L1 4800 Algorithms

abhi shelat

Sep 9 2016

anthem

let me intro myself

first goal: create an amazing learning experience

second goal: instill enthusiasm for this area

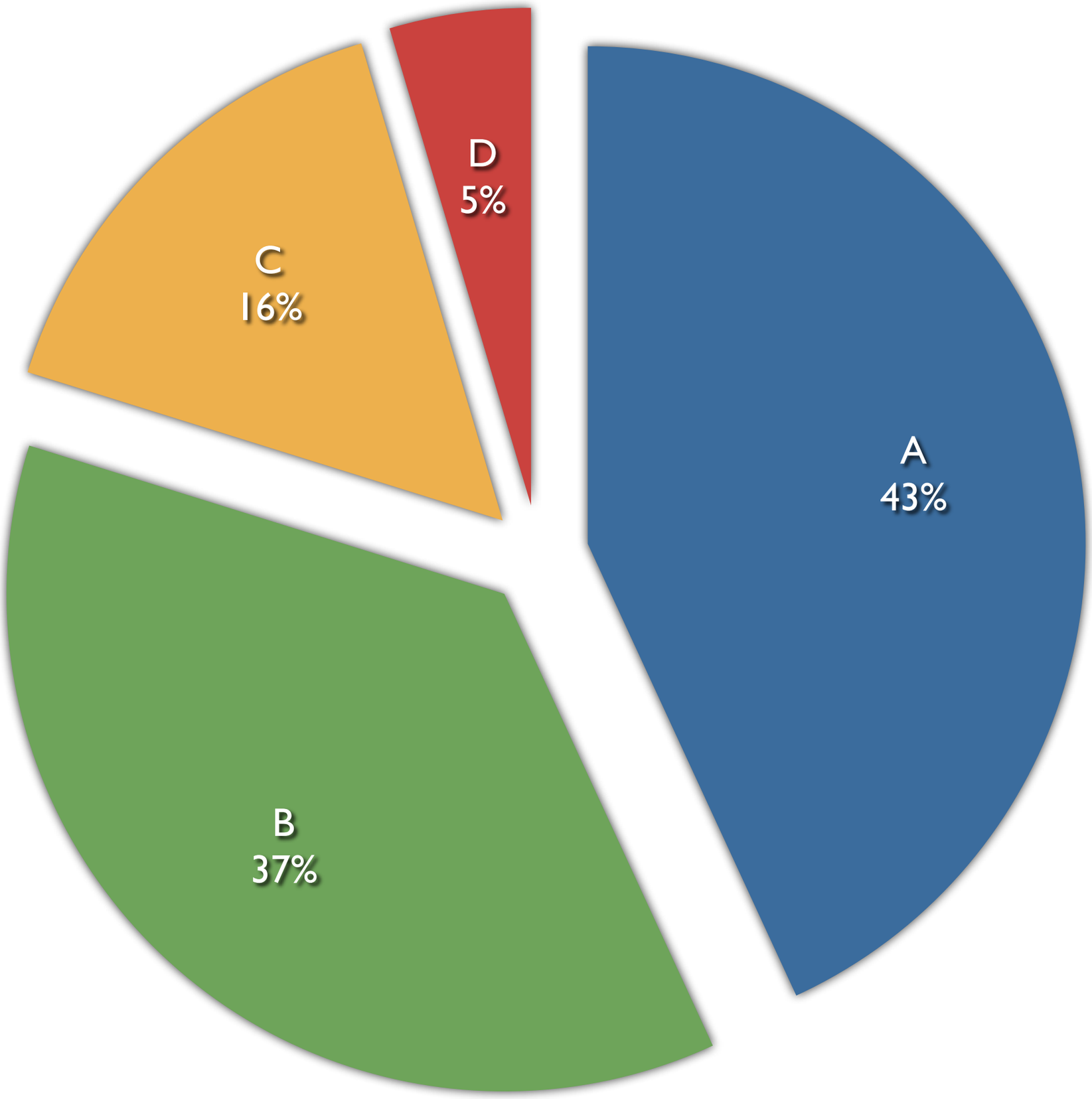
third goal: help prepare you for a job in cs

caveat emptor

This was one of the most brutally difficult courses I have taken. Almost every homework ended with me staying up all night before it was due in order to get it finished. However, all told, this has also been one of the most worthwhile classes I have taken. The work is very difficult, but because of that it was even more rewarding every time I solved a problem. Abhi is incredibly enthusiastic about the topic and really does his best to get the class to actually learn something. He also really knows the subject, and is almost always able to quickly and accurately respond to any student questions.

Algorithms has single-handedly been the most difficult, yet most rewarding class I have ever taken. Ever. The class was taught in the best way for me to learn. Personally, I am able to work my best when I can work on projects on my own schedule. Thus, having all of the work in a 'pset' format was optimal. The homeworks were hard, but they're completely worth the effort; likewise for the exams. Prof. Shelat is really enthusiastic about Algorithms, and that really came through in his teaching. The lectures were interesting and very informative; it was very helpful to have the annotated PDF's and screencasts. Also, I appreciated all of the ways that Shelat made himself available to the students. Piazza was a great way to answer questions, and Shelat was very quick to respond to emails. Despite the high difficulty of the course, there was never a moment where I felt that I couldn't solve a problem. By that, I don't mean that the problems were easy or simple, but rather, I knew that if I put in enough time and effort, I would eventually be able to solve them. This was a significant change in my learning paradigm because Algorithms is the first class I've taken where I've wanted to solve the problems we were given distinctly for the acting of solving them and knowing how they work. There was no busy-work in this class; all of it was meaningful. Taking algorithms this semester was the reason why I was able to pass the programming interviews I had this fall. I supremely enjoyed this class and I am very glad that I took it.

Shelat turned this formerly-easy class into pure hell. All the assignments have been stupid hard, throw-up-your-hands-in-frustration level difficulty. And they rarely have anything to do with the lectures. And the problems are poorly written. And the assignment grading is excessively harsh, frequently arbitrary, and often inconsistent. And Shelat has been completely unresponsive to the many student complaints about all this. This has been the worst kind of hard class; the kind where you work insanely hard only to accomplish nothing meaningfull....Bottom line: Shelat should never be allowed to teach an undergraduate course ever again, at any school!


D
5%
C
16%
A
43%
B
37%

50% hw

50% exams

what is this course about?

Theme

Small problems are easy to solve

Theme

Small problems are easy to solve

Solve big problems by making them into smaller ones

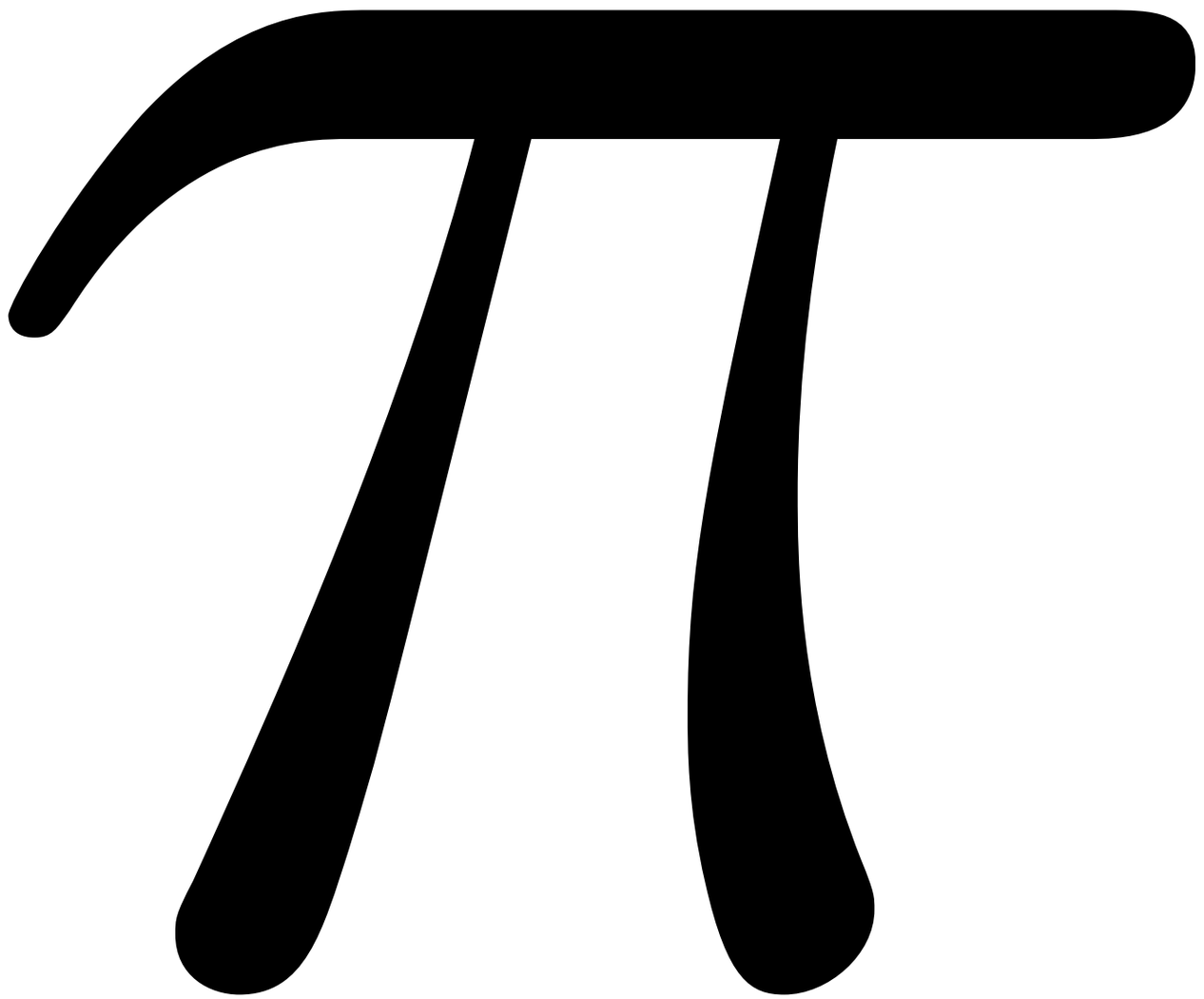
Theme 2

to convince through reason is

a good mark of understanding

great pyramid at giza 2500bc

image from wikimedia



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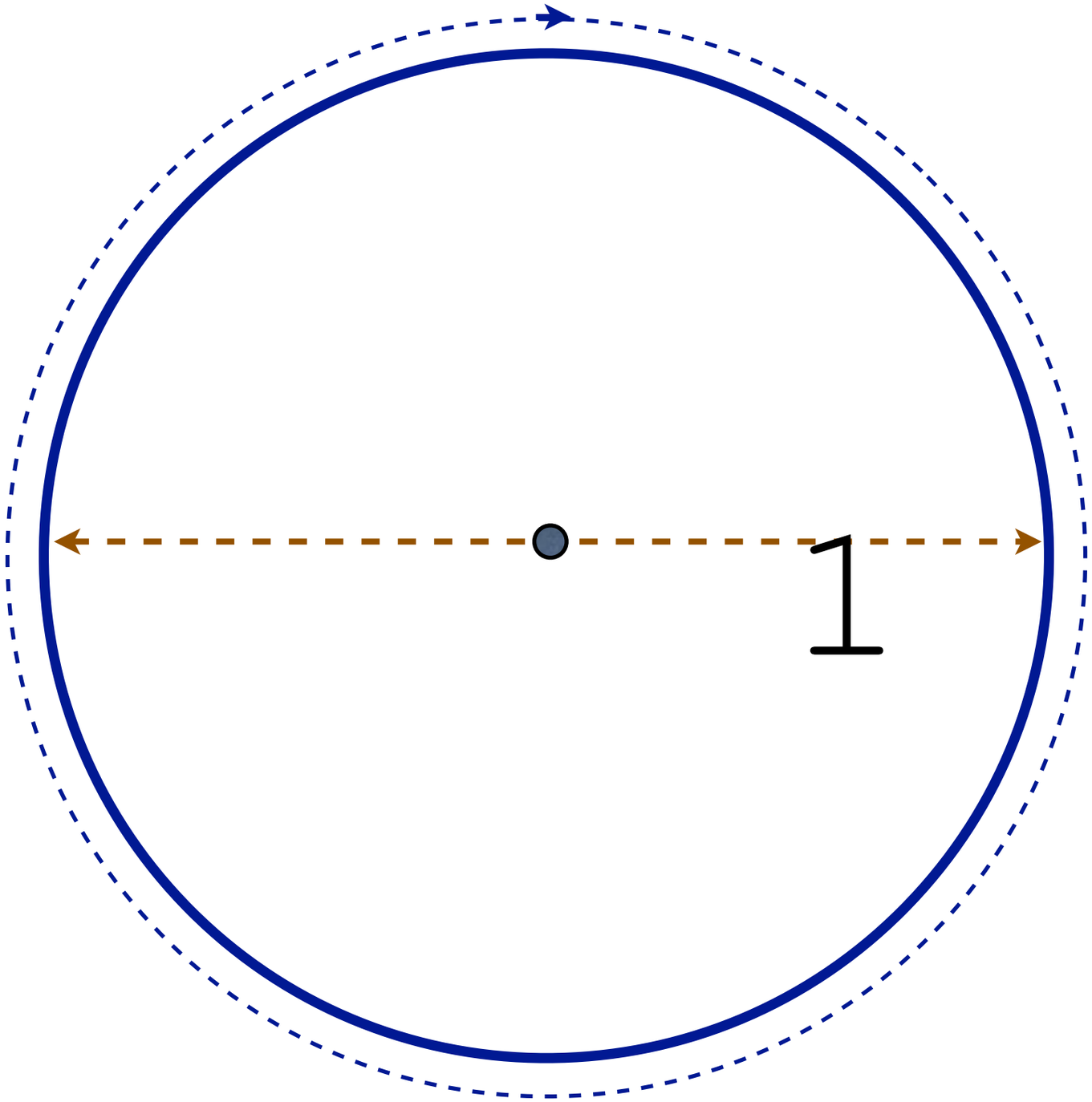
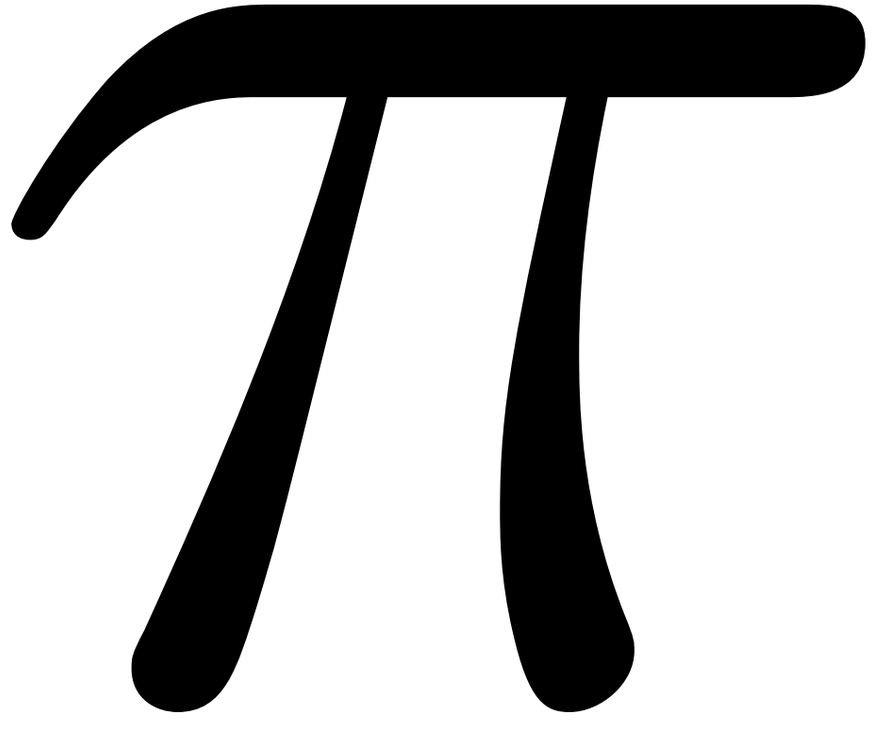
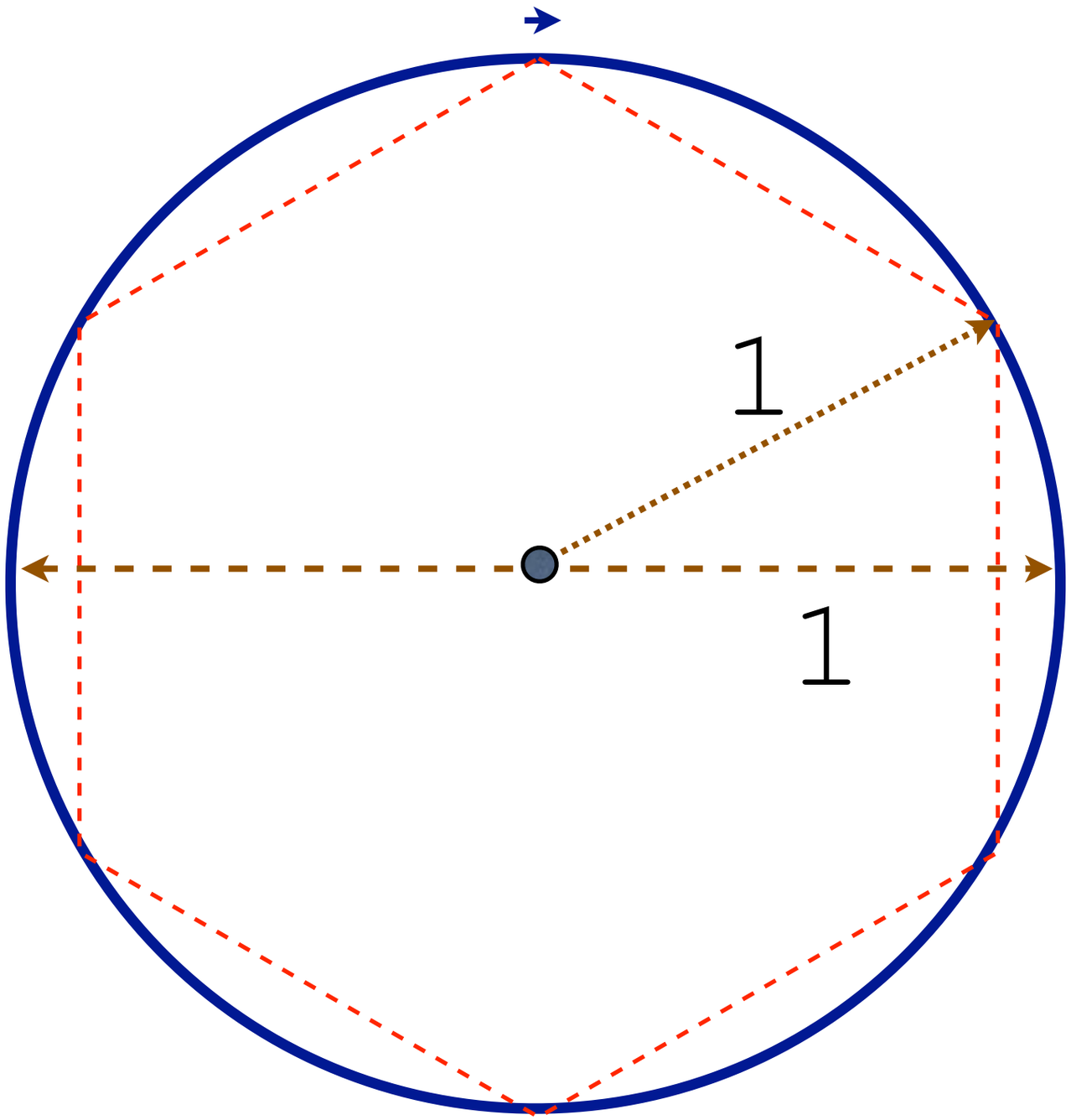


“how much granite/glass do i need?”

algorithm to compute

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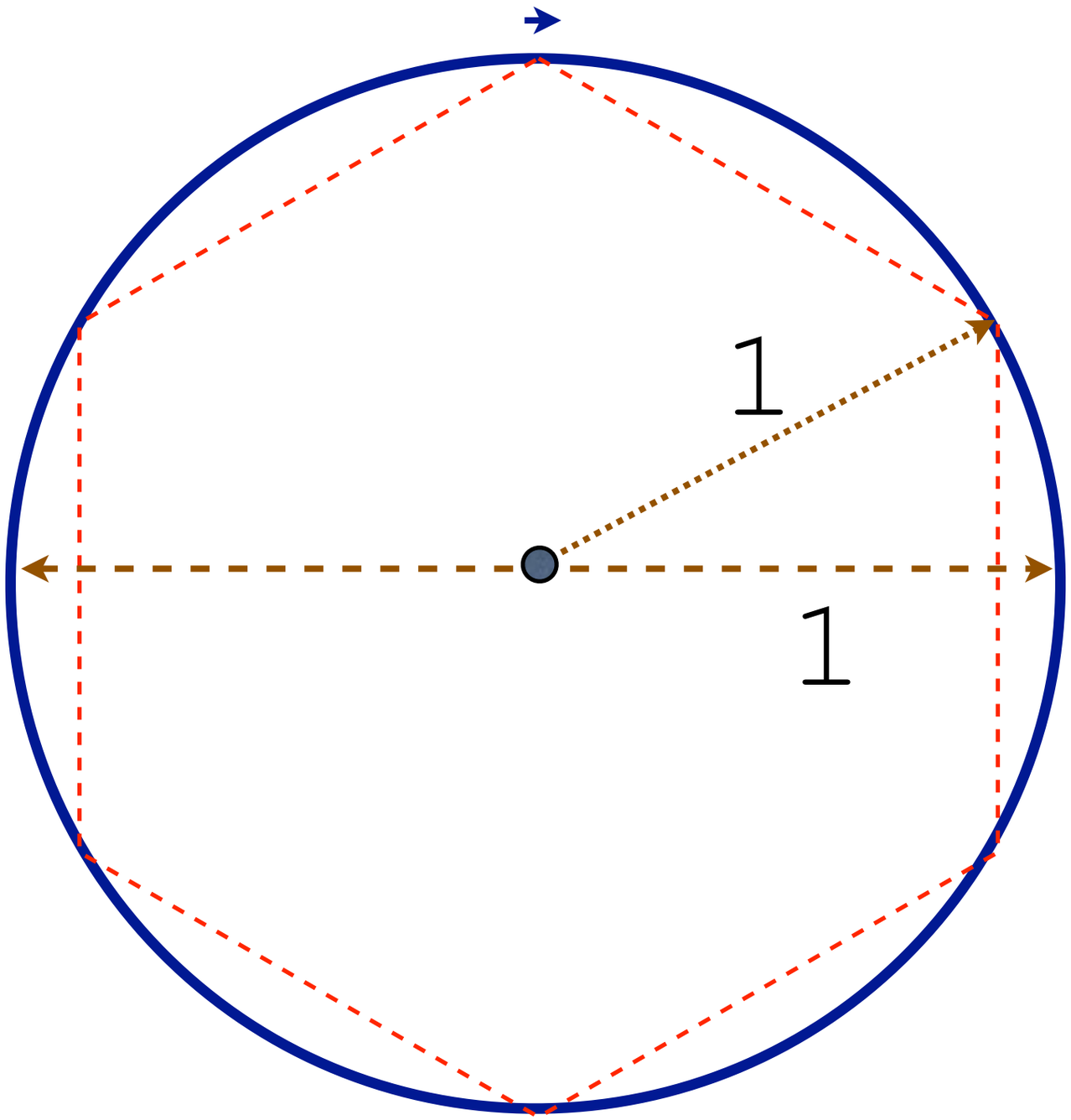
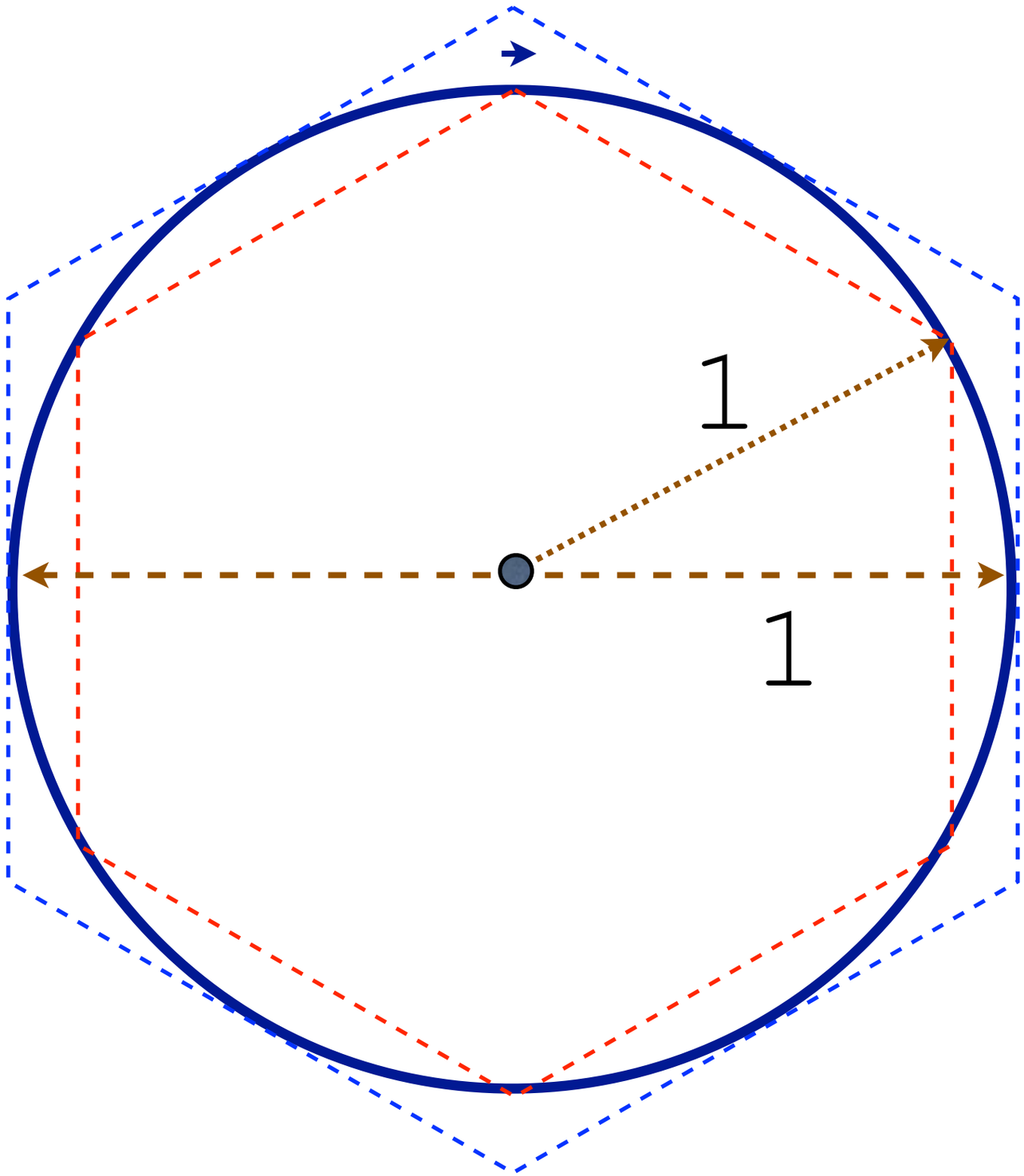
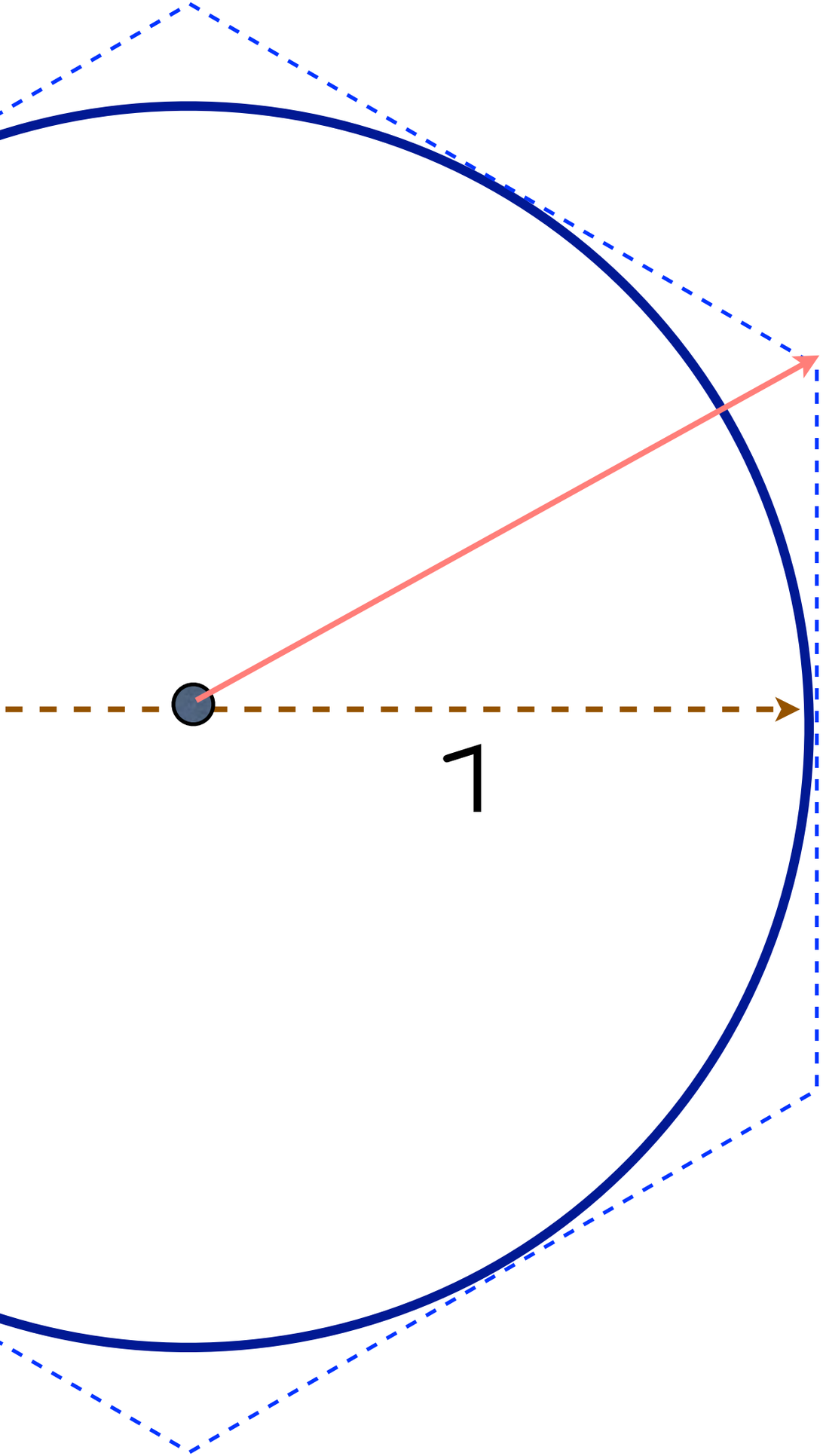


red perimeter $< \pi d$

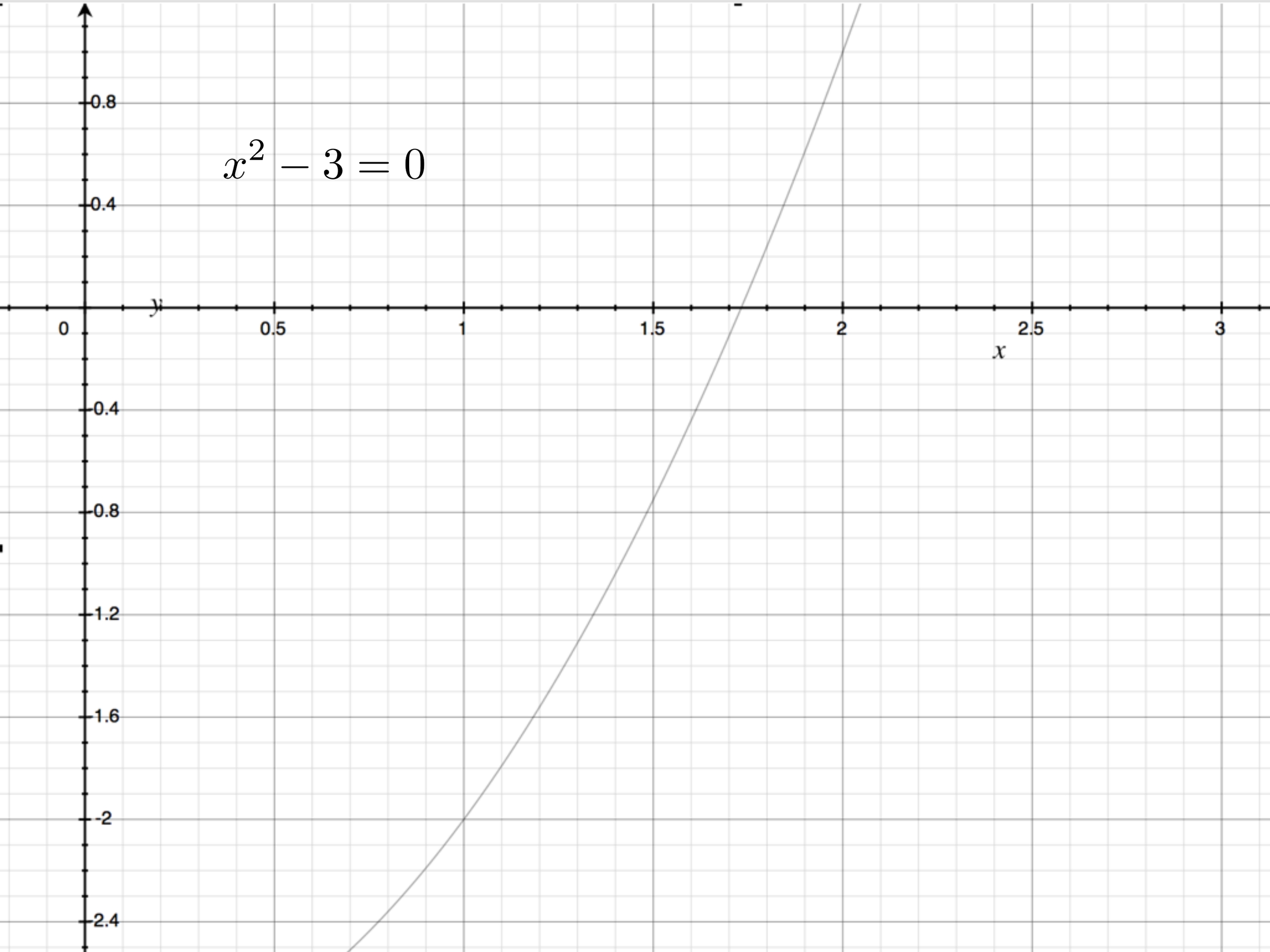


red perimeter $< \pi d <$ blue perimeter

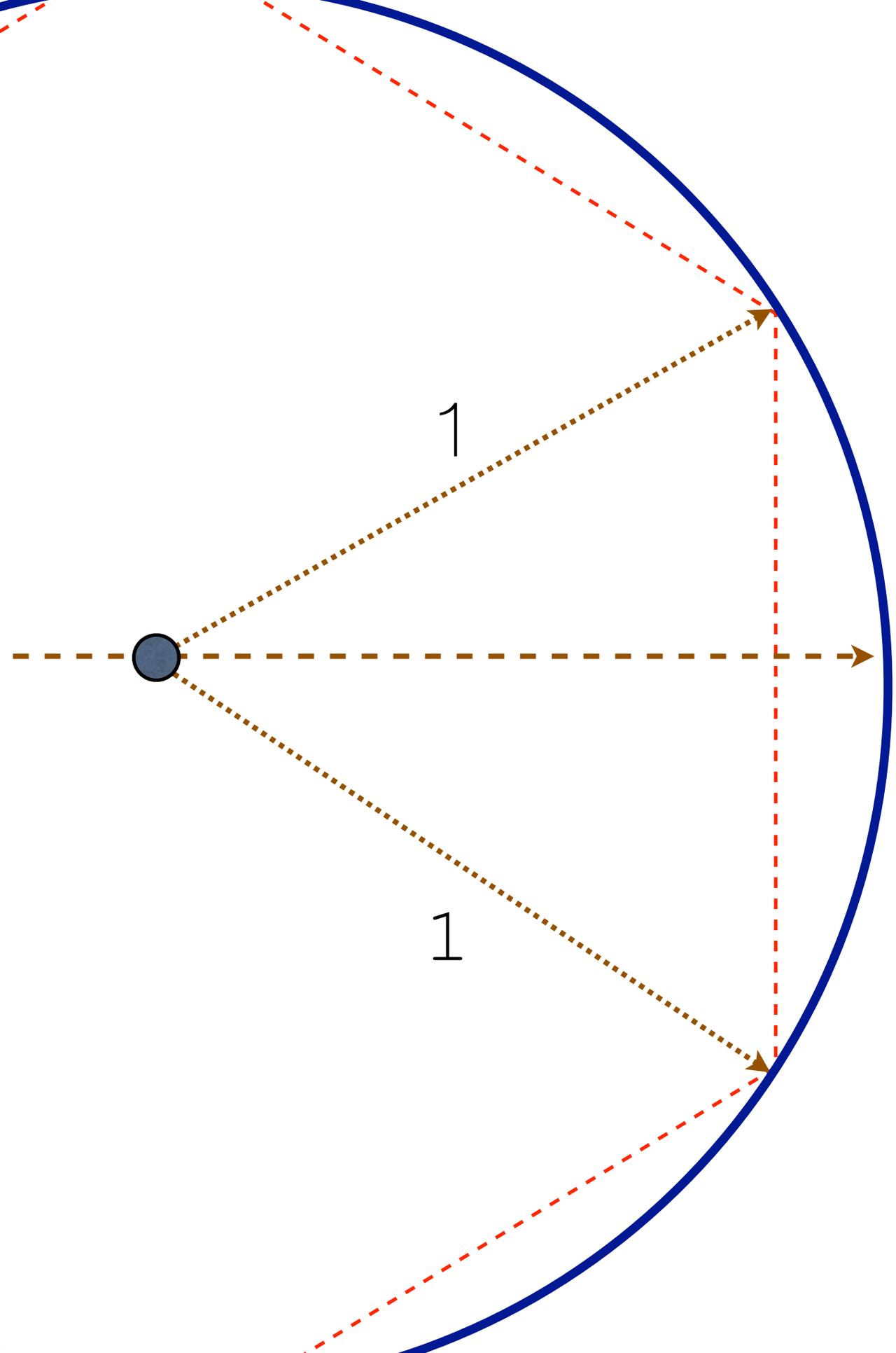

1

$$\sqrt{3}$$

$x^2 - 3 = 0$



$$\frac{265}{153} \approx \sqrt{3}$$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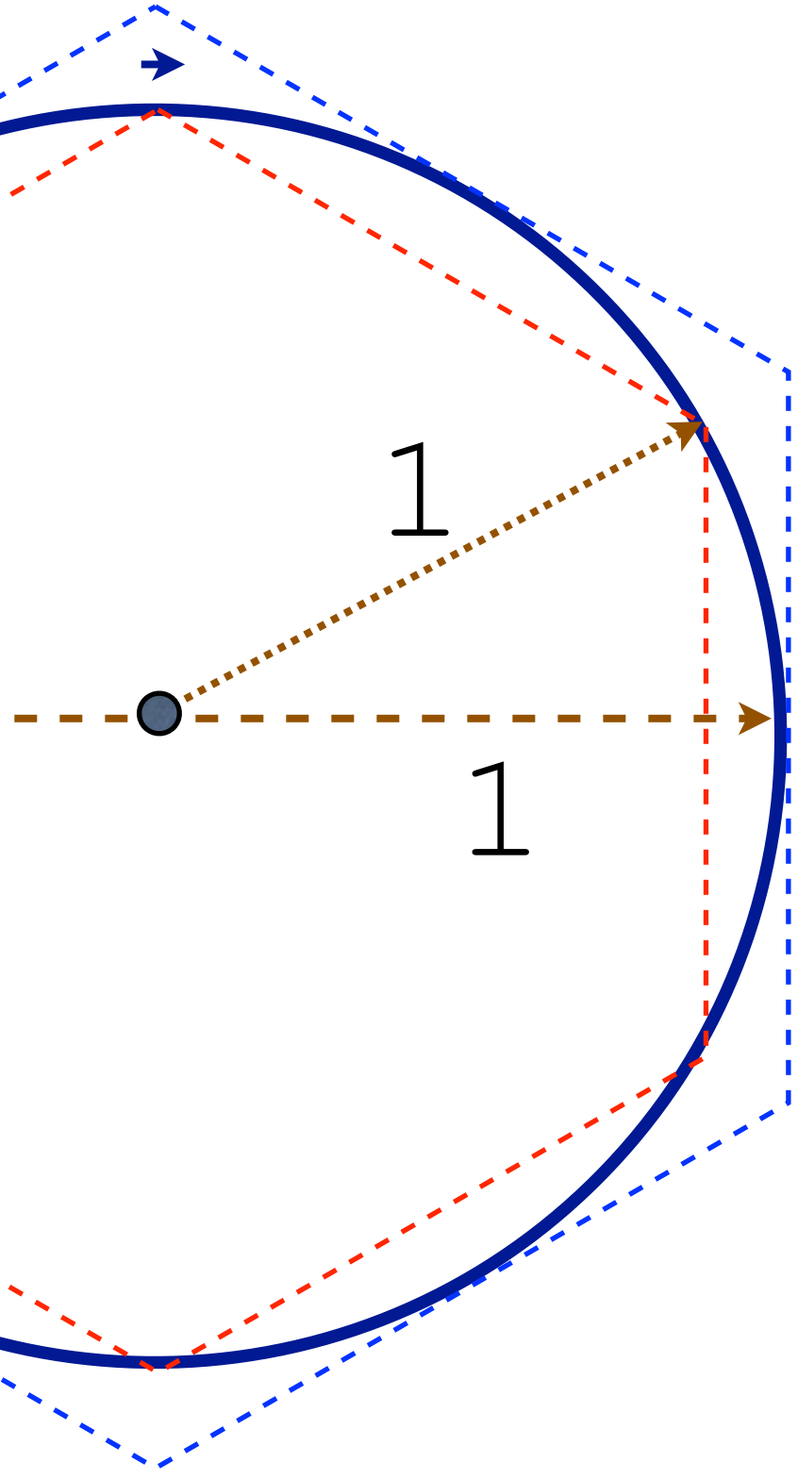
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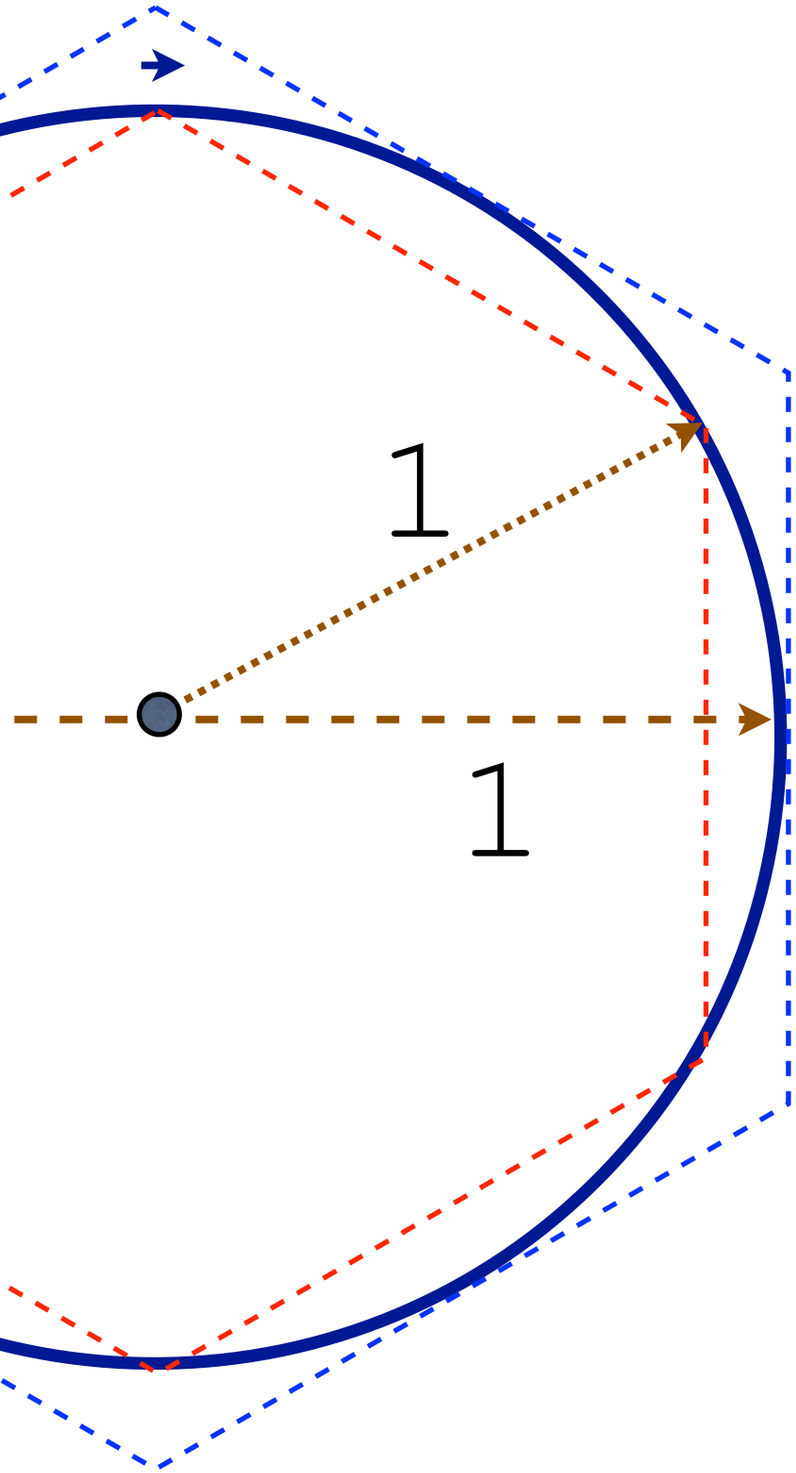
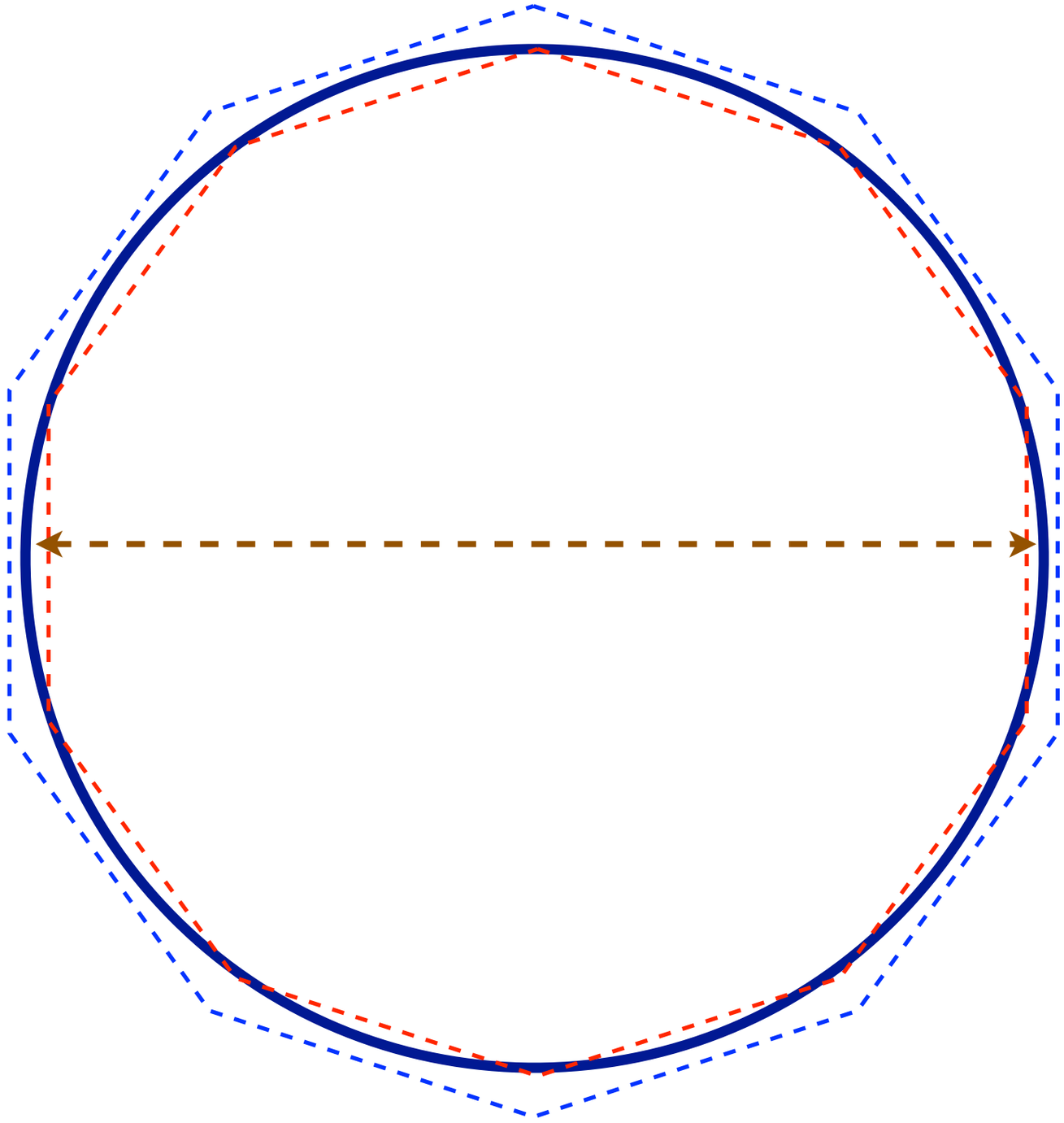


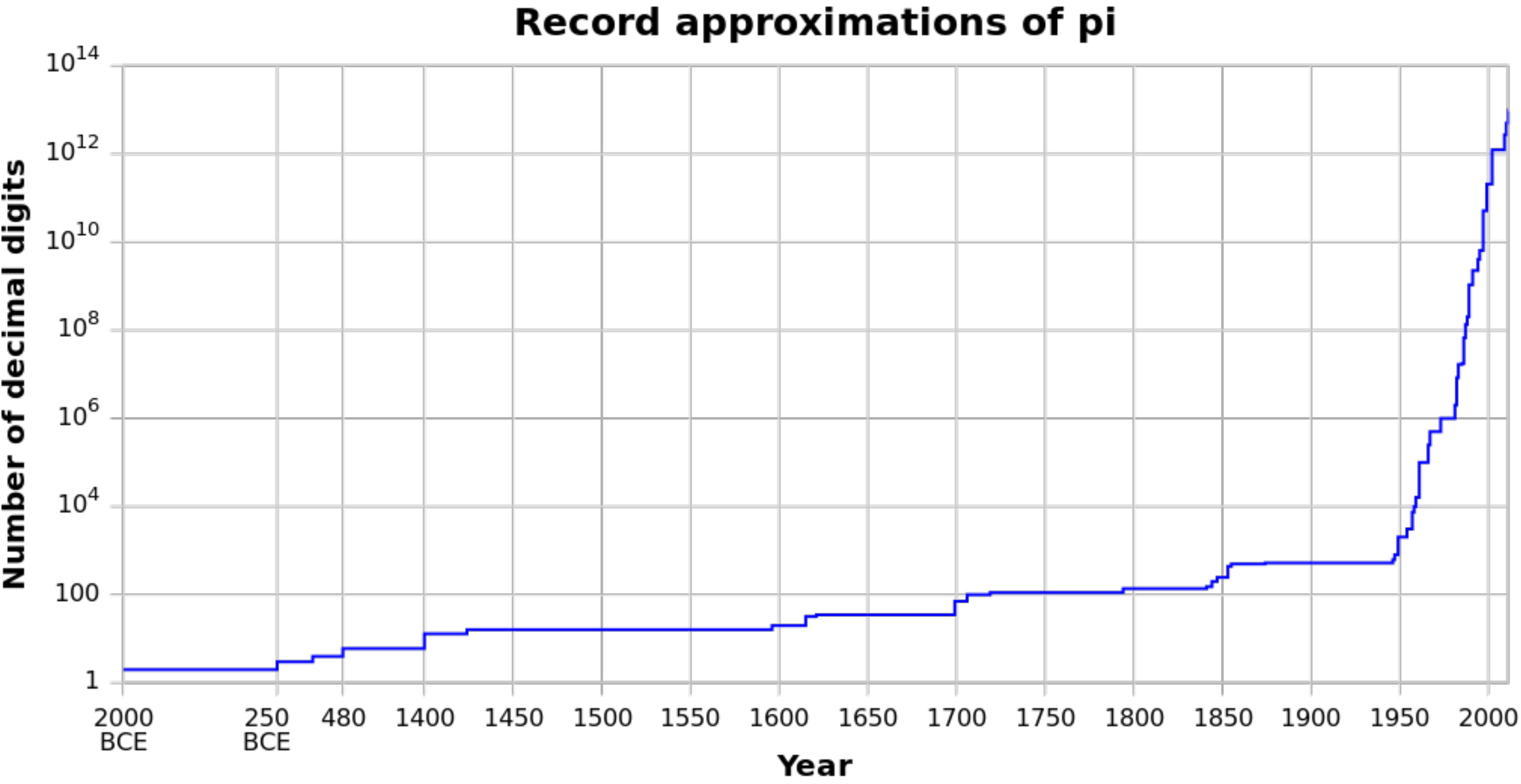
red perimeter $< \pi d <$ blue perimeter



$$3\frac{10}{70} > \pi > 3\frac{10}{71}$$

Using 96-gon,
Archimedes

how to analyze this approach?



https://en.wikipedia.org/wiki/Approximations_of_%CF%80#/media/File:Record_pi_approximations.svg

$$\pi = \frac{9801}{\sqrt{8}} \left(\sum_{n=0}^{\infty} \frac{(4n)!(1103 + 26390n)}{(n!)^4 396^{4n}} \right)^{-1}$$

$$\pi = \frac{9801}{\sqrt{8}} \left(\sum_{n=0}^{\infty} \frac{(4n)!(1103 + 26390n)}{(n!)^4 396^{4n}} \right)^{-1}$$

n=0

$$\pi = \frac{9801}{\sqrt{8}} \left(\sum_{n=0}^{\infty} \frac{(4n)!(1103 + 26390n)}{(n!)^4 396^{4n}} \right)^{-1}$$

n=0

$$\pi \approx_0 \frac{9801}{\sqrt{8}} \left[1103\right]^{-1}$$

3.14159273001330576017

$$\pi = \frac{9801}{\sqrt{8}} \left(\sum_{n=0}^{\infty} \frac{(4n)!(1103 + 26390n)}{(n!)^4 396^{4n}} \right)^{-1}$$

n=1

$$\pi = \frac{9801}{\sqrt{8}} \left(\sum_{n=0}^{\infty} \frac{(4n)!(1103 + 26390n)}{(n!)^4 396^{4n}} \right)^{-1}$$

n=1

$$\pi \approx_1 \frac{9801}{\sqrt{8}} \left[1103 + \frac{24 \cdot 27493}{396^4} \right]^{-1}$$

3.141592653589793877998905826300

benefits?

good algorithms touch every aspect of our lives

Google

TESLA MOTORS

at&t

good algorithms defend freedom

image:history of air cargo

what skills do you need for this course?

precision

creativity

in·ge·nu·i·ty

how to learn in this class

no cookbook

develop
general problem
solving
skills

understand
known
techniques

work with your peers

work with your peers

but do not copy

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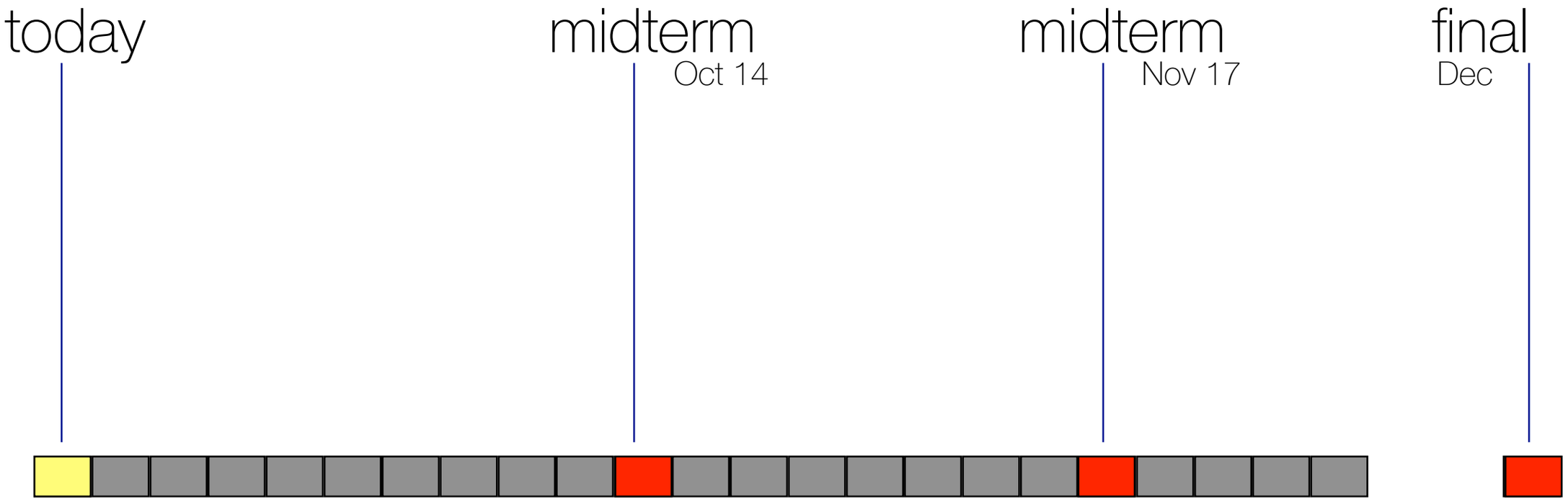
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Oct 14
midterm
Nov 17
final
Dec

today

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Dec

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graphs

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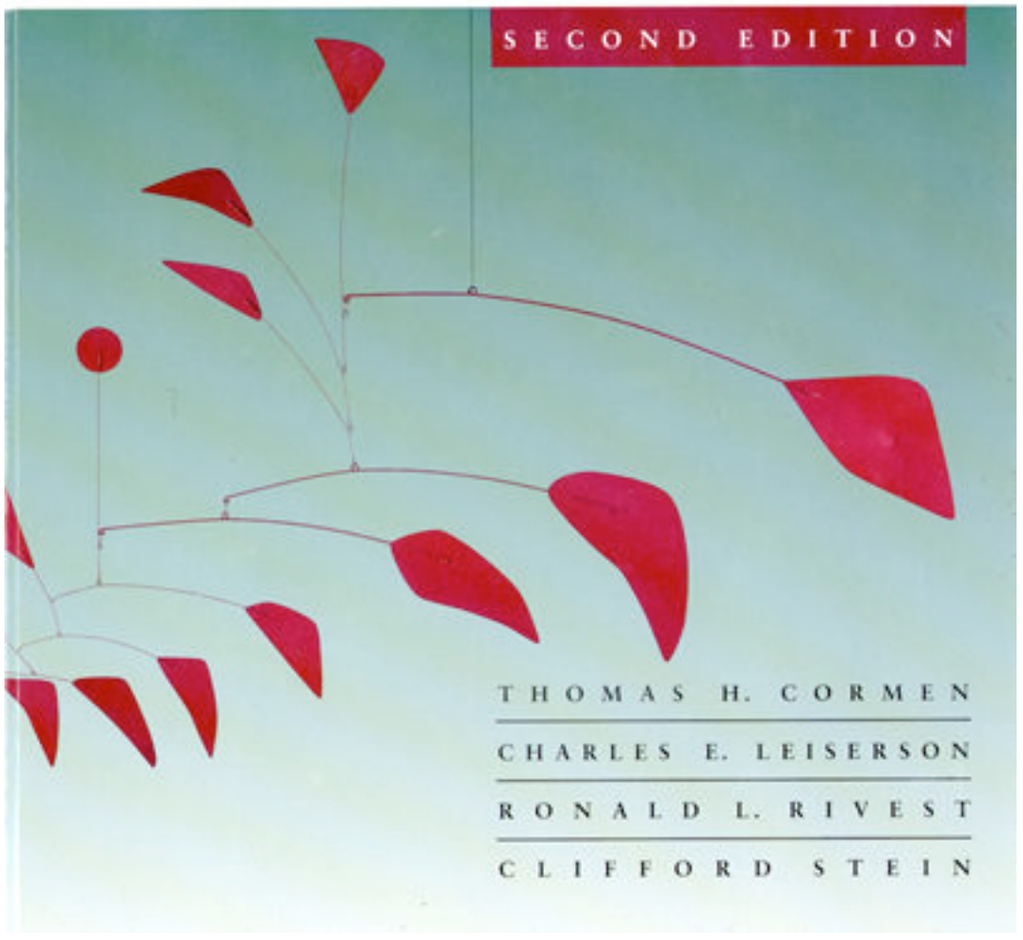
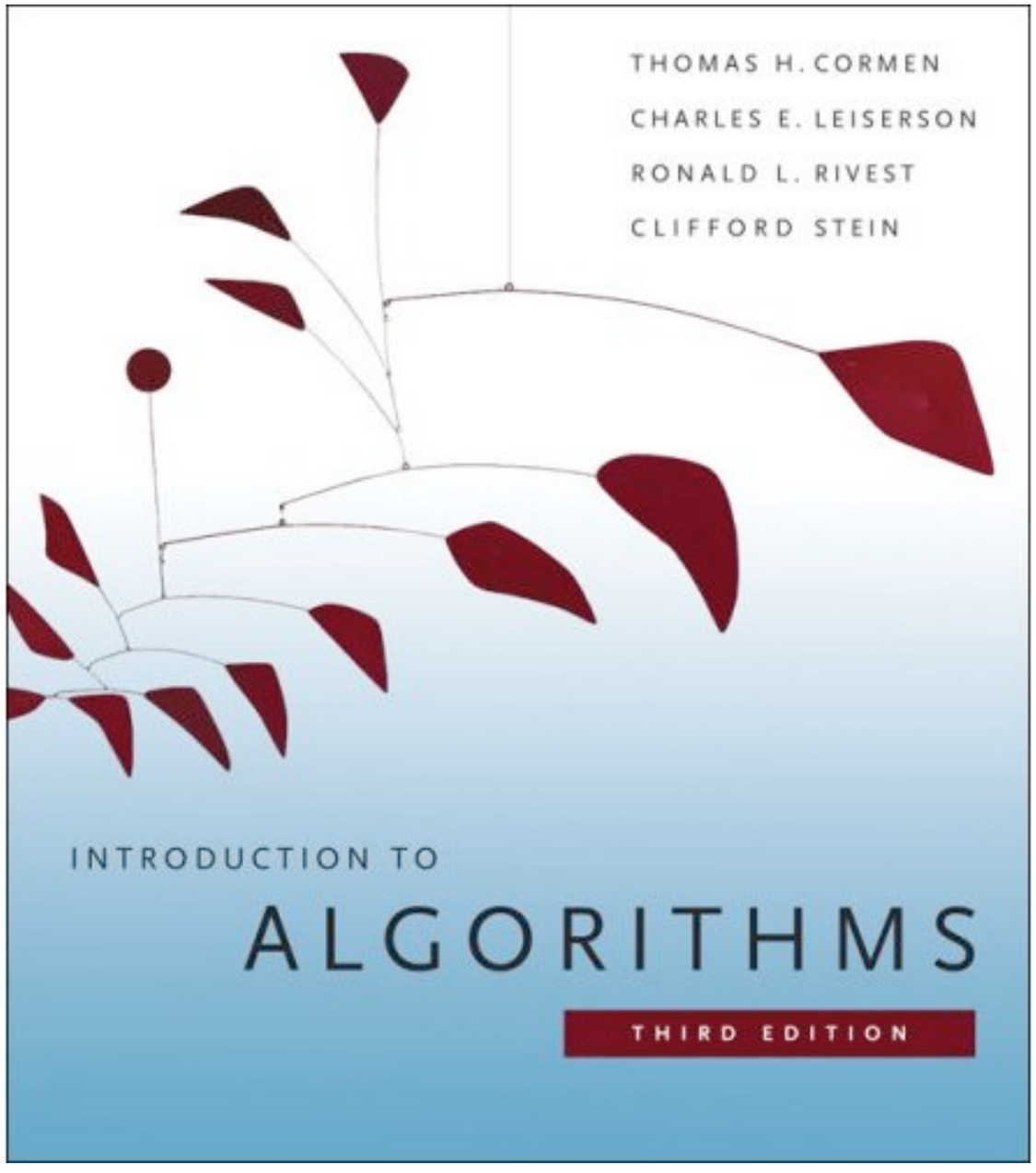
greedy

lp,np,etc

INTRODUCTION TO

ALGORITHMS





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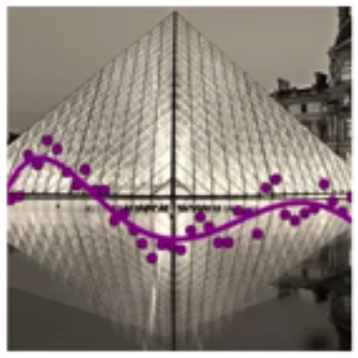
Algorithms, Part I

Princeton University



Approximation Algorithms Part I

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LaTeX documentation

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Or LaTeX 2ε in 157 minutes

by Tobias Oetiker

hw0.tex

Typeset | LaTeX | Macros | Tags | Templates

```
%---------change this by adding your uva id into the {}
\def\yourname{}
% --- no need to change anything in this section ----------------------------------------------------
\def\homework{1} % 0 for solution, 1 for problem-set only
\def\duedate{fri jan 29, 2016 at 5p}
\def\duelocation{via \href{https://church.cs.virginia.edu/16s-4102/}{submission site}}
\def\hnumber{0}
\def\prof{abhi shelat}
\def\course{\href{https://www.cs.virginia.edu/~shelat/16s-4102}{cs4102 - algorithms - s'16}}

\documentclass[11pt]{article}
%-----------------------------------------------------------------------------------------------------

%% ================ no need to edit any of this stuff

|
%%% ==== standard installations of latex include all of the files that are referenced in this section.  However,
%%% ==== if you are having compile problems, consider commenting some of these commands out
\usepackage[colorlinks,urlcolor=blue]{hyperref}
\usepackage[osf]{mathpazo}
\usepackage{amsmath,amsfonts,graphicx}
\usepackage{latexsym}
\usepackage[top=1in,bottom=1.4in,left=1.5in,right=1.5in,centering]{geometry}
\usepackage{color}
\definecolor{mdb}{rgb}{0.3,0.02,0.02}
\definecolor{cit}{rgb}{0.05,0.2,0.45}
\markboth{\yourname}{\yourname}
%%% ============================================================================


%%% ============ should be no need to edit anything in this section ====================
\newenvironment{proof}{\par\noindent{\it Proof.}\hspace*{1em}}{$\Box$\bigskip}
\newcommand{\qed}{$\Box$}
\newcommand{\alg}[1]{\mathsf{#1}}
\newcommand{\handout}{
  \renewcommand{\thepage}{H\hnumber-\arabic{page}}%
  \noindent%
  \begin{center}%
    \vbox{%
   \hbox to \columnwidth {\sc{\course} --- abhi shelat \hfill}%
   \vspace{-2mm}%
   \hbox to \columnwidth {\sc due \MakeLowercase{\duedate} \duelocation\hfill {\Huge\color{mdb}H\hnumber.
\yourname}}%
    }
  \end{center}
```

hw0.pdf

Scale 115 | Page 1 of 1

CS4102 - ALGORITHMS - S'16 — ABHI SHELAT

DUE FRI JAN 29, 2016 AT 5P VIA SUBMISSION SITE

You may collaborate with other students on the homework but your own individually written solution, identify your collaborat edge any external sources that you consult.

PROBLEM 1 *Passage*

Typeset your favorite passage from a book.

PROBLEM 2 *Asymptotic notation*

Let f be a function. Give a formal definition of the set $\Theta(f)$.

$$\Theta(f) = \{ \text{ functions } g \text{ such that } \ldots$$

Hint: Use the `\exists` command to make the "there exists" s `\forall` command to make the "for all" symbol $\forall$.

PROBLEM 3 *includegraphics command*

Learn how to include drawings in your documents with the `\inc` command by submitting a caricature of me.

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- Contact information

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```
...
\extramarks{}{Continued on next page\ldots}
Some text that may or r
\extramarks{Continued\
\end{verbatim}

\CmdIndex{extramarks}
Note that the \Cmd{extramarks} command must be close to the text, i.e no
empty lines (paragraph boundaries) should intervene. Otherwise the page may
be broken at that boundary and the extramarks would come on the wrong page.

There are two new marks that can be used in the page layout with this
package: If commands of the form
\verb|\extramarks{|$m_1$\verb|}{|$m_2$\verb|}| are given
\CmdIndex{firstxmark}
\CmdIndex{lastxmark}
\Cmd{firstxmark} gives you the first $m_1$ value and
\Cmd{lastxmark} gives you the last $m_2$ value
of the current page.
\CmdIndex{firstleftmark}
\CmdIndex{lastrightmark}
es you the \Cmd{firstleftmark} and \Cmd{lastrightmark}
at complement the standard \latex/ marks.

he point that marks are the correct way to do this, let me
``solution'' that will not work\footnote{Actually there is
ay but it requires two \latex/ passes: you can put \Cmd{label}
before and after the text and compare the \Cmd{pageref}s.}:

\begin{verbatim}
\lhead{Continued}
```

Greek small Letters

α β χ δ ε φ φ γ η ι κ λ μ ν ο π ϖ θ ϑ ρ σ ς τ υ ω ξ ψ ζ

Go to
Insert Label
Insert Reference
Insert Reference to Page
Properties...

fancyhdr.tex

```
  -i-ni-tion would
Underfull \hbox (badness 5077) in paragraph at lines 1088--1095
  /cmr10/be /cmtt10/\thechapter-\arabic{page} /cmr10/but you can give this def-i-
  ni-tion your-self af-ter the
  [16] [17] [18] [19] [20] [21] [22] [23] [24]
  No file fancyhdr.ind.
  [25] (fancyhdr.aux)
LaTeX Warning: Label(s) may have changed. Rerun to get cross-references right.
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Inserts a reference to the item in the current document

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Submitting HW

gradescope

Honor Policy

I, _____, do hereby certify on my honor that during this course,

1. I shall write my answers entirely by myself, and neither share nor request text, code, or drawings.

2. I will not give or derive assistance from any unauthorized sources or the web.

counting

1 stand

1. stand
2. set your “number” to one

1. stand
2. set your “number” to one
3. greet a neighbor (pause if odd person out)

1. stand
2. set your “number” to one
3. greet a neighbor (pause if odd person out)
4. if you are older, give “number” and sit
   if you are younger, add “numbers”

1. stand
2. set your “number” to one
3. greet a neighbor (pause if odd person out)
4. if you are older, give “number” and sit
   if you are younger, add “numbers”
5. if you are standing & you have a neighbor, goto 3

lets analyze this alg

how fast does it work:

1 stand

2 set

3 greet

4 sit/add

5 repeat

how fast does it work:

$T(n)$ # steps to finish in a room with n people

1 stand

2 set

3 greet

4 sit/add

5 repeat

how fast does it work:

$$T(n) = 1 + 1 + T(\lceil n/2 \rceil)$$

what is a recurrence?

what is a recurrence?

$$T(n) = T(\lceil n/2 \rceil) + 2$$

$$T(1) = 3$$

solve a simpler case when n is a power of 2.

$$T(2^k) = 2 + T(2^{k-1})$$

$$T(2^k) = 2 + T(2^{k-1})$$

"intuition here"

"intuition here"

$$T(2^k) = 2 + T(2^{k-1})$$

$$= 2 + 2 + T(2^{k-2})$$

"intuition here"

$$T(2^k) = 2 + T(2^{k-1})$$

$$= 2 + 2 + T(2^{k-2})$$

$$= \overbrace{2 + 2 + \cdots + 2}^{k} + T(2^0)$$

"intuition here"

$$T(2^k) = 2 + T(2^{k-1})$$

$$= 2 + 2 + T(2^{k-2})$$

$$= \overbrace{2 + 2 + \cdots + 2}^{k} + T(2^0)$$

$$= 2k + T(1)$$