

# Ximera @ TUG2024

Wim Obbels, and Bart Snapp and Jim Fowler

July 19 2024

# Intro

- Ximera stands for



Ximera: Interactive Mathematical Educational Resources for All

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- authors only write  $\text{\LaTeX}$  code



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The ultimate goal: promote sustained student success and savings.

# What does Ximera do ?

```
\begin{enumerate}
| \item  $\mu$  (presumed population mean) = \answer{400}$
| \item  $\sigma$  (population standard deviation) = \answer{25}$
| \item  $\bar{x}$  (sample mean) = \answer{410}$
| \item  $n$  (sample size) = \answer{100}$
\end{enumerate}
```

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```

## Single Source Code

- (a)  $\mu$  (presumed population mean) =
- (b)  $\sigma$  (population standard deviation) =
- (c)  $\bar{x}$  (sample mean) =
- (d)  $n$  (sample size) =

PDF worksheet

- (a)  $\mu$  (presumed population mean) =  ?
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Interactive Ximera page

- (a)  $\mu$  (presumed population mean) =
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PDF solution manual

# Ximera history

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- 2016-: many courses are developed, and published on <https://ximera.osu.edu>



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Jesse Hoobergs and Wim Obbels; docker, layout, extra functionality

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- 2024-2026: grant from 'Open Textbooks Pilot Program'

# Example (HTML, OSU layout)

XIMERA [Get Help](#) Saved! Erase Sign In

Ximera Demo **Example Theory Module** Simple exercises Ximera Documentator Document classes 'ximera' and 'xourse' Environments Commands Ximera Showcase

wimdemo / [Short Ximera Demo Xourse](#) / Example Theory Module

This is an example of a theory module in Ximera, with some useful [environments](#) and [commands](#).

**Remark.** It is advisable to also view the PDF version, where this remark suggests to consult the Online version.

Use `\begin{definition}` for definitions, and `\begin{exercise}` for exercises.

**Definition 2.** The absolute value of a real number  $a$ , denoted by  $|a|$ , is

$$|a| \stackrel{\text{def}}{=} \begin{cases} a & \text{if } a \geq 0 \\ -a & \text{if } a < 0. \end{cases}$$

**Exercise.**

**Question.**  $|2 - 5| =$   ?

# Example (HTML, KU Leuven layout)

**KU LEUVEN** Very Short Ximera Demo Course

Search in table of contents... Example Theory Module

**Ximera Demo**  
Example Theory Module  
Simple exercises  
**Ximera Documentation**  
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**Exercise 1.**

- $|2 - 5| =$
- $|5 - 2| =$    $a_4$
- $|5 - \sqrt{2}| =$
- $|1 - \sqrt{2}| =$

Familiarize yourself with the (interactive!) graph of the cosine function:  
(via Desmos, implemented as `\graph[xmin=-5,xmax=20,ymin=-1,ymax=1]{y=\cos(x)}`)

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# Example (PDF activity)

theorie.pdf 1 / 1 150%

p. 1

## Example Theory Module

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- $|2 - 5| = \dots \dots$
- $|5 - 2| = \dots \dots$
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- $|1 - \sqrt{2}| = \sqrt{2} - 1 \quad |1 - \sqrt{2}|$

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Graph of  $y = \cos(x)$

but because you are using the PDF version, that of course does not work, and we only show a rather *boring* graph with tikz here:

theorie.pdf 1 / 1 150%

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**Exercise 1.**

- $|2 - 5| = 3$
- $|5 - 2| = 3$
- $|5 - \sqrt{2}| = 3.58578643763$
- $|1 - \sqrt{2}| = \sqrt{2} - 1$

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# Example (PDF course)

demo.pdf 3 / 19 145%

MODULE 1: XIMERA DEMO p. 1.1

## 1.1 Example Theory Module

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- $|5 - 2| = \dots$
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Familiarize yourself with the (interactive!) graph of the cosine function:  
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demo.pdf 3 / 21 145%

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(via Desmos, implemented as `\graph[xmin=-5,xmax=20,ymin=-1,ymax=1]{y=\cos(x)}`)

Graph of  $y = \cos(x)$

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# Example (source of activity (1))

```
1 \documentclass{ximera}
2 % \handouttrue
3 \input{../preamble.tex}
4 \addPrintStyle{..}
5
6 \begin{document}
7   \author{Wim Obbels}
8   % \title{Example Theory Module}
9   % \maketitle
10  % \begin{abstract} A simple Ximera module \end{abstract}
11  \xmtitle{Example Theory Module}{A simple Ximera module}
12  \label{xim:ximeraDemo}
13
14  This is an example of a theory module in Ximera,
15  with some useful \hyperref[xim:ximeraEnvironments]{environments} and \hyperref[xim:ximeraCommands]{commands}.
16
17  % Demo: small adhoc differences between PDF and HTML version
18  \pdfOnly{
19    \begin{remark}
20      It is advisable to also view the Online version, where this remark refers to the PDF.
21      \ifhandout
22        By the way, you are using the \textit{handout} PDF, which does \textbf{not} contain answers. \\\
23        There is also a so-called \textit{standard} PDF \textit{which does contain answers and hints}.
24      \else
25        You are, by the way, using the so-called \textit{standard} PDF, which \textbf{contains the answers} to the exercises. \\\
26        There is also a \textit{handout} PDF \textit{without the answers}.
27      \fi
28    \end{remark}
29  }
30  \begin{onlineOnly}
31    \begin{remark}
32      It is advisable to also view the PDF version, where this remark suggests to consult the Online version.
33    \end{remark}
34  \end{onlineOnly}
```



## Example (source of activity (2))

```
ximeradoc > demo > %X theorie.tex
39 Use \verb|\begin{definition}| for definitions, and \verb|\begin{exercise}| for exercises.
40
41 \begin{definition}\label{showcase:absolutevalue}
42   The \textbf{absolute value} of a real number  $a$ , denoted by  $|a|$ , is
43   \[
44     |a| \perpdef \begin{cases}
45       \phantom{-}a & \text{if } a \geq 0 \\
46       -a & \text{if } a < 0.
47     \end{cases}
48   \]
49 \end{definition}
50
51 \begin{exercise}\n1
52
53   \begin{xmmulticols}
54     \begin{question}  $|2-5|$  = \answer{3}$ \end{question}
55     \begin{question}  $|5-2|$  = \answer[onlineshowanswerbutton]{3}$ \end{question}
56     \begin{question}  $|5-\sqrt{2}|$  = \answer[onlinenoinput]{3.58578643763}$ \end{question}
57     \begin{question}
58        $|1-\sqrt{2}|$  = \wordChoice{\choice[correct]{ $\sqrt{2} - 1$ }\choice{ $1-\sqrt{2}$ }}
59     \end{question}
60   \end{xmmulticols}
61 \end{exercise}
62
63 Familiarize yourself with the (interactive!) graph of the cosine function: \[
64 (via Desmos, implemented as \verb|\graph[xmin=-5,xmax=20,ymin=-1,ymax=1]{y=\cos(x)}|)
65 \[
66 \graph[xmin=-5,xmax=20,ymin=-1,ymax=1]{y=\cos(x)}
67 \]
68 \pdfOnly{
69   but because you are using the PDF version, that of course does not work,
70   and we only show a rather \textit{boring} graph with tikz here:
71
72   \begin{image}[0.7\textwidth]
73     \begin{tikzpicture}
74       \begin{axis}[
```

# Example (source of xourse)

UNTITLED (WORKSPACE)

- ximeradoc
  - .ximera
  - architecture
  - auteurs
    - ximeraCommands.tex
    - ximeraDocumentclasses.tex
    - ximeraEnvironments.tex
    - ximeraFailcase.tex
    - ximeraShowcase.tex
  - demo
    - exercises.tex
    - theorie.tex
  - git
    - gitConcepts.tex
  - ximera-downloads
  - .gitignore M
  - .gitlab-ci.yml
  - demo.tex M
  - global.css
  - global.sty
  - preamble.tex
  - printstyle.sty
  - README.md
  - test.tex
  - xmlatex

```
ximeradoc > TeX demo.tex > ...
1 \documentclass{xourse}
2 \input{preamble.tex}
3 \addPrintStyle{.}
4
5 \def\xmbaseUrl{https://set.kuleuven.be/voorkennis/ximerademo/demo}
6 % \handouttrue
7 % \printpartfrontpagefalse
8 \printactivityqrcode>true
9
10 \begin{document}
11   \xmtitle{Short Ximera Demo Xourse}{Ximera intro}
12
13 \part{Ximera Demo}
14   \activitychapter{demo/theorie.tex}
15   \practicesection{demo/exercises.tex}
16
17 \part{Ximera Documentation}
18   \activitychapter{auteurs/ximeraDocumentclasses.tex}
19   \activitychapter{auteurs/ximeraEnvironments.tex}
20   \activitychapter{auteurs/ximeraCommands.tex}
21   \activitychapter{auteurs/ximeraShowcase.tex}
22   \activitychapter{auteurs/ximeraFailcase.tex}
23
24 \part{GIT Documentation}
25   \activitychapter{git/gitConcepts.tex}
26
27 \end{document}
```

# Example (hints/solutions)

## Simple exercises

This document contains some simple exercises to show the functionality of Ximera. It can also serve as a testcase, and as a source to copy pieces of code from.

**Exercise 1.** Solve these simple questions that use the command `\answer`. Compare the LaTeX-code with the PDF and the online version.

1)  $1 + 1 =$   ? (code: `\answer{2}` )

Show hint ▾

Show solution ▾

2)  $1 + 1 =$   ? (code: `\answer[format=integer]{2}` )

Show solution ▾

3)  $1 + 1 =$   ? (code: `\answer[given]{2}` )

Show solution ▾

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1)  $1 + 1 =$   ? (code: `\answer{2}` )

Hide hint ▾

**Hint:** Try to enter  $1 + 1$ . See next question to prevent this.

Hide solution ▾

**Solution:** A simple exercise.

2)  $1 + 1 =$   ? (code: `\answer[format=integer]{2}` )

Hide solution ▾

**Solution:** Now you can only enter an integer. The dubious answer  $1 + 1$  is no longer possible.

3)  $1 + 1 =$   ? (code: `\answer[given]{2}` )

Hide solution ▾

**Solution:** With the option 'given' the answer is printed *also in the handout*. In the standard PDF, an additional block is added to make it stand out. Online this option makes no difference.

Note: there are/will be other options to manipulate showing

# Example (hints/solutions source)

```
ximeradoc > demo > TeX exercises.tex > ...
```

```
1
2 \documentclass{ximera}
3 \input{../preamble.tex}
4 \addPrintStyle{..}
5
6 \begin{document}
7   \author{Wim Obbels}
8   \xmtitle{Simple exercises}{}
9   \label{xim:simple_exercises}
10
11 This document contains some simple exercises to show the functionality of Ximera.
12 It can also serve as a testcase, and as a source to copy pieces of code from.
13
14 \begin{exercise}
15   Solve these simple questions that use the command \verb|\answer|.
16   Compare the \LaTeX-code with the PDF and the online version.
17   \begin{question}  $1+1 = \answer{2}$  \hspace{2cm} (code: \verb|\answer{2}| )
18     \begin{hint}
19       Try to enter  $1+1$ . See \hyperref[exc:answer_integer]{next question} to prevent this.
20     \end{hint}
21     \begin{oplossing}
22       A simple exercise. % Note that \verb|1+1| is also a correct answer.
23     \end{oplossing}
24   \end{question}
25
26   \begin{question}  $1+1 = \answer[format=integer]{2}$  \hspace{2cm} (code: \verb|\answer[format=integer]{2}| )
27     \begin{oplossing}
28       Now you can only enter an integer. The dubious answer  $1+1$  is no longer possible.
29     \end{oplossing}
30   \end{question}
31
32   \begin{question}  $1+1 = \answer[given]{2}$  \hspace{2cm} (code: \verb|\answer[given]{2}| )
```

# Styling (HTML/HTML(alt)/PDF)

## Linear Independence

**Definition 4.** (Linear Independence) Let  $\mathbf{v}_1, \mathbf{v}_2, \dots, \mathbf{v}_k$  be vectors of  $\mathbb{R}^n$ . We say that the set  $\{\mathbf{v}_1, \mathbf{v}_2, \dots, \mathbf{v}_k\}$  is *linearly independent* if the only solution to

$$c_1 \mathbf{v}_1 + c_2 \mathbf{v}_2 + \dots + c_p \mathbf{v}_k = \mathbf{0} \quad (2)$$

is the *trivial solution*  $c_1 = c_2 = \dots = c_k = 0$ . If, in addition to the trivial solution, a *non-trivial solution* (not all  $c_1, c_2, \dots, c_k$  are zero) exists, then we say that the set  $\{\mathbf{v}_1, \mathbf{v}_2, \dots, \mathbf{v}_k\}$  is *linearly dependent*.

**Remark 5.** Given a set of vectors  $X = \{\mathbf{v}_1, \mathbf{v}_2, \dots, \mathbf{v}_k\}$  we can now ask the following questions:

- (a) Are the vectors in  $X$  linearly dependent according to Definition 4?
- (b) Can we write one element of  $X$  as a linear combination of the others?
- (c) Does  $X$  contain redundant vectors?

It turns out that these questions are equivalent. In other words, if the answer to one of them is "YES", the answer to the other two is also "YES". Conversely, if the answer to one of them is "NO", then the answer to the other two is also "NO". We will start by illustrating this idea with an example, then conclude this section by formally proving the equivalency.

**Example 6.** What can we say about the following sets of vectors in light of Remark 5?

- (a)  $\begin{bmatrix} 2 \\ -3 \end{bmatrix}, \begin{bmatrix} 0 \\ 3 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \end{bmatrix}, \begin{bmatrix} 1 \\ -2 \end{bmatrix}$
- (b)  $\begin{bmatrix} 2 \\ 1 \\ 1 \end{bmatrix}, \begin{bmatrix} -3 \\ 1 \\ 1 \end{bmatrix}$

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is the *trivial solution*  $c_1 = c_2 = \dots = c_k = 0$ . If, in addition to the trivial solution, a *non-trivial solution* (not all  $c_1, c_2, \dots, c_k$  are zero) exists, then we say that the set  $\{\mathbf{v}_1, \mathbf{v}_2, \dots, \mathbf{v}_k\}$  is *linearly dependent*.

**Remark 1.** Given a set of vectors  $X = \{\mathbf{v}_1, \mathbf{v}_2, \dots, \mathbf{v}_k\}$  we can now ask the following questions:

- (a) Are the vectors in  $X$  linearly dependent according to Definition 2?
- (b) Can we write one element of  $X$  as a linear combination of the others?
- (c) Does  $X$  contain redundant vectors?

It turns out that these questions are equivalent. In other words, if the answer to one of them is "YES", the answer to the other two is also "YES". Conversely, if the answer to one of them is "NO", then the answer to the other two is also "NO". We will start by illustrating this idea with an example, then conclude this section by formally proving the equivalency.

**Example 1.** What can we say about the following sets of vectors in light of Remark 1?

- (a)  $\begin{bmatrix} 2 \\ -3 \end{bmatrix}, \begin{bmatrix} 0 \\ 3 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \end{bmatrix}, \begin{bmatrix} 1 \\ -2 \end{bmatrix}$
- (b)  $\begin{bmatrix} 2 \\ 1 \\ 4 \end{bmatrix}, \begin{bmatrix} -3 \\ 1 \\ 1 \end{bmatrix}$

**Explanation 1.** (a) We will start by addressing linear

## Linear Independence

p. 4

**Definition 2** (Linear Independence). Let  $\vec{v}_1, \vec{v}_2, \dots, \vec{v}_k$  be vectors of  $\mathbb{R}^n$ . We say that the set  $\{\vec{v}_1, \vec{v}_2, \dots, \vec{v}_k\}$  is *linearly independent* if the only solution to

$$c_1 \vec{v}_1 + c_2 \vec{v}_2 + \dots + c_p \vec{v}_k = \vec{0} \quad (2)$$

is the *trivial solution*  $c_1 = c_2 = \dots = c_k = 0$ .

If, in addition to the trivial solution, a *non-trivial solution* (not all  $c_1, c_2, \dots, c_k$  are zero) exists, then we say that the set  $\{\vec{v}_1, \vec{v}_2, \dots, \vec{v}_k\}$  is *linearly dependent*.

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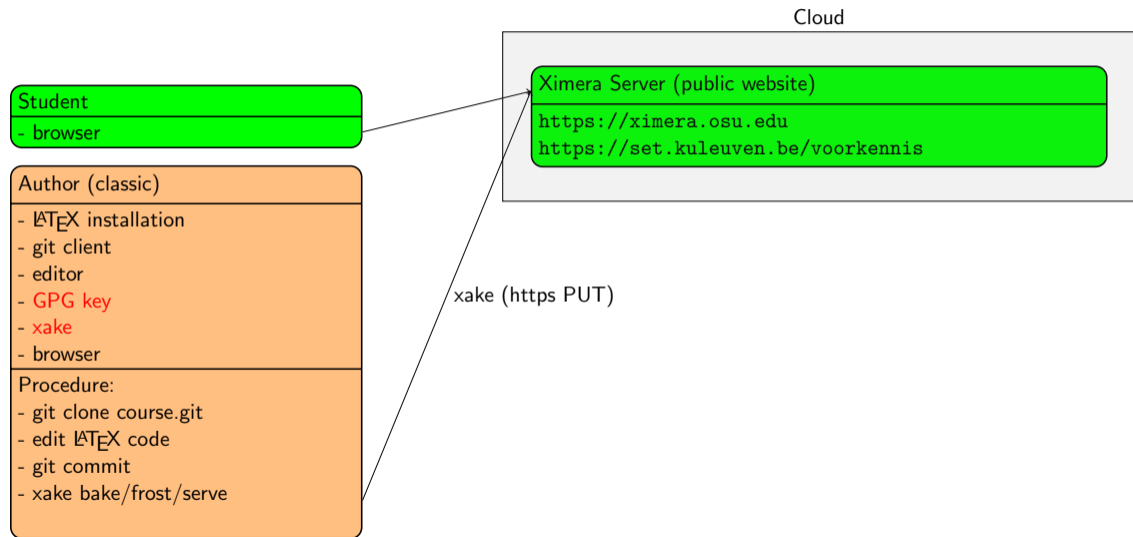
**Example 1.** What can we say about the following sets of vectors in light of Remark 1?

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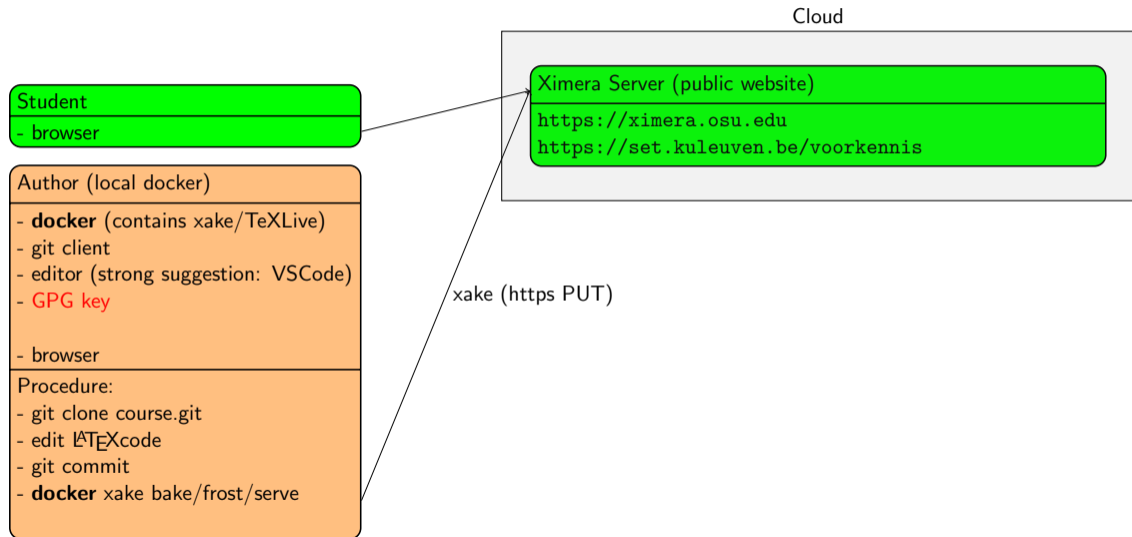
## More Ximera features

- hints/feedback/solutions; foldable environments
- answers with 'expressions' i.e.  $x^2-4$  vs  $-4+x^2$  vs  $(x + 2)(x-2)$
- Integration of geogebra/youtube/google docs/xkcd
- LTI link to LMS (Blackboard/Moodle/...); only LTI 1.1
- Integration of SAGE
- Downloadable student activity statistics
- Extra validators for answers (in javascript)
- ...

# Build Architecture ('classic')

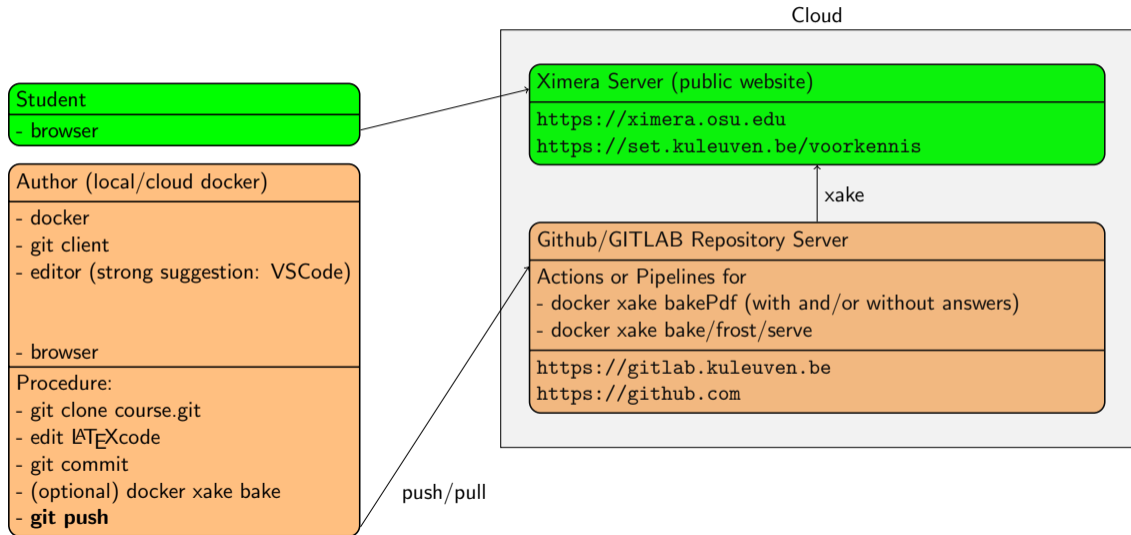


# Build Architecture ('local docker')





# Build Architecture ('cloud')



## Further developments

- Accessibility (both HTML and PDF)

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- Grade and performance database and dashboard

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<https://people.math.osu.edu/fowler.291/latex/>

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- Better documentation
- Better VSCode/docker/cloud support

# Grants

Grants from \$500 to \$5000 are available for concrete contributions.

Contact: [ximera@math.osu.edu](mailto:ximera@math.osu.edu)



Thanks for your attention.

**Questions:** ask them right now, or mail them.

- <https://github.com/XimeraProject>
- <https://ximera.osu.edu/testing/examples>
- <https://set.kuleuven.be/voorkennis/examples/examples>
- <https://people.math.osu.edu/fowler.291/latex/>

Contact:

About Ximera, grants etc.: [ximera@math.osu.edu](mailto:ximera@math.osu.edu) (Bart Snapp, Jim Fowler)

About this talk : [wim.obbels@kuleuven.be](mailto:wim.obbels@kuleuven.be)