Introduction to LaTeX

Vincent Knight
M1.30
knightva@cf.ac.uk

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Overview

Objectives

Using TEX, LATEX and $\mathcal{AMS}$-LATEX you will be able to

- Create documents containing mathematics.
- Create presentations.

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Using TEX, LATEX and $\mathcal{AMS}$-LATEX you will be able to

- Create documents containing mathematics.
- Create presentations.

I will not attempt to teach you everything there is to know about LATEX, (I most certainly do not know all there is to know). My goal is to teach you enough to get you started and more importantly to know where to go if you need to get further.

History of LaTeX

"As a computer scientist, I really identify with patterns of 0's and 1's; I ought to be able to do something about this." [Donald Knuth]

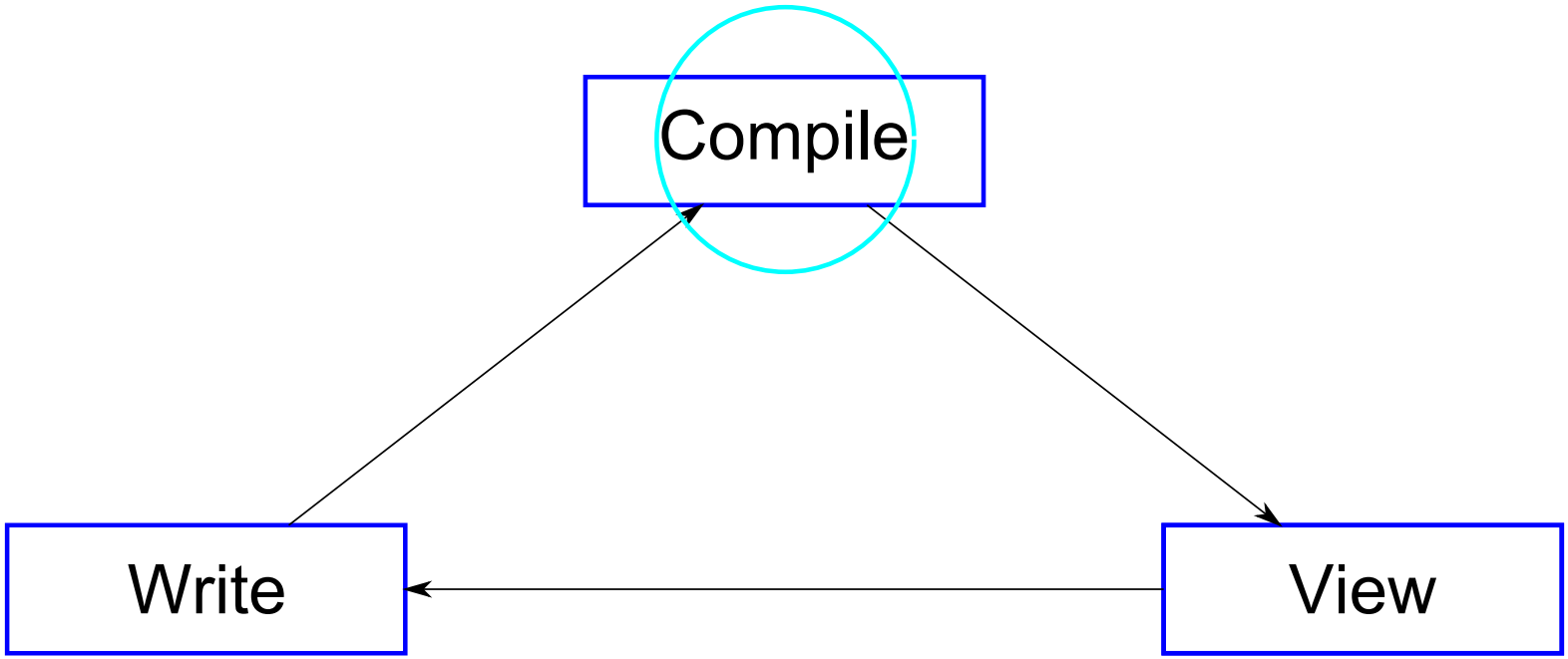
Donald Knuth was unhappy with "state of the art" mathematical typesetting in 1976. It took him 10 years to develop TeX a document mark-up language. It is not an editor but a programming language. Since TeX, various improvements have been made. Importantly each of these improvements has a different name.This means that there are no compatibility issues. LaTeX is based on TeX (it is a family of macros that makes using TeX easier). The American Mathematical Society created a package called $\mathcal{AMS}$-LaTeX that we will be using during this course.

Installing LaTeX

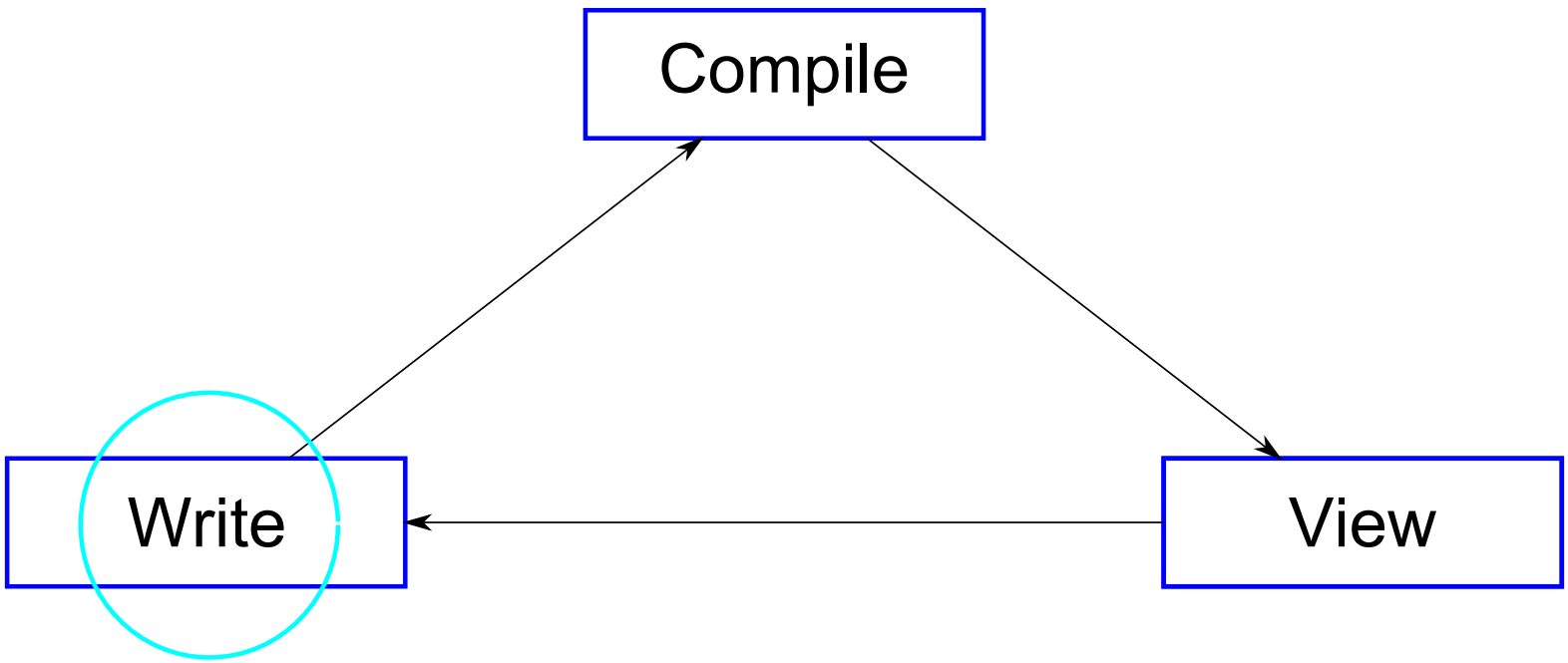
3 things are needed to be able to 'TeX' documents:

- A typesetting system (we will use MiKTeX)
- A word editor (we will use TeXworks)
- Patience

Editing Cycle



Editing Cycle



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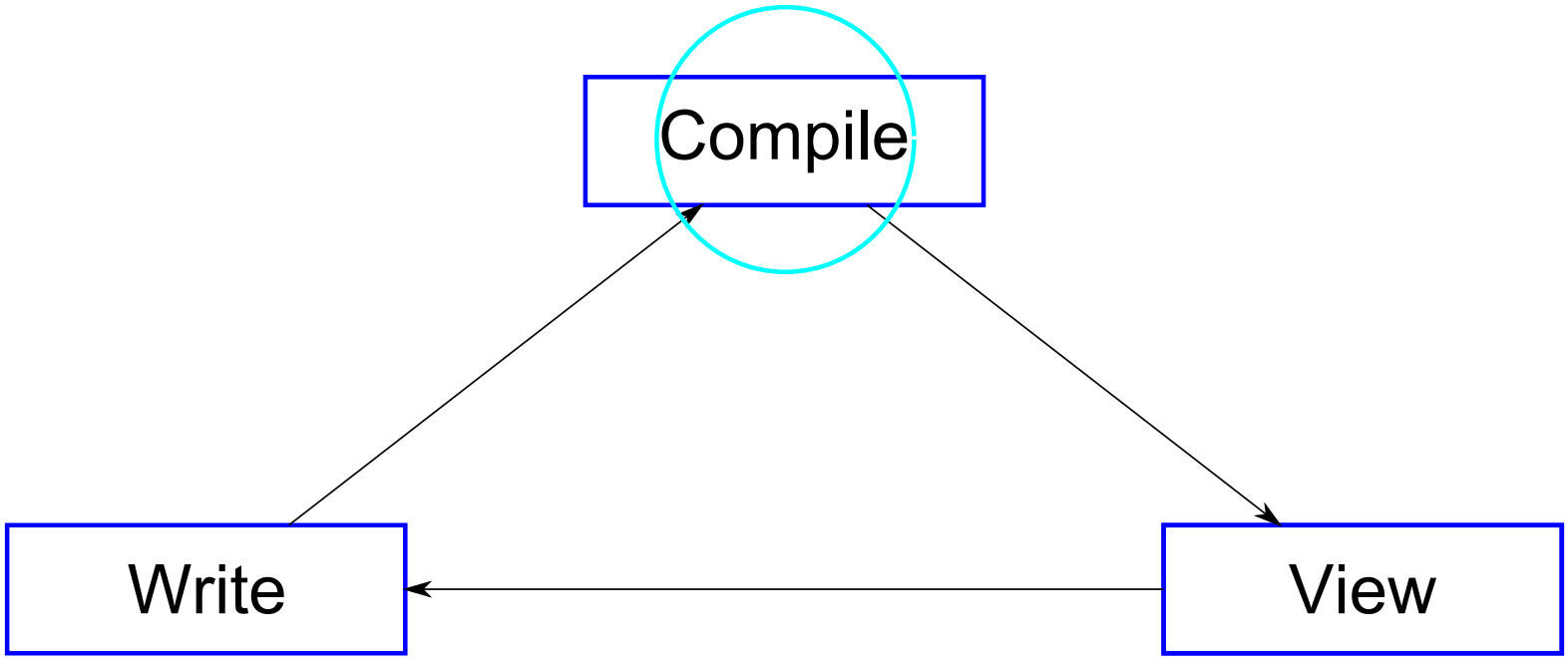

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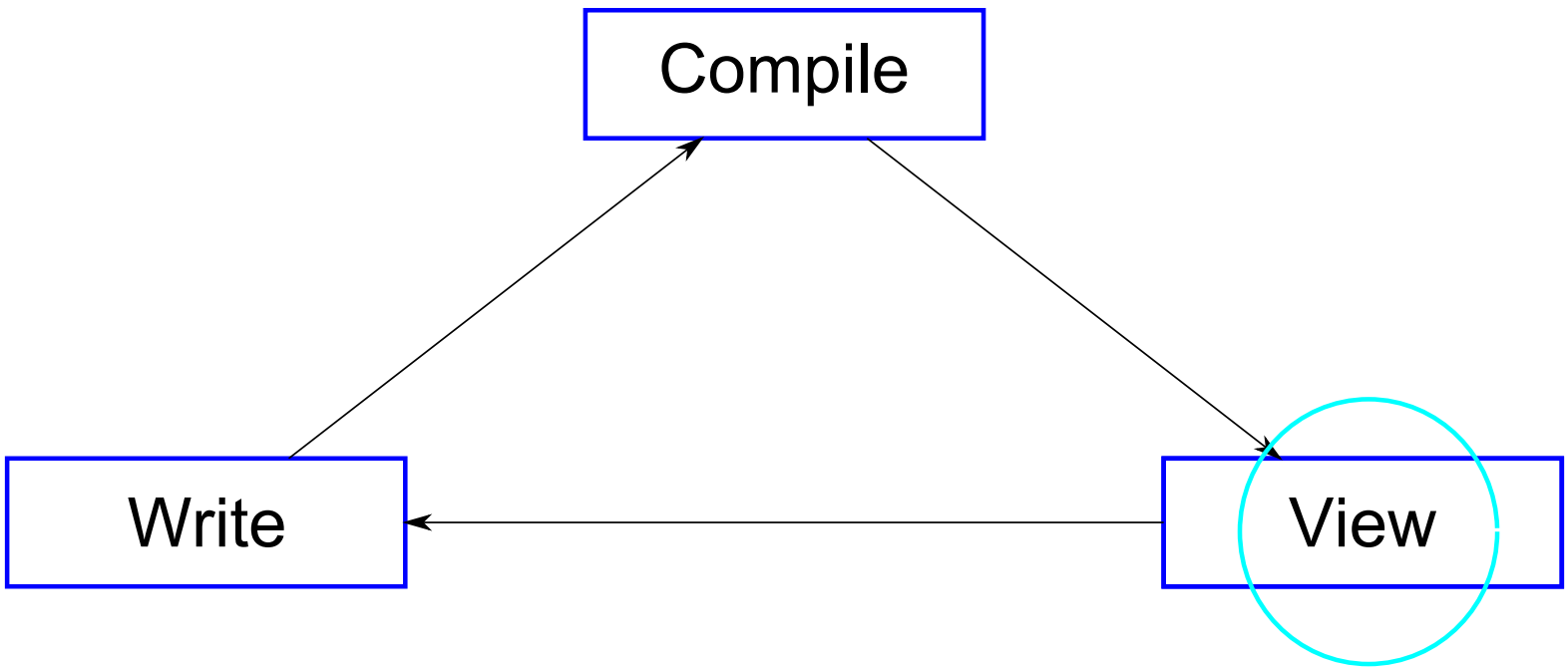

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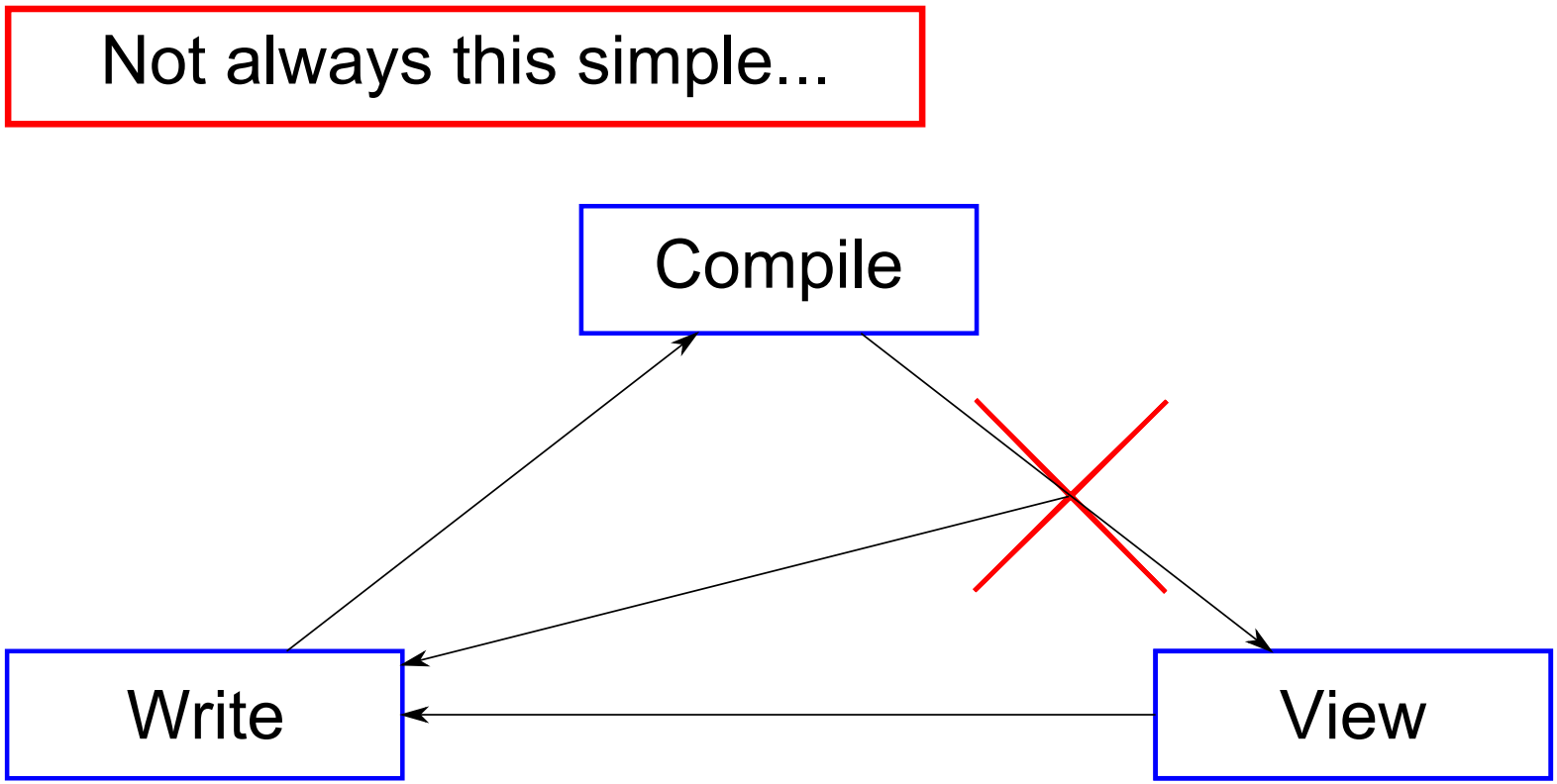

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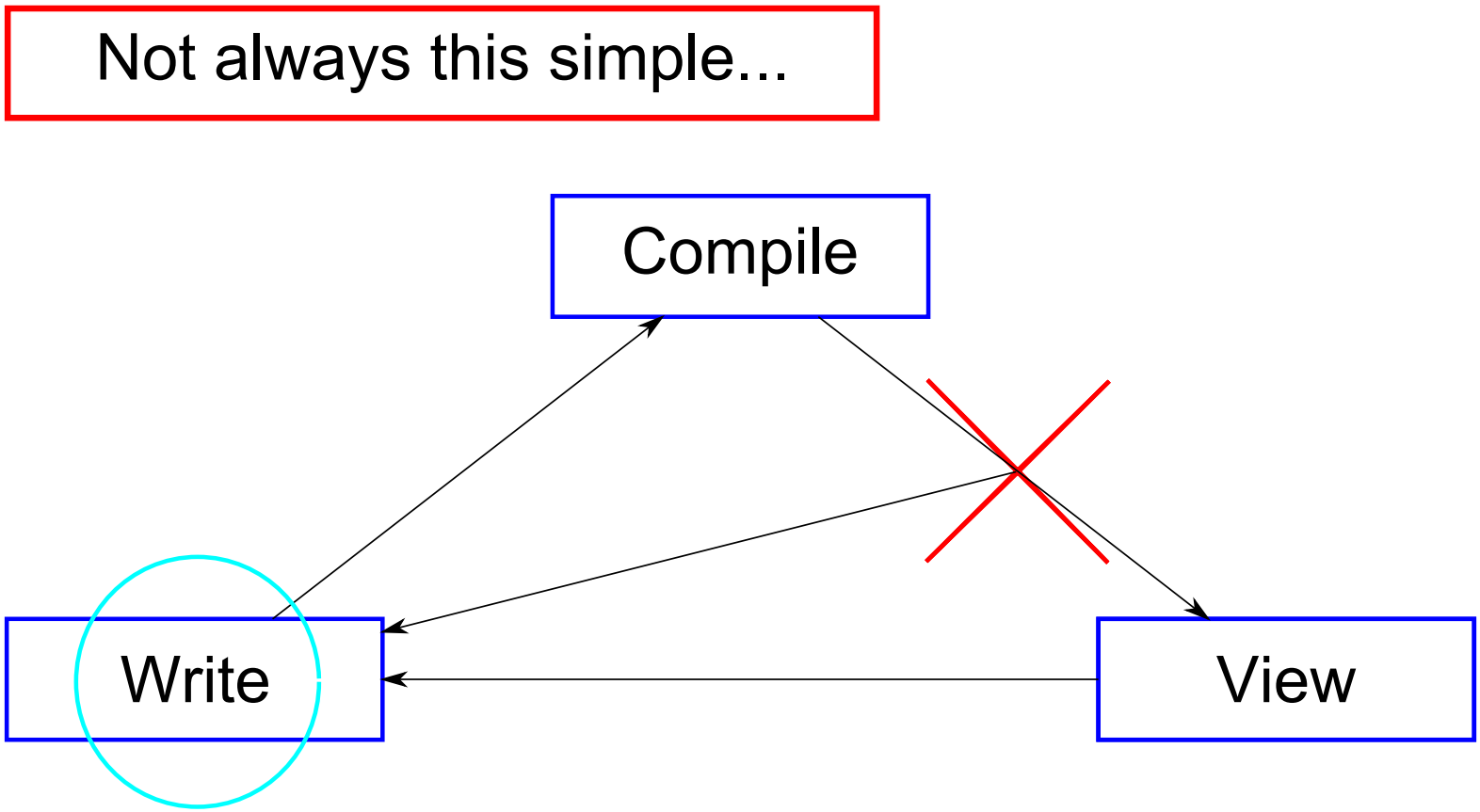

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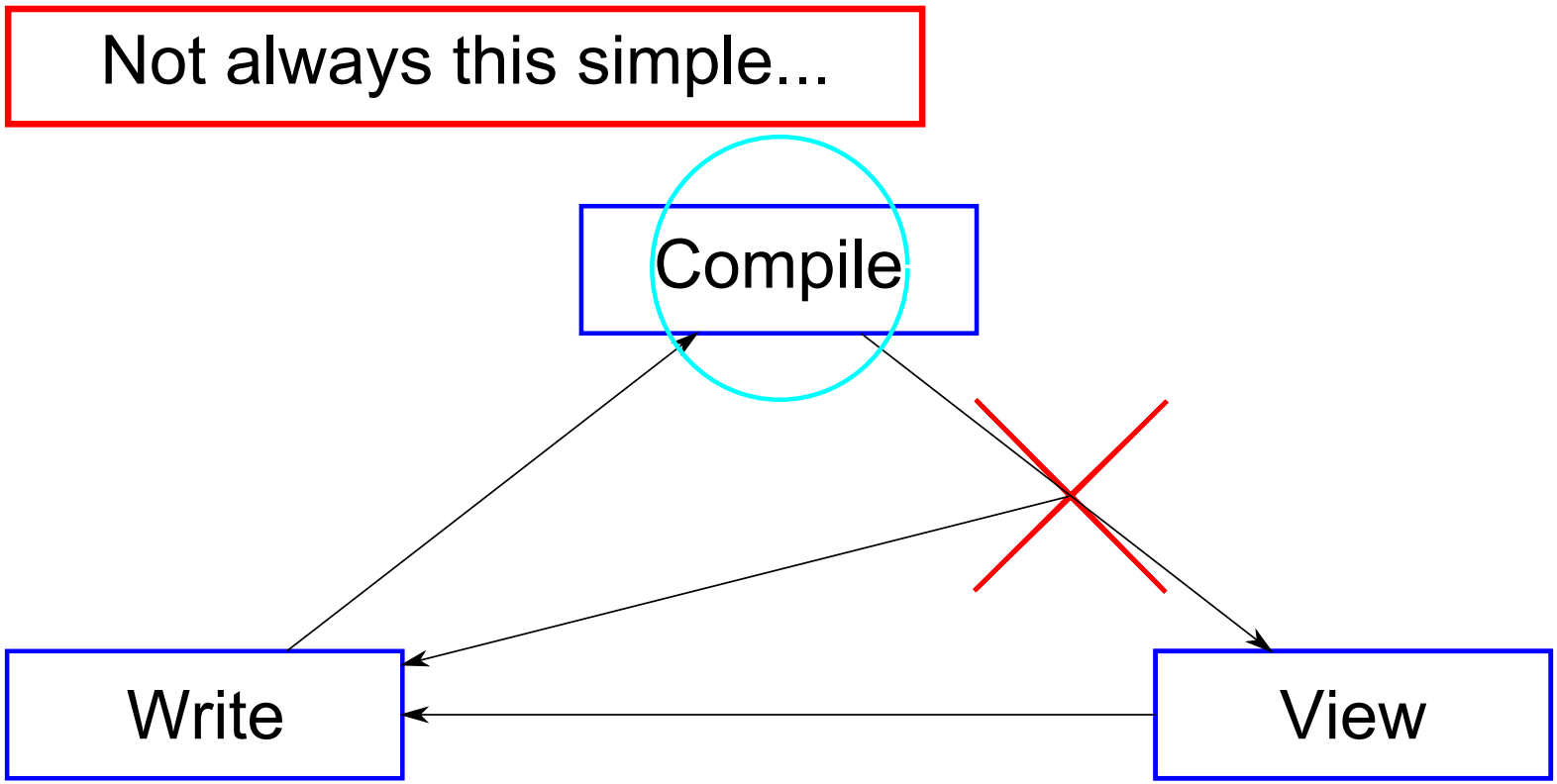

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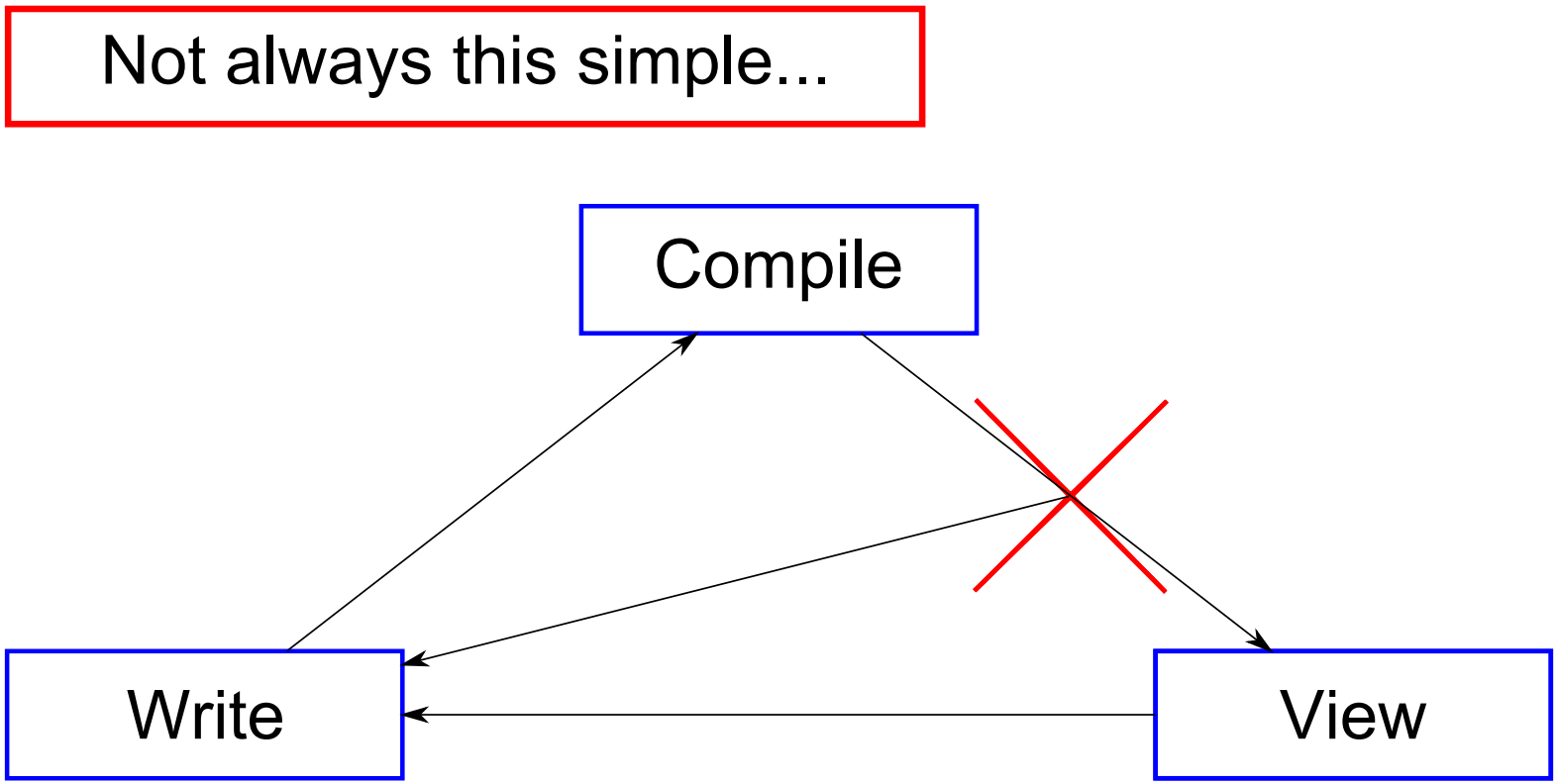

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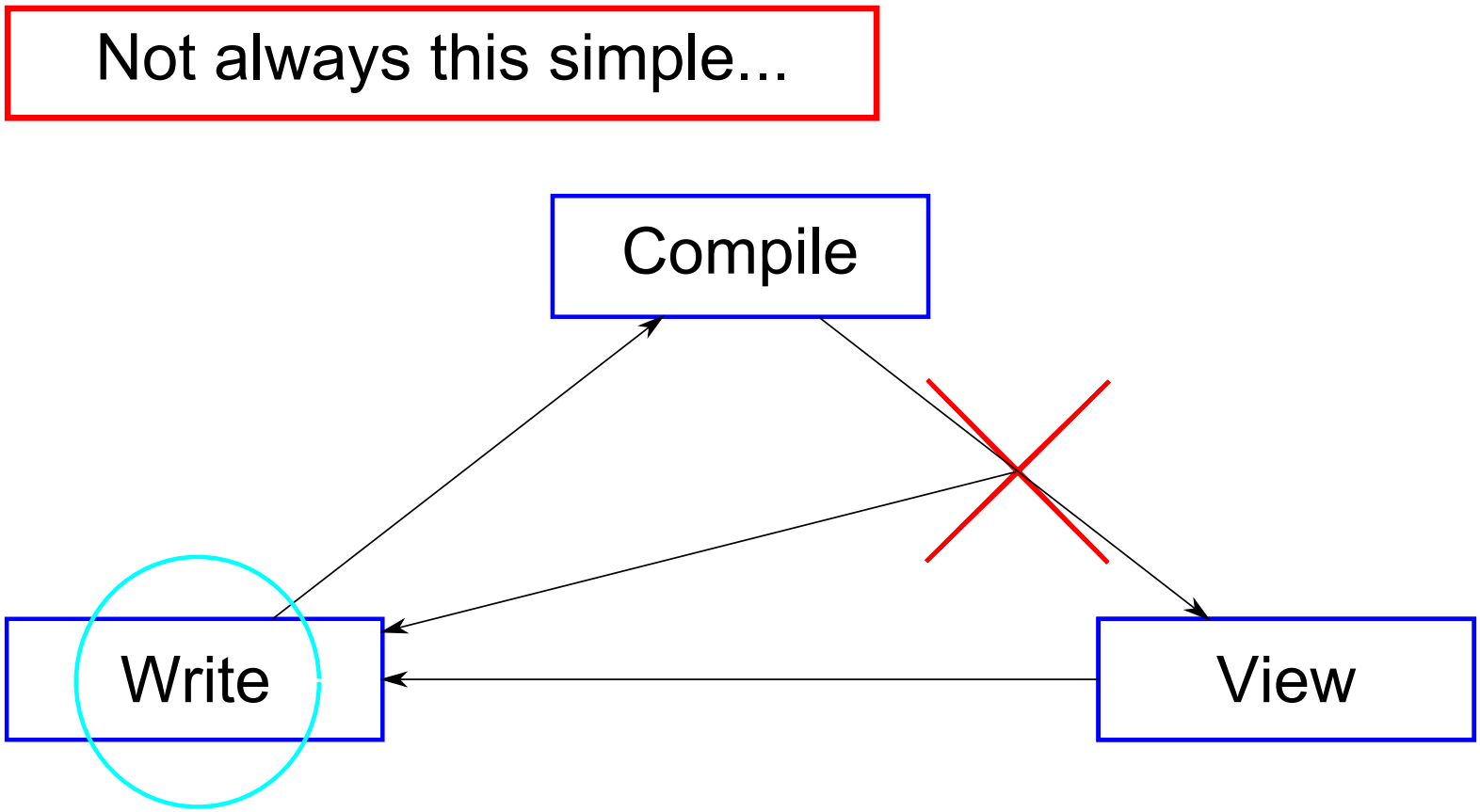

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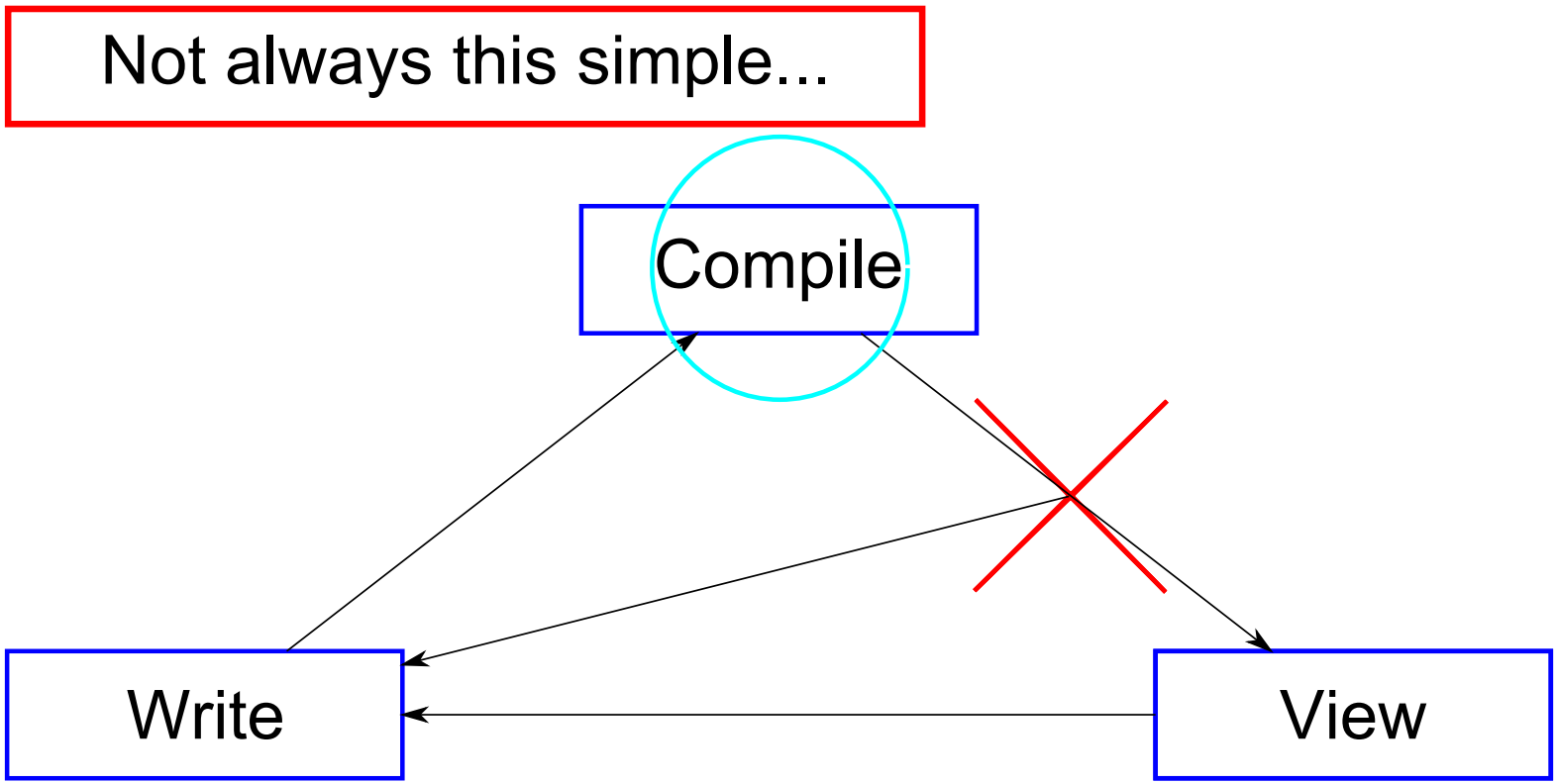

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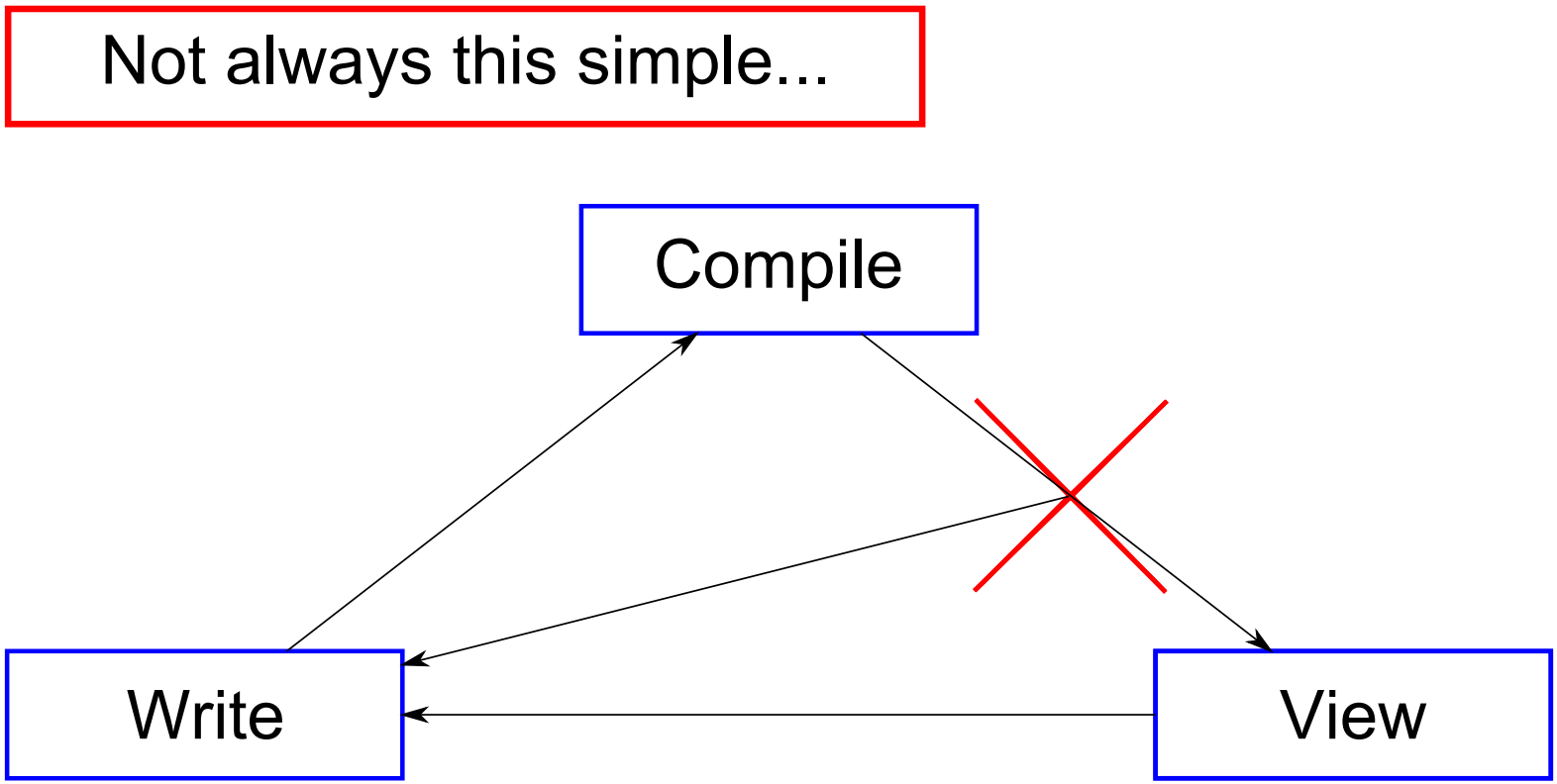

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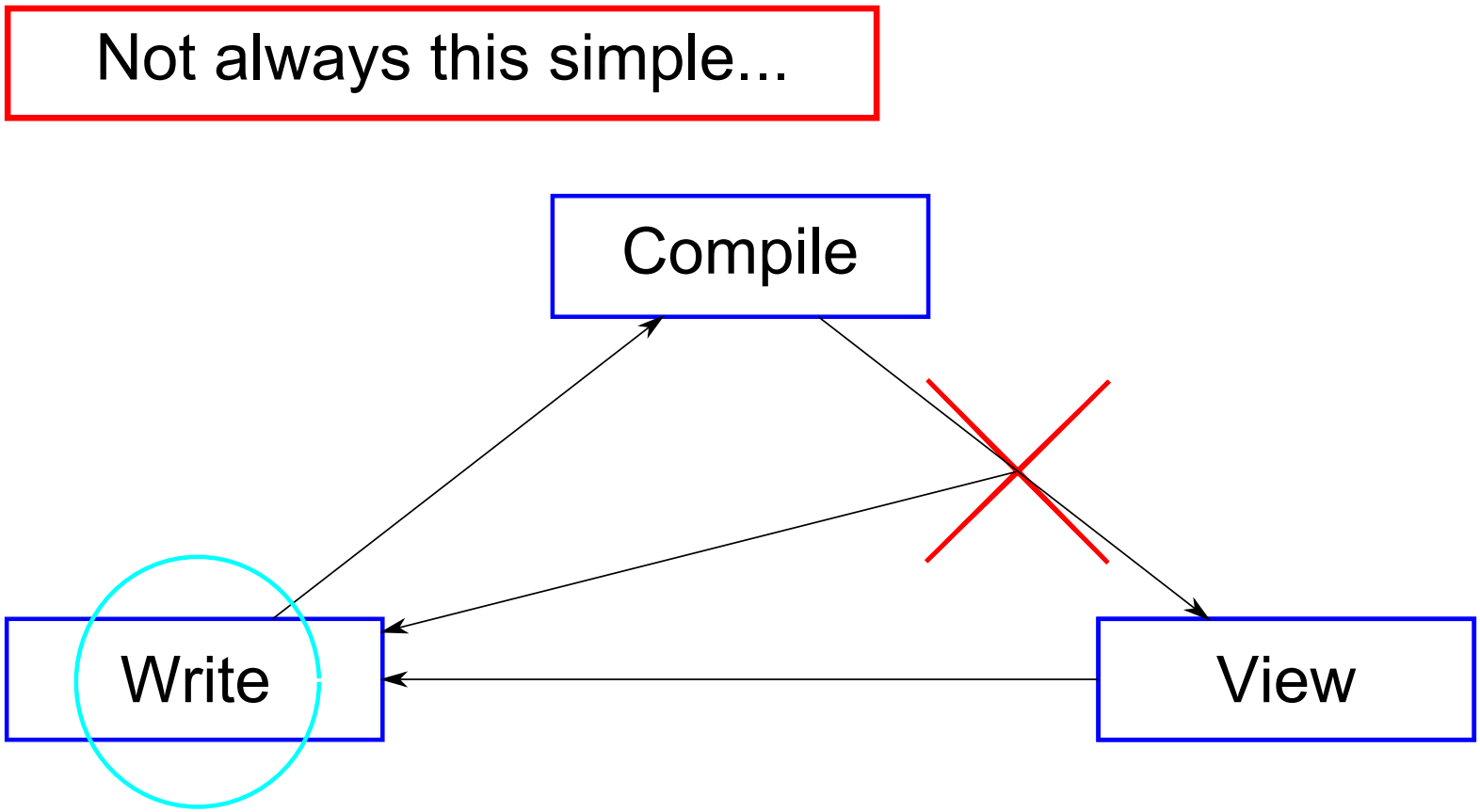

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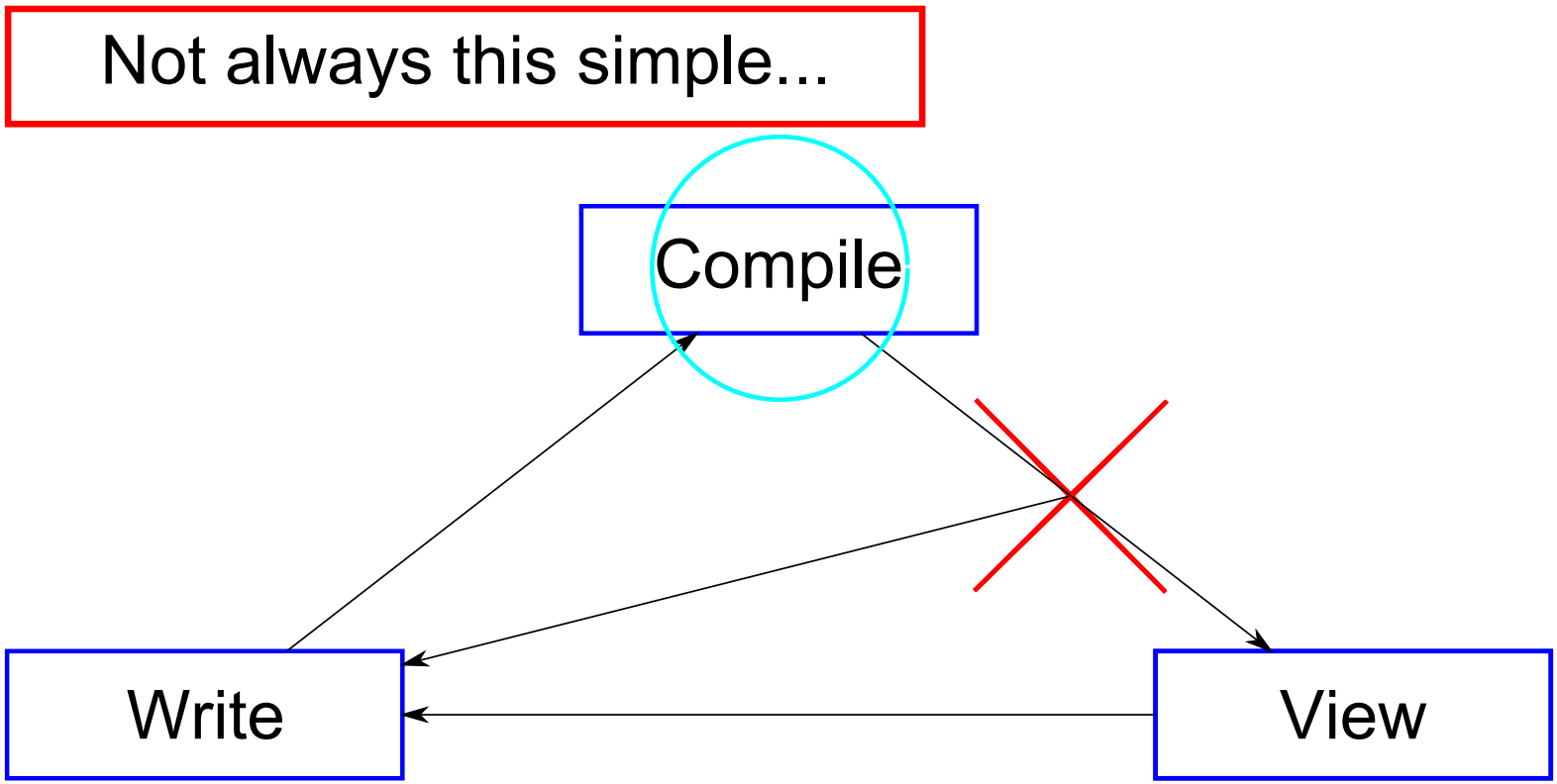

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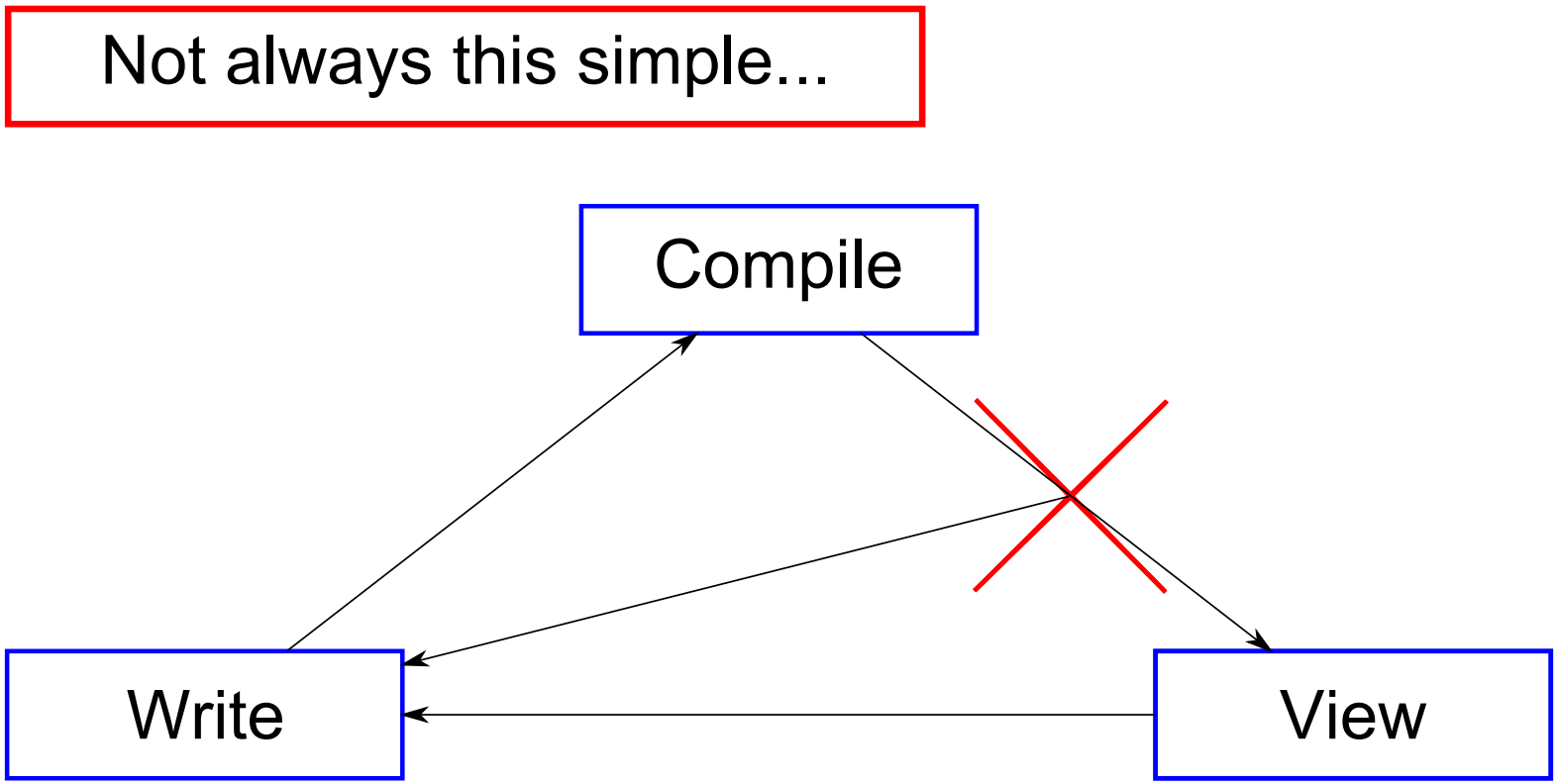

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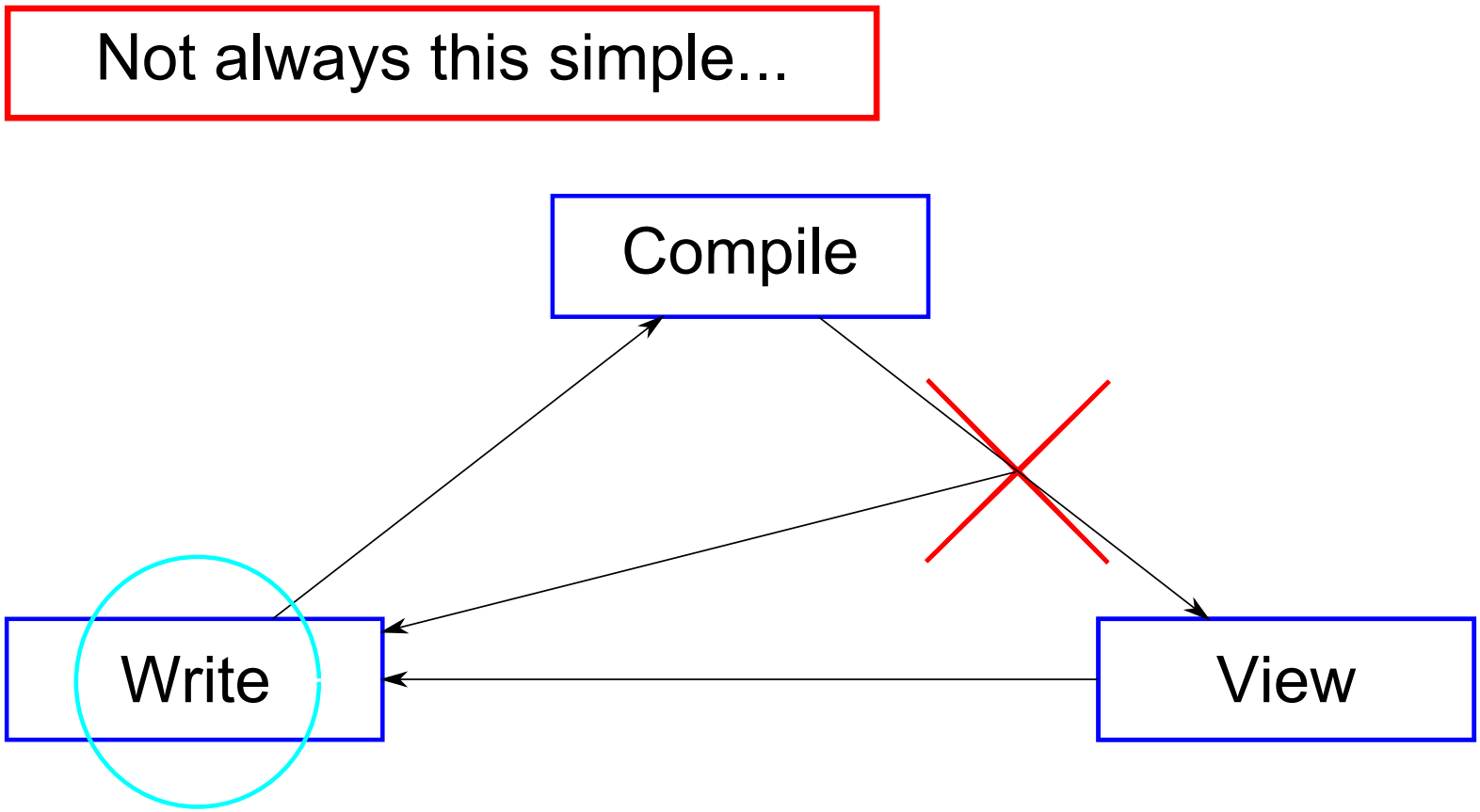

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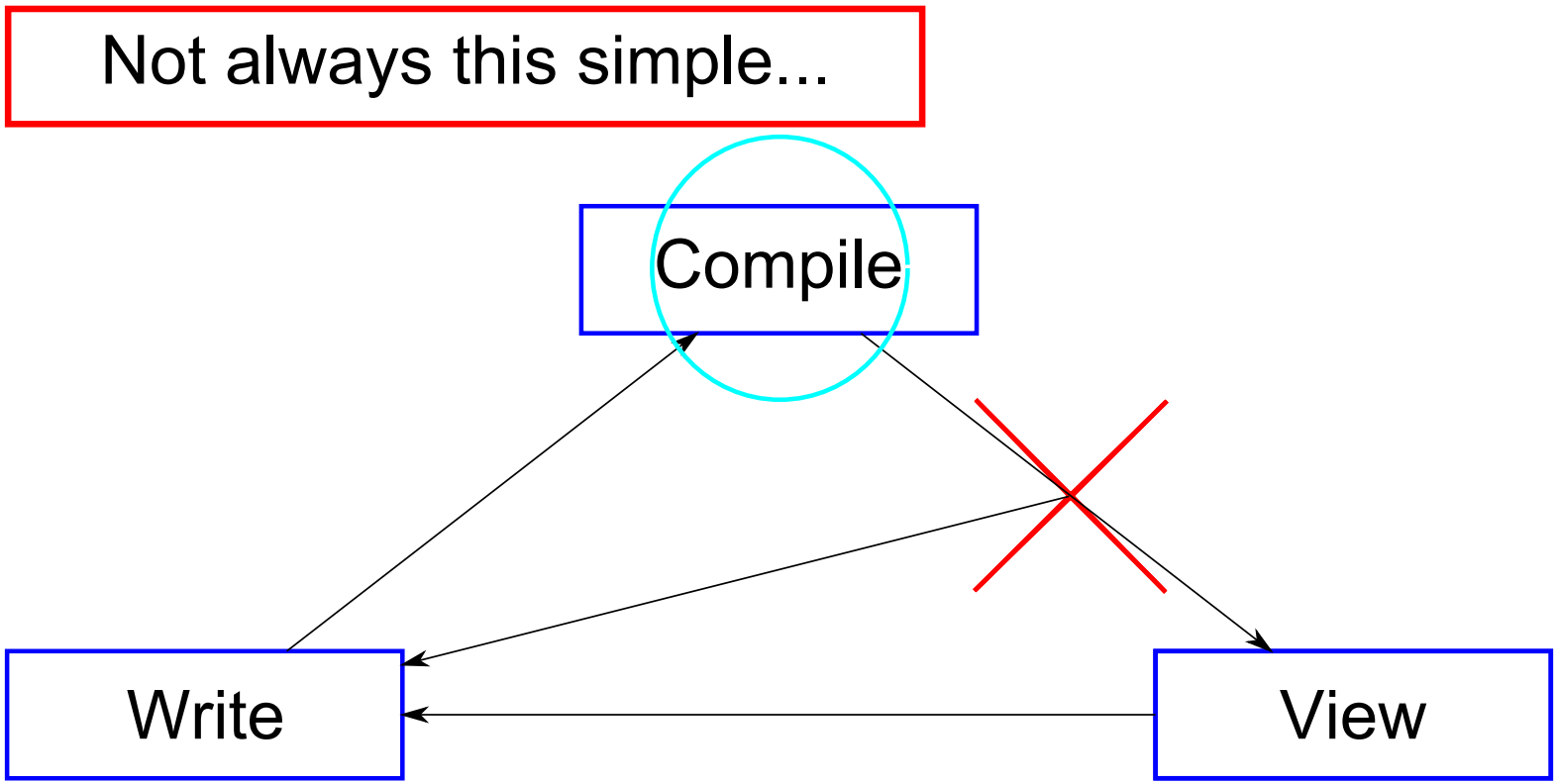

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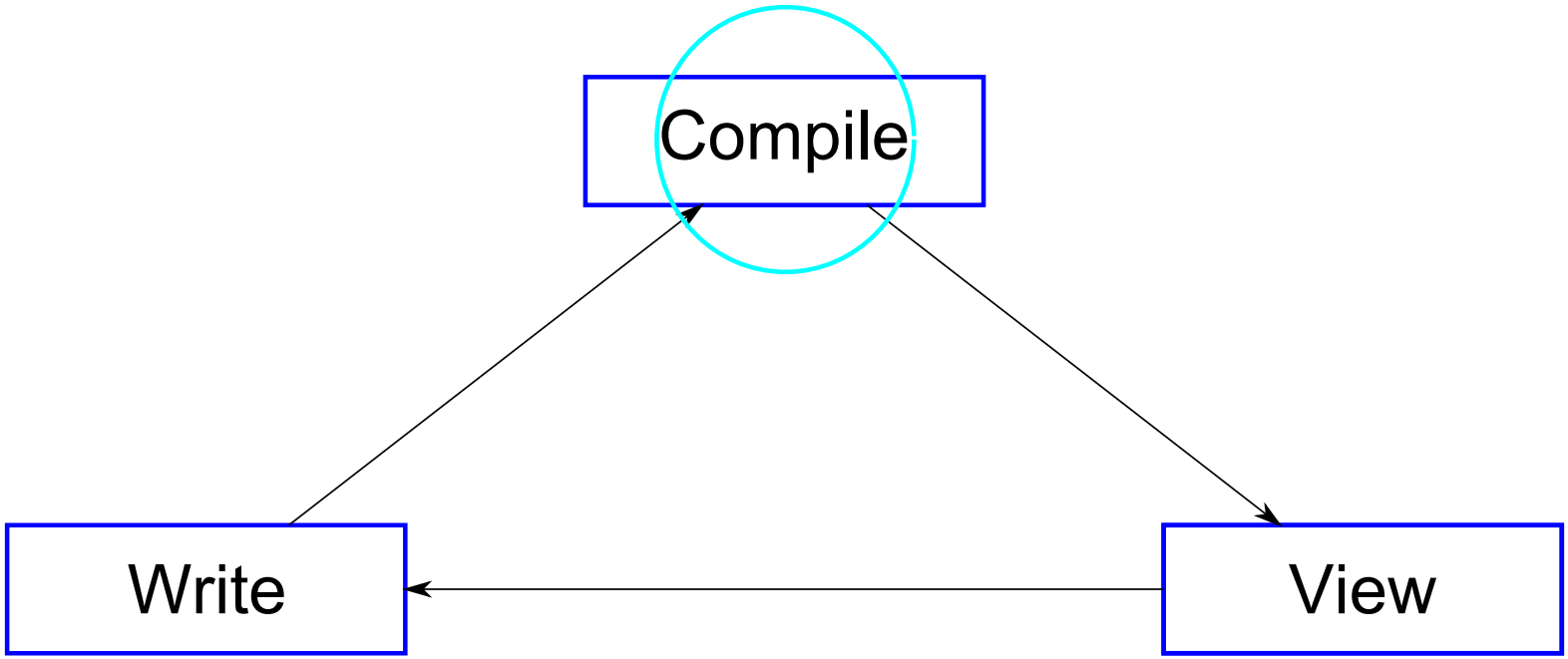

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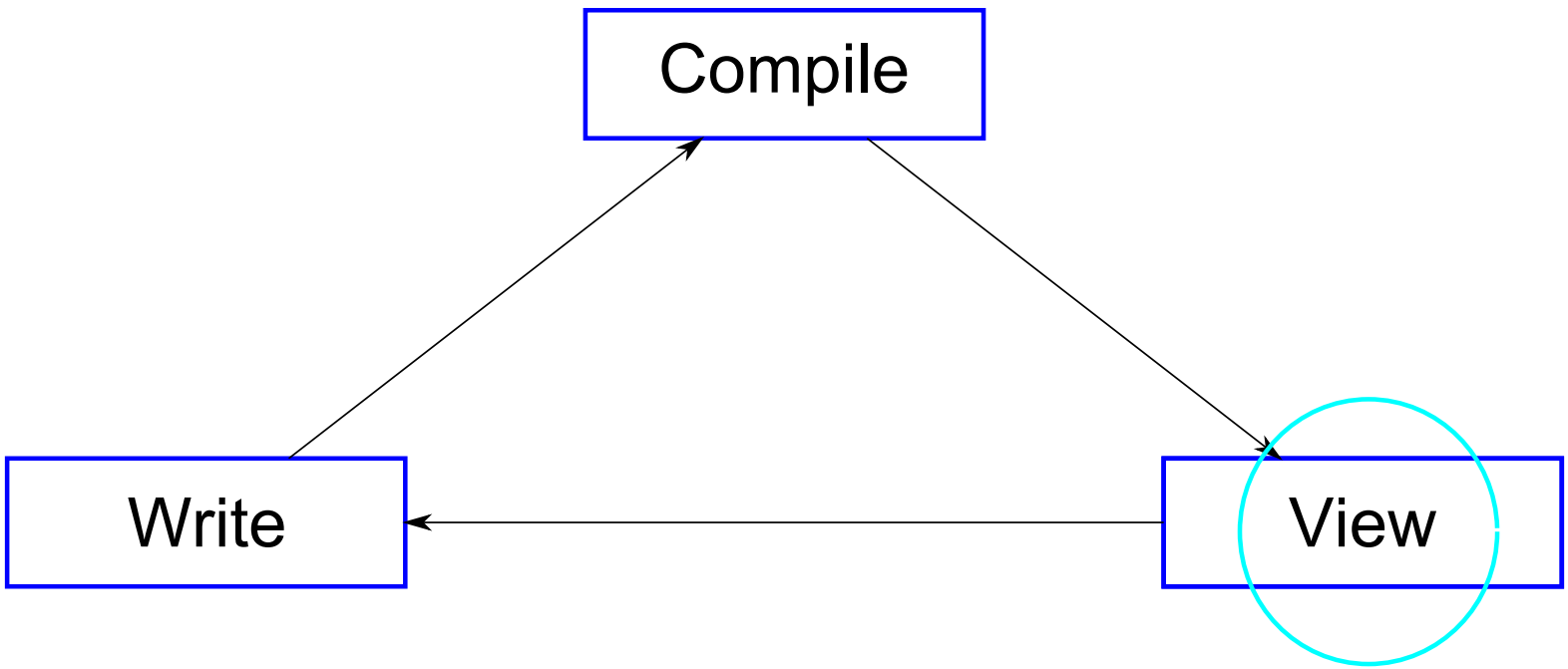


Example

- Create a new document in TeXworks.
- Save it (cheatsheet.tex).
- Write the following code:

```
\documentclass{article}

\begin{document}
I can write normal text.
\end{document}
```

- Ensure the dropdown window has: "pdfLaTeX" selected.
- Click on the green arrow (ctrl+T).

Example

This outputs a pdf file with the following output:

I can write normal text.

General Rules

- The following keys are used to type text in a source file:

  a-z A-Z 0-9

  $+ = * / ( ) [ ]$

- You may also use the following punctuation marks:

  ' ; . ? ! : ‘ ’ -

- Finally there are 13 special keys that are used in LaTeX commands:

  `# $ % & ~ _ ^ \ { } @ " |`

Example

Now attempt to add the following text:

I can write normal text.

I can centre text.

I can put text on the right.

Example

```
\documentclass{article}

\begin{document}
I can write normal text.

\begin{center}
I can centre text.
\end{center}

\begin{flushright}
I can put text on the right.
\end{flushright}

\end{document}
```

LaTeX Structure

```
\documentclass{...}
\usepackage{...}
...

\begin{document}

\title{...}
\author{...}
\date{...}


\maketitle

\begin{abstract}
...
\end{abstract}

\section{...}
\section{...}

\newpage
\pagestyle{...}
\bibliographystyle{...}
\bibliography{...}
```

LaTeX Structure

`\documentclass{...}`

This command takes an argument that defines the type of document we want to produce. Some of the most common are listed below:

- article (very common)
- report
- letter
- book
- beamer (this is what was used to make these slides)

It is also possible to create your own. This is often done by publishers who simply provide you with their own class file.

LaTeX Structure

`\usepackage{...}`

The is a very important command that calls external macros. Common packages are listed below:

- amsmath (very useful)
- hyperref
- mathdots
- enumerate

Once again it is possible to create your own.

Structure

Create the following title for your cheatsheet:

```
\title{ \LaTeX\ cheatsheet}
\author{Your Name}
\date{\today}
```

Importantly include the following code to actually include the title:

```
\maketitle
```

LaTeX Structure

Add the following abstract to your cheatsheet:

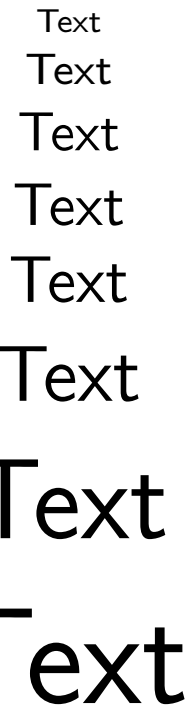
```
\begin{abstract}

This document will be useful to me as a
\textbf{reference} document from which
I can start all my future \LaTeX\ files.

\end{abstract}
```

Text Sizes

```
\tiny
\scriptsize
\small
\normalsize
\large
\Large
\huge
\Huge
```



LaTeX Structure

Add the following line of code to your cheetsheet:

```
\begin{center}
\tiny Text\\
\scriptsize Text\\
\small Text\\
\normalsize Text\\
\large Text\\
\Large Text\\
\huge Text\\
\Huge Text
\end{center}
```

Spacing

There are various ways of of handling spacing in LaTeX.

- The `\\` command ends a line.
- Horizontal spaces can be added using `\ ,\:, \;`or `\hspace{length}`.
- Vertical spaces can be added using `\vspace{length}`.

where `length` is a multiple of one of the following units:

`pt`	a point is about 0.3515mm
`bp`	a big point is about 0.3527mm
`mm`	a millimeter
`cm`	a centimeter
`in`	an inch
`ex`	roughly the height of an 'x' in the current font
`em`	roughly the height of an 'M' in the current font

Page Formatting

It is very simple in LaTeX to control your page formatting. Experiment with the following code in your preamble.

```
\setlength{\textheight}{240mm}
\setlength{\textwidth}{166mm}
\setlength{\topmargin}{0mm}
\setlength{\oddsidemargin}{0mm}
```

Line Spacing

To deal with line spacing, include the "setspace" package to your preamble (`\usepackage{setspace}`). Then experiment with the following commands.

```
\singlespacing
\doublespacing
\onehalfspacing
```

Paragraph Formatting

We can format the indentation and spacing of paragraphs using the following commands:

```
\setlength{\parindent}{0mm}
\setlength{\parskip}{0mm}
```

Lists

There are various ways to list elements in LaTeX. Experiment with the following code in your cheatsheet:

```
There are various ways to have lists in \Latex\:

\begin{itemize}
\item Like
\item This
\end{itemize}

or

\begin{enumerate}
\item Like
\item This
\end{enumerate}
```

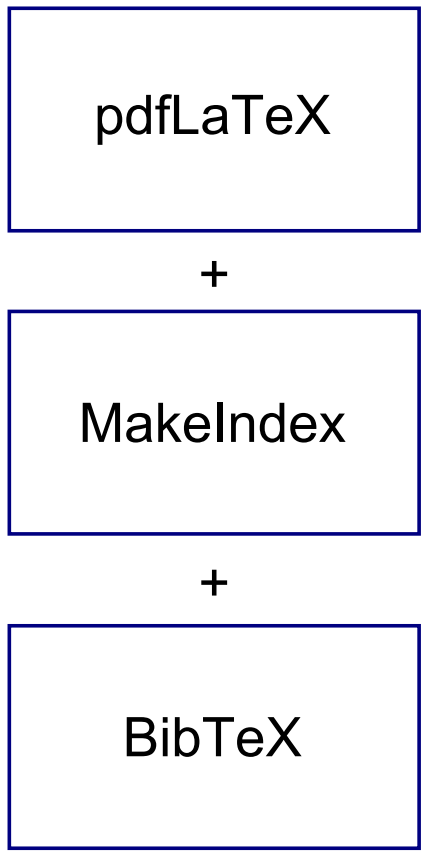
Bibliographies, Sections and Figures

We will now see how to include and refer to:

- Tables
- Bibliographies
- Sections
- Figures

Importantly these can all be referenced very easily using the `\label{...}` and `\ref{...}` commands.

pdfLaTex+MakeIndex+BibTeX



Compiles the code.

Cross references the code.

Updates the bibliography from the bibtex file.

Tables

Tables are created using the tabular and table environment.

```
\begin{table}
\begin{tabular}{|c|c|c|}
\hline
Names&Gender&Start Time\\
\hline
Angelico&Male&1100\\
\hline
Leanne&Female&0830\\
\hline
Lisa&Female&0730\\
\hline
Paul&Male&0730\\
\hline
\end{tabular}
\caption{My Table}\label{My_Table}
\end{table}
```

Tables

Names	Gender	Start Time
Angelico	Male	1100
Leanne	Female	0830
Lisa	Female	0730
Paul	Male	0730

Table : My Table

Bibliographies

LaTeX handles bibliographies using 2 tools:

- A *bibtex* file that stores all your references.
- The `\cite{...}` command.

Create a new file in texworks and write the following code:

```
@book{Gratzer2007,
author = {Gr\"{a}tzer, George},
publisher = {Springer},
title = {{More Math Into LaTeX: A Guide for
          Documentation and Presentation}},
year = {2007}
}
```

Save this file as a bibtex file (Myfirstbibfile.bib).

Bibliographies

To reference a document simply call it in by using its 'citation key' and the command `\cite{...}`. Add the following code to your cheat sheet:

```
A very helpful reference for
\LaTeX\ is \cite{Gratzer2007}.
```

Finally point your cheat sheet in the direction of your bibtex file by using the following code:

```
\newpage
\bibliographystyle{plain}
\bibliography{Myfirstbibfile}
```

To compile your bibliography you must ensure that you use bibtex as well as pdflatex.

Sections

Documents can be further fragmented using the sections command:

```
\section{...}
\subsection{...}
\subsubsection{...}
```

Sections

Include a label to your first section (`\label{General_Typesetting}`) and add the following code to your cheat sheet:

```
\section{Typesetting Mathematics}
In Section \ref{General_Typesetting} we saw how to type
general text. We will now type mathematics.
```

Finally include a table of contents by using: `\tableofcontents`

Inserting Figures

Inserting figures in to a LaTeX document is also very simple (using pdf-LaTeX) using the 'graphicx' package. Simply ensure that your figure (for the purpose of this exercise go find a jpg of your choice from the internet) is located in the same folder as your LaTeXdocument and use the following code (as well as including `\usepackage{graphicx}` in your preamble):

```
\begin{figure}[h]
\begin{center}

\includegraphics[width=10cm]{picture}

\caption{My first picture in \LaTeX.}\label{pic_fig}
\end{center}
\end{figure}

It is good to see that we can reference
figures like this: Figure \ref{pic_fig}.
```

Inserting Figures

Note that the compilation engine you use has an effect on what format of picture you may use:

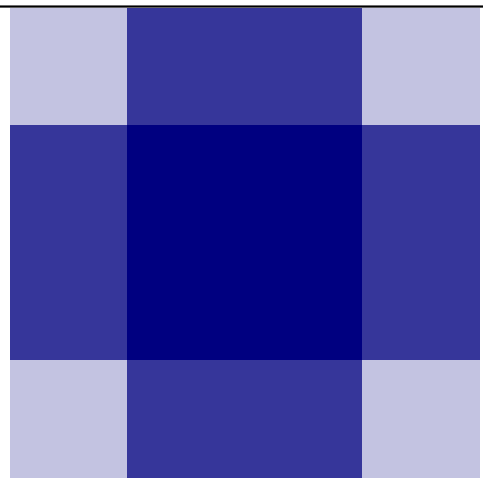
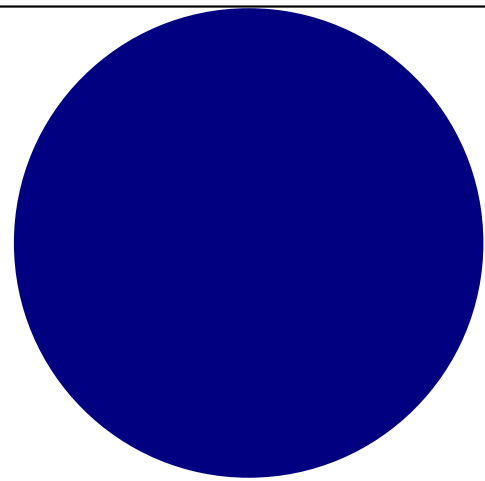
Compiler	Compatible Image Files
pdfLaTeX	JPG, PNG, PDF
LaTeX	Encapsulated PostScript (EPS)
XeLaTeX	(All?)

Vector Graphics

There are two types of “pictures”:

- Bitmaps (JPG, PNG,etc...)
- Vector graphics (EPS,PDF,SVG,...)

The latter allows for a better scaling of images:

	Bitmap	Vector Graphics
Original		
Scaled		

Typesetting mathematics

"The hardest thing is to go to sleep at night, when there are so many urgent things needing to be done. A huge gap exists between what we know is possible with today's machines and what we have so far been able to finish." [Donald Knuth]

Typesetting mathematics is LaTeX's strength. We will concentrate on the building blocks. These allow us to build very complicated formulae. Concentrate selectively on the ones you need.

Math in text

Math in text (*inline*) is enclosed by $ symbols (or by \(and \)).
Add the following code to your cheatsheet:

```
Mathematics can be typed in to \LaTeX\ as $x^2$
and/or \((a+b)^2=a^2+2ab+b^2\).
```

Math in text

Mathematics can be typed in to LaTeX as x^2 and/or $(a+b)^2 = a^2 + 2ab + b^2$.

Displayed Mathematics

Math in display mode is enclosed by $$ symbols (or by \[and \]).
Add the following code to your cheatsheet:

```
It is sometimes nicer to display more
complex formula like this:
$$\sum_{i=1}^ni={n(n+1)\over 2}$$
and
\[\int_{0}^nxdx={n^2\over2}\]
```

Displayed Mathematics

It is sometimes nicer to display more complex formula like this:

$$\sum_{i=1}^{n} i = \frac{n(n+1)}{2}$$

and

$$\int_0^n x dx = \frac{n^2}{2}$$

Displayed Mathematics

It is also possible to display mathematics as equations that can be referred to later.

```
\begin{equation}\label{my_first_equation}
e=mc^2
\end{equation}
```

```
In equation (\ref{my_first_equation}) we
have a very well known relationship!
```

Text in Maths

Sometimes you might want to include texts in math statements. This can be done easily thanks to the $\mathcal{AMS}$-LaTeX package and the `\text` command. Attempt the following code:

```
\[x^2=1\text{ implies }x=\pm1\]
```

Try the same code without the `text` function.
(Another option is `\mbox`)

Arithmetic

Arithmetic operations are quite simple in LaTeX. Try the following code.

```
\subsection{Arithmetic}

\begin{itemize}
\item $a+b$
\item $a-b$
\item $-a$
\item $ab$
\item $a\cdot b$
\item $a\times b$
\item $a/b$
\item ${a\over b}$
\item $\frac{a}{b}$
\end{itemize}
```

Arithmetic

Subscripts and superscripts are obtained with the following code:

```
Some examples of subscripts and superscripts:
\begin{itemize}
\item $a_{k}$
\item $b^{2}$
\item $a_{b^{2}}$
\item $a^{b^{c}}$
\end{itemize}
```

Integrals

Experiment with the following code

```
\subsection{Integrals}

$$\int_{0}^{\pi}x^2\,dx$$
```

Binomial Coefficients

Binomial coefficients (such as $\binom{n}{2}$ are obtained with the following code:

```
\subsection{Binomial Coefficients}

\begin{itemize}
\item ${n\choose 2}$
\item $\binom{r^2}{a}$
\end{itemize}
```

Congruences

Congruence equations such as:

$$7 \equiv 3 \pmod 4$$

or

$$2001 \equiv 0 \pmod 3$$

are obtained with the following code:

```
\subsection{Congruences}

\begin{itemize}
\item $7\equiv 3\pmod 4$
\item $2001\equiv 0\pod 3$
\end{itemize}
```

Delimeters

Parentheses and square brackets are very easy to obtain in LaTeX. Experiment with the following code:

```
\subsection{Delimiters}

 $$(\int_{0}^y{1+x\over 2+y}\,dy)$$
 $$\left(\int_{0}^y{1+x\over 2+y}\,dy\right)$$
 $$\left[\int_{0}^y{1+x\over 2+y}\,dy\right]$$
 $$\left|\int_{0}^y{1+x\over 2+y}\,dy\right|$$
 $$\left\|\int_{0}^y{1+x\over 2+y}\, dy\right\|$$
```

Ellipsis

The *ellipsis* (...) in text is provided by the `\dots` command.

```
\subsection{Ellipsis}

 $$A\dots Z$$
 $$F(x_1,\dots,x_n)$$
 $$x_1+\dots+x_n$$
```

Ellipsis

$$A \ldots Z$$

$$F(x_1, \ldots, x_n)$$

$$x_1 + \cdots + x_n$$

Math Accents

Experiment with the following code

```
\subsection{Math Accents}

\begin{enumerate}
\item $\bar{a}$
\item $\hat{a}$
\item $\tilde{a}$
\item $\vec{a}$
\end{enumerate}
```

Matrices

The matrix:

$$\begin{matrix}
a+b+c & uv & x-y\\
a+b & u+v & z\\
\end{matrix}$$

is typed with the following code:

```
\subsection{Matrices}

$$\begin{matrix}
a+b+c&uv&x-y\\
a+b&u+v&z\\
\end{matrix}$$
```

Matrices

The matrix:

$$\begin{pmatrix} a & b \\ c & d \\ e & f \end{pmatrix}$$

is typed with the following code:

```
$$\begin{pmatrix}
a&b\\
c&d\\
e&f\\
\end{pmatrix}$$
```

Matrices

The matrix:

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix}$$

is typed with the following code:

```
$$\begin{vmatrix}
a&b\\
c&d\\
\end{vmatrix}$$
```

The Align Statement

It is possible to create aligned text using code similar to:

```
\subsection{Aligned Statements}

\begin{align}
(x+h)^2-x^2&=x^2+2xh+h^2-x^2\nonumber\\
           &=2xh+h^2\nonumber\\
           &=h(2x+h)\nonumber
\end{align}
```

The Align Statement

$$\begin{aligned}(x+h)^2 - x^2 &= x^2 + 2xh + h^2 - x^2 \\ &= 2xh + h^2 \\ &= h(2x+h)\end{aligned}$$

The Align Statement

Annotated text can also be added

```
\begin{align}
(x+h)^2-x^2&=x^2+2xh+h^2-x^2&&\text{(by distributivity)}\\
           &=2xh+h^2&&\text{(by subtraction)}\\
           &=h(2x+h)&&\text{(by factorisation)}
\end{align}
```

The Cases Statement

It is possible to create partitioned statements.

```
\subsection{Cases Statements}

$$
1+(-1)^n=\begin{cases}
0,& \text{if $n$ odd}\\
2,& \text{if $n$ even}
\end{cases}
$$
```

And the rest...

There are many many many more symbols and operators that you can use. Please see the "TEX Quick Reference".

Beamer

"The most important thing in the programming language is the name. A language will not succeed without a good name. I have recently invented a very good name and now I am looking for a suitable language." [Donald Knuth]

There are ≥ 2 ways to construct presentations from LaTeX documents:

1. Simply cut and paste from your pdf document in to powerpoint (bad).
2. Use the *Beamer* document class (good).

Your first presentation

- Create a new document in TeXworks.
- Save it (firstbeamer.tex)
- Write the following code:

```
\documentclass{beamer}

\begin{document}
\frame{This is my first slide.}
\end{document}
```

- Ensure the dropdown window has: "pdfLaTeX" selected.
- Click on the green arrow (ctrl+T)

Changing the look of things

There are various presentation styles to choose from (and you can make your own. Add `themestyle{Boadilla}` to your preamble. Experiment with various other styles:

```
% \usetheme{default}
% \usetheme{Boadilla}
% \usetheme{Madrid}
% \usetheme{Montpellier}
% \usetheme{Warsaw}
% \usetheme{Copenhagen}
% \usetheme{Goettingen}
% \usetheme{Hannover}
\usetheme{Berkeley}
```

Title Page

To use beamer fully you need to know a few commands. For example in a normal LaTeX document you would use the `\maketitle` command but in beamer you simply add a title slide (or frame) with the following code:

```
\begin{frame}
\titlepage
\end{frame}
```

This will create a title slide with the title information included in the top matter (note: beamer allows you to add a `\institution{}` command to your title).

Frame titles

Edit your firstbeamer file so as to have sections and a frame title:

```
\section{Simple Beamer}
\frame{\frametitle{My first slide}
This is my first slide}
```

Now that you have sections add an 'Overview' slide (to come after your title slide):

```
\frame{\frametitle{Overview}
\tableofcontents}
```

Overlays

Beamer is capable of producing progressive slides using the following commands:

1. `pause`
2. `only`
3. `onslide`

These commands create overlays.

Pause

Experiment with the following code:

```
\section{Overlays}
\subsection{Pause}

\frame{\frametitle{Pause}
\begin{itemize}
\item This is my first bullet point.\pause
\item Wait for my third bullet point.\pause
\item Here it is.
\end{itemize}
}
```

Only

Experiment with the following code:

```
\subsection{Only}

\frame{\frametitle{Only}
\only<1,2>{Here is the expansion of $(x+y)^2$:}
\only<2>{$$(x+y)^2=x^2+2xy+y^2$$}
\only<3>{This slide has 3 overlays}
}
```

Handouts

Add the `[handout]` option to your document class. This is very useful when preparing presentations as compiling with a large number of overlays can take quite a long time.

Onslide

Experiment with the following code:

```
\subsection{Onslide}

\frame{\frametitle{Onslide}
\onslide<1,2>{Here is the expansion of $(x+y)^2$:}
\onslide<2>{$$(x+y)^2=x^2+2xy+y^2$$}
\onslide<3>{This slide has 3 overlays}
}
```

What I left out...

- PS-Tricks
  An excellent package for drawing pictures with code...
- Hyperefs
  An easy package to add to any document that takes advantage of pdf's capability.
- Big documents
  It is possible to handle big projects (such as a thesis) with the `\include{}` command.

Last but not least

- Scribtex.com

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- Mendeley.com

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- Dropbox.com

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- Mendeley.com
- Dropbox.com
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- Inkscape.org
- Google.com