Contents

1 Lecture 16.01.2020

- scientific approach: trying to solve a new problem with an old method, an old problem with a new method – but not solving a new problem with a new method
- abstracts are very important because that is often all that people see
- since 2002 the most important thing in academic writing is the number of citations a paper receives
- web of Science is a citation counting system
- *Impact Factor* is a measure of how much a publication/journal matters
- papers are dense and have previously unknown research
- length of 4 to 40 pages – have all the normal/expected sections
- letters are usually shorter, much denser, of high importance – 4 pages
- bookends reference miner and reference management software
- impact factor and citations are first order approximations of the quality of a paper
- some good journals: Nature, Science, PNAS, Nature Communications, SIAM Review, Physical Review Letters, Nature Physics, Nonlinearity, Communications in Mathematical Physics, Physical Review E, IEEE Transactions on Pattern Analysis and Machine Intelligence...
- reviews/monographs: comprehensive and organized collection and synthesis of a new body of knowledge – someone goes through many papers and writes something about the state of the field or something
- review can be by many authors, monograph only has one author
- **write a paper about the solving of quadratic equations according to the principles outlined in the Read_applied.pdf p. 12**

2 Lecture 21.01.2020

2.1 Homework

2.1.1 Working group session 2

1. Concise
   - What is the topic of the paper? – Analyzing patterns in human speech in 6 European languages, with 4h of material per language in different situations and 16000 hertz, 2 bit sampling
   - How many key messages does the paper have? – Two
   - What are they? – The energy distribution follows a power law and is very similar between languages; The interevent timings between languages (their histograms) also mostly follow a power law and converge for short timings

    - Are they relevant? – the seem to be relevant for speech synthesis and understanding what speech and how it works, maybe shared human characteristics; there does not seem to be chaos at the root of human speech
2. Highlight and contextualize
    - Summary of key results in title and abstract? – Yes, even though I would question the "universality" part of the title
    - Contextualize results in introduction? – Yes, maybe a bit too much, they mention everything from earthquakes to stochastic noise and fractals
    - Introduction motivates importance? – yes, many disciplines and unanswered questions
    - Reference to previous works? – Yes, a ton of them
3. Coherent structure
    - Clarity of exposition? – Could be better, it is all very brief and assumes a lot of prior knowledge, might be due to constraints for length for publishing
    - Reinforcement of key message? – yes, but they introduce multiple new things in the Discussion to do so
    - Intro – Statement – Calculations, Simulations, Experiments – Discussion? – Yes
4. Logic flow
    - Information is logically sequential? – Yes, time intervals -> energy -> energy histograms -> energy release scaling -> interval scaling with inverses of previous data
    - Conclusions follow logically? – Yes, they are drawn from data, but I'm not sure how badly they massaged the data because the used logarithmic binning which I don't know anything about
5. Simple
    - As simple as possible? – Kind of, I don't know enough to really judge that, I would have left out some things, but I can't say if they were necessary
    - Excess notation? – No
6. Readable
    - Use of appendix for non-essential technicalities? – Yes, online datasets and stuff
    - Consistent notation? – Yes, consistent and sparingly
    - Good use of figures? – Yes, three figures that illustrate the data
    - Experiments, Simulations, Theories support key message(s)? –

3 Lecture 23.01.2020

To make references to equations in the text, type `\label{<name>}` and then refer to it using `\ref{<name>}`, it will automatically be done.
There is a command for splitting equation over multiple lines, look it up.

3.1 Greek letters

Name	Symbol
pi	π
chi	χ
rho	ρ
Pi	Π
Psi	Ψ

3.2 Symbols of binary operations

Name	Symbol
big triangle down	$\bigtriangledown$
dagger	$\dagger$
minus	$-$
times	$\times$

3.3 Unusual symbols

Name	Symbol
approximately	$\approx$
parallel	$\parallel$
not in	$\notin$

3.4 Inline formulae

- $M = \{x \in A \mid x > 0\}$
- $f\colon X \to Y$
- tan alpha = $\tan \alpha$, ln(e) = $\ln(e)$
- It is easy to see that $23^{1993} \equiv 1 \mod G$
- sum = $\sum_1^n x$
- product = $\prod_1^n x$
- supremum = $\sup x$
- limit with upper bound = $\overline{\lim}\, x$

3.5 Big formulae

$$\sum_{i=1}^{n} n^2 = \frac{n(n+1)(2n+1)}{6}$$

$$\overline{\lim_{n\to\infty}}\, a_n = \inf_n \sup_{m\geq n} a_m$$

$$\oint_{-\infty}^{+\infty} f(x)dx = \frac{1}{3}$$

$$\oint\limits_{-\infty}^{+\infty} f(x)dx = \frac{1}{3}$$

$$\prod_{n=1}^{n} i = 0$$

3.6 Symbols of other operators or special characters

Name	Symbol
partials	∂
infinity	∞
nabla	∇
for all:	$\forall$:
norm	$\|A\|$
asterisk	$*$
not equal	$\neq$
in, owns	$\in$, $\ni$
greater or equal	$\geq$
lesser or equal	$\leq$

4 Lecture 28.01.2020

- new command `\mbox`
- to break a line we can use `\\`, in text also `\newline`
- to break a line, we can use `\linebreak`
- the size of a newline can be specified in brackets `\\[5pt]`
- we can also use `\smallskipamount` and larger variants of that
- to quote: `\begin{quote}` *text* `\end{quote}`, this is just some normal text that should not concern the quote that I am writing here

  > this is a quote of utmost importance. It is so important that I will put it into quotation mode. Hopefully people will pay attention.

  Now we should continue with normal text and the quote should be finished now. Let's see how this will look when it is compiled using `pandoc`.
- `flushleft`, `flushright`, `center` can be used to align text
- Here is some text Which is formatted to be right-aligned in pandoc and not in latex

4.1 Itemize

- test 1 Some wild text:

  - sub 1
  - sub 2

- under other list

```
\begin{itemize}
    \item test 1
Some wild text:
    \begin{itemize}
        \item sub 1
        \item sub 2
    \end{itemize}
    \item under other list
\end{itemize}
```

4.2 Enumerate

1. number 1
2. number 2
   (a) sub number 1
   (b) sub number 2
3. below sub list

```
\begin{enumerate}
    \item number 1
    \item number 2
    \begin{enumerate}
        \item sub number 1
        \item sub number 2
    \end{enumerate}
    \item below sub list
\end{enumerate}
```

4.3 Images

- to insert images or `.svg` files it is best to put them in the same folder as the tex sourse file
- using `\usepackage{svgproc}` is good when one wants to work with these kinds of files

5 Lecture 30.01.2020

- British Council on Abstract and how to write them well
- the file could be very useful if we ever need to write any kind of abstract

- every part of our future papers should be very well thought out
- there tend to be very critical details in there that one needs to think about
- Competencies (p. 7)
  - Achievement
  - Analytical Thinking
  - Professional Confidence
  - Relationship Building
- Key Questions
  1. What is an abstract?
  2. Who is an abstract for?
  3. Why write an abstract?
  4. When do we write them?
  5. How long should they be?
- references, at least in Chicago style, you put references in the footnotes of the page and put a raised number at the place of citation

6 Lecture 04.02.2020

6.1 Midterm project

- report (>15 pages) and presentation (10 min)
- end of February
- topic: choose on our own, just something mathematical
- written LaTeX report
- number of pages: > 15
- based on that report we will prepare presentations
- presentation can be ppt, beamer, prezi, etc.
- paper should contain some kind of controversy: general sentiment is this, but science say otherwise
- what are we thinking and why, what are the reasons for that?
- we will get an example of a report from last year
- all the latex things that we have considered should be included
  - upper and lower footnotes
  - change margins if told to
  - page numbering
  - numbering references, citations
  - acknowledgements
  - chapters, sections
  - toc
  - formula numbering
  - different types of indents
  - all the major parts of a paper, including abstract
  - title page
- presentation based on that report
  - will be discussed in future classes
  - the how and what with eyes and hands and all of that

- structure
  - title page
  - abstract
  - toc
  - introduction
  - main part with multiple sections
  - conclusion
  - acknowledgements
  - references

6.2 Notes

- we can download TexLive to locally compile stuff
- it is quite big and he is showing us how it would work
- abstract: passive voice
- references: `\cite{<name>}` to cite a specific thing in your bibliography
- topic 6 will have an example paper for us

7 Lecture 06.02.2020

7.1 Abstract

-abstract of the paper *Application of Additional Argument Method to Burgers Type Equation with Integral Term* - sentences are all very short - no connection between sentences - it contains all the important information - no flow in the abstract - maybe a bit too long? haven't checked

7.2 Report

- presentation on report
  - *why* did you do it (Motivation/Introduction)
  - *how* did you do it (Method/Theory)
  - *what* did you find (Results)
  - *what* does it mean (Discussion)
- presentation principles (Aristotle)
  1. tell what you are going to say
  2. tell it
  3. tell what you said
- a good talk is about **one main idea**
- for a 10 minute report somewhere around 20 slides are good
- title slide, intro slides, Q&A slide as well
- ≤ 7 lines per slide
- don't have too much text and do not read from you slides
- voice and body language

  - don't fold your arms
  - look at your audience
  - be enthusiastic
  - move a bit on the stage
  - make eye contact
- tell a story but do not make it a riddle, tell the audience where you will end up and how you will get there
- use appropriate jargon that your audience can understand
- make the presentation a mix of technical and non-technical jargon
- try to keep it as simple as possible
- practice giving talks before – practice leads to a sigmoid improvement curve
- optimize time and don't go too slow but also not to fast
- allow questions (or not), but tell people
- include something visual in every slide
- **DON'T END LATE**

8 Lecture 11.02.2020

- 30 seconds per slide, we should print out the paper and submit the `.tex` and `.pdf` files
- now we'll talk about the abstract for one of his papers

8.1 Talks

- are not papers
- level should fit the audience – know the level of your topic and the audience
- don't be intimidated by the audience
- don't try to impress the audience with your brilliance
- **first half or third of the presentation should be completely understandable to anybody in the audience**
  - explain the problem
  - what is the conflict or controversy between the generally accepted view and this research
- carry everyone along and just be a good speaker
- talk about examples
- prove only easy results if at all, only hint at how it's done if it is difficult
- concentrate on qualitative analysis and not quantitative analysis
- put your results in context
- **don't introduce too many ideas**
- plan your time well and don't go over the time limit, rather end 1 or 2 minutes early
- plan your talk well, but be ready to make changes to your plan
- beginning: tell an interesting story that all of us will find intriguing, present a question that provides suspense, the satisfy the audience by providing the answer they are craving

9 Lecture 13.02.2020

9.1 Homework – Better Abstract

9.1.1 Original ~66 words

Application of Additional Argument Method to Burgers type equation with an integral term on the right-hand side was considered. A scheme of the method for the Burgers type equation is constructed. The validness of the scheme construction using Computer Algebra System (CAS) Maple was proved. The capability of modern CAS to prove mathematical theorems was demonstrated. The graphical solution of the series sample equations was constructed.

9.1.2 Rewrite ~65 words

This paper considers an application of the Additional Argument Method to the Burgers' equation with an integral term on the right-hand side. The scheme of this method for Burgers' equation is constructed and its validity proven using the Computer Algebra System Maple. The proof demonstrates the capability of these systems to prove mathematical theorems. Furthermore, the graphical solution of the series sample equations is constructed.

What is Burgers' equation/why is it useful?
What does that mean?
What does the integral term signify?

9.2 Notes

Source: Write Applied.pdf
Building a Draft

1. tentative title
2. sketch of the abstract
3. structure of the results section
4. prepare all the figures
5. write down the content of all of the sections of the body
6. sketch the discussion
7. write down an introduction
8. rewrite discussion and abstract

9.2.1 Goals of a Paper

- convince the reader that what you are saying is sound
- the reader should understand and appreciate the beauty of the mathematics you are presenting

9.2.2 Definitions

- research = the *systematic* investigation into a and study of *materials and sources* in order to establish *facts* and reach new conclusions.
  - we need a plan, sequential discovery by building on precious discoveries
  - If I have seen further is is by standing on the shoulder of giants. –Isaac Newton
- fact = consistent with objective reality or can be proven
- scientific method = falsifiable from evidence
- mathematical proofs = exhaustive reasoning, always true
  - inference rules, axioms, theorems

9.2.3 Literature Search

- LiteratureSearch.pdf

9.2.4 Other Notes

- stuff is supposed to be connected to other parts of a paper
- check for internal coherence and stuff
- be scientific
- main purpose of writing is to communicate
- style of writing mathematical papers: solve old problem with a new method or new problem with old method
- use a software that can adequately handle mathematical expressions
- abstract in passive voice, present tense
- introduction should contextualize the topic and motivate the reader to read further
- build on previous research, synthesize questions that have already been addressed
- in the conclusion your work should be related to other people's findings should be talked about
- abstract should catch the interest of people that work in your and close fields
- do not use symbols in the abstract if you can help it, if you use them, use them more than once
- when he says controversy he means that there should be some revelation that might not be immediately obvious
- usually less than 200 word limit for abstracts, maybe 300 words or 3000 symbols
- obviously a good understanding of the literature is required to make this work
- **reasonable amount of creativity creativity**
- get ready to work on difficult, unsolved problems, to be stuck

10 Lecture 18.02.2020

11 Lecture 18.02.2020

11.1 Homework – Better Abstract and Introduction

11.1.1 Original ~574 words

11.1.1.1 Abstract

Application of Additional Argument Method to Burgers type equation with an integral term on the right-hand side was considered. A scheme of the method for the Burgers type equation is constructed. The validness of the scheme construction using Computer Algebra System (CAS) Maple was proved. The capability of modern CAS to prove mathematical theorems was demonstrated. The graphical solution of the series sample equations was constructed.

11.1.1.2 Introduction

A new method for studying partial differential equations, later called "the Additional Argument Method"(AAM) was developed in the works [1]– [5]. This method allows to reducing partial differential equation to the system of integral equations, which is much easier to analyze in terms of the existence and uniqueness of solutions.Naturally, the idea of application of the Method to investigate the classic problems appeared. One of them is the Burgers equation which is the particular one-dimensional case of the Navier-Stokes equation. Besides the applications to hydrodynamics, Burgers equation has applications to wide variety of knowledge fields. For example, the Burgers equation is used in macroeconomics to model development of the "World Economy" system [6].

t is the time interval of consideration,KS is the self-organization coefficient, the structural characteristics, the parameter, which describes the economical usefulness, the effectiveness of political system structure and characterizes dissipation minimization and capability to optimize resource distribution for industry and benefits for consumption.

l=Y is the production of goods in the time interval t is the output speed or economic growth in the time interval; is economic growth rates;LQ=LKNis skilled labor or population of the country taking into account labor qualification where:Lis population;L is population growth rate;L is population growth rate;Nis population with higher education; KNis coefficient of qualification of work of public system, characteristics of the growth of structural information, expressed by created new knowledge.Creating new knowledge is the intellectual labour of the population with higher education, expressed by the growth of the population with higher education N.

Another example of Burgers equation application is the single-band transport stream modelling. This macroscopic (hydrodynamic) model was developed by Witham G. ([7],1974). In contrast to the previously proposed models, based on the law of conservation of the number of vehicles, the "farsightedness" of driver swas taken into account [10]. where Q(p) = pv(p);p(t,x) is the amount of transport per unit length at time t in the

neighborhood of a route point x;v(t,x) is velocity at time t in the neighborhood of a route point. The left-hand side of equation (1) represents the conservation law of trans-port. The diffusion terms appearing in the right-hand side of equation correspond to the fact that drivers reduce speed with increasing traffic density ahead and increase speed when decreasing.

In the work [2] the scheme of the additional argument method is implemented for the various classes of equations. In this paper the solution of the particular equation was verified. The solving of this problem is quite complicated and time-consuming. Therefore the decision to use of the CAS Maple to facilitate verification of the correctness of the solution was taken. In the following part of the paper the theoretical bases of Additional Argument Method is given. The detailed prove of the theorem using Maple is provided. The test example with the known analytical solution was compared to the solution obtained by AAM. Then the solution of the problem with integral term on the right hand side is provided. This theoretical analysis is followed by sample equation with the numerical solution and it's graph.

11.1.2 Rewrite ~265 words

11.1.2.1 Abstract

This paper considers an application of the Additional Argument Method to the Burgers' equation with an integral term on the right-hand side. The scheme of this method for Burgers' equation is constructed and its validity proven using the Computer Algebra System Maple. The proof demonstrates the capability of these systems to prove mathematical theorems. Furthermore, the graphical solution of the series sample equations is constructed.

11.1.2.2 Introduction

The *Additional Argument Method* (AAM) is a new method for studying partial differential equations which was developed in the works [1]–[5]. The AAM allows partial differential equations to be reduced to a system of integral equations whose existence and uniqueness of the solutions is easier to analyze. Accordingly, applying this method to classic problems is of interest. One such classic problem is the Burgers equation, the particular one-dimensional case of the Navier-Stokes equation. Besides its applications to hydrodynamics, the Burgers equation is used in macroeconomics to develop the "World Economy" system [6] and to model single-band transport streams [7].

The scheme of the AAM is implemented in [2] for various classes of equations. This paper verifies the particular equation using the Computer Algebra System Maple because the solving of this problem is quite complicated and time-consuming. First, the theoretical bases of the AAM is given and a detailed proof of the theorem using Maple is provided. An example with a known analytical solution is compared to the solution obtained through AAM. Then, the solution of the problem with an integral term on the right-hand side is provided. Finally, a sample equation with the numerical solution and it's graph is shown.

11.2 Notes