Ximera @ TUG2024

Wim Obbels, and Bart Snapp and Jim Fowler

July 19 2024

Intro

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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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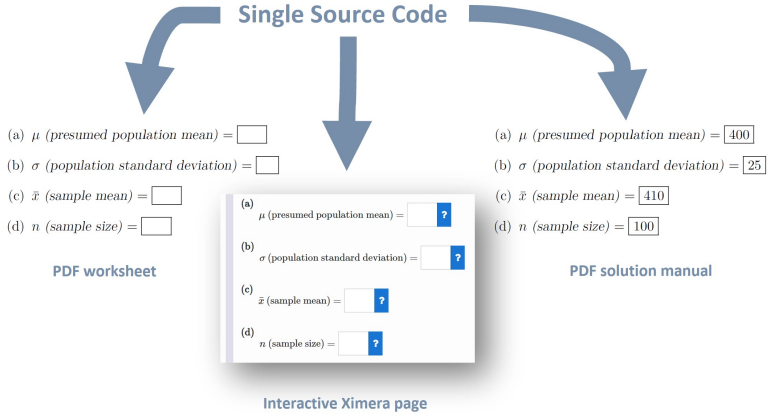

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- 2010: LaTeX to (interactive) app on iPad, by Bart Snapp et al.

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- 2019: Ximera-server at KU Leuven, Belgium
  Jesse Hoobergs and Wim Obbels; docker, layout, extra functionality

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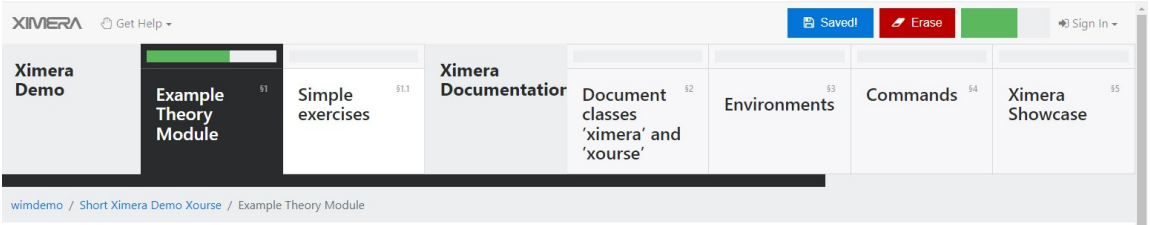
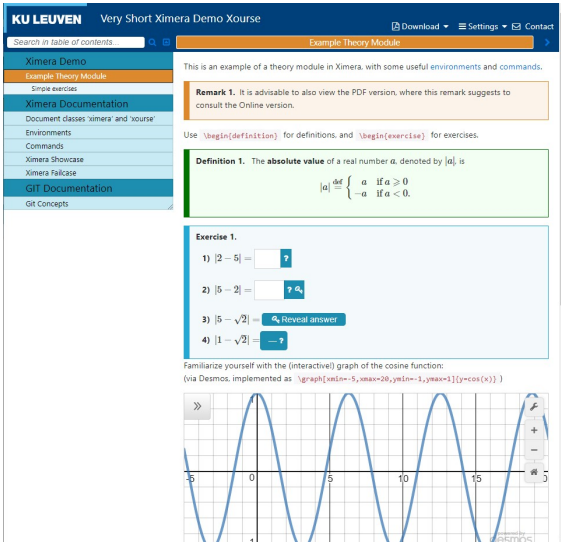
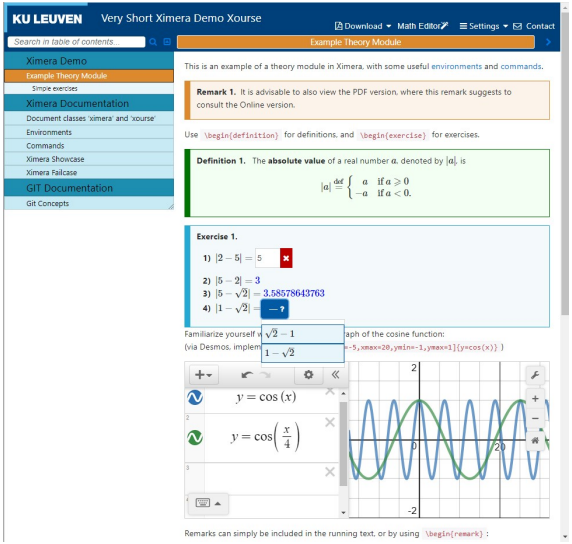
  Jesse Hoobergs and Wim Obbels; docker, layout, extra functionality
- 2024-2026: grant from 'Open Textbooks Pilot Program'

Example (HTML, OSU layout)



Example (HTML, KU Leuven layout)





Example (PDF activity)

theorie.pdf 1 / 1 − 150% +

Example Theory Module

This is an example of a theory module in Ximera, with some useful environments and commands.

Remark 1. It is advisable to also view the Online version, where this remark suggest to the PDF.

By the way, you are using the *handout* PDF, which does **not** contain answers.
There is also a so-called *standard* PDF *which does contain answers and hints*.

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

Definition 1. The **absolute value** of a real number a, denoted by $|a|$, is

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

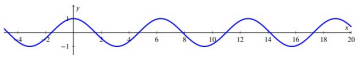
Exercise 1.

1. $|2-5| = \ldots\ldots$
2. $|5-2| = \ldots\ldots$
3. $|5-\sqrt{2}| = \ldots\ldots$
4. $|1-\sqrt{2}| = \boxed{\sqrt{2}-1} \mid \boxed{1-\sqrt{2}}$

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)})

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:



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Exercise 1.

1. $|2-5| = 3$
2. $|5-2| = 3$
3. $|5-\sqrt{2}| = 3.58578643763$
4. $|1-\sqrt{2}| = \boxed{\sqrt{2}-1}$

Familiarize yourself with the (interactive!) graph of the cosine function:
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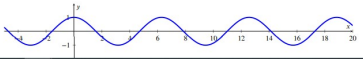
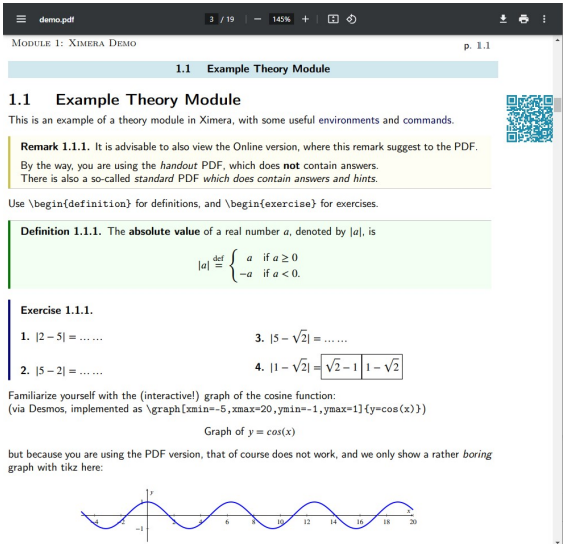


Example (PDF xourse)



Example (source of activity (1))

```
\documentclass{ximera}
% \handouttrue
\input{../preamble.tex}
\addPrintStyle{..}

\begin{document}
    \author{Wim Obbels}
    % \title{Example Theory Module}
    % \maketitle
    % \begin{abstract}  A simple Ximera module \end{abstract}
    \xmtitle{Example Theory Module}{A simple Ximera module}
    \label{xim:ximeraDemo}

This is an example of a theory module in Ximera,
with some useful \hyperref[xim:ximeraEnvironments]{environments} and \hyperref[xim:ximeraCommands]{commands}.

% Demo: small adhoc differences between PDF and HTML version
\pdfOnly{
    \begin{remark}
        It is advisable to also view the Online version, where this remark refers to the PDF.
        \ifhandout
            By the way, you are using the \textit{handout} PDF, which does \textbf{not} contain answers. \\
            There is also a so-called \textit{standard} PDF \textit{which does contain answers and hints}.
        \else
            You are, by the way, using the so-called \textit{standard} PDF, which \textbf{contains the answers} to the exercises. \\
            There is also a \textit{handout} PDF \textit{without the answers}.
        \fi
    \end{remark}
}
\begin{onlineOnly}
 \begin{remark}
    It is advisable to also view the PDF version, where this remark suggests to consult the Online version.
 \end{remark}
\end{onlineOnly}
```

Example (source of activity (2))

ximeradoc > demo > theorie.tex

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

\begin{definition}\label{showcase:absolutevalue}
    The \textbf{absolute value} of a real number $a$, denoted by $|a|$, is
    \[
        |a| \perdef \begin{cases}
                        \phantom{-}a  & \text{if } a \geq 0 \\
                                -a  & \text{if } a<0.
                    \end{cases}
    \]
\end{definition}

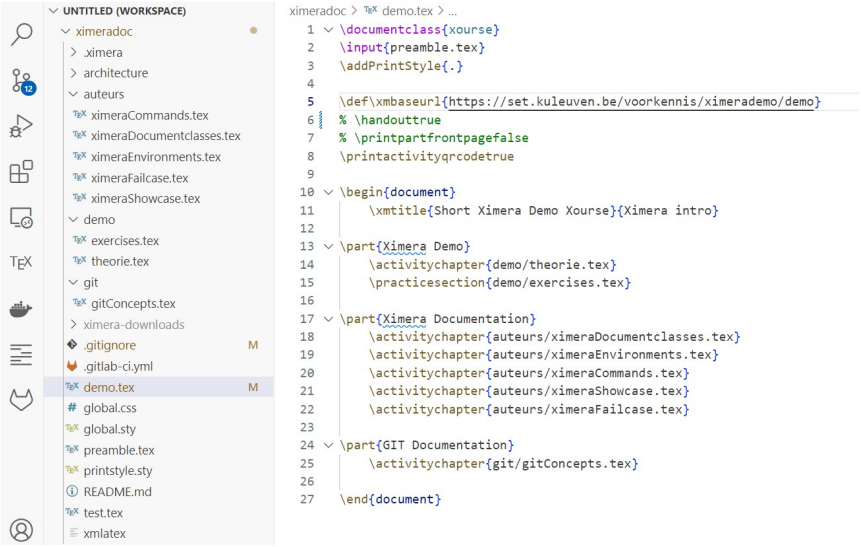
\begin{exercise}\nl

    \begin{xmmulticols}
    \begin{question} $|2-5|        = \answer{3}$                          \end{question}
    \begin{question} $|5-2|        = \answer[onlineshowanswerbutton]{3}$    \end{question}
    \begin{question} $|5-\sqrt{2}| = \answer[onlinenoinput]{3.58578643763}$ \end{question}
    \begin{question}
        $|1-\sqrt{2}| = $\wordChoice{\choice[correct]{$\sqrt{2} - 1$}\choice{$1-\sqrt{2}$}}
    \end{question}
    \end{xmmulticols}
\end{exercise}

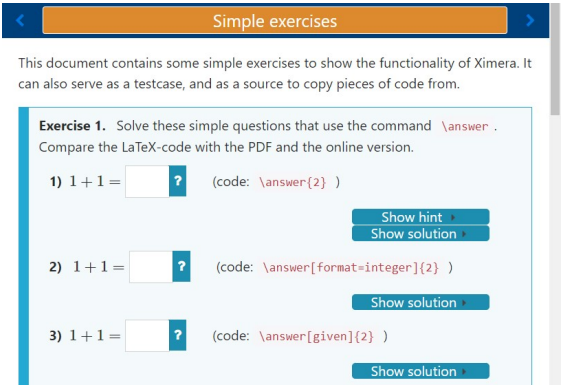
Familiarize yourself with the (interactive!) graph of the cosine function:  \\
(via Desmos, implemented as \verb|\graph[xmin=-5,xmax=20,ymin=-1,ymax=1]{y=cos(x)}|)
\[
 \graph[xmin=-5,xmax=20,ymin=-1,ymax=1]{y=cos(x)}
\]
\pdfOnly{
but because you are using the PDF version, that of course does not work,
and we only show a rather \textit{boring} graph with tikz here:

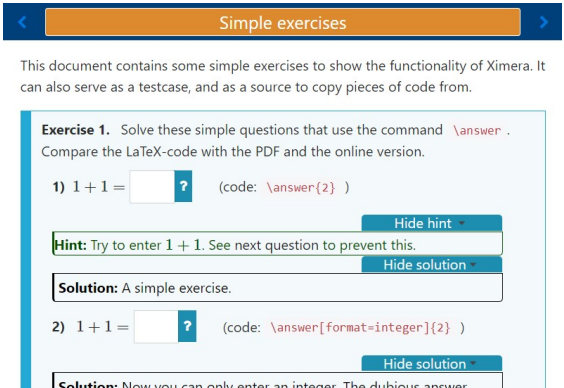
\begin{image}[0.7\textwidth]
    \begin{tikzpicture}
    \begin{axis}[
```

Example (source of xourse)



Example (hints/solutions)





Example (hints/solutions source)

ximeradoc > demo > 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_exercies}
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 $\mathbf{v}_1, \mathbf{v}_2, \ldots, \mathbf{v}_k$ be vectors of $\mathbb{R}^n$. We say that the set $\{\mathbf{v}_1, \mathbf{v}_2, \ldots, \mathbf{v}_k\}$ is *linearly independent* if the only solution to

$$c_1\mathbf{v}_1 + c_2\mathbf{v}_2 + \ldots + c_p\mathbf{v}_k = \mathbf{0} \tag{2}$$

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

Remark 5. Given a set of vectors $X = \{\mathbf{v}_1, \mathbf{v}_2, \ldots, \mathbf{v}_k\}$ 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) $\left\{\begin{bmatrix} 2 \\ -3 \end{bmatrix}, \begin{bmatrix} 0 \\ 3 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \end{bmatrix}, \begin{bmatrix} 1 \\ -2 \end{bmatrix}\right\}$

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

Linear Independence

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

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Remark 1. Given a set of vectors $X = \{\mathbf{v}_1, \mathbf{v}_2, \ldots, \mathbf{v}_k\}$ 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) $\left\{\begin{bmatrix} 2 \\ -3 \end{bmatrix}, \begin{bmatrix} 0 \\ 3 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \end{bmatrix}, \begin{bmatrix} 1 \\ -2 \end{bmatrix}\right\}$

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

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

Linear Independence

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

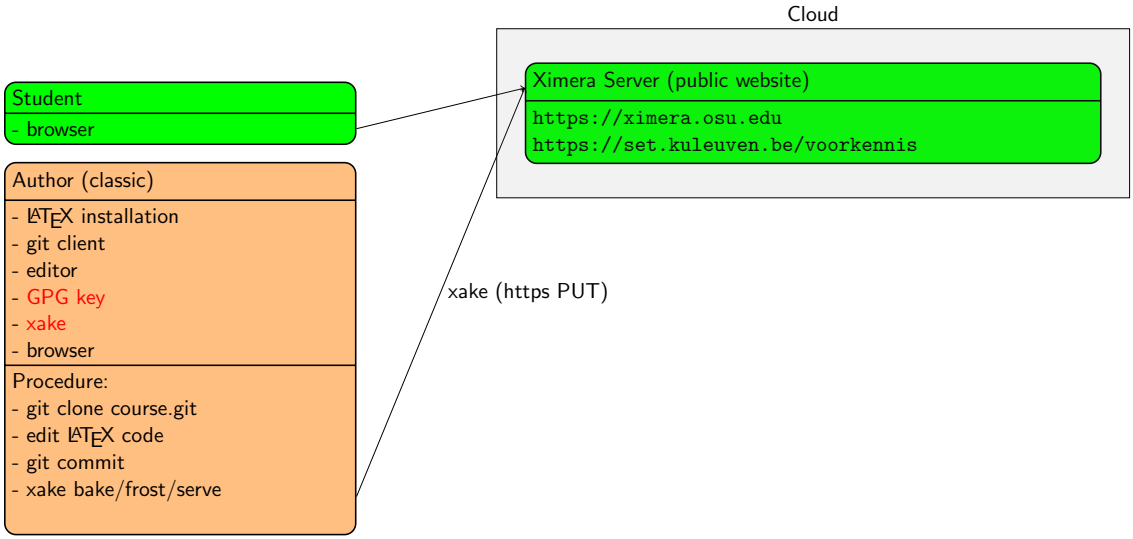
(a)
$$\left\{\begin{bmatrix} 2 \\ -3 \end{bmatrix}, \begin{bmatrix} 0 \\ 3 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \end{bmatrix}, \begin{bmatrix} 1 \\ -2 \end{bmatrix}\right\}$$

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

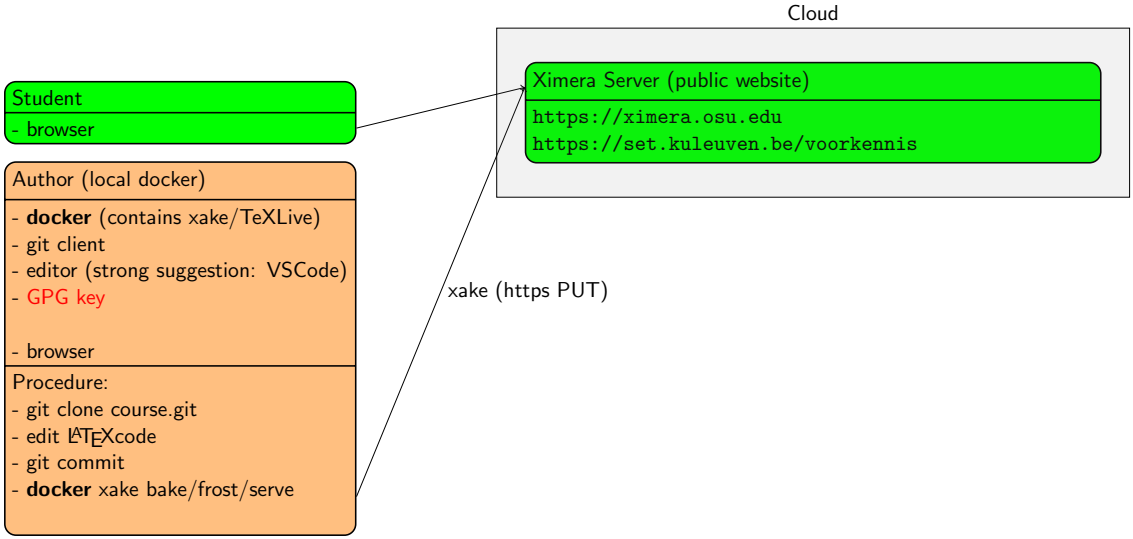
More Ximera features

- 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)
- ...

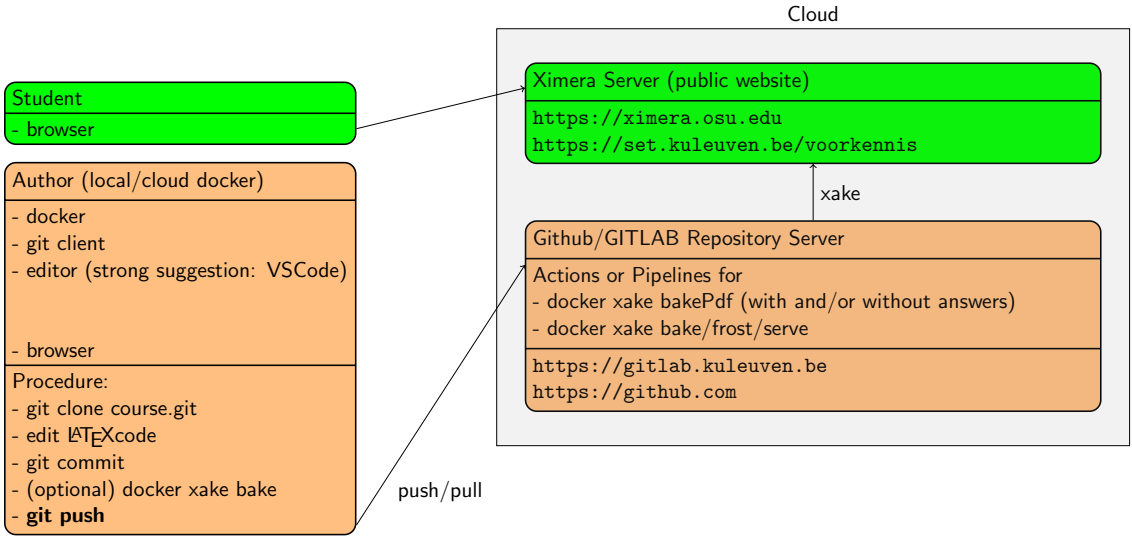
Build Architecture ('classic')



Build Architecture ('local docker')



Build Architecture ('cloud')



Further developments

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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

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 (Bart Snapp, Jim Fowler)
About this talk :	wim.obbels@kuleuven.be