Scientific writing and research ethics

Structure and language of scientific articles

Presentation based on:
N.J. Higham
*Handbook of writing for the Mathematical Sciences*

Uppsala, December 14, 2016
In order to write a good article we have to think clearly and know what do we want to say.

Next comes the question how to say/write it.

Writing is difficult!
However, correcting a draft is easier than starting from scratch.
How to proceed?

Ask Google on 'Scientific writing': 21400000 references, Wednesday 14th December, 2016.
A reviewer: The book claims, "We know of no book as broad in its coverage, as critical in its analysis of existing trends, and as international in its scope." The claim is immodest but accurate.
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The claim is immodest but accurate.
Plan:

- **Ingredients** of Mathematical writing
  - symbols
  - words against symbols
  - definitions, theorems, ...

- **English usage**
  - Abbreviations
  - 'a', 'an', 'the' ...
  - overused words
  - consistency
  - ...

- **When English is a foreign language**
  - Thinking in English
  - Construction, phrases
  - Spelling
Notations:

- unambiguous
- easy to remember
- no harmful second meanings
- profit from useful second meanings

Let $\tilde{H}_k = Q_k^H \tilde{H} Q_k$

Partition $X = [X_1, X_2]$ and let $\tilde{X} = \text{range}(X_1)$

Follow the conventions:

- where $\delta(x - x_1)$ is the Dirac delta function
- we can use a defect-correction method:
  compute a correction $\delta u^{(0)}(x_i)$ and let $u^{(1)} = u^{(0)} + \delta u^{(0)}$
'Words versus symbols’ guidelines

- Use words as long as they do not take too much space, compared to symbols; explain in words what the symbols mean.
- Use symbols for a precise mathematical statement or if the idea would be too cumbersome to express only with words.

Since $\|g'(0)\| > 1$, 0 is a repelling fixed point, so $x_k \not\to 0$ as $k \to \infty$.
Since $\|g'(0)\| > 1$, zero is a repelling fixed point, so $x_k$ does not tend to zero as $k \to \infty$.

∀ for all
∃ there exists
⇒ it follows that
≠ 0 nonzero
The mathematical expressions are part of the sentence, so they have to be punctuated:

The general form of the estimate has the form

\[ \gamma \leq \sqrt{m + 1} \]

This estimate is valid for ...
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This estimate is valid for ...
Avoid otiose (functionless, not required) words/notations:
The method converges for \( it = 10 \) iterations.
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Avoid otiose (functionless, not required) words/notations:
The method converges for \( it = 10 \) iterations.

Avoid starting a sentence with a mathematical expression:
\( A \) is symmetric.
The matrix \( A \) is symmetric.
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Avoid otiose (functionless, not required) words/notations:
The method converges for \( it = 10 \) iterations.

Avoid starting a sentence with a mathematical expression:

\( A \) is symmetric.
The matrix \( A \) is symmetric.

\begin{align*}
\text{If } x > 1 & \quad f(x) < 0. \\
\text{If } x > 1, & \quad f(x) < 0. \\
\text{If } x > 1, & \quad \text{then } f(x) < 0.
\end{align*}
For \( n = 2 \) (1) holds with \( \delta = 0 \).

For \( n = 2 \), equation (1) holds with \( \delta = 0 \).

General rule: 

'\( A \)' or 'The' 
not unique unique

Let the Schur decomposition of \( A \) be \( Q \Lambda Q^* \).

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Let \( Q \Lambda Q^* \) be a Schur decomposition of \( A \).

Let \( A \) have a Schur decomposition \( Q \Lambda Q^* \).

Under what conditions does the method converge to the solution of \( f(x) = 0 \)?
.miscellaneous

The \( \left\{ \begin{array}{l} \text{k-th} \\
\text{k’ht} \\
\text{k}^{th} \\
k\text{th} \\
\end{array} \right\} \) term

\[-(b - a)^3/12 \cdot f''(\eta) \quad -8((b - a)^3/12) \cdot f''(\eta)\]
Definitions:

To think about:
- why is it necessary to include it?
- where minimize the distance between the definition and the first use, but before the first use
- how when there are multiple possibilities to define something, choose the one that is
  - short
  - consistent with related definitions
  - expressed in terms of fundamental properties
  - easy to understand.

‘Normal matrix’ - more than 70 ways to characterize it!

A graph is connected if there is a path from every vertex to every other vertex.
Math. statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theorem</td>
<td>A major result that is of independent interest. Proof usually nontrivial.</td>
</tr>
<tr>
<td>Lemma</td>
<td>An auxiliary result, a step towards a theorem.</td>
</tr>
<tr>
<td>Proposition</td>
<td>Not clearly defined, tends to mean a minor theorem, but not a theorem which might be incorrect.</td>
</tr>
<tr>
<td>Corollary</td>
<td>Direct or easy consequences of the theorem or proposition.</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Statement to be taken for further reasoning.</td>
</tr>
<tr>
<td>Proofs</td>
<td>The readers are not interested in proofs, in general. - illustrate a technique - outline of a key idea - do not include simple computations</td>
</tr>
</tbody>
</table>
English usage - keep it simple!

- "A" or "AND"
  a uniformly convergent sequence
  an LAPAC routine
  a NAG routine

- Abbreviations
  , i.e. (id est) in other words ie.
  which is to say
  , e.g. (exempli gratia) for example eg.
  for instance
  if and only if iff
  et al. (et alii) and other people et. al.
  (et alia) and other things

Let’s / It’s / can’t / don’t
Gaussian Elimination (GE) is a method for solving a system of \( n \) linear equations in \( n \) unknowns. GE has a long history.

As stated in Theorem 2, ...

... as stated in the above later theorem ...
Active versus passive

The answer was provided to sixteen decimal places by Gaussian elimination.

Gaussian elimination gave the answer to sixteen decimal places.

Passive voice brings variety and is the choice when a specific information is missing:

The above subjects have been given serious research attention in the course of the last twenty years.

The following problem is next considered.

Consider the problem ...
The Ten Commandments of Good Writing

1. Each pronoun should agree with their antecedent.
2. Just between you and I, case is important.
3. A preposition is a poor word to end a sentence with.
4. Verbs has to agree with their subject.
5. Don't use no double negatives.
6. Remember to never split an infinitive.
7. When dangling, don't use participles.
8. Join clauses good, like a conjunction should.
9. About sentence fragments.
10. Don't write a run-on sentence it is difficult when you got to punctuate it so it makes sense when the reader reads what you wrote.
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Adjective and Adverb Abuse

Use those with caution in technical writing, as they are imprecise:

– The proof is very easy.
– The result is quite important.
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Avoid using nouns as adjectives:
– The method for convergence rate estimation ...
– The method for estimating the convergence rate ...
Adjective and Adverb Abuse

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– The proof is very easy.
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Avoid using nouns as adjectives:
– The method for convergence rate estimation ...
– The method for estimating the convergence rate ...
– Euler is unstable. → Euler’s method is unstable.
– This sequence is Cauchy. → This is a Cauchy sequence.

λ and µ are the coefficients of Lamé.
λ and µ are the so-called Lamé coefficients.
Adjective and Adverb Abuse

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– The proof is very easy.
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– The method for convergence rate estimation ...
– The method for estimating the convergence rate ...
– Euler is unstable. → Euler’s method is unstable.
– This sequence is Cauchy. → This is a Cauchy sequence.
– ... $\lambda$ and $\mu$ are the coefficients of Lamé.
– ... $\lambda$ and $\mu$ are the so-called Lamé coefficients.
It is interesting to consider how to ...
It is **interesting** to consider how to ...
It is //_____________ instructive // to consider how to ...

nice, very, quite, rather
It is **interesting** to consider how to ...

It is **instructive** to consider how to ...

nice, very, quite, rather

XX essentially derived the singular value decomposition.
XX derived the singular value decomposition for sparse, nonsingular matrices.
Ambiguous 'this' and 'it'

Always make it clear for the reader what is the entity under consideration.
Ambiguous 'this' and 'it'

Always make it clear for the reader what is the entity under consideration.

Condition (1) is not satisfied for the first method, which is why we do not consider it further.
Ambiguous 'this' and 'it'

Always make it clear for the reader what is the entity under consideration.

Condition (1) is not satisfied for the first method, which is why we do not consider it further.

... preconditioners were first presented in [1,2] and are multilevel extensions of the methods in [3] and [4]. Here, block matrices are considered...
# British versus American

<table>
<thead>
<tr>
<th>British</th>
<th>American</th>
<th>British</th>
<th>American</th>
</tr>
</thead>
<tbody>
<tr>
<td>behaviour</td>
<td>behavior</td>
<td>speciality</td>
<td>specialty</td>
</tr>
<tr>
<td>catalogue</td>
<td>catalog</td>
<td>travelling</td>
<td>traveling</td>
</tr>
<tr>
<td>centre</td>
<td>center</td>
<td>modelling</td>
<td>modeling</td>
</tr>
<tr>
<td>grey</td>
<td>gray</td>
<td>...yse</td>
<td>...yze</td>
</tr>
<tr>
<td>marvellous</td>
<td>marvelous</td>
<td>acknowledgement</td>
<td>acknowledgment</td>
</tr>
<tr>
<td>skilful</td>
<td>skillful</td>
<td>focussed</td>
<td>focused</td>
</tr>
</tbody>
</table>

Moral: (1) Be consistent! (2) Use dictionaries!
## Common misspellings

<table>
<thead>
<tr>
<th>Correct</th>
<th>Misspelled</th>
</tr>
</thead>
<tbody>
<tr>
<td>analogous</td>
<td>analagous</td>
</tr>
<tr>
<td>dependent</td>
<td>dependant</td>
</tr>
<tr>
<td>discrete</td>
<td>discreet</td>
</tr>
<tr>
<td>to practise</td>
<td>to practice</td>
</tr>
<tr>
<td>led (past)</td>
<td>lead (present)</td>
</tr>
<tr>
<td>lose</td>
<td>loose</td>
</tr>
<tr>
<td>preceding</td>
<td>preceeding</td>
</tr>
<tr>
<td>referring</td>
<td>refering</td>
</tr>
<tr>
<td>separate</td>
<td>seperate</td>
</tr>
<tr>
<td>supersede</td>
<td>supercede</td>
</tr>
<tr>
<td>zeros</td>
<td>zeroes</td>
</tr>
</tbody>
</table>
Consistency

Use only one of: $ker(A), null(A)$

Cholesky factorization, Cholesky decomposition

orthogonalise, optimise
orthogonalize, optimize

OBS: Distinguish between:

▶ affect, effect
▶ alternate, alternative
▶ compare with, compare to
▶ compose (make up), comprise (to consist of), constitute

The course comprises three topics.
These three topics constitute the course.
’Which’ versus ’That’

- Extra property (which)
  Consider the matrix A, which is symmetric, positive definite.

- Focus on a particular element
  Consider the matrix A, that is symmetric, positive definite.
'Which' versus 'That'

- Extra property (which)
  Consider the matrix A, which is symmetric, positive definite.

- Focus on a particular element
  Consider the matrix A, that is symmetric, positive definite.

---

False 'If':
If we wish to compare the solution of \( f - \lambda k(f) = 0 \) and \( f_n - \lambda k(f_n) = 0 \), then XY shows that for a wide class of nonlinear functions \( k(f) \), \( \| f - f_n \| \leq c(\lambda \| k(f) - k(f_n) \|) \).
When we wish to compare .... we can use XY’s result that shows ...
To compare ... we can use ...
Hyphenation: 'ill’–’ill-’; 'well’–’well-’

\[
\begin{align*}
&\text{This is an ill-posed problem.} \\
&\text{The problem is ill posed} \\
&\text{The well-known theorem ...} \\
&\text{The theorem is well known.} \\
&\text{An ill-conditioned function} \\
&\text{A very ill conditioned function!} \\
&\text{The second-order term...} \\
&\text{This term is of second order.}
\end{align*}
\]
## Variations:

<table>
<thead>
<tr>
<th>Anglo-Saxon</th>
<th>French</th>
<th>Latin</th>
</tr>
</thead>
<tbody>
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<td>ask</td>
<td>question</td>
<td>interrogate</td>
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</tr>
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<td>good</td>
<td>marvellous</td>
<td>superior</td>
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<tr>
<td>show</td>
<td>establish</td>
<td>exhibit, demonstrate</td>
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<td>necessity</td>
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### Simplifications:

- conduct an investigation: investigate
- in the course of: during
- in the case that: if
Tenses

We will discuss this in Section ...
This will be proven is proved in Theorem 3.

Banach shows that ...
Banach showed that ...
Tenses

We will discuss this in Section ...
This will be proven is proved in Theorem 3.

Banach shows that ...
Banach showed that ...

Refer to your earlier result:
I showed in [1] that ...
We showed in [1] ...
The author showed in [1] that ...
It was shown in [1] ...
When English is a foreign language
Thinking in English

capable to do capable of doing
we have the possibility to obtain we can obtain
this approach permits to exploit this approach exploits
the solution has been known since the solution has been known for
ten years ten years
Articles: some rules

(1) Do not use "the" with plural or uncountable nouns when talking in general:
   – Mathematics is interesting.
   – Indefinite integrals do not always have a closed form solution..

(2) Do not use singular countable names/nouns without articles:
   – a derivative is ...
   – the derivative is ...
   but not 'derivative is...

Theorem shows that ...

Following properties are basic.
Constructions:

Let ... be ...
Suppose (that) ... is/are ...
We define ... to be ...
It is straightforward to see that ...
If ... then ...
A lower bound for ...
By substituting .... into .... we obtain ...
Let \( \{ v_i \}_{i=1}^n \) be the eigenvectors of \( A \) and \( \{ \lambda_i \}_{i=1}^n \) are the corresponding eigenvalues.
Thinking in English, cont.

A greater flexibility of non-conforming Finite Elements comparing them with the conforming ones, makes them attractive for application to the solution of the problems, which are difficult to solve by the conforming Finite elements due to various so called locking phenomena.
Thinking in English, cont.

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We give up and rewrite:
A greater flexibility of non-conforming Finite Elements comparing them with the conforming ones, makes them attractive for application to the solution of the problems, which are difficult to solve by the conforming Finite elements due to various so called locking phenomena.

Due to the so-called locking phenomena, some problems turn out to be difficult to solve using conforming Finite elements. The locking effect is circumvented by using the more flexible non-conforming finite element.
Thinking in English, cont.

Because one pair-member has to receive before send data and vice versa, each processor will be set to receive or send first by assigning each processor a value which depends on which of the members have a higher processor number.
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The processors are numbered consecutively in an increasing order and act in pairs. Within each pair, a send-receive operation has to take place. In order to prevent blocking, we order the execution of the send and the receive operations for each pair, so that the processor with the smaller number first issues the receive command and then the send command, while ...
Thinking in English, cont.

**Theorem 3**: Let us consider the macroelement $M$. Let $A_H$ be the FE matrix corresponding to the space $V_H(M)$ with standard nodal basis $\{\phi_1, \phi_2, \phi_3\}$, i.e.

$$\langle A_H x, x \rangle = a(u, u) \text{ for } u = \sum x_i \phi_i, \; x \in \mathbb{R}^3$$

and $A_{22}$ is the matrix corresponding to the space $V_2$, i.e.

$$\langle \hat{A}_{22} x, x \rangle = a(v, v) \text{ for } v = \sum x_j \phi_j^2, \; x \in \mathbb{R}^3.$$ 

Above,

$$a(u, u) = \int_M \langle Dd(u), d(u) \rangle \, dx$$

with matrix of coefficients $D$, which is a general SPD matrix, and $d(u) = \text{grad}(u)$. Then
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This splitting can be useful for the construction of multi-level preconditioners for the system \( Au = b \), where \( A \) is the FE matrix corresponding to \( V_h(M) \) or \( V_h \), if the following conditions are valid:

The block \( A_{22} \) of the matrix FE matrix, which corresponds to \( V_2 \), is spectrally equivalent to the FE matrix \( A_H \) corresponding to the coarse grid space \( V_H \) and the constant \( \gamma = \cos(V_2, V_2) \) is bounded by some \( \gamma \), which is independent on the size of discretization \( h \).

Moreover, very important will be the dependence of the constants of the spectral equivalence and \( \gamma \) on possible anisotropy of the problem, because non-conforming FE has special interest just for the anisotropic problems.

To this end, we get the following results.

**Theorem 1:** Let us consider the macroelement \( M \). Let \( A_H \) be the FE matrix corresponding to the space \( V_H(M) \) with standard nodal basis \( \{ \phi_1, \phi_2, \phi_3 \} \), i.e.

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\langle A_H x, x \rangle = a(u, u) \text{ for } u = \sum \alpha_i \phi_i, \ x \in R^d
\]

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\]

where

\[
a(u, u) = \int_M (Dd(u), d(u)) \, dx
\]

with matrix of coefficients \( D = \begin{bmatrix} k_1 & 0 \\ 0 & k_2 \end{bmatrix} \) and \( d(u) = \text{grad}(u) \). Then

\[
\langle \hat{A}_{22} x, x \rangle = 8 \langle A_H x, x \rangle,
\]

i.e. the matrices \( \hat{A}_{22} \) and \( A_H \) are spectrally equivalent independently on the constants \( k_1 \) and \( k_2 \) of the orthotropy.
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a(u, u) = \int_M (Dd(u), d(u)) \, dx
\]

with matrix of coefficients \( D = \begin{bmatrix} k_1 & 0 \\ 0 & k_2 \end{bmatrix} \) and \( d(u) = \text{grad}(u) \). Then

\[
\langle \hat{A}_{22} x, x \rangle = 8 \langle A_H x, x \rangle,
\]

i.e. the matrices \( \hat{A}_{22} \) and \( A_H \) are spectrally equivalent independently on the constants \( k_1 \) and \( k_2 \) of the orthotropy.
Some thoughts about writing

"Bad thinking never produces good writing." (L. Lamport)

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"The worse things one can write are those that do not make sense."
Structure of a scientific article

A general rule:

1. Say what you are going to do.
2. Do it.
3. Say what have you done.
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VERY important: who is your audience?
VERY IMPORTANT: the title
Structure of a scientific article, cont.

1. Abstract

2. Introduction - put the work in perspective with respect to other related work, give motivation, sketch the structure of the rest of the text.

3. Main sections
   3.1 Setting, definitions, notations
   3.2 Method description, properties, theoretical derivations
   3.3 Numerical illustrations (reproducible tests !!!!!, parameters, computer used, readable figures and tables... Analysis of the results, comparisons etc.

4. Conclusions, outlook

5. Bibliography (styles)

6. Appendices
Something on plagiarism:

Question: Are our ’copy-paste’ activities detected?
Answer: Yes they are. To a large extend.

An illustration via the online submission system of one of the scientific journals, published by Wiley...