

An Introduction to T_EX and Its World

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December 5, 2005

What T_EX is

- The following all apply, more or less
 - word processor
 - document preparation system
 - typesetting system
 - desktop publishing system
- Initial heritage was for creating good looking math books
 - Professor Donald Knuth
 - math typesetting for *The Art of Computer Programming*
 - many innovations in computer typesetting

Examples of T_EX-produced documents

- Personal letter
- Draft technical document
- Book privately published for family members
- Business letter
- Brochure for non-profit group
- Company newsletter
- Fancy technical document

Our goal here is to show you a range of examples from fairly amateurish to fairly professional. For some more, highly professional, examples, see

<http://www.tug.org/texshowcase/>

12 Linden Road, E. Sandwich, MA 02537

October 30, 2005

Dear Edna,

Thank you for your letter.

I am sorry to hear about your weather situation.

We are having wonderful spring days—clear, warm, plants flowering, and lawn (unfortunately) growing. We have seen a fox at the edge of our yard a couple of times lately.

I hope you liked the two books I sent you. I think both of the authors are marvelous writers (although neither is short winded), and I enjoyed these two books in particular.

We saw a nice movie a couple of days ago—Off the Map. It is well done and gentle with several quirky but still attractive characters.

I haven't time for a long letter now. Thanks again for your letter.

Love,

What is T_EX?

When someone asks you, “what is that word processor you are using?”, have you ever wished you had a one page description to hand them. Here is what we would hand them.

Technically speaking, T_EX is a computer application for laying out (“typesetting”) pages of text based on the text the user has written and other instructions the user has given. In other words, like the ubiquitous Word, T_EX decides where to split lines of text, where to start a new page, and so on.

T_EX was created by the noted computer scientist and innovator in computer-based typesetting, Donald Knuth, who developed it over many years and made it freely available to the world. Knuth provided for and invited *users to extend TeX*, and it has been extended to many types of documents (letters, articles, books, slide shows, concert posters, etc.) and many domains (chemistry, chess, music, poetry, linguistics, critical editions, etc.). The most popular extension to T_EX is L^AT_EX which many users find more natural to use than basic T_EX with its very low level of typesetting commands.

T_EX is always used in conjunction with a text editor that lets you move around in your document adding new text or changing it and adding instructions for how you want the text formatted. Unlike Word, T_EX is available from a variety of commercial, shareware or free sources, configured in ways that different users may find suitable (<http://www.tug.org/interest.html>). But, at their core, all of these have the same T_EX “typesetter” from Knuth.

Another way T_EX is different than Word and many other word processors is that all typesetting instructions are explicitly typed into and shown in the document file. For instance, when you tell L^AT_EX it’s time to show you the formatted version of your document, the L^AT_EX file contents

```
\documentclass[A4]{letter}
\usepackage{times}
\begin{document}
This is a small example of a
two paragraph document.
```

```
This is the \emph{second}
paragraph.
\end{document}
```

would be converted to

This is a small example of a two paragraph document.

This is the *second* paragraph.

Where Word uses an extra strike of the Enter key to indicate a new paragraph and this information is hidden after the last character of the para-

graph (or with the ¶ sign), L^AT_EX uses an extra blank line to indicate a paragraph break (see the example). In Word you can select the style of document, paper size, and font with various menu commands; in L^AT_EX you type these instructions into your file as shown in the first two lines of the example. In Word you might type control-i to turn on italics, then type a word, and then type control-i again to turn off italics; in L^AT_EX you indicate *emphasis* explicitly as shown in the first line of the second paragraph of the example.

Our purpose here is to explain what T_EX is—not to compare the power of T_EX with the power of other types of word processors. Suffice it to say that many people find T_EX or one of its extensions useful in a variety of applications.

Because T_EX from any source has the same extendable basic capability and because the capability for extension is very explicit, users are motivated to extend T_EX, and there is tremendous sharing of extensions among T_EX users. The Comprehensive T_EX Archive Network (CTAN) is a massive collection of T_EX extensions for various application domains, document types, and typesetting flourishes. Discussion groups such as `comp.text.tex` and `texhax` provide forums where users can seek help from other (some very expert) users. The T_EX User Group (TUG) and other national users groups provide other resources such as user conventions and journals (like this one).

If you aren’t already using T_EX, `protext` for Windows (<http://tug.org/protext>), `gwTEX` for MacOSX (<http://www.rna.nl/tex.html>), or T_EX Live for Unix (<http://tug.org/tex-live>) are good starting points. When you are asked how much to install, choose to install *all* packages.

After getting a system installed, first try to run `pdflatex sample2e` and view the result, `sample2e.pdf`. Then, start reading documentation either online (Not So Short Introduction to L^AT_EX, <http://tug.org/tex-archive/info/lshort/>) or in print (Kopka & Daly’s *Guide to T_EX*, <http://tug.org/books/index.html#guidelatex>). (Studying the source file `sample2e.tex` is also a way to begin to understand L^AT_EX.) There are *many* other books and documents if you get to wanting more. If you need help with a specific problem, check the T_EX FAQ (<http://www.tex.ac.uk/faq>). Another starting point is <http://tug.org/begin.html>; a more comprehensive list is <http://tug.org/interest.html>. You can also reach various TUG volunteers by emailing support@tug.org.

Karl Berry (karl@freefriends.org)

David Walden (dave@walden-family.com)

TO THE BEST OF MY MEMORY

Stories from the Life of
Velva Magdalena Diede Walden

AN ORAL HISTORY

TOLD TO AND EDITED BY

SARA COWLES WALDEN



Velva Magdalena Diede
High School Graduation, 1935

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North Dakota Years

Antelope, N. D., My Birth and Birth Customs

I was born February 24, 1915, in my home at a location near Antelope, North Dakota, a village that no longer exists. Antelope was a store and two grain elevators; the post office was in the store. After the post office was closed, thirty years ago or so, they closed down the elevators, too. But it was right on the railroad track, on the Northern Pacific Railroad. The only reason people went to Antelope basically was to get the mail (after some years we had a rural mail carrier) and to take the grain to the elevator and the cream to the station platform. We would take our cream cans and put them on the platform, and then when the train came through they would be picked up. We had lots of heavy cream. So often now when I'll pick up something heavy somebody will come up and say, "Oh, that's too heavy for you." I tell them, "I was raised on eight and ten gallon cream cans!"

When I was born there was a midwife and her name was Mrs. Eisenbry. She was the midwife for the entire area. She lived about fifteen miles south of where we lived. I knew her well as the years went on, because we went to the same church. She attended all births during that whole period of time. In fact, my mother was attended by this same midwife for all my four brothers, except Lloyd. When Lloyd was born, the doctor came to our home. I don't know why.

There was a doctor in Hebron, Dr. Sam Schierbaum, who was there for many years. When I was born, my father's cousin, Emma Staiger, came and took care of my mother and me. She was a foster sister to my father, so she was "Aunt Emma" to us. Her older sister had a daughter named Velva, and I understand that the reason I was named Velva was because Aunt Emma wanted me to have that name.

There was an interesting custom when babies were born. I never remember taking a baby gift for a newborn, but being farmers we always killed and cleaned a hen. A batch of egg noodles was made (with egg yolks only because that made them so nice and yellow). A cake was baked. Sometimes it was an angel food because we had egg whites left over to use. Sometimes the cake was a two layer cake with jelly filling between the layers. These three items — hen, noodles and cake — were taken when you visited a new mother. The hen and noodles were to be used to make chicken noodle soup for the nursing mother.

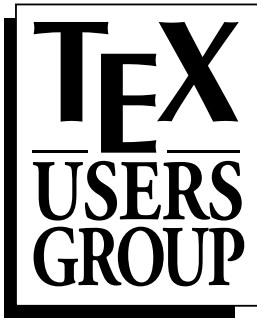
I was the first child to survive infancy. My mother gave birth to two other daughters. My parents were married in 1910, and I was not born until 1915. There were two other births before I was born: Rachel Diana, who lived three weeks, and Maria, who was stillborn. After me came Oscar, Herman, Ishmael and Lloyd.



Figure 3: *Velva's parents, Maria Reich and Christian Diede, Jr., on their wedding Day, November 1, 1910.*



Figure 4: *Velva's father driving six horses on the drill, seeding wheat, around 1920.*



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Portland, OR US

[†]Honorary

April 10, 2005

Dear TUG member,

Thank-you for joining the TeX Users Group, and welcome! Enclosed please find a complimentary copy of *TUGboat*. Please know you will receive all materials due for the year, even if some are mailed after 2005. We sincerely hope that will not be the case.

If you would like to get started with the TeX Collection and/or CTAN CD software right away, and didn't purchase it already, last year's releases are available to purchase at a discount. The 2004 TeX Collection includes a DVD (containing both TeX Live and CTAN), and the TeX Live and ProTeXt CD's. CTAN CD's are available as well. The 2005 software will hopefully be ready for distribution by late summer. More information about the software is on the web at <http://tug.org/texlive/texcollection.html>.

2005 is an election year for TUG, and there are two candidates running for TUG President. A paper ballot is enclosed. We recommend mailing as soon as possible, as ballots must be postmarked by May 17, 2005—and please don't forget to put postage on the return envelope. More information about the election is on the TUG web site at <http://tug.org/election>.

Finally, please don't hesitate to contact myself (office@tug.org) or the TUG board of directors (board@tug.org) for any reason.

Thanks again, and, welcome!

Sincerely,

Robin Laakso
TUG Executive Director

Except during the nine months before he draws breath, no man manages his affairs as well as a tree does.

George Bernard Shaw

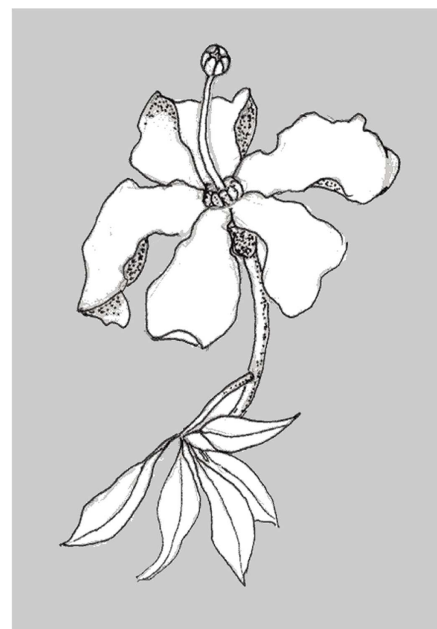
Aviary and Treetops Terrace

AS YOU ARRIVE AT THE PATH leading up to the Aviary, look to your left to see a stand of floss silk trees, *Chorisia speciosa*. They are recognizable by their bright green thorny trunks.

Native to Brazil, floss silk trees bloom in October and November when they are covered with large pink and white flowers. Their fruits are large green avocado-shaped pods containing both seeds and a downy white fluff that gently covers the area when the pod splits open. The seeds are favorites of many species of parrots. **Continue uphill to reach the gardens in front of the Aviary.**

There is a Montezuma cypress, *Taxodium mucronatum*, on the downslope near the bamboo palm. The cypress, called *ahuehuete* by the Aztecs and considered sacred, is the national tree of Mexico. Even so, its conservation status is “threatened.”

Visit the dawn redwood, *Metasequoia glyptostroboides*, **to the right of the rest room by the Aviary.** This tree was widely distributed in the Northern Hemisphere from the Cretaceous period down to about 26 million years ago when it vanished from the fossil record and was believed to be extinct. Then during World War Two, a living dawn redwood was discovered in a remote area of Sichuan Province by a Chinese forester. After the war, an expedition led by paleobotanist Dr. Ralph Chaney of UC Berkeley located a small forest of these trees in a valley 30 miles from where the first tree was found. Today, dawn redwoods are growing all over the world, serving as ambassadors from the Age of Dinosaurs. Like the bald cypress, the dawn redwood is deciduous and so is bare during winter.



21. Floss Silk Tree

Joe Hogg's paper on developing a brochure

<http://www.tug.org/pracjourn/2005-3/hogg/>

In this issue


- [MDaemon Stops Spam!](#)
- [SSL How To's](#)
- [White Lists & Exclusions](#)
- [Server Security Basics](#)
- [GW Folder Sharing](#)

Osirusoft RBL Gone!

Osirusoft, a popular antis spam black list site, is offline following extended denial of service attacks. The Osirusoft listing should be removed from MDAemon's Spam Blocker:

1. Choose the *Security > Spam Blocker* command.
2. Select the *Spam Blocker Hosts* tab.
3. Click on the item containing *osirusoft* and click on *Remove*.
4. Click on *OK* to exit.

Positive Reviews!

MDaemon continues to receive positive reviews of its speed, security, low cost, easy installation and usability. It is praised for professional strength and beginner ease of use. See the [review summaries](#), plus  links to the complete reviews.

RelayFax Upgrade/Rewrite

RelayFax is being rewritten with new technology. Also, Upgrade Protection is available. See the Upgrade Protection questions in the [RelayFax FAQ](#). Also see the [RelayFaX](#) white paper.

MDaemon 6.8 Stops Spam

Two new features — Bayesian filtering and heuristic detection — have made MDAemon 6.8 very effective at stopping spam before it reaches users.

New AntiSpam tools come included, at no additional cost, with MDAemon 6.8 PRO!

With *Bayesian filtering*, each email site decides what is spam and legitimate email by dragging and dropping examples of both into the filtering engine. The filter then compares the content of the examples to the content of new messages to separate spam from real mail. Given several hundred examples of each type, Bayesian filtering is more than 95 percent accurate on spam, with virtually zero mistakes for important email.

Heuristic spam detection uses feature-matching rules — red HTML text, for example — to identify spam. Through years of “learning” what spam (and legitimate) messages typically look like, the heuristic rules have become very reliable in separating spam from normal email.

MDaemon supports multiple means of fighting spam, including assured access through white lists.

For more information on stopping spam with MDAemon, see the [Security Tools for Spam Control](#) white paper, the [MDaemon AntiSpam HowTos](#) and the [AntiSpam tutorial](#), by Ross McWilliam.

SSL How To's

The Secure Socket Layer (SSL) can protect your MDAemon email communications on the Internet by using:

- server authentication certificates
- data encryption
- personal authentication certificates

An authentication certificate resides on your server and makes sure your users are communicating with your server only.

Data encryption converts ordinary data into codes only the sender and receiver software can understand.

A personal authentication certificate resides on a client computer and verifies the identify and ownership of the client computer.

MDaemon can use SSL for its IMAP, POP, SMTP and WorldClient webmail functions.

Setting up SSL for email and webmail are individual and independent processes. See the [MDaemon SSL HowTos](#).

Myriad application areas

- All manner of documents: books, papers, theses, posters, newsletter, leaflets, . . .
- Every possible application area: humanities, science, mathematics, history, genealogy, games, . . . , with the characters and symbols to match
- Dozens of languages and alphabets: Arabic, Chinese, Hindu, Hebrew, Greek, old German, . . .

Sample of article style

David Walden

October 29, 2005

1 Introduction

This is an example of a document using the standard article style. You can see that the file begins with a line declaring the style to use. The content of the document is between lines indicating the beginning and the end of the text of the document. The third line declares the title of the document. The fourth line declares the authors. The fifth line indicates that the title information should now be formatted. After that we have the text of the article. The default article style is used with the author really only being concerned with the content of the article.

2 Some observations

While it is easiest to just use the default assumptions of the article style, practically everything can be changed; we will talk more about this later in this presentation. Such changes can be made in a global way such that the change is indicated in one place and it takes effect everywhere in the document. For instance, we could declare a different format for section titles once at the top of the document, and all of the section titles would be appropriately changes. Notice that there are default assumptions for the font types and sizes for the various elements of the document, e.g., title, author line, section titles, and text.

3 Conclusion

The sequences of characters beginning with a backslash and perhaps followed by open and closed braces with other text within the braces are called commands, consisting of control sequences and parameters.

Notice that the system has chosen how to lay out the lines and text and words within lines. Although many of us may not have very discerning eyes in this regard, the system efforts in this area typically are of very high quality.


```
\documentclass{article}
\begin{document}
\title{Sample of article style}
\author{David Walden}
\maketitle
```

```
\section{Introduction}
```

This is an example of a document using the standard article style. You can see that the file begins with a line declaring the style to use. The content of the document is between lines indicating the beginning and the end of the text of the document. The third line declares the title of the document. The fourth line declares the authors. The fifth line indicates that the title information should now be formatted. After that we have the text of the article. The default article style is used with the author really only being concerned with the content of the article.

```
\section{Some observations}
```

While it is easiest to just use the default assumptions of the article style, practically everything can be changed; we will talk more about this later in this presentation. Such changes can be made in a global way such that the change is indicated in one place and it takes effect everywhere in the document. For instance, we could declare a different format for section titles once at the top of the document, and all of the section titles would be appropriately changed. Notice that there are default assumptions for the font types and sizes for the various elements of the document, e.g., title, author line, section titles, and text.

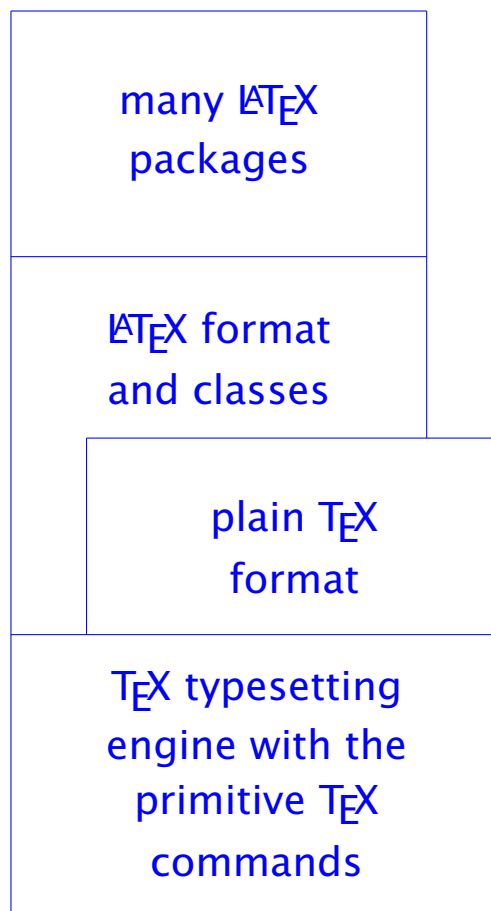
```
\section{Conclusion}
```

The sequences of characters beginning with a backslash and perhaps followed by open and close braces with other text within the braces are called commands, consisting of control sequences and parameters.

Notice that the system has chosen how to lay out the lines and text and words within lines. Although many of us may not have very discerning eyes in this regard, the system efforts in this area typically are of very high quality.

```
\end{document}
```

Levels of T_EX



Some complications

a) type --- to produce —

b) type -- to produce -

c) type - to produce -

d) type ‘ ‘ to produce “ and ’ ’ to produce ”

e) type ‘ to produce ‘ and ’ to produce ’

f1) \$ % & # _ { }

f2) \\$ \% \& \# _ \{ \}

```
\documentclass{letter}
\address{12 Linden Road\\East Sandwich, MA 02537}
\signature{David C. Walden}
\begin{document}
\begin{letter}{\\ \\ }
\opening{Dear ,}

\closing{Sincerely,}
\end{letter}
\end{document}
```

12 Linden Road
East Sandwich, MA 02537

December 4, 2005

Robin Laakso
TUG
xxxx
Portland, OR mmm

Dear Robin,

I was very happy to receive your letter about the production of *TUGboat*, the journal of the T_EX Users Group.

I have three thoughts in response to your letter:

1. We should hope that we don't have any more issues that are over 250 pages long. Such big issues really bust the budget.
2. We need to think about how we accrue costs for *TUGboat* production in the case when it is published on schedule and in the case when it is published a month or two late.
3. We should see if we can more accurately anticipate the costs and schedule for *TUGboat* production in 2006.

I will appreciate receiving your thoughts on my thoughts. Please do not hesitate to tell me if you think I am wrong, especially about point 2 above.

Sincerely,

David C. Walden

```
\documentclass{letter}
\address{12 Linden Road\\East Sandwich, MA 02537}
\signature{David C. Walden}
\begin{document}
\begin{letter}{Robin Laasko\\TUG\\xxxx\\Portland, OR nnnn}
\opening{Dear Robin,}
```

I was very happy to receive your letter about the production of `\textit{TUGboat}`, the journal of the `\TeX` Users Group.

I have three thoughts in response to your letter:
`\begin{enumerate}`

`\item` We should hope that we don't have any more issues that are over 250 pages long. Such big issues really bust the budget.

`\item` We need to think about how we accrue costs for `\textit{TUGboat}` production in the case when it is published on schedule and in the case when it is published a month or two late.

`\item` We should see if we can more accurately anticipate the costs and schedule for `\textit{TUGboat}` production in 2006.

`\end{enumerate}`

I will appreciate receiving your thoughts on my thoughts. Please do not hesitate to tell me if you think I am wrong, especially about point 2 above.

```
\closing{Sincerely,}
\end{letter}
\end{document}
```

```

\documentclass[12pt]{letter}

\newcommand{\TB}{\textit{TUGboat}}
\newcounter{XX}

\address{12 Linden Road\\East Sandwich, MA 02537}
\signature{David C. Walden}
\begin{document}
\begin{letter}{Robin Laasko\\TUG\\xxxx\\Portland, OR nnnn}
\opening{Dear Robin,}

I was very happy to receive your letter about the production of \TB,
the journal of the \TeX\ Users Group.

I have three thoughts in response to your letter:
\begin{enumerate}

\item We should hope that we don't have any more issues that are
over 250 pages long. Such big issues really bust the budget.

\item \setcounter{XX}{\value{enumi}} We need to think about how we accrue costs for \TB\
production in the case when it is published on schedule and in the case
when it is published a month or two late.

\item We should see if we can more accurately anticipate the costs and
schedule for \TB\ production in 2006.

\end{enumerate}

I will appreciate receiving your thoughts on my thoughts. Please do
not hesitate to tell me if you think I am wrong, especially about point
\arabic{XX} above.

\closing{Sincerely,}
\end{letter}
\end{document}

```

12 Linden Road
East Sandwich, MA 02537

December 4, 2005

Robin Laakso
TUG
xxxx
Portland, OR mnnn

Dear Robin,

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3. We should see if we can more accurately anticipate the costs and schedule for *TUGboat* production in 2006.

I will appreciate receiving your thoughts on my thoughts. Please do not hesitate to tell me if you think I am wrong, especially about point 2 above.

Sincerely,

David C. Walden

Some domains where \LaTeX is particularly useful

- Typesetting
- Math
- Codifying style of document to application
- Large documents
- Languages
- Extensibility
- System independence
- Targeting different output systems

Math mode

Here is an example of some math: x^2+y^2

yields

Here is an example of some math: $x^2 + y^2$

$x^2+2xy + y^2$

yields

$$x^2 + 2xy + y^2$$

Theoretical Computer Science Cheat Sheet

Identities Cont.

38. $\binom{n+1}{m+1} = \sum_k \binom{n}{k} \binom{k}{m} = \sum_{k=0}^n \binom{k}{m} n^{n-k} = n! \sum_{k=0}^n \frac{1}{k!} \binom{k}{m}$, **39.** $\begin{bmatrix} x \\ x-n \end{bmatrix} = \sum_{k=0}^n \left\langle \begin{matrix} n \\ k \end{matrix} \right\rangle \binom{x+k}{2n}$,
40. $\left\{ \begin{matrix} n \\ m \end{matrix} \right\} = \sum_k \binom{n}{k} \left\{ \begin{matrix} k+1 \\ m+1 \end{matrix} \right\} (-1)^{n-k}$, **41.** $\begin{bmatrix} n \\ m \end{bmatrix} = \sum_k \begin{bmatrix} n+1 \\ k+1 \end{bmatrix} \binom{k}{m} (-1)^{m-k}$,
42. $\left\{ \begin{matrix} m+n+1 \\ m \end{matrix} \right\} = \sum_{k=0}^m k \left\{ \begin{matrix} n+k \\ k \end{matrix} \right\}$, **43.** $\begin{bmatrix} m+n+1 \\ m \end{bmatrix} = \sum_{k=0}^m k(n+k) \begin{bmatrix} n+k \\ k \end{bmatrix}$,
44. $\binom{n}{m} = \sum_k \binom{n+1}{k+1} \binom{k}{m} (-1)^{m-k}$, **45.** $(n-m)! \binom{n}{m} = \sum_k \begin{bmatrix} n+1 \\ k+1 \end{bmatrix} \left\{ \begin{matrix} k \\ m \end{matrix} \right\} (-1)^{m-k}$, for $n \geq m$,
46. $\left\{ \begin{matrix} n \\ n-m \end{matrix} \right\} = \sum_k \binom{m-n}{m+k} \binom{m+n}{n+k} \begin{bmatrix} m+k \\ k \end{bmatrix}$, **47.** $\begin{bmatrix} n \\ n-m \end{bmatrix} = \sum_k \binom{m-n}{m+k} \binom{m+n}{n+k} \left\{ \begin{matrix} m+k \\ k \end{matrix} \right\}$,
48. $\left\{ \begin{matrix} n \\ \ell+m \end{matrix} \right\} \binom{\ell+m}{\ell} = \sum_k \left\{ \begin{matrix} k \\ \ell \end{matrix} \right\} \left\{ \begin{matrix} n-k \\ m \end{matrix} \right\} \binom{n}{k}$, **49.** $\begin{bmatrix} n \\ \ell+m \end{bmatrix} \binom{\ell+m}{\ell} = \sum_k \begin{bmatrix} k \\ \ell \end{bmatrix} \begin{bmatrix} n-k \\ m \end{bmatrix} \binom{n}{k}$.

Trees

Every tree with n vertices has $n - 1$ edges.

Kraft inequality: If the depths of the leaves of a binary tree are d_1, \dots, d_n :

$$\sum_{i=1}^n 2^{-d_i} \leq 1,$$

and equality holds only if every internal node has 2 sons.

Recurrences

Master method:

$$T(n) = aT(n/b) + f(n), \quad a \geq 1, b > 1$$

If $\exists \epsilon > 0$ such that $f(n) = O(n^{\log_b a - \epsilon})$ then

$$T(n) = \Theta(n^{\log_b a}).$$

If $f(n) = \Theta(n^{\log_b a})$ then

$$T(n) = \Theta(n^{\log_b a} \log_2 n).$$

If $\exists \epsilon > 0$ such that $f(n) = \Omega(n^{\log_b a + \epsilon})$, and $\exists c < 1$ such that $af(n/b) \leq cf(n)$ for large n , then

$$T(n) = \Theta(f(n)).$$

Substitution (example): Consider the following recurrence

$$T_{i+1} = 2^{2^i} \cdot T_i^2, \quad T_1 = 2.$$

Note that T_i is always a power of two.

Let $t_i = \log_2 T_i$. Then we have

$$t_{i+1} = 2^i + 2t_i, \quad t_1 = 1.$$

Let $u_i = t_i/2^i$. Dividing both sides of the previous equation by 2^{i+1} we get

$$\frac{t_{i+1}}{2^{i+1}} = \frac{2^i}{2^{i+1}} + \frac{t_i}{2^i}.$$

Substituting we find

$$u_{i+1} = \frac{1}{2} + u_i, \quad u_1 = \frac{1}{2},$$

which is simply $u_i = i/2$. So we find that T_i has the closed form $T_i = 2^{i2^{i-1}}$.

Summing factors (example): Consider the following recurrence

$$T(n) = 3T(n/2) + n, \quad T(1) = 1.$$

Rewrite so that all terms involving T are on the left side

$$T(n) - 3T(n/2) = n.$$

Now expand the recurrence, and choose a factor which makes the left side "telescope"

$$\begin{aligned}
 1(T(n) - 3T(n/2)) &= n \\
 3(T(n/2) - 3T(n/4)) &= n/2 \\
 \vdots & \\
 3^{\log_2 n - 1}(T(2) - 3T(1)) &= 2
 \end{aligned}$$

Let $m = \log_2 n$. Summing the left side we get $T(n) - 3^m T(1) = T(n) - 3^m = T(n) - n^k$ where $k = \log_2 3 \approx 1.58496$. Summing the right side we get

$$\sum_{i=0}^{m-1} \frac{n}{2^i} 3^i = n \sum_{i=0}^{m-1} \left(\frac{3}{2}\right)^i.$$

Let $c = \frac{3}{2}$. Then we have

$$\begin{aligned}
 n \sum_{i=0}^{m-1} c^i &= n \left(\frac{c^m - 1}{c - 1} \right) \\
 &= 2n(c^{\log_2 n} - 1) \\
 &= 2n(c^{(k-1)\log_2 n} - 1) \\
 &= 2n^k - 2n,
 \end{aligned}$$

and so $T(n) = 3n^k - 2n$. Full history recurrences can often be changed to limited history ones (example): Consider

$$T_i = 1 + \sum_{j=0}^{i-1} T_j, \quad T_0 = 1.$$

Note that

$$T_{i+1} = 1 + \sum_{j=0}^i T_j.$$

Subtracting we find

$$\begin{aligned}
 T_{i+1} - T_i &= 1 + \sum_{j=0}^i T_j - 1 - \sum_{j=0}^{i-1} T_j \\
 &= T_i.
 \end{aligned}$$

And so $T_{i+1} = 2T_i = 2^{i+1}$.

Generating functions:

1. Multiply both sides of the equation by x^i .
2. Sum both sides over all i for which the equation is valid.
3. Choose a generating function $G(x)$. Usually $G(x) = \sum_{i=0}^{\infty} x^i g_i$.
3. Rewrite the equation in terms of the generating function $G(x)$.
4. Solve for $G(x)$.
5. The coefficient of x^i in $G(x)$ is g_i .

Example:

$$g_{i+1} = 2g_i + 1, \quad g_0 = 0.$$

Multiply and sum:

$$\sum_{i \geq 0} g_{i+1} x^i = \sum_{i \geq 0} 2g_i x^i + \sum_{i \geq 0} x^i.$$

We choose $G(x) = \sum_{i \geq 0} x^i g_i$. Rewrite in terms of $G(x)$:

$$\frac{G(x) - g_0}{x} = 2G(x) + \sum_{i \geq 0} x^i.$$

Simplify:

$$\frac{G(x)}{x} = 2G(x) + \frac{1}{1-x}.$$

Solve for $G(x)$:

$$G(x) = \frac{x}{(1-x)(1-2x)}.$$

Expand this using partial fractions:

$$\begin{aligned}
 G(x) &= x \left(\frac{2}{1-2x} - \frac{1}{1-x} \right) \\
 &= x \left(2 \sum_{i \geq 0} 2^i x^i - \sum_{i \geq 0} x^i \right) \\
 &= \sum_{i \geq 0} (2^{i+1} - 1) x^{i+1}.
 \end{aligned}$$

So $g_i = 2^i - 1$.

Some domains where \LaTeX is particularly useful

- Typesetting
- Math
- Codifying style of document to application
- Large documents
- Languages
- Extensibility
- System independence
- Can use the editor of your choice
- Targeting different output systems

Getting started with T_EX

- Obtaining the T_EX system
- Books, manuals and tutorials
- Obtaining consulting help
- Joining a users' group

T_EX Users Group (TUG) history and function

- General goal is helping promote the well-being of T_EX and the T_EX user community
- Originally a developers' group
- Now actually a users' group
- Has been producing the journal *TUGboat* for over twenty-five years
- Annually sends out CDs and DVD with an up-to-date T_EX system and the latest add-ons, although there is no need to update your T_EX system very often
- Annual conference
- Other resources — see web site tug.org
- Reduced fees for students, seniors, etc.

Thank you

Some useful URLs

Sources of T_EX

T_EX Live CD or DVD

<http://tug.org/texlive>

ProT_EXt CD or DVD (for Windows)

<http://tug.org/protext>

MacT_EX

<http://tug.org/mactex>

Commercial vendors

<http://www.tug.org/interest.html#vendors>

Consulting help

TUG's discussion group

<http://www.tug.org/mailman/listinfo/texhax>

USENET discussion group

<http://groups.google.com/group/comp.text.tex>

T_EX FAQ

<http://www.tex.ac.uk/faq>

CTAN (Comprehensive T_EX Archive Network)

<http://tug.org/ctan.html>

Documentation

Some initial free and commercial documentation on T_EX

<http://tug.org/begin.html#doc>

User groups

T_EX Users Group (TUG)

<http://www.tug.org>

Other users' groups

<http://www.tug.org/usergroups.html>