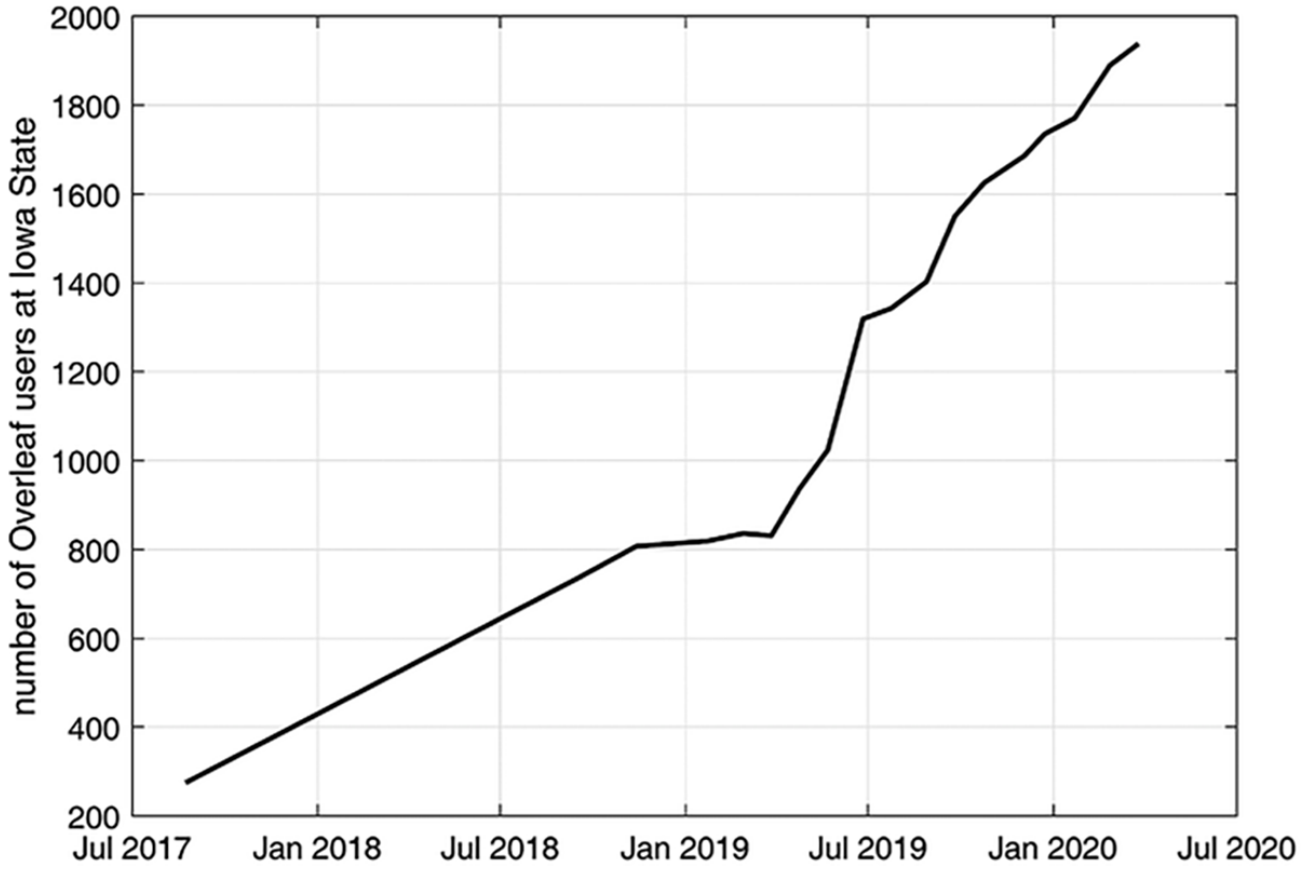
Science Societies

# Be a more productive writer with online LaTex

By Brian Hornbuckle, Kati Togliatti, Richard Cirone, Eric Schares

May 15, 2020




*Online LaTex users at Iowa State over time. An institutional Overleaf license was initiated in September 2018.*

Members Forum is a place for ASA, CSSA, and SSSA members to share their opinions and perspectives on any issue relevant to our members. The views and opinions expressed are not necessarily those of the publisher. Do you have a perspective on a particular issue that you'd like to share with fellow members? Submit it to our Members Forum section at @email. Submissions should be 800 words or less and may be subject to review by our editors-in-chief.

---

Writing a report, thesis, dissertation, journal article, or research proposal can be both intimidating and time consuming. We encourage all scientific writers to consider using a system called LaTex to create written documents because it can make large projects more manageable and increase your efficiency. With the advent on online services, using LaTex is easier than ever before. Online tools have made it possible for all scientists (regardless of computer savviness) to take advantage of its many features. In short, online LaTex could be a game-changer for you! In this article, we explain what LaTex is and describe some of its many features that you can use to become a more productive writer.

First, who are "we?" Three of us are current or former members of the Department of Agronomy at Iowa State University. Brian is a faculty member who started using LaTex as a graduate student and has since used it to write all of his journal papers, grant proposals, and research reports, as well as recommendation letters, memos, lab

instructions, home- work problems, and exams (as well as this article). There is almost nothing he writes without using LaTex! Kati and Richard are (or were) graduate students at Iowa State who have used (or are using) LaTex to write theses, dissertations, and journal papers. Eric is a university librarian who supports the use of LaTex for all disciplines across campus.

## What is LaTex?

What exactly is LaTex? Technically it is a "document preparation system," but think of it simply as a programming language for writing. It is similar to html (Hypertext Markup Language), the language used to build web pages. Navigate to any URL, save it as a file, then open it up in any basic text editor (like TextEdit on a Mac or Notepad on Windows), and you'll see a bunch of text commands that allow your web browser to construct the page you are viewing. LaTex is another type of "markup language" that tells your computer how to format text into paragraphs, equations, section headings, chapters, and more. An example of LaTex code is shown in Figure 1. It produces the output shown in Figure 2.

```
\section{Theory}  \label{sec:theory}

\subsection{Thermal Time}  \label{sec:ttime}

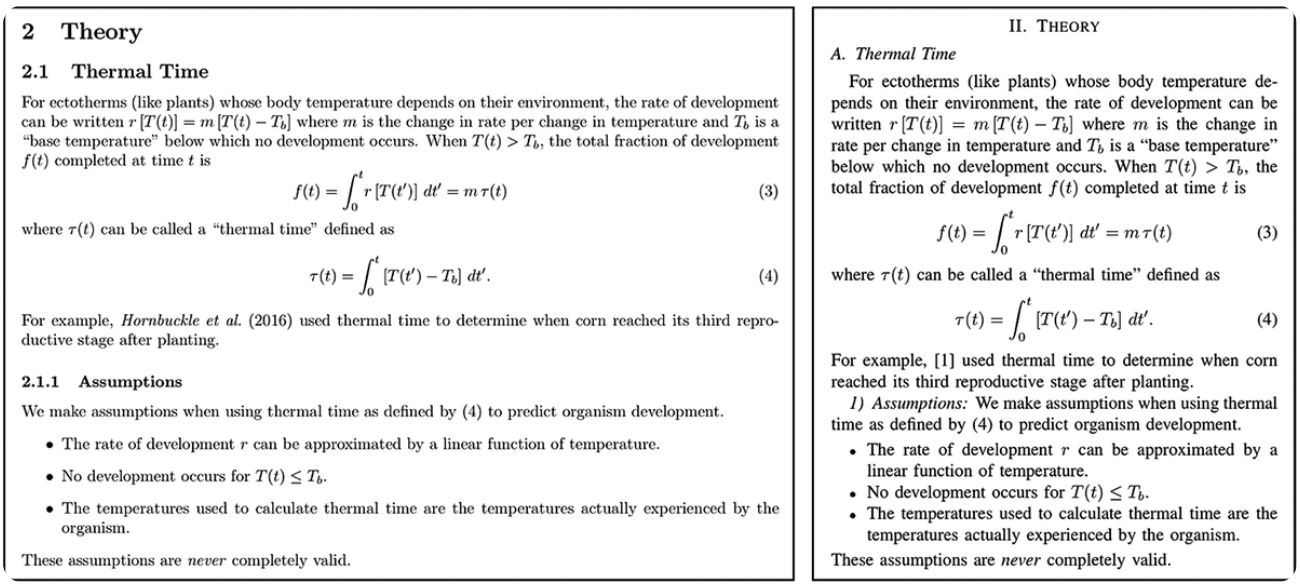
For ectotherms (like plants)
whose body temperature depends on their environment,
the rate of development can be written
$r\left[T(t)\right]= m \left[T(t) - T_b\right]$
where $m$ is the change in rate per change in temperature
and $T_b$ is a ``base temperature''
below which no development occurs.  %: $r\left[T(t) \leq T_b\right] = 0$.
When $T(t) > T_b$,
the total fraction of development $f(t)$ completed at time $t$ is
\begin{equation}
f(t) = \int^t_0 \! r\left[T(t')\right] \, dt' = m \, \tau(t) \label{eq:full}
\end{equation}
where $\tau(t)$ can be called a ``thermal time''
defined as
\begin{equation}
\tau(t) =\int^t_0 \left[ T(t') - T_b \right]\, dt'.  \label{eq:tau}
\end{equation}
For example,
\cite{hornbuckle_etal2016} used thermal time to determine when corn reached
its third reproductive stage after planting.  % include more references?

\subsubsection{Assumptions}  \label{sec:assump}

We make assumptions when using thermal time as defined by~(\ref{eq:tau})
to predict organism development.
%Some of the more important assumptions are the following.
\begin{itemize}
\item The rate of development $r$ can be approximated
by a linear function of temperature.
\item No development occurs for $T(t) \leq T_b$.
\item The temperatures used to calculate thermal time
are the temperatures actually experienced by the organism.
\end{itemize}
These assumptions are \emph{never} completely valid.
```

```
39\section{Theory}  \label{sec:theory}
40
41\subsection{Thermal Time}  \label{sec:ttime}
42
43For ectotherms (like plants)
44whose body temperature depends on their environment,
45the rate of development can be written
46$r\left[T(t)\right]= m \left[T(t) - T_b\right]$
47where $m$ is the change in rate per change in temperature
48and $T_b$ is a ``base temperature''
49below which no development occurs.  %: $r\left[T(t) \leq T_b\right] = 0$.
50When $T(t) > T_b$,
51the total fraction of development $f(t)$ completed at time $t$ is
52\begin{equation}
53  f(t) = \int^t_0 \! r\left[T(t')\right] \, dt' = m \, \tau(t) \label{eq:full}
54\end{equation}
55where $\tau(t)$ can be called a ``thermal time''
56defined as
57\begin{equation}
58  \tau(t) =\int^t_0 \left[ T(t') - T_b \right]\, dt'.  \label{eq:tau}
59\end{equation}
60For example,
61\cite{hornbuckle_etal2016} used thermal time to determine when corn reached
62its third reproductive stage after planting.  % include more references?
63
64\subsubsection{Assumptions}  \label{sec:assump}
65
66We make assumptions when using thermal time as defined by~(\ref{eq:tau})
67to predict organism development.
68%Some of the more important assumptions are the following.
69\begin{itemize}
70\item The rate of development $r$ can be approximated
71  by a linear function of temperature.
72\item No development occurs for $T(t) \leq T_b$.
73\item The temperatures used to calculate thermal time
74  are the temperatures actually experienced by the organism.
75\end{itemize}
76These assumptions are \emph{never} completely valid.
```

***Figure 1,*** *LaTex code is just plain-text in a file with a .tex extension. Commands and structure are scattered throughout the text, and special text editing applications will highlight commands and apply helpful formatting (Aquamacs 3.5 for macOS shown at right). This code produces the output in Figure* ***2****.*



## 2 Theory

### 2.1 Thermal Time

For ectotherms (like plants) whose body temperature depends on their environment, the rate of development can be written $r\,[T(t)] = m\,[T(t) - T_b]$ where $m$ is the change in rate per change in temperature and $T_b$ is a "base temperature" below which no development occurs. When $T(t) > T_b$, the total fraction of development $f(t)$ completed at time $t$ is

$$f(t) = \int_0^t r\,[T(t')]\;dt' = m\,\tau(t) \qquad (3)$$

where $\tau(t)$ can be called a "thermal time" defined as

$$\tau(t) = \int_0^t [T(t') - T_b]\;dt'. \qquad (4)$$

For example, *Hornbuckle et al.* (2016) used thermal time to determine when corn reached its third reproductive stage after planting.

#### 2.1.1 Assumptions

We make assumptions when using thermal time as defined by (4) to predict organism development.

- The rate of development $r$ can be approximated by a linear function of temperature.
- No development occurs for $T(t) \leq T_b$.
- The temperatures used to calculate thermal time are the temperatures actually experienced by the organism.

These assumptions are *never* completely valid.

## II. Theory

### A. Thermal Time

For ectotherms (like plants) whose body temperature depends on their environment, the rate of development can be written $r\,[T(t)] = m\,[T(t) - T_b]$ where $m$ is the change in rate per change in temperature and $T_b$ is a "base temperature" below which no development occurs. When $T(t) > T_b$, the total fraction of development $f(t)$ completed at time $t$ is

$$f(t) = \int_0^t r\,[T(t')]\;dt' = m\,\tau(t) \qquad (3)$$

where $\tau(t)$ can be called a "thermal time" defined as

$$\tau(t) = \int_0^t [T(t') - T_b]\;dt'. \qquad (4)$$

For example, [1] used thermal time to determine when corn reached its third reproductive stage after planting.

*1) Assumptions:* We make assumptions when using thermal time as defined by (4) to predict organism development.

- The rate of development $r$ can be approximated by a linear function of temperature.
- No development occurs for $T(t) \leq T_b$.
- The temperatures used to calculate thermal time are the temperatures actually experienced by the organism.

These assumptions are *never* completely valid.

***Figure 2,*** *LaTex output is a .pdf file. This output is produced by the code in Figure* ***1****. The standard style (shown on the left) is produced automatically. Specialized class files exist for different formats, requiring only a single line of code to completely change the look of the document (IEEE two-column format shown on the right).*

LaTex is *not* a proprietary tool created by a for-profit company. It is freely available through many online repositories such as **https://ctan.org** and **https://tug.org**. There is also an enormous amount of online help available. LaTex is also *not* a WYSI-WYG (what-you-see-is-what-you-get) document creation tool (e.g., Microsoft Word) as is obvious from Figure **1**. You are writing code when using LaTex, and that code must be interpreted by a computer and turned into another file that is shared with readers. Recently created online services now allow this code interpretation and file generation to be accomplished in the cloud instead of only on your own computer, which now makes it possible for everyone, regardless of their computing experience, and regardless of their preferred computing platform (e.g., Windows, Mac, Linux, and even a ChromeBook), to use LaTex since all you need is your favorite web browser (e.g.,

Firefox, Chrome, or Safari).

## LaTex Advantages

Why write using a programming language? Isn't writing hard enough as it is? While it can take some time to adjust, the LaTex environment has many advantages, which allow you to focus on writing and not on all of the other things needed to create scientific documents.

**Forget about formatting.** Don't constantly adjust the placement of figures, choose a font size, and waste time setting up headings, indentations, etc. Let LaTex do it for you and just write! If you want a fancy document, find the appropriate class or style file on the web that will tell LaTex how to format your text. An example of output using a style file provided by the IEEE (an international professional society with more than 400,000 members) for its journals is shown in Figure 2.

**Don't write a bibliography ever again!** Is the citation style *Last name*, *First name* or *Last name*, *First initial*? Where does the year go again? Let LaTex handle all that for you! Once you create a simple database to store bibliographic information, LaTex generates your references by pulling that information into your document when you use the \cite command. See the reference to Hornbuckle et al. (2016) in Figures 1 and 2 and the database and output in Figure 3.

```
@article(hornbuckle_etal2016,
author = "B. K. Hornbuckle and J. C. Patton and VanLoocke, A. and A. E. Suyker
and M. C. Roby and V. A. Walker and E. R. Iyer and D. E. Herzmann and E. A. Endacott",
title = "{SMOS} Optical Thickness Changes in Response
to the Growth and Development of Crops, Crop Management, and Weather",
journal = rse,
volume = 180,
pages = "320-323",
doi = "10.1016/j.rse.2016.02.043",
year = 2016)
```

```
\bibliography{micro_bkh,other_bkh,soil_bkh}
\bibliographystyle{IEEEtran}
```

REFERENCES

[1] B. K. Hornbuckle, J. C. Patton, A. VanLoocke, A. E. Suyker, M. C. Roby, V. A. Walker, E. R. Iyer, D. E. Herzmann, and E. A. Endacott, "SMOS optical thickness changes in response to the growth and development of crops, crop management, and weather," *Remote Sens. Environ.*, vol. 180, pp. 320–323, 2016.

```
\bibliography{micro_bkh,other_bkh,soil_bkh}
\bibliographystyle{agu08}
```

## References

Hornbuckle, B. K., J. C. Patton, A. VanLoocke, A. E. Suyker, M. C. Roby, V. A. Walker, E. R. Iyer, D. E. Herzmann, and E. A. Endacott (2016), SMOS optical thickness changes in response to the growth and development of crops, crop management, and weather, *Remote Sens. Environ.*, *180*, 320–323, doi: 10.1016/j.rse.2016.02.043.

***Figure 3,*** *A database-like entry (top) in a .bib file contains all article information. A simple command creates the reference list using your database files in the style of choice (middle, IEEE; bottom, AGU).*

**Automatic renumbering of equations and sections.** If you decide to insert a new figure, section, chapter, or equation, LaTex can automatically adjust the numbering if you \label the items you want to keep track of and use the \ref command to refer to them. No more hunting down each instance of Figure 2 to change it to Figure 3 and worrying that you missed one. For example, see Lines 58 and 66 in Figure 1 and the corresponding result in Figure 2.

**Equations that are easier to create and format beautifully.** Instead of inserting graphics with a drag-and-drop feature, text commands are also used to create mathematical equations that look like equations you see in books. This is one of LaTex's major strengths (and a main reason LaTex was created). See Figures 1 and 2.

**Include notes within your document.** Text behind a "%" character is not included in the final document. (To write a "%" in the final output use "\%".) These "comments" are similar to those found in other computer programming languages and can be used to write reminders or keep prose you might use later. See the red text highlighted in Figure 1, which does not appear in Figure 2.

**Split a large document up into smaller pieces.** Because LaTex is code, you can store different parts of a document in different files. This allows you to work on smaller sections separately without having the entire document open. This is especially useful for theses, dissertations, and long proposals.

**Standard output.** LaTex produces a .pdf file that all computers can recognize.

Online tools have now made it possible for *all* writers to use LaTex. In the past, a local installation on your computer was required, and this was often complicated. You had to make sure your computer had the correct "packages" of interest, and installation varied among operating systems. (The process needed to use LaTex offline has gotten easier, and some of us prefer it.) Now many online LaTex environments exist (e.g., overleaf.com, papeeria.com, cocalc.com, and LaTexbase.com) at various price points (some free) and corresponding capabilities. Our university and many others, including several land grants, have institutional overleaf.com subscriptions, which provide students and faculty with "pro" accounts. Since our license was initiated at the end of 2018, the number of users of online LaTex at Iowa State has grown considerably (Figure 4).

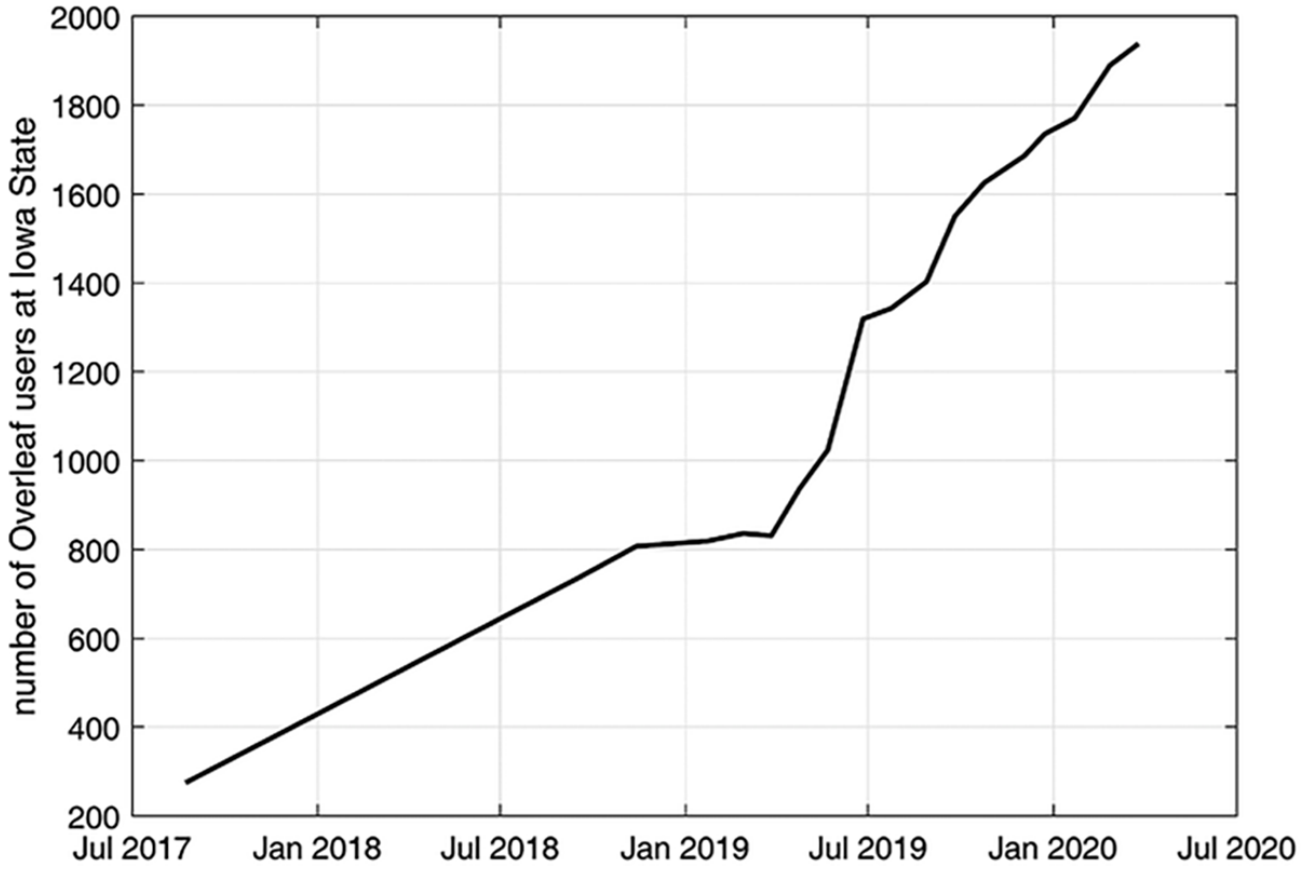



***Figure 4,*** *Online LaTex users at Iowa State over time. An institutional Overleaf license was initiated in September 2018.*

While engineering and computer science users are most numerous on our campus (with statisticians, mathematicians, and physicists close behind), agronomists are currently in the top 10. Many are students in AGRON 183 (Basic Skills for Agronomists). In this course, a LaTex template is provided for writing lab reports. Besides allowing students to easily create professional-looking documents, the use of LaTex is an equalizer (it is new for all) and thus promotes inclusion (students from nontraditional backgrounds are not at a disadvantage). An additional benefit is that it gives students a taste of computer programming—the idea that it is possible to tell a computer what to do. As more and more data become available, many agronomists will need to use computer-programming skills for data analysis.

Finally, the added (and quite significant benefit) of online LaTex is that documents can be shared much in the same way as by using other services like GoogleDocs. Brian and Kati used Overleaf to write a manuscript without having to worry about whether each was editing the current version because there was only *one* they edited at the same time. Managing a research proposal with many co-investigators would also be much easier using online LaTex than passing around a document file and reconciling edits made by different people. Another advantage is that many professional societies provide journal templates and style files, some of which reside directly inside the online tool. Manuscripts can even be submitted to some journals through Overleaf.

## Conclusion

In summary, we encourage all scientific writers to use LaTex to increase writing productivity. We are pleased that it is now possible to submit LaTex manuscripts to ACSESS journals because of the transition to Wiley Publishing. We further encourage ACSESS to create templates and style files for scientists who have adopted the LaTex writing environment. Doing so could broaden the readership and potentially increase the number and quality of journal articles. If you'd like to get started with LaTex, consider visiting Brian's public Canvas page at **https://canvas.iastate.edu/courses/70584** to find the code for this article as well as other examples.

**More news & perspectives**

**Back to issue**

**Back to home**

*Text © . The authors. CC BY-NC-ND 4.0. Except where otherwise noted, images are subject to copyright. Any reuse without express permission from the copyright owner is prohibited.*