LaTeX

A Perfect way to be Perfect

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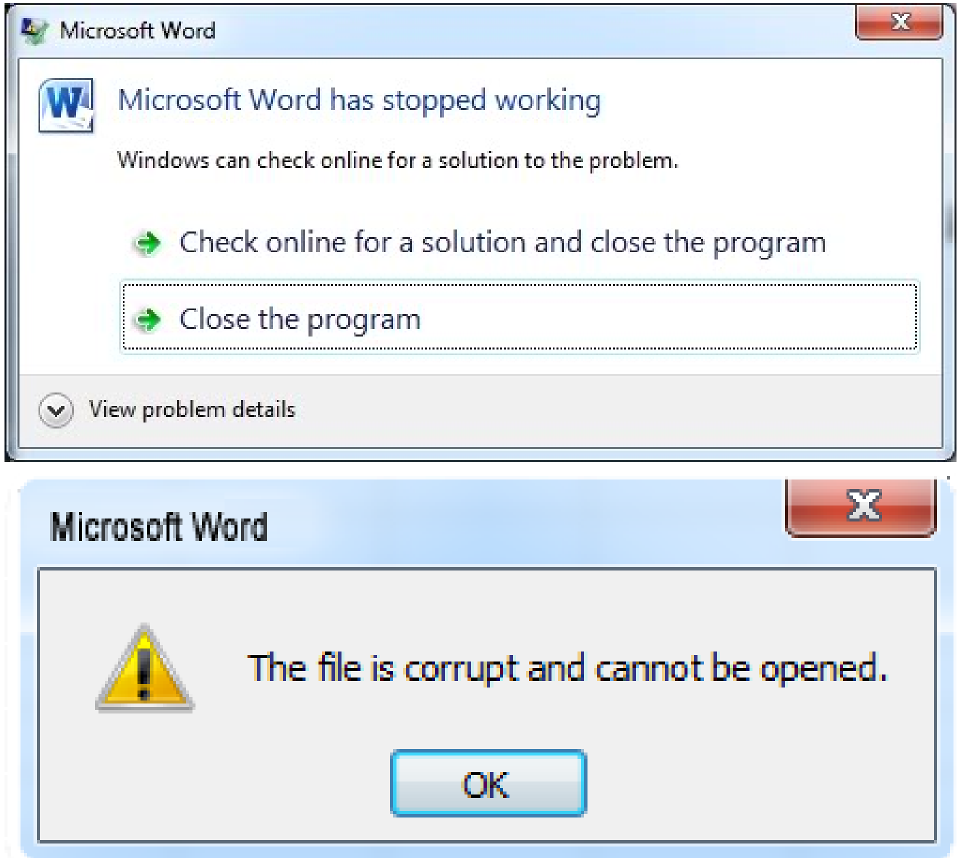
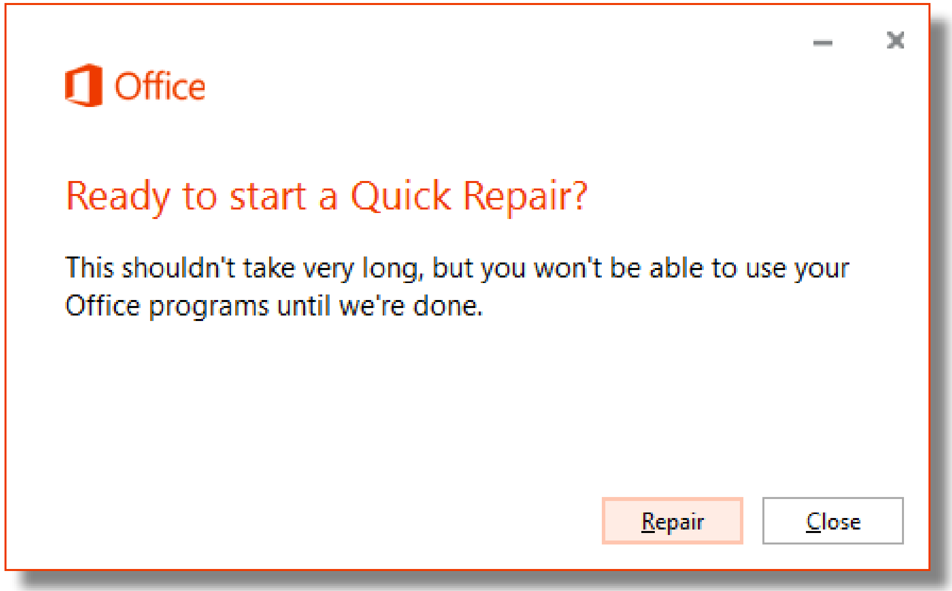
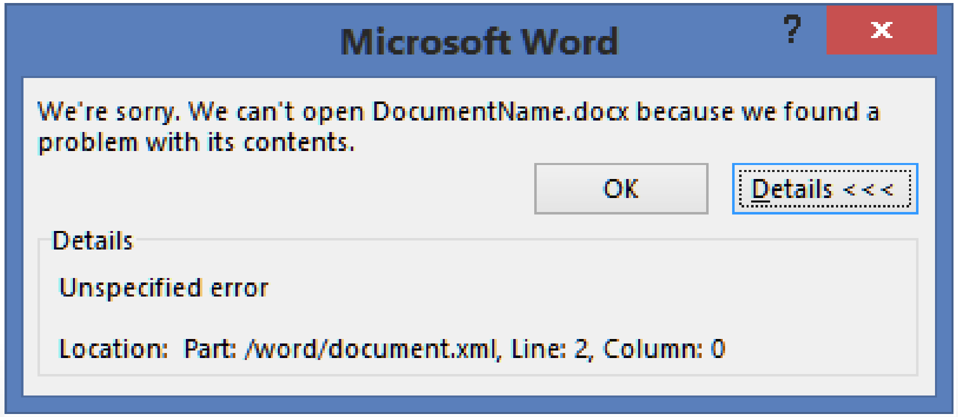
How many of you got the following experiances?



How many of you got the following experiances?





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How often you think of these questions?

- Is the likelihood of a crash is directly proportional to the importance of a document?
- Is the likelihood of a crash is inversely proportional to the time left before its deadline.
- Is the likelihood of a crash is directly proportional to the duration since you last saved the doucument?
- Is the likelihood of you throwing your computer out of the window is directly proportional to the number of times you get a message

  "The file cannot be opened" ?

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Are you tired?

These problems can occur when you use more graphics and complex scripts running behind the program.

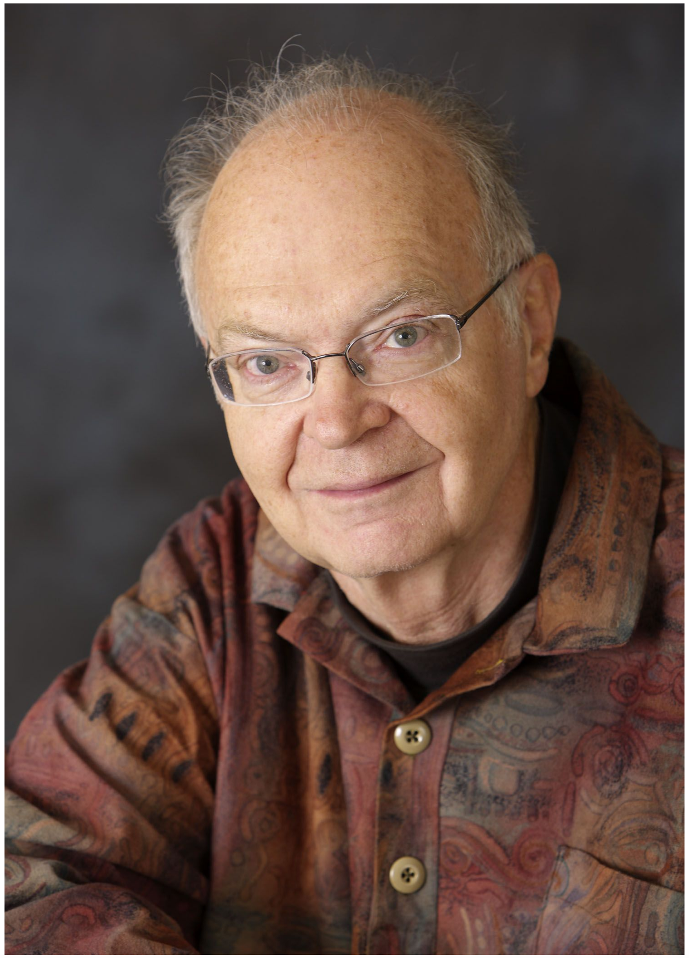
- Have you any time typed a document of more than 1000 pages?
- What if a software or program get you out off all these issues?

What we need?

- A neat document when you write a report.
- When you are writing the content, there should not be any deviation such as formatting the document.
- An automatted numbering system for chapter and section headings.
- Excellent bibliography management.
- Even if we go for 100000000 pages document, this **should not** be painful.

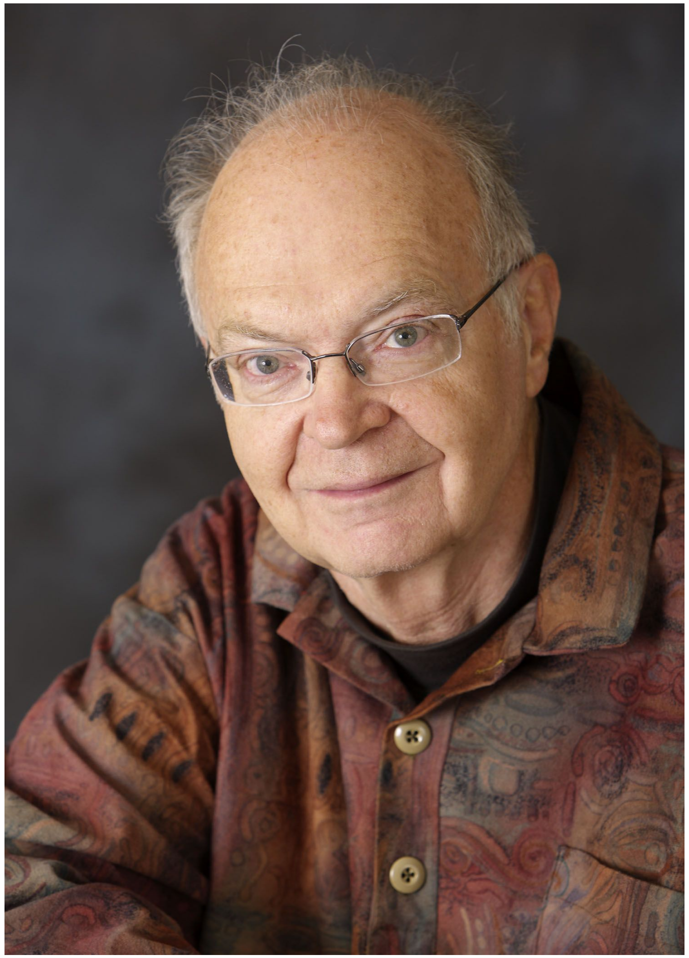
Revolutionists in the type setting world

- Donald Ervin Knuth (1938)
- American computer scientist, mathematician
- Professor emeritus at Stanford University.



Revolutionists in the type setting world

- In 1978, he created a typesetting system, called Tex (pronounced ‘tech’).
- Tex gave extremely fine-grained control of document layout.
- However, the vast flexibility meant it was complex.



Revolutionists in the type setting world

- Leslie Lamport
- February 7, 1941
- American computer scientist
- Microsoft Research in Mountain View, California.
- In 1983, created a set of macros that abstracted away many of the complexities of TeX.

What is a $\LaTeX$?

- LaTeX is essentially a markup language.
- Content is written in plain text
- Content and the format of the doucument is separated.
- The LaTeX interpreter reads in a LaTeX marked-up file, renders the content into a document and dumps it a new file.

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Separation of content and style

- When producing your LaTeX document, you are concentrating on the content itself.
- No deviation from your content.

Portability

- An actual LaTeX file is merely a text file, which is just about the most portable format in computing.
- Your data will never be corrupted or missed unless you delete the file itself.
- Standard output is dvi file which stands for device independent.

Flexibility

- You can get LaTeX to do just about anything you can think of!
- There are other crazy packages that you can install which allow you to typeset music scores, chessboards and cross-words!
- If you’re struggling to do a task, someone will have undoubtedly written a package to solve it easily!

Control

- LaTeX is much more clever in positioning your images and tables with a lot of common sense.
- Unlike word processors, it has a high floating sense to place these objects.
- You can have total control over the presentation of your document.

Quality

- It's difficult to disagree that the output from LaTeX is far superior to what Word can produce.
- High mathematical content, takes the LaTeX to high in quality.
- Its algorithms for laying out text are more sophisticated and extremely fine-grained.

1 Sample page of mathematical typesetting

First some large operators both in text: $\iiint\limits_{\mathcal{Q}} f(x,y,z)\,dx\,dy\,dz$ and $\prod_{\gamma\in\Gamma_{\bar{C}}}\partial(\widetilde{X}_\gamma)$; and also on display:

$$\begin{aligned}\iiiint\limits_{\mathbf{Q}} f(w,x,y,z)\,dw\,dx\,dy\,dz &\leq \oint_{\partial\mathbf{Q}} f'\left(\max\left\{\frac{\|w\|}{|w^2+x^2|};\frac{\|z\|}{|y^2+z^2|};\frac{\|w\oplus z\|}{\|x\oplus y\|}\right\}\right)\\ &\precapprox \biguplus_{\mathbb{Q}\Subset\bar{\mathbf{Q}}}\left[f^*\left(\frac{\int\mathbb{Q}(t)}{\sqrt{1-t^2}}\right)\right]_{t=\alpha}^{t=\vartheta}\end{aligned} \tag{1}$$

For x in the open interval $]-1,1[$ the infinite sum in Equation (2) is convergent; however, this does not hold throughout the closed interval $[-1,1]$.

$$(1-x)^{-k} = 1+\sum_{j=1}^{\infty}(-1)^j\begin{Bmatrix}k\\j\end{Bmatrix}x^j \quad \text{for } k\in\mathbb{N}; k\neq 0. \tag{2}$$

Scalability

- In my personal experience, using Word for documents with more than 20 pages has not been a pleasant experience.
- You are free to split up large documents into smaller chunks and then let LaTeX combine them altogether later (like one chapter per file).
- It can also create tables of content, indexes and bibliographies easily, even on multi-file projects.

$$
\begin{aligned}
\left(\int_{-\infty}^{\infty} e^{-x^2} dx\right)^2 &= \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} e^{-(x^2+y^2)}\, dx\, dy \\
&= \int_0^{2\pi}\int_0^{\infty} e^{-r^2} r\, dr\, d\theta \\
&= \int_0^{2\pi}\left(-\frac{e^{-r^2}}{2}\bigg|_{r=0}^{r=\infty}\right) d\theta \\
&= \pi.
\end{aligned}
$$

Stability

There is no risk of you ever losing your original source text.

No bounds for the usage.

- LaTeX can be used as back end for many programming languages such as R, Python, matlab, mathematica, to prepare the report. For example,

```
library(stargazer)
stargazer(mtcars)
```

gives the latex code for the table which consists of mtcars data set.

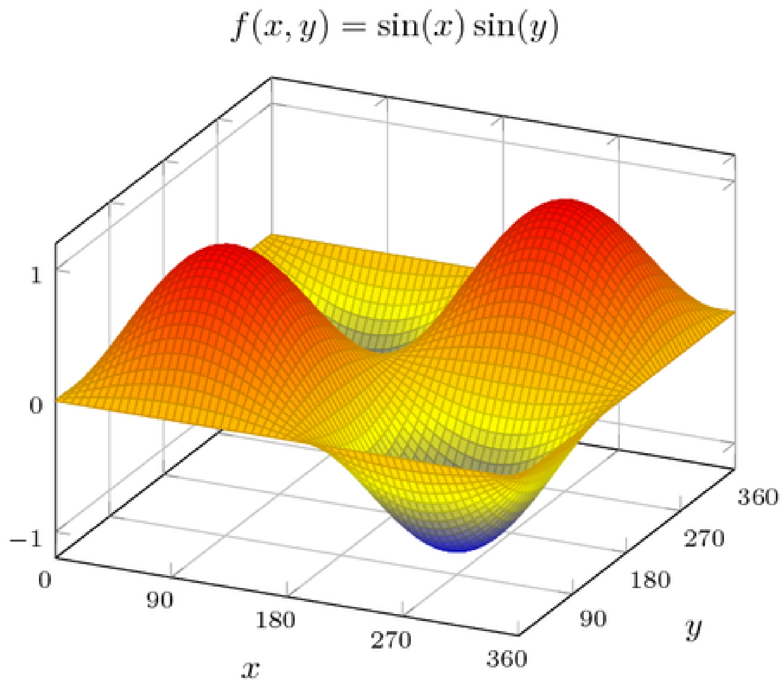
The output

TABLE 2.1
Data Set: mtcars2

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
mpg	32	20.091	6.027	10	15.4	22.8	34
cyl	32	6.188	1.786	4	4	8	8
disp	32	230.722	123.939	71	120.8	326	472
hp	32	146.688	68.563	52	96.5	180	335
drat	32	3.597	0.535	2.760	3.080	3.920	4.930
wt	32	3.217	0.978	1.513	2.581	3.610	5.424
qsec	32	17.849	1.787	14.500	16.892	18.900	22.900
vs	32	0.438	0.504	0	0	1	1
am	32	0.406	0.499	0	0	1	1
gear	32	3.688	0.738	3	3	4	5
carb	32	2.812	1.615	1	2	4	8

Mind map using LaTeX and tikz

Reproducible Graphs



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Cost

"You get what you pay for" fails here…!!!

What are we going to do in this sequence of tutorials?

Build a template for your thesis from the scratch. Thats all!!!

Final output will be...

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Title page and table of contents

MANIPAL
ACADEMY *of* HIGHER EDUCATION
(Deemed to be University under Section 3 of the UGC Act, 1956)

Generalized inverses: Applications in the theory of special class of matrices

A thesis submitted to

Manipal Academy of Higher Education, Manipal

in partial fulfillment of the requirement for the degree of

Doctor of Philosophy

by

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under the guidance of

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Chapters may look like…

List of Symbols

S	Semigroup
a^-	Generalized inverse of a
$a^=$	Outer inverse of a
a_r^-	Reflexive generalized inverse of a
$a^\dagger$	Drazin inverse of a

Chapter 1

Introduction

Generalized inverse of a matrix over a field is defined by many authors such as Moore, Penrose, C. R. Rao, Ben-Israel, in the literature for singular matrices/rectangular matrices analogue to inverse of matrix.

1.1 Regular elements in semigroup

Throughout this thesis, we denote

Publications

[P1] R. B. Bapat, S. K. Jain, K. M. P. Karantha, and M. D. Raj, "Outer inverses: Characterization and applications," *Linear Algebra Appl.*, vol. 528, pp. 171–184, Sep. 2017.

[P2] K. M. Prasad and M. D. Raj, "Bordering method to compute core-EP inverse," *Special Matrices*, vol. 6, pp. 193–200, Apr. 2018.

[P3] M. P. Karantha, D. R. Micheal, and M. Vinay, "An iterative method to find core–EP inverse," *Bull. Kerala Math. Assoc.*, vol. 16, no. 1, pp. 139–152, Jun. 2018.

Contents pages…

Remark 2.6. In Theorem 2.5(ii), it is easy to observe that $eS = aS$(resp. $Sf = Sa$). This is evident because, if $a \in eS$, then $a = ep$ for some $p \in S$, and hence for any $aq \in aS$, $aq = epq \in eS$.

Corollary 2.7. *Let a, $b \in S$ such that $a, b \in aS = bS$ (or $Sa = Sb$). Then a is regular if and only if b is regular.*

Proof. a is regular if and only if

$$\text{there exists an idempotent } e \text{ such that } a \in eS = aS = bS. \tag{2.5}$$

Given that $b \in bS$. Therefore,

$$(2.5) \text{ holds if and only if there exists } e \in S \text{ such that } b \in eS = bS.$$

if and only if b is regular. □

We now introduce the outer inverses with some range inclusion property.

Definition 2.8 ((y,x)–inverse). Let a, x, $y \in S$. a is said to have (y,x)–inverse if there exists $b \in S$ such that

$$bab = b,\ bS = yS \text{ and } Sb = Sx.$$

Lemma 2.9. *Let $a,x,y \in S$. If a has (y,x)-inverse b, say, then b is unique.*

Proof. Need to be written □

Lemma 2.10. *Let $a,x,y \in S$. If a has (y,x)–inverse then x,y are regular.*

Proof. Let b be the (y,x)–inverse a. Then

$$bab = b,\ bS = yS \text{ and } Sb = Sx.$$

Note that b is regular and $bS = yS$ and $Sb = Sx$. Hence, by Corollary 2.7, y and x are regular. □

Lemma 2.11. *Let $x, e \in S$ and e be an idempotent. Then*

(i) $ex = x$ if and only if $xS \subseteq eS$ and $x \in eS$.

(ii) $xe = s$ if and only if $Sx \subseteq Se$ and $x \in Se$.

Proof. Given that $x,e \in S$ and e is an idempotent.
(i). Let $ex = x$. Then $x \in eS$ and $xS = exS \subseteq eS$. Conversely, suppose $x \in xS \subseteq eS$. Note that, $x = ey$ for some $y \in S$ since $x \in eS$. Therefore, $ex = e.ey = ey = x$. Hence (i).

Statement (ii) can be proved similar to the proof of statement (i). □

Question 1. In Lemma 2.11(i), is the condition $x \in eS$ necessary?

Let us consider $S = \{a,b,c\}$ and

$$\cdot : S \to S \text{ defined by } x \cdot y = a \text{ for all } x,y \in S. \tag{2.6}$$

Then $(S,\cdot)$ is a semigroup. Consider $e = a$ and $x = b$. Note that $e = a$ is an idempotent and $x \notin eS$. By (2.6) it is clear that $xS = eS$. But $ex = ab = a \neq b = x$. Hence the condition $x \in eS$ is necessary in Lemma 2.11(i).

Let b be the (y,x)–inverse of a. Then y is regular, $y \in yS = bS = baS$ which together with ba is an idempotent implies that $bay = y$ by Lemma 2.11. Similar argument proves that $xab = x$. Further, $b \in (ySb) \cap (bSx)$ is clear since b is in $bS = yS$ and $Sb = Sx$. Hence, the outer inverse defined in the Definition 2.8 is same as that of the outer inverse defined by Drazin in [1].

Appendices & Bibliography…

Subject Index…

ARE YOU READY?

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