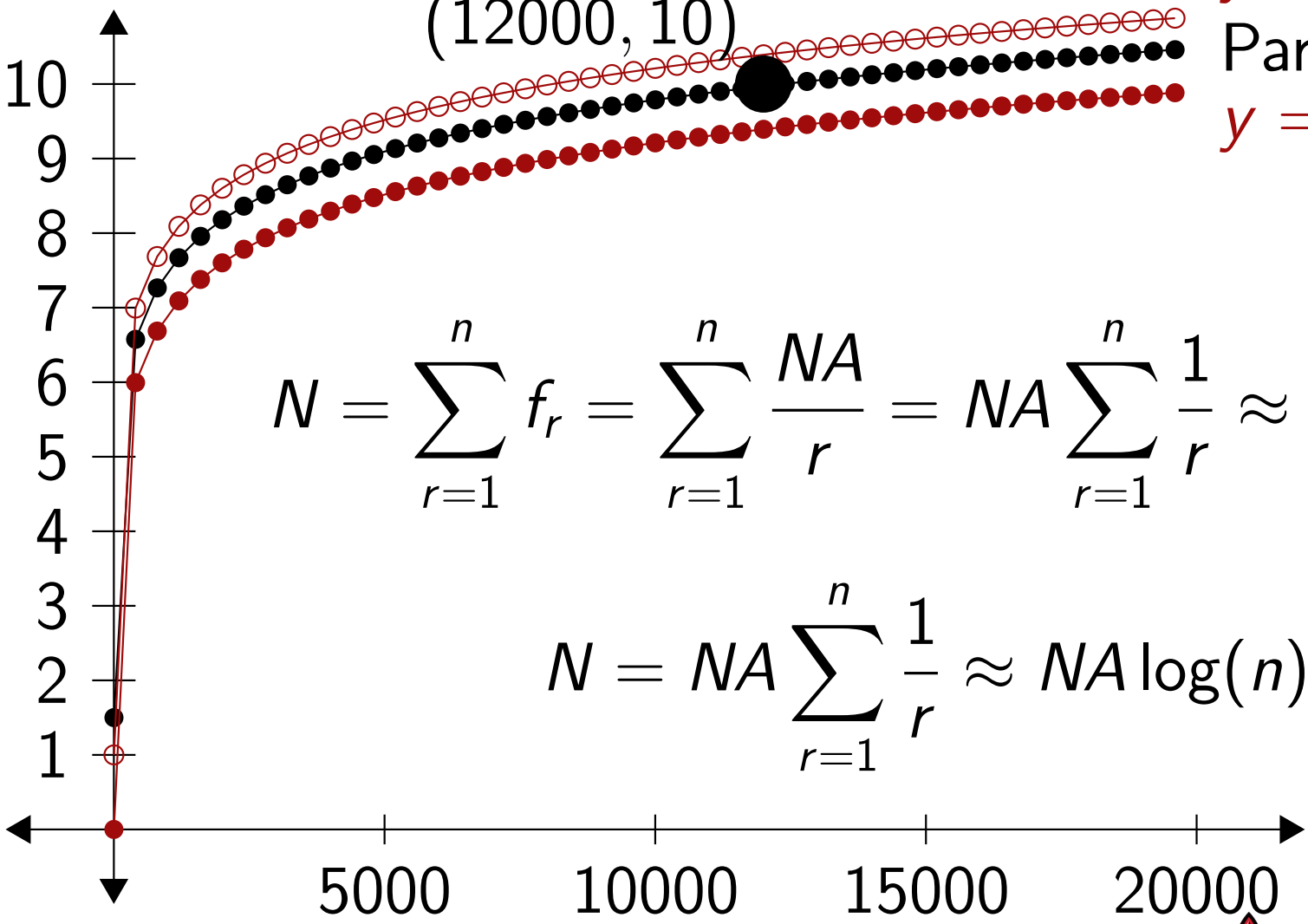

$y = \log(n) + 1$

Partial Sum

$y = \log(n)$

$$N = \sum_{r=1}^{n} f_r = \sum_{r=1}^{n} \frac{NA}{r} = NA \sum_{r=1}^{n} \frac{1}{r} \approx NA \log(n)$$

$$N = NA \sum_{r=1}^{n} \frac{1}{r} \approx NA \log(n)$$

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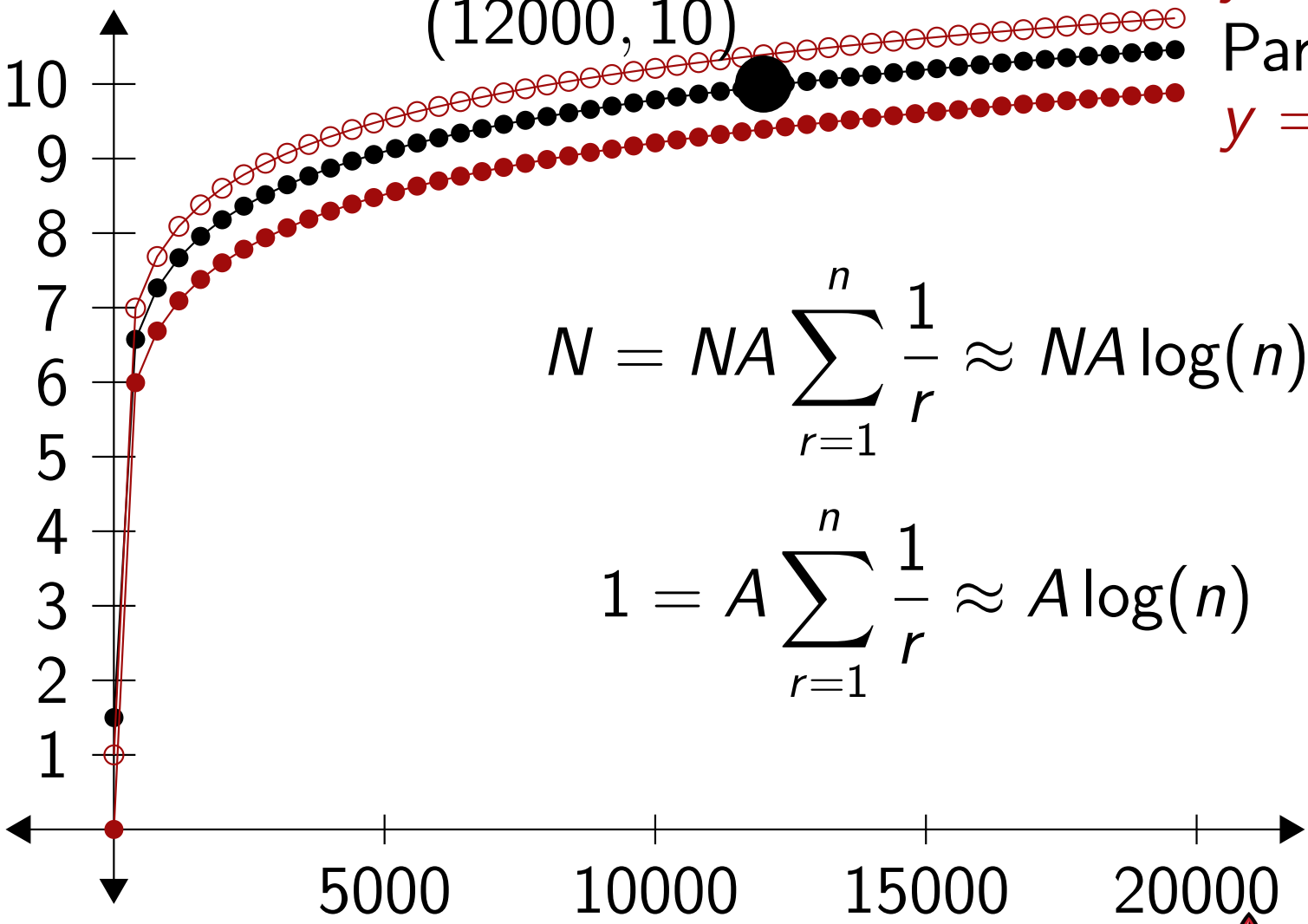


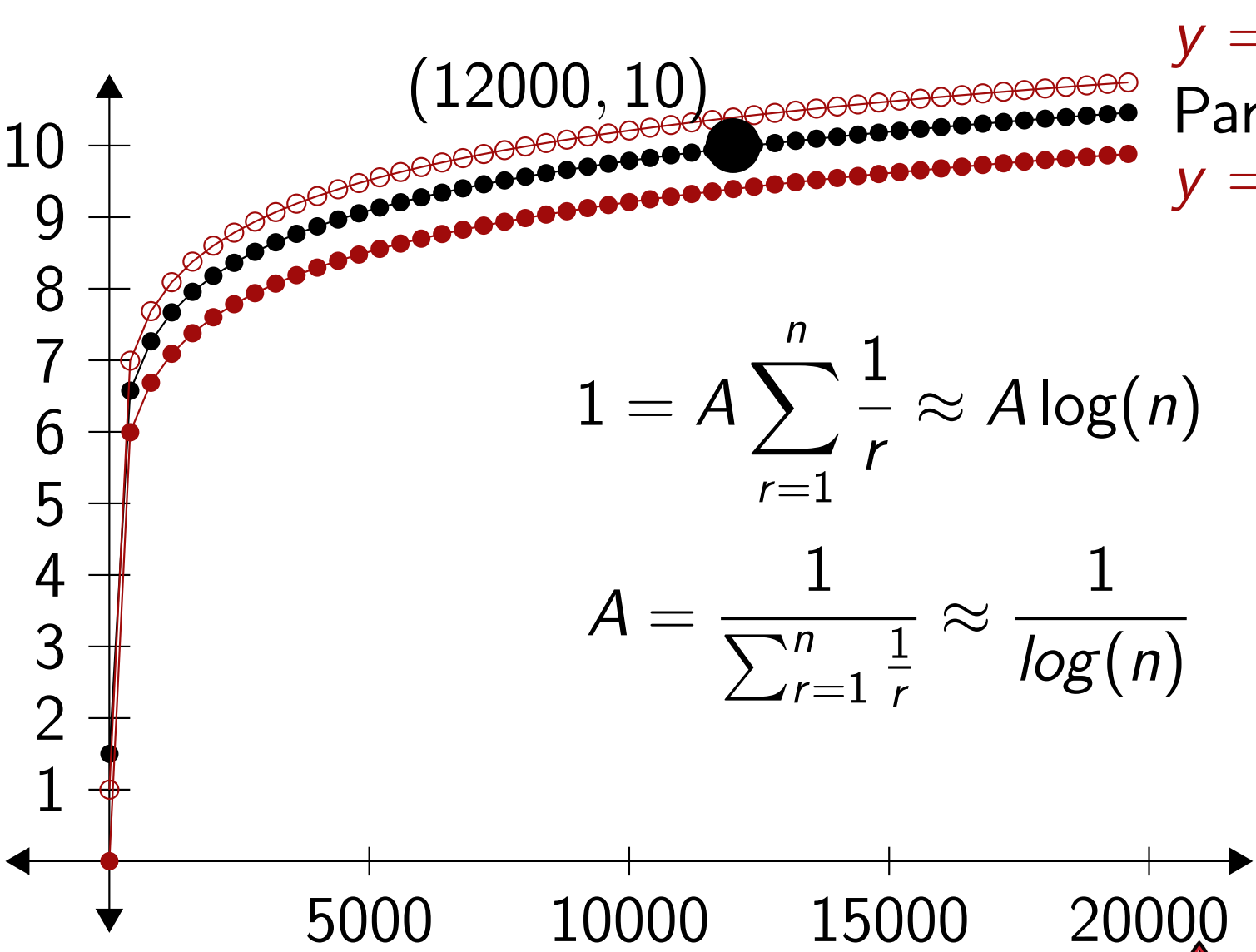
$y = \log(n) + 1$

Partial Sum

$y = \log(n)$

$$N = NA \sum_{r=1}^{n} \frac{1}{r} \approx NA \log(n)$$

$$1 = A \sum_{r=1}^{n} \frac{1}{r} \approx A \log(n)$$



$y = \log(n) + 1$

Partial Sum

$y = \log(n)$

$$1 = A \sum_{r=1}^{n} \frac{1}{r} \approx A \log(n)$$

$$A = \frac{1}{\sum_{r=1}^{n} \frac{1}{r}} \approx \frac{1}{log(n)}$$

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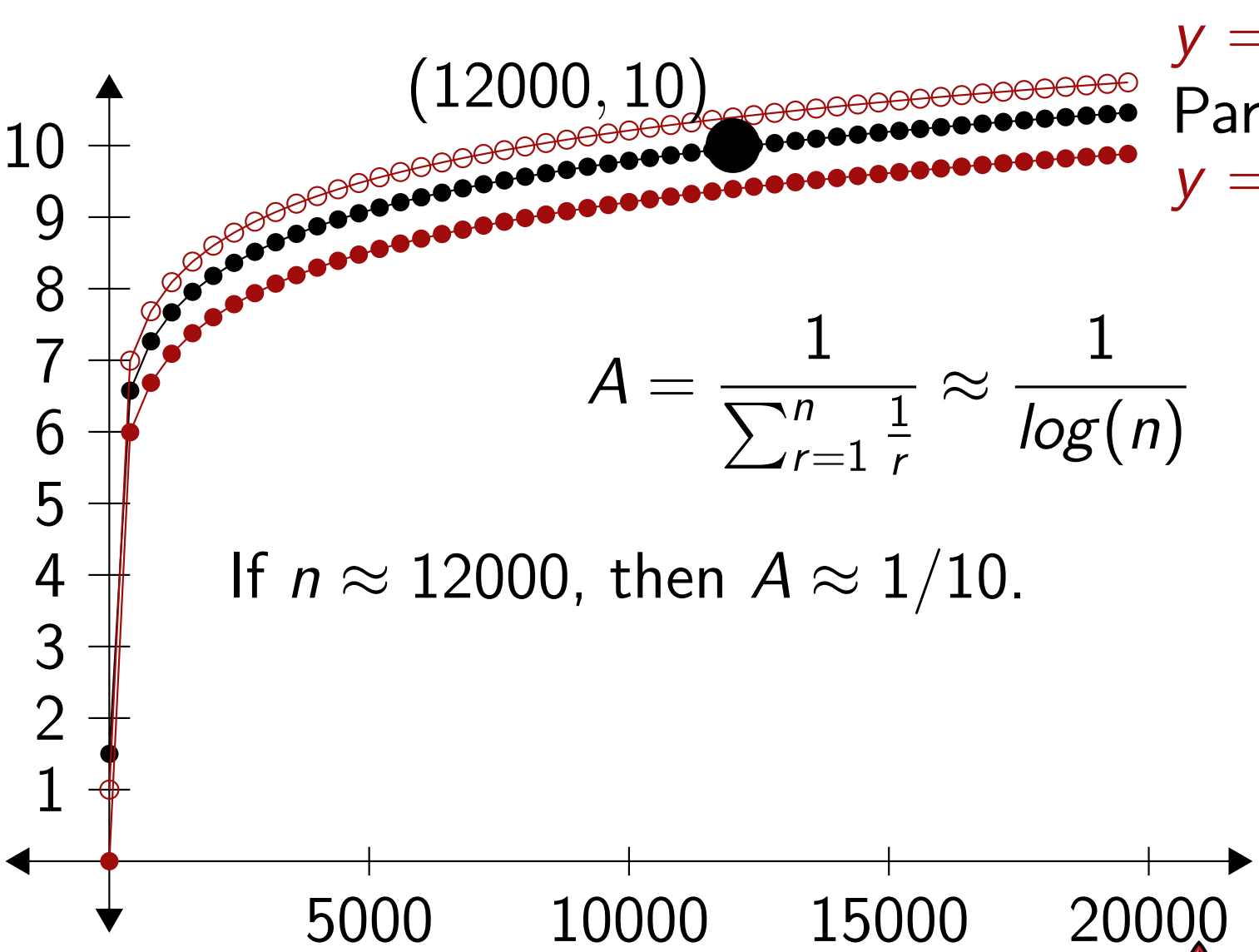


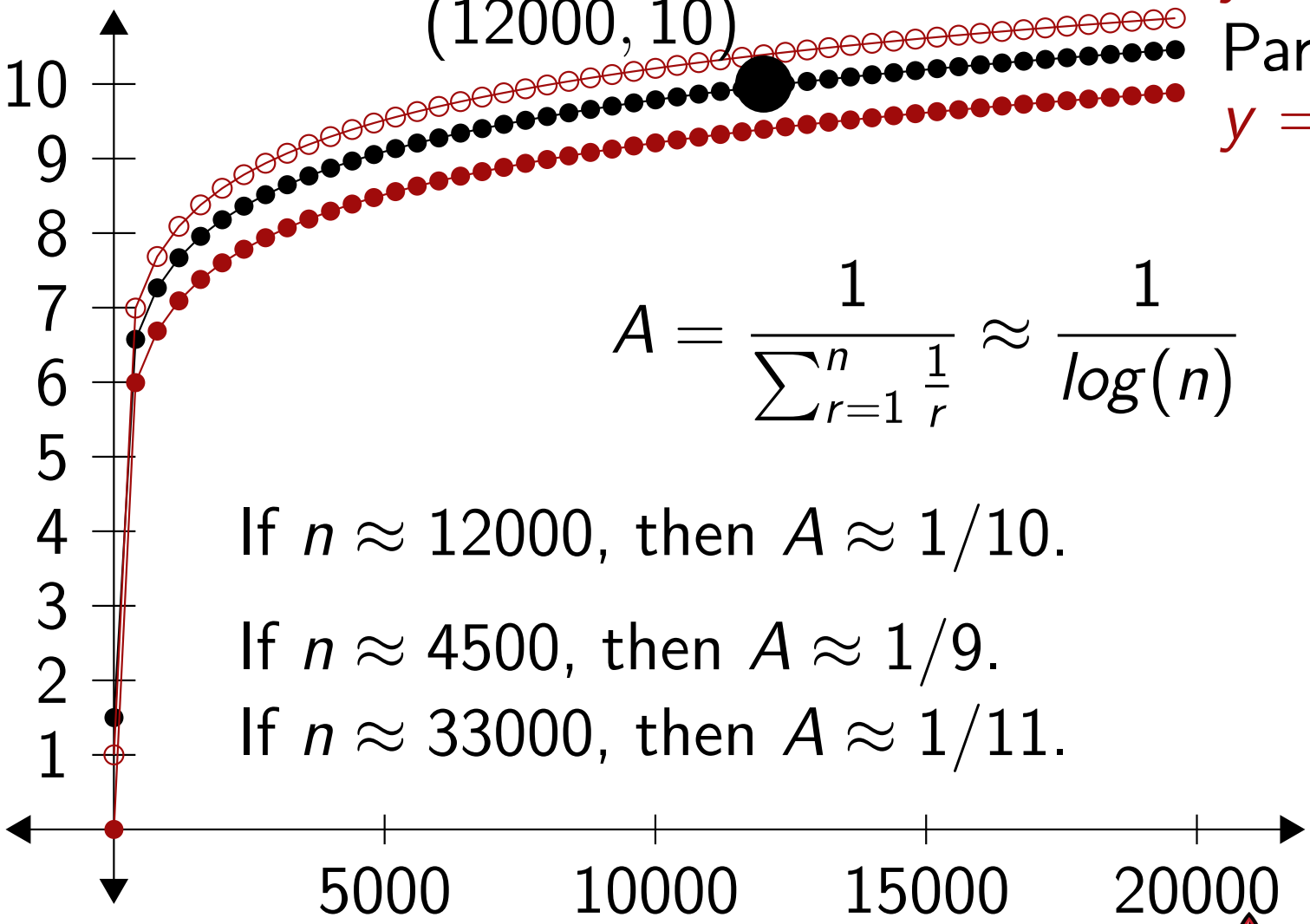
$y = \log(n) + 1$

Partial Sum

$y = \log(n)$

$$A = \frac{1}{\sum_{r=1}^{n} \frac{1}{r}} \approx \frac{1}{log(n)}$$

If $n \approx 12000$, then $A \approx 1/10$.



$y = \log(n) + 1$

Partial Sum

$y = \log(n)$

$$A = \frac{1}{\sum_{r=1}^{n} \frac{1}{r}} \approx \frac{1}{log(n)}$$

If $n \approx 12000$, then $A \approx 1/10$.

If $n \approx 4500$, then $A \approx 1/9$.

If $n \approx 33000$, then $A \approx 1/11$.

Outline

Code Output can be LaTeX Input

```
1  write = open("Graph03.tex","w")
2  Max = 20000
3  s = 0.0
4  for i in range (1,Max+1,1):
5     a = 1/float(i)
6     s += a
7     if i%400==2:
8        write.write ("\\fill (%d,%f)
      circle (2pt);\n" % (i,s))
9
10 s = 0.0
11 write.write ("\\draw ")
```

```
\fill (2,1.500000) circle (2pt);
\fill (402,6.574911) circle (2pt);
\fill (802,7.264948) circle (2pt);
\fill (1202,7.669374) circle (2pt);
\fill (1602,7.956536) circle (2pt);
\fill (2002,8.179367) circle (2pt);
\fill (2402,8.361481) circle (2pt);
\fill (2802,8.515483) circle (2pt);
\fill (3202,8.648903) circle (2pt);
\fill (3602,8.766599) circle (2pt);
\fill (4002,8.871890) circle (2pt);
\fill (4402,8.967144) circle (2pt);
\fill (4802,9.054108) circle (2pt);
```

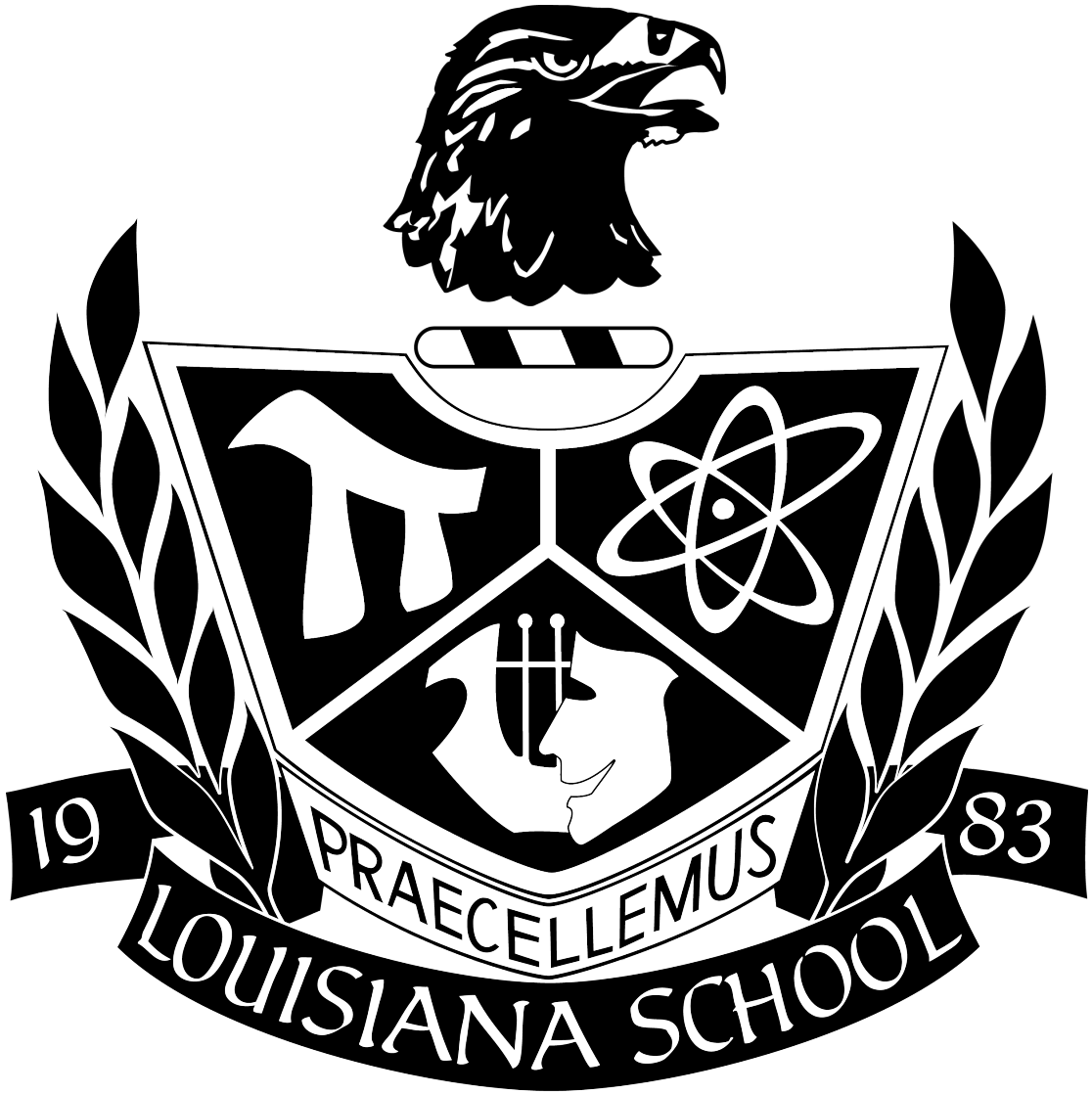
```
\begin{tikzpicture}[x=0.004mm,y=5.5mm]
  \input{Graph03}
  \path (20000,10.5) node [right] {
  Partial Sum};
  \fill [black] (12000,10) circle (6pt
  ) node [above left] {$(12000,10)$};
```

LaTeX Input is Plain Text

- Code Output can be LaTeX Input
- Structured Documents
  - Multi-File
  - Chapters, Sections, Subsections
  - Table of Contents
  - Index
  - Bibliography
- Git
  - Version Control
  - Collaboration

Outline

Questions?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