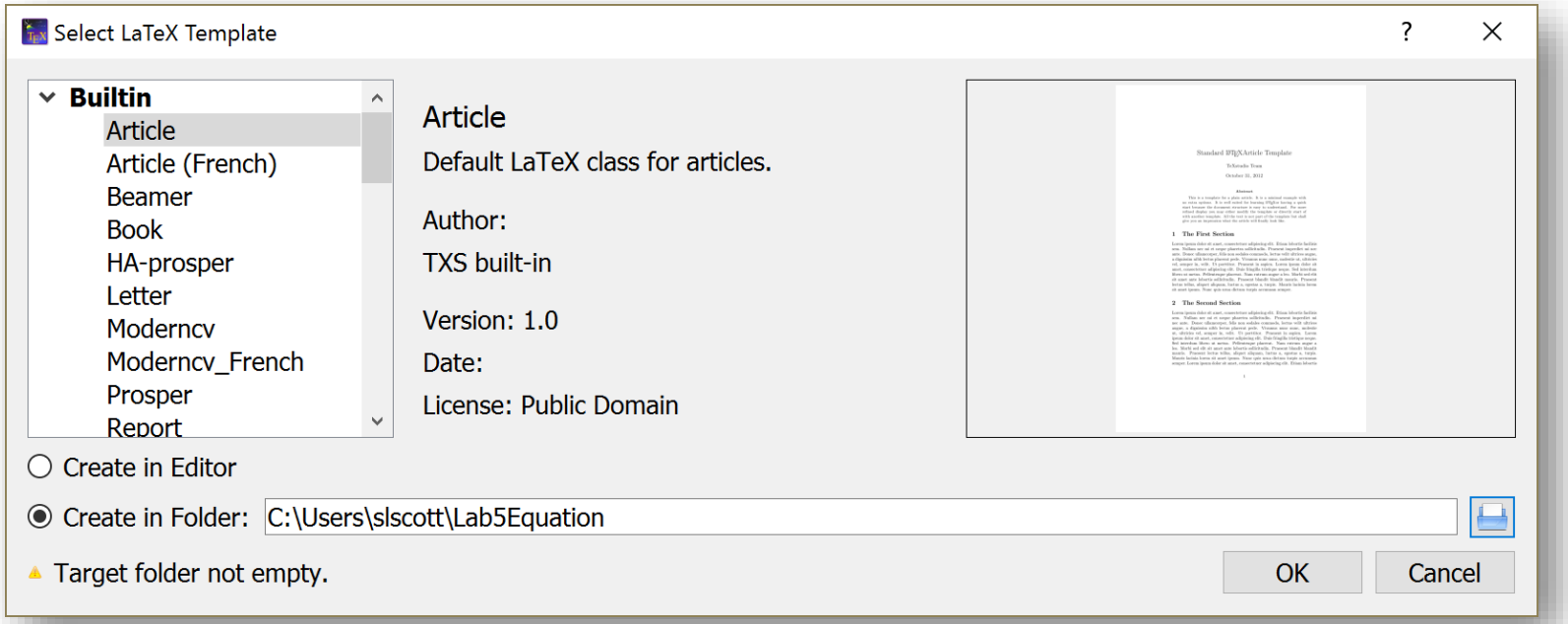
LaTex Lab 5: Equations

CSI 500

Course material derived from:
Lamport, L. (1994). *LATEX: a document preparation system: user's guide and reference manual*. Addison-Wesley.

Article

- Let's make another LaTex document
- Make a new folder called "Lab5Equation"
- In TexStudio, File, New From Template
- Select "Article"
- Select "Create in Folder", and navigate to your "Lab5Equation" folder.
- Press OK

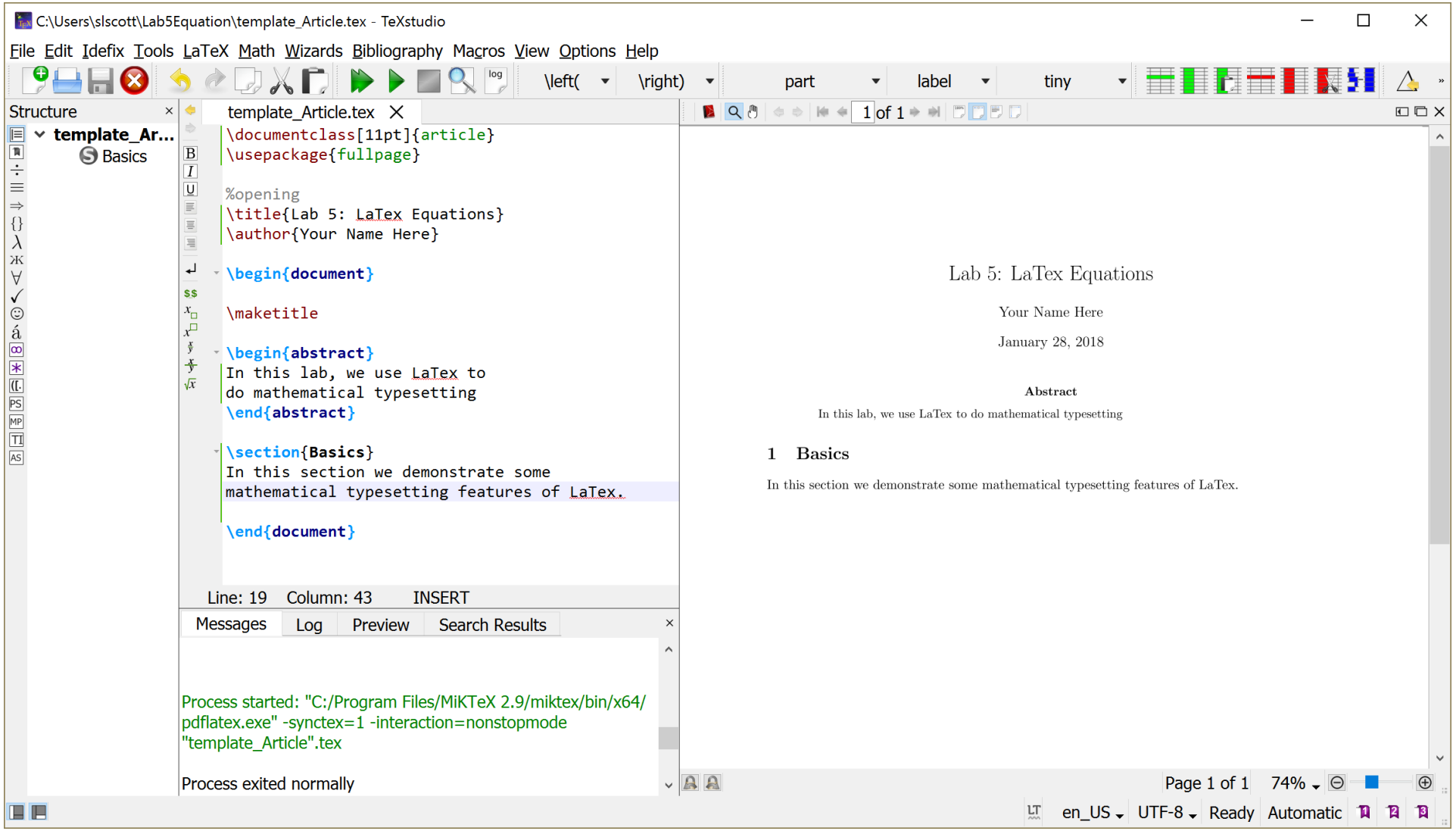


Equation LaTex code

- Type in the following in the editor window.
  - Your additions are shown in RED font color
  - the "%" indicates comments
- Save the document
- Press the green arrowhead titled "Build and View" on the menu bar - it looks like this 
- At the dialog box, press F5 and OK

```
% Equation example
\documentclass[11pt]{ article }
\usepackage{ fullpage }

%opening
\title{Lab 5 - LaTex Equations}
\author{ Your Name }

\begin{ document }

\maketitle

\begin{ abstract }
In this lab, we use LaTex to do mathematical typesetting
\end{ abstract }

\section{}

\end{ document }
```

What it should look like



Math mode in LaTex

- LaTex normally operates in one of three distinct "modes"
- Paragraph mode
  - normal text processing
- LR (Left to Right) mode
  - similar to paragraph mode, but handles line splits differently
- Math mode
  - designed to handle mathematical expressions
  - delimited by "inline" operator $, such as

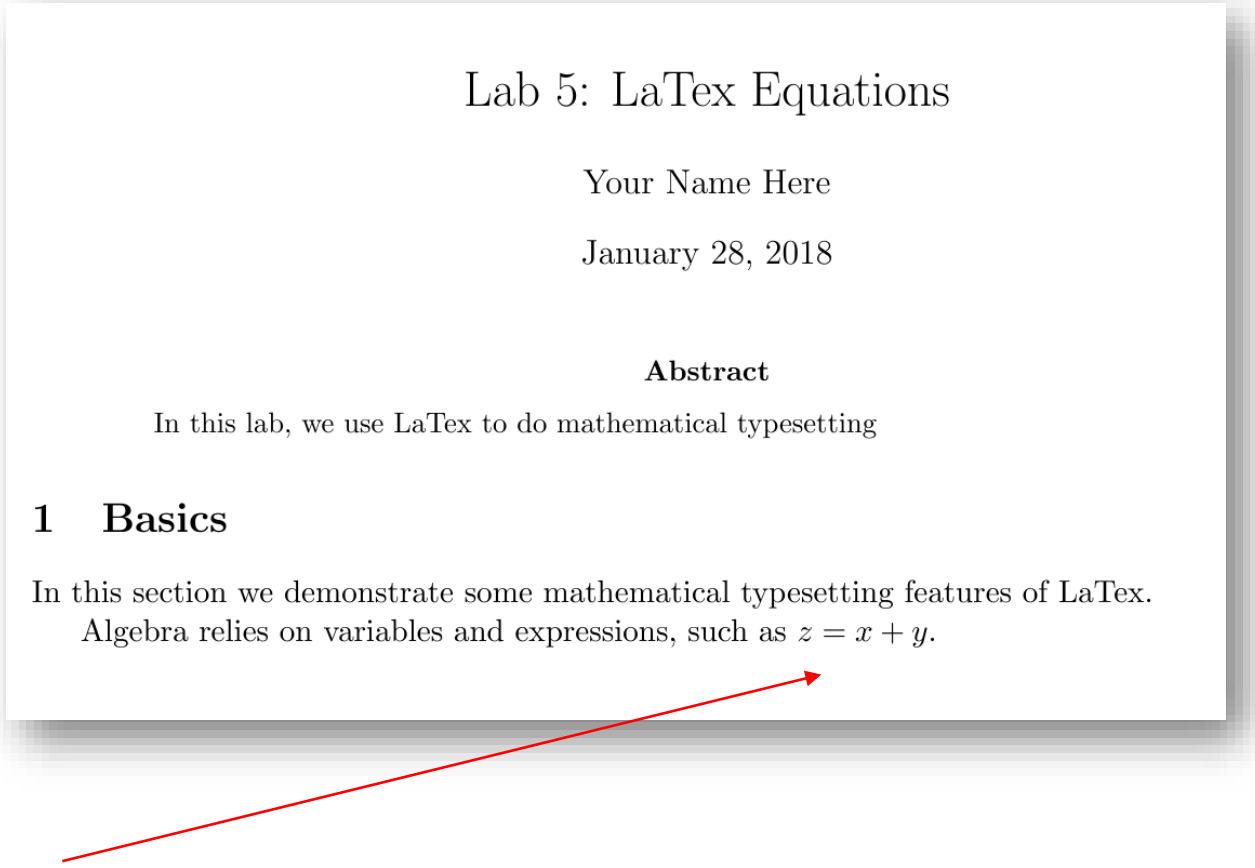
    $ expression(s) $
  - *delimited by braces operator [ ], such as*

    \[expression(s) \]
  - *delimited explicitly by defining a math environment , such as*

    \equation{begin} expression(s) \equation{end}

Using "In-line" math expressions with exp

- You may include mathematical expressions or variables within your text but without a numbered equation reference.
  - In LaTex, this is done by surrounding the expression with dollar sign characters '$'
  - Anything inside the dollar signs is treated as a mathematical expression
- Example:
  - `Algebra relies on variables and expressions, such as $z = x + y$.`
  - note math font and italic spacing



Lab 5: LaTex Equations

Your Name Here

January 28, 2018

Abstract

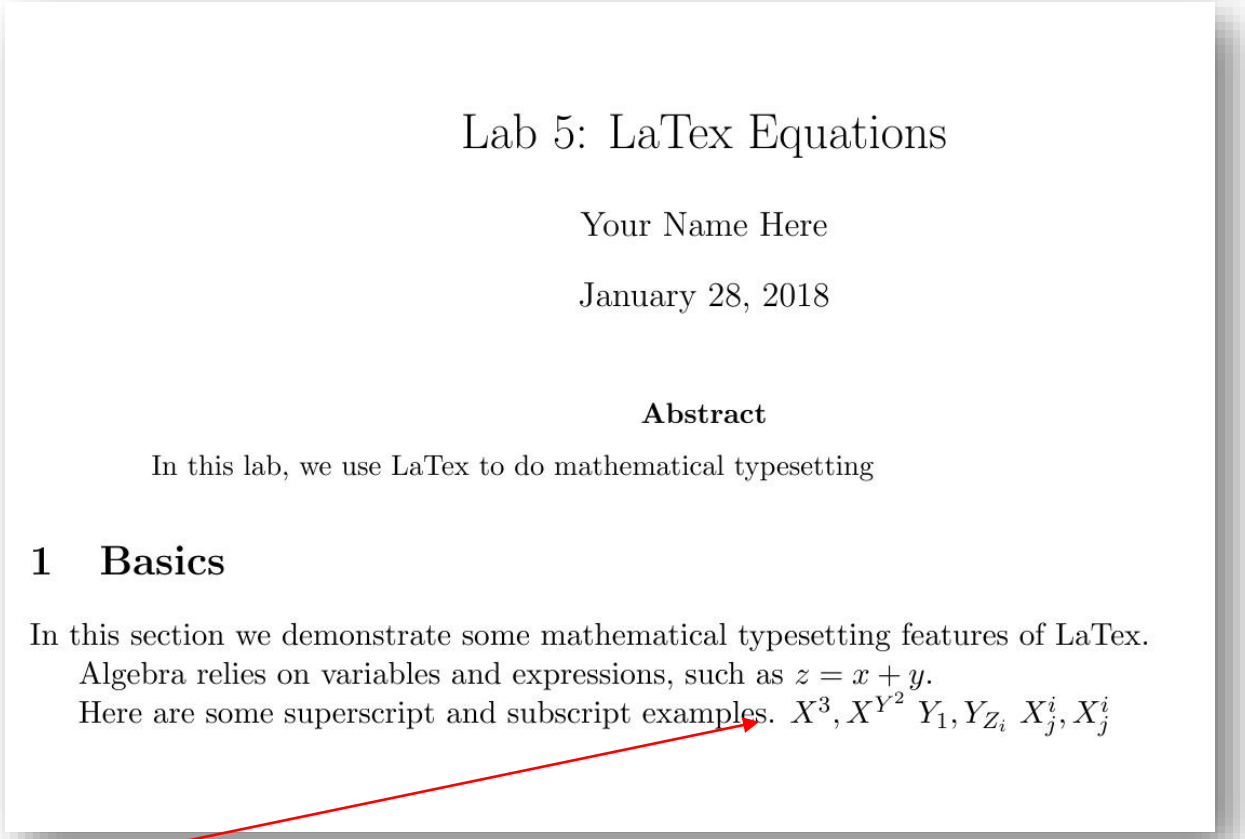
In this lab, we use LaTex to do mathematical typesetting

1 Basics

In this section we demonstrate some mathematical typesetting features of LaTex. Algebra relies on variables and expressions, such as $z = x + y$.

Using superscripts and subscripts

- Expressions may have a superscript (which may be another expression) using the ^ operator
- Expressions may have a subscript (which may be another expression) using the _ operator
- Combined super and subscripts are also possible
- Examples:
  - `X^{3}, X^{Y{2}}`
  - `Y_{1}, Y_{Z_i}}`
  - `X^{i}_{j}, X_{j}^{i}`



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January 28, 2018

Abstract

In this lab, we use LaTex to do mathematical typesetting

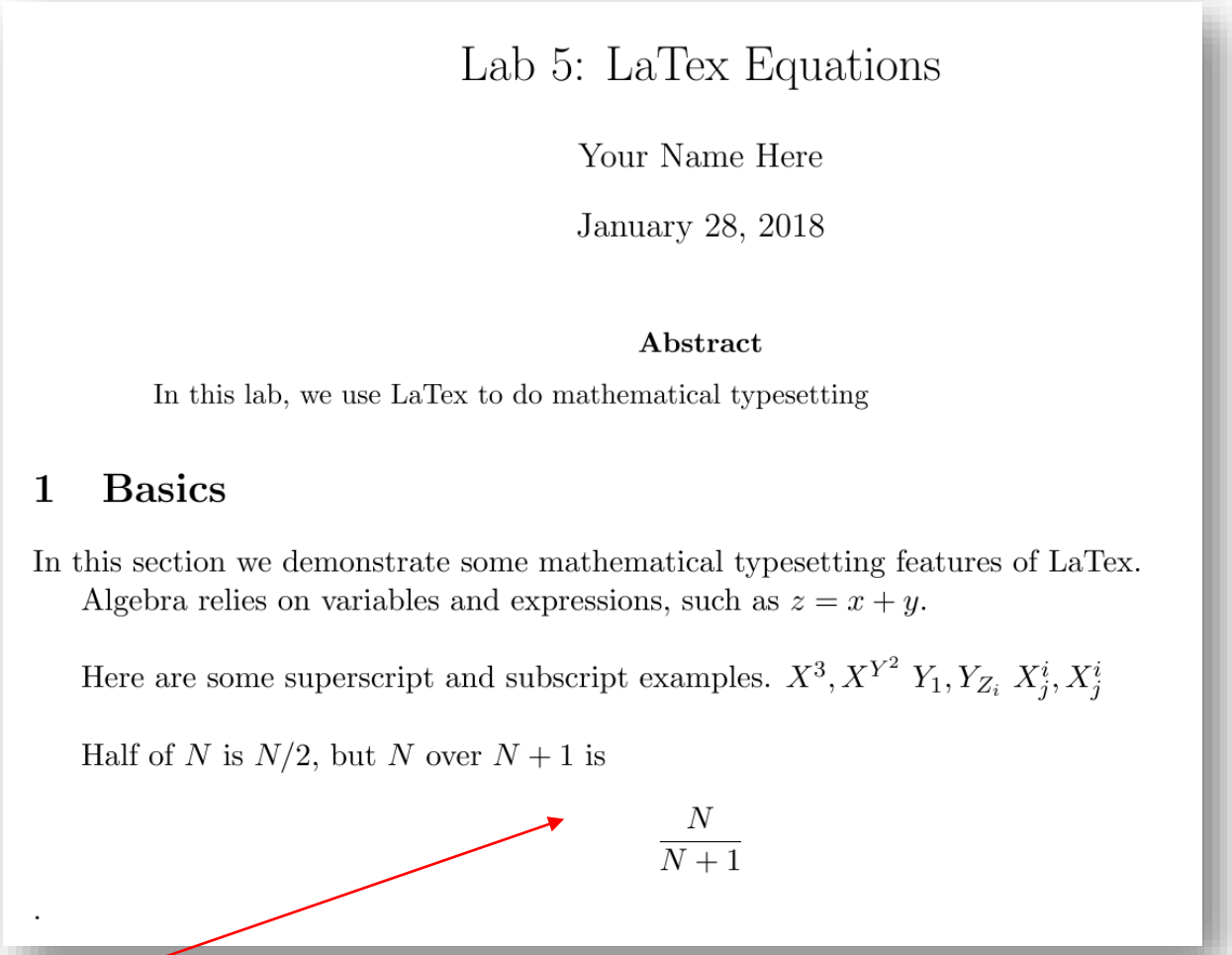
1 Basics

In this section we demonstrate some mathematical typesetting features of LaTex.
Algebra relies on variables and expressions, such as $z = x + y$.
Here are some superscript and subscript examples. X^3, X^{Y^2} Y_1, Y_{Z_i} X^i_j, X^i_j

Using fractions

- fractions can be expressed using the / operator while in inline mode
- fractions can also be expressed using the \frac{numerator} {denominator} notation within a math mode
- Examples

```
Half of $N$ is $N/2$,
but $N$ over $N+1$
is \[ \frac{N} {N+1} \].
```



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Half of N is $N/2$, but N over $N+1$ is

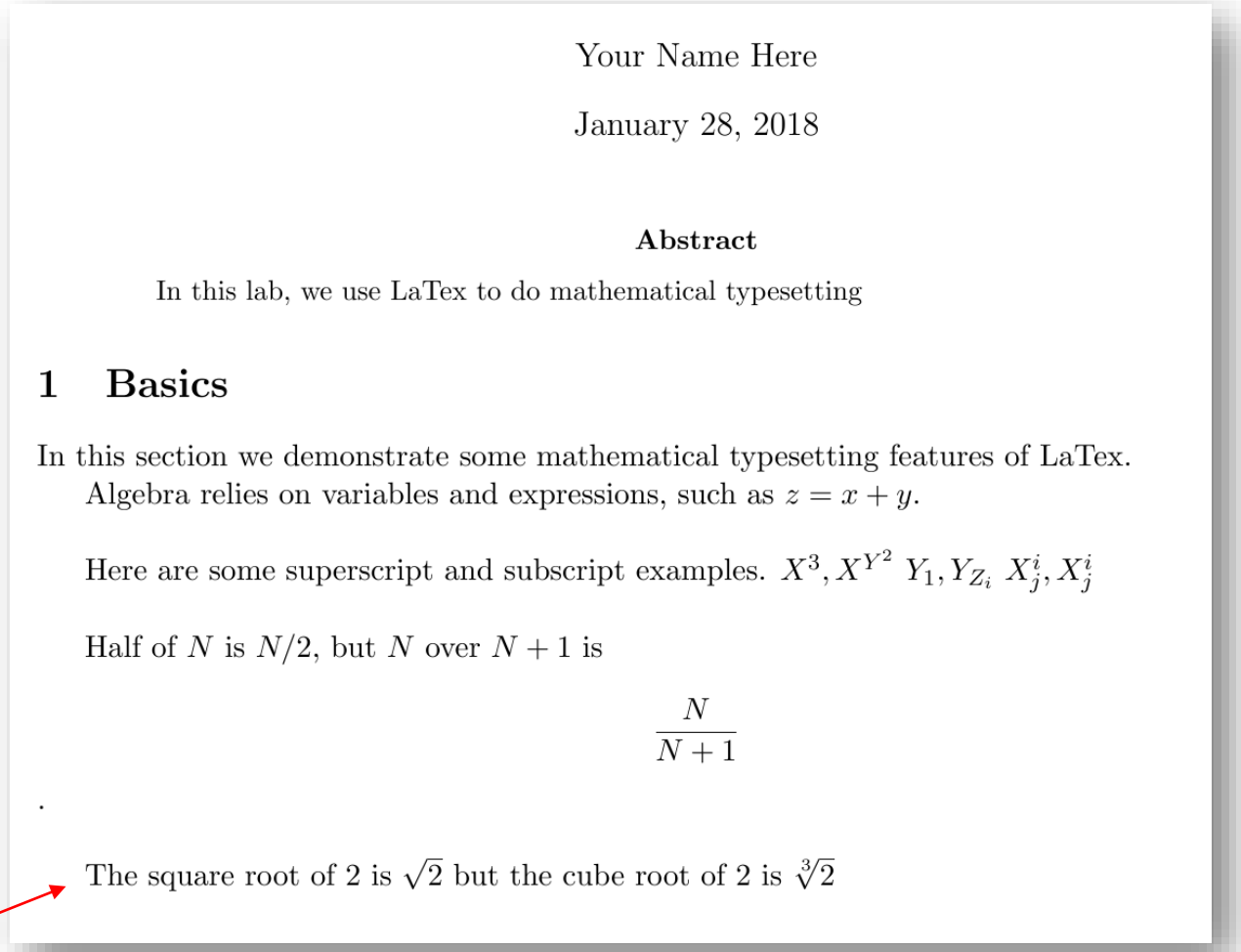
$$\frac{N}{N+1}$$

.

Using roots

- roots are expressed using the \sqrt{expression} command
- for roots other than 2, use the optional parameter n to specify which root, \sqrt[n]{expression}
- Examples

```
The square root of 2 is
$\sqrt{2}$
but the cube root of 2
is $\sqrt[3]{2}$
```



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Half of N is $N/2$, but N over $N+1$ is

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The square root of 2 is $\sqrt{2}$ but the cube root of 2 is $\sqrt[3]{2}$

Using ellipsis

- LaTex provides two types of ellipsis
  - \cdots is used for center ellipsis
  - \ldots is used for lower ellipsis
- Examples

```
Gauss' famous equation is
\[ \frac{N(N+1)}{2} = 1 +
2 + 3 + \cdots + N \] \\

A sum of terms is $x_{1},
x_{2}, ~\ldots~ , x_{N}$
```

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Here are some superscript and subscript examples. $X^3, X^{Y^2}\ Y_1, Y_{Z_i}\ X_j^i, X_j^i$

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Gauss' famous equation is

$$\frac{N(N+1)}{2} = 1+2+3+\cdots+N$$

A sum of terms is $x_1, x_2, \ \ldots\ , x_N$

Math Symbols: Greek Letters

- Greek letter can be specified in upper or lower case
  - lower case letters indicated by \lettername
  - upper case letters indicated by \Lettername
  - where Roman and Greek have the same symbol, no uppercase command is provided (e.g. A, B, Z)
- Examples

```
Here are some upper case Greek
letters.
$A, B, \Gamma, \Delta, \Upsilon$ \\
Here are some lower case Greek
letters.
$\alpha, \beta, \gamma, \delta,
\upsilon$ \\
```

$$\frac{N}{N+1}$$

The square root of 2 is $\sqrt{2}$ but the cube root of 2 is $\sqrt[3]{2}$

Gauss' famous equation is

$$\frac{N(N+1)}{2} = 1+2+3+\cdots+N$$

A sum of terms is $x_1, x_2, \ \ldots\ , x_N$

Here are some upper case Greek letters. $A, B, \Gamma, \Delta, \Upsilon$

Here are some lower case Greek letters. $\alpha, \beta, \gamma, \delta, \upsilon$

Math Symbols: Operators

- LaTex has lots of built-in math symbols
  - Check the documentation or your quick ref sheet for some examples
  - Operators invoked using \command notation, such as \leq for less than or equal
- Examples

```
Here are some mathematical
operators.
$5 \leq 8; 3 \geq 2; 7
\neq 8; 10 \ll 1000$ \
```

$$\frac{N}{N+1}$$

The square root of 2 is $\sqrt{2}$ but the cube root of 2 is $\sqrt[3]{2}$

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$$\frac{N(N+1)}{2} = 1+2+3+\cdots+N$$

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Here are some lower case Greek letters. $\alpha, \beta, \gamma, \delta, \upsilon$

Here are some mathematical operators. $5 \leq 8; 3 \geq 2; 7 \neq 8; 10 \ll 1000$

Math Symbols: Summation

- LaTex includes capability to express summations and integrals
- summations use the \sum command
- Examples

```
Here is a summation
operator.
\[ \sum_{i=0}^{i=10}
x_{i}^{2} = 385 \] \\
```

The square root of 2 is $\sqrt{2}$ but the cube root of 2 is $\sqrt[3]{2}$

Gauss' famous equation is

$$\frac{N(N+1)}{2} = 1 + 2 + 3 + \cdots + N$$

A sum of terms is $x_1, x_2, \ \ldots \ , x_N$

Here are some upper case Greek letters. $A, B, \Gamma, \Delta, \Upsilon$

Here are some lower case Greek letters. $\alpha, \beta, \gamma, \delta, \upsilon$

Here are some mathematical operators. $5 \leq 8; 3 \geq 2; 7 \neq 8; 10 \ll 1000$

Here is a summation operator.

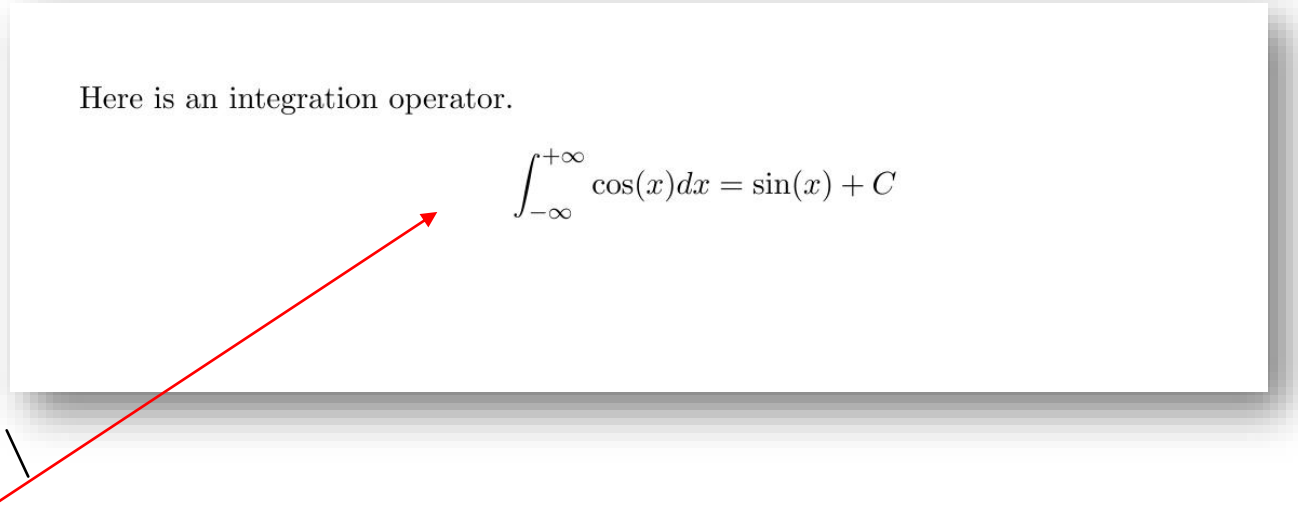
$$\sum_{i=0}^{i=10} x_i^2 = 385$$

1

Math Symbols: Integration

- LaTex includes capability to express summations and integrals
- summations use the \int command
- Examples

```
Here is an integration
operator.
\[ \int_{-\infty}^{+\infty}
\cos(x)dx = \sin(x) + C \] \\
```



Math Symbols: Logs

- LaTex includes capability to express log and "log-like" functions
- Can't use the word 'log' because it would be treated like 3 variables 'l','o', and 'g'.
- logs use the \log command
- Examples

```
Here is a log operator.
\[ f(x) = k\log(x) \] \\
```

Here is an integration operator.

$$\int_{-\infty}^{+\infty} \cos(x)dx = \sin(x) + C$$

Here is a log operator.

$$f(x) = k\log(x)$$

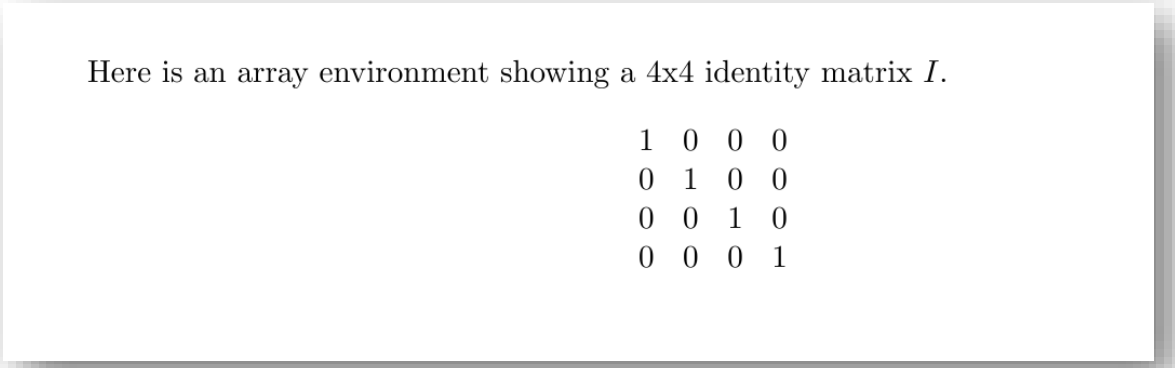
other built-in function work similarly

\sin	\sec	\exp	\min
\cos	\cot	\inf	\max
\tan	\csc	\gcd	\lim

and others…

Arrays

- LaTex provides the array environment for matrix expressions
- Similar to the table environment, but works in math mode
  - each element is an expression or formula
- Example:

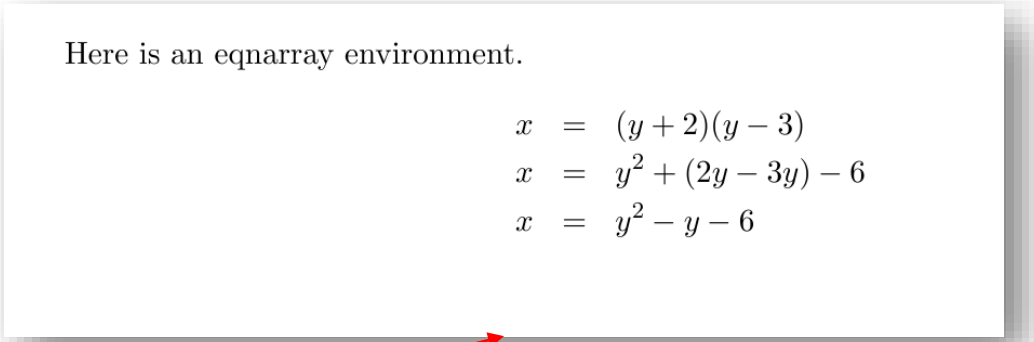



```
Here is an array environment showing a 4x4
identity matrix $I$.
\[
        \begin{array}{cccc}
        1 & 0 & 0 & 0 \\
        0 & 1 & 0 & 0 \\
        0 & 0 & 1 & 0 \\
        0 & 0 & 0 & 1 \\
        \end{array}
\]
```

Equation Arrays

- LaTex provides a special predefined 3-column environment for multiline,numbered equations
- invoked using \begin{eqnarray} {expressions} \end{eqnarray}
- Example:

```
Here is an eqnarray environment.
\begin{eqnarray}
        x & = & (y + 2)(y - 3) \\
        x & = & y^{2} + (2y - 3y) - 6 \\
        x & = & y^{2} - y - 6
\end{eqnarray}
```



Numbered Equations

- LaTex has several ways to enter "math" mode
  - "inline" modes are used for math expressions in narrative.
  - Formal numbered equations require equation environment

Here is an equation $y = \sin(x)$

Here is an inline equation $y = \sin(x)$

Here is an unnumbered equation on next line

$$y = \sin(x)$$

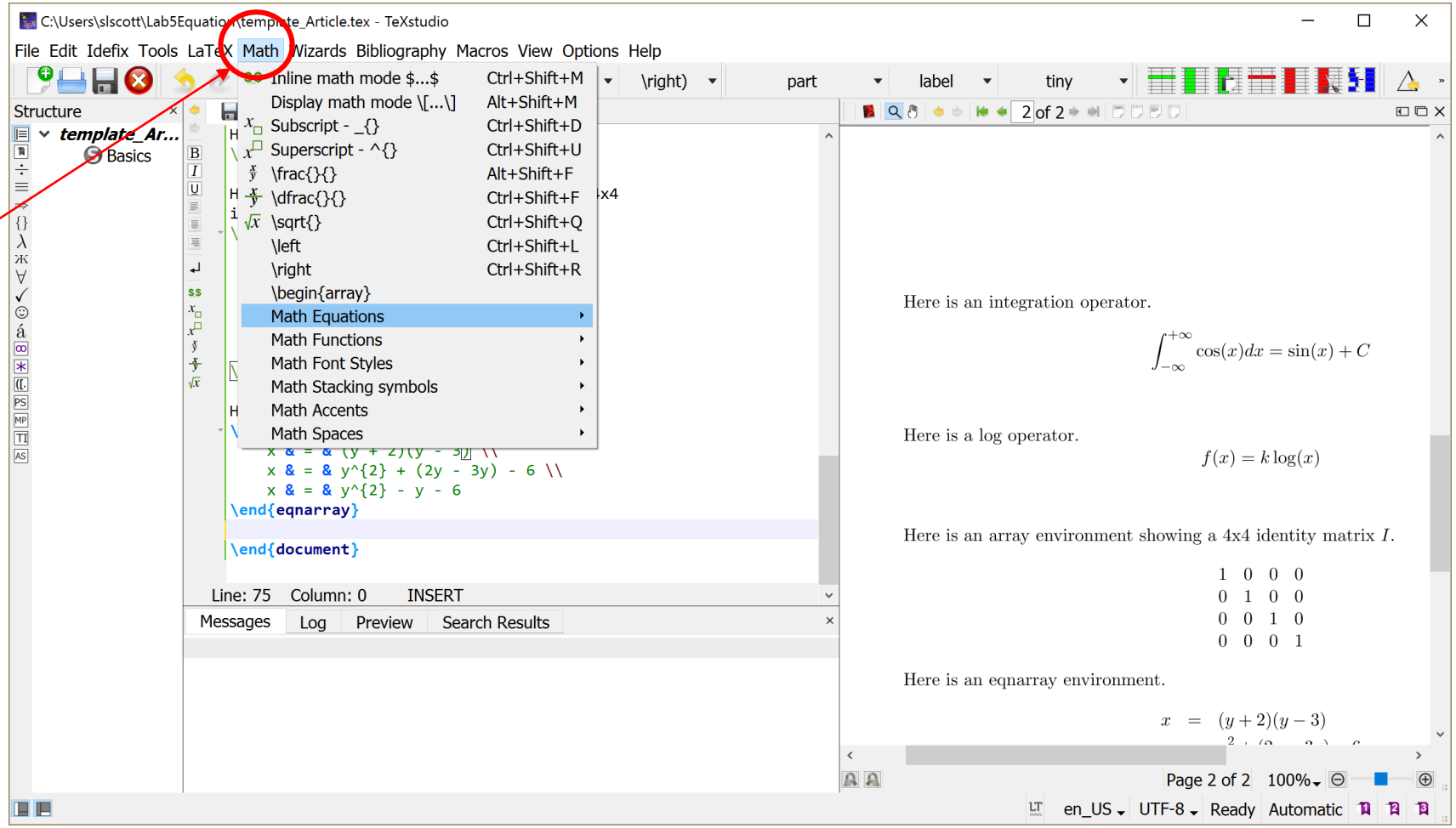
Here is a numbered equation environment, Equation 1.

$$y = \sin(x) \tag{1}$$

```
Here is an equation $y = \sin(x)$ \\

Here is an inline equation \( y = \sin(x) \) \\

Here is an unnumbered equation on next line \[ y = \sin(x) \] \\

Here is a numbered equation environment, Equation \ref{eqn:trigfunc}. \\

\begin{equation}
        y = \sin(x)
        \label{eqn:trigfunc}
\end{equation}
```

Using the TexStudio Math Toolbar

- TexStudio includes everything we just talked about (and more) under the Math toolbar.
- You can use this pull-down menu tool if you forget the syntax of a math command



Equations summary

- LaTex provides extensive features to typeset mathematical expressions
  - this is one of the main reasons LaTex is so widely used in academia and publishing
- The TexStudio IDE provides a Math menu pulldown with most of the functions built-in
  - You can code them manually too, of course