Writing A Scientific Research Article

STUDENT LEARNING SUPPORT

Graduate Student Support

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Ryerson University sits on the Traditional Territory of the Mississauga's of New Credit First Nation. We are honoured to be a part of this community of our Indigenous colleagues and students.

- Chi Miigwetch

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Parts of a Research Article

Abstract

Introduction

Materials and methods

Results

Discussion

Conclusions

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Variations

‘Method’ is sometimes called ‘Procedure’ or ‘Experiment’.

If there are several parts to the experiment, there may be several smaller sections of ‘Results + Discussion’ followed by a section called ‘Conclusions’.

Tense Usage

- Past tense to describe the experiment:

e.g. “When the temperature was raised to 300 degrees Celsius, the output doubled.”

- Present tense to refer to established facts:

e.g. “Like all fermions, electrons have spin = 1/2”

- Present tense to refer to documents, figures, etc.:

e.g. “The results are shown in Table 1.”

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Focus of the Paper

All sections of the paper must focus on the ‘Results’ section.

There should be nothing in any of the other sections that is not related in some way to the results.

Questions Considered By Referees 1 of 3

Is the contribution new?

Is the contribution significant?

Is it suitable for publication in the journal?

Is the organization acceptable?

Do the methods and the treatment of results conform to acceptable scientific standards?

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Questions Considered By Referees 2 of 3

Are the conclusions firmly based in the data presented?

Is the length of the paper satisfactory?

Are all illustrations required?

Are all the figures and tables necessary?

Are the figure legends and table titles adequate?

Questions Considered By Referees 3 of 3

Do the Title and Abstract clearly indicate the content of the paper?

Are the references up to date, complete, and the journal titles correctly abbreviated?

Is the paper excellent, good, or poor?

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Results

Write this section first.

Write the results as a story.

Use figures and tables when these can clarify the presentation.

Keep these uncluttered.

Write captions as narratives.

Graph Readability

To make your graphs effective :

- Avoid putting too much information on one graph.
- Avoid crowding the information.
- Be sure that the different data sets are clearly distinguishable.
- Be sure that the labels are clearly understandable.
- Be sure that the caption clearly identifies and describes the graph.

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Table Readability

To make your tables effective:

- Avoid putting too much information in one table.
- Be sure that the data can be easily seen.
- Be sure that the different data sets are presented in a logical order.
- Be sure that the labels are clearly understandable.
- Be sure that the caption clearly identifies and describes the graph.

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Results Section

- Stresses the most important findings
- Indicates the figures and tables where detailed information is located
- Shows major trends in the results but does not discuss them
- Does not describe detailed data that are shown in tables and/or figures.

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Methods Section

Try to match the subheadings in the Methods section with those in the Results section.

Try to introduce a methods sentence with a phrase that relates the method to an aim:

- e.g. "To generate an antibody to GmDmt;1, a 236-bp DNA fragment coding for 70 Nterminal amino acids was amplified using the PCR..." (Cargill & O'Connor, 2009, p.36).

Avoid Top-Heavy Passive Sentences

Can you rewrite the following sentence to make it easier to read?

“Wheat and barley, collected from the Virginia field site, as well as sorghum and millet, collected at Loxton, were used” (Cargill & O’Connor, 2009, p. 39).

Rule: subject + verb in the first nine words; list at the end.

Avoid Repetition

"The data were collected and correlations were calculated using..." (Cargill & O'Connor, 2009, p. 40)

Change to: "The data were collected and correlations calculated using..."

Introduction: 5 Stages

Stages are indicated in the following extract from the introduction of McNeill, A.M, Zhu, C.Y. & Fillery, I.R.P. (1997) Use of in situ 15N-labelling to estimate the total below-ground nitrogen of pasture legumes in intact soil-plant systems. Australian Journal of Agricultural Research 48, 295-304. Quoted in: Cargill, M. & O'Connor, P. (2009) Writing Scientific Research Articles: Strategy and Steps, pp. 42-43. Chichester: Wiley-Blackwell.

Stage 1: Setting

Stage 2: Literature Review

Stage 3: Need for more investigation

Stage 4: Purpose

Stage 5: (optional) Justification

Example of Stages in an Introduction (1 of 4)

Stage 1 = regular font, **Stage 3 = bold font**

Current estimates of the below-ground production of N by pasture legumes **are scarce** and rely mainly on data from harvested macro-roots (Burton 1976; Reeves 1984) **with little account taken of fine root material or soluble root N leached by root washing**. Sampling to obtain the entire root biomass is extremely difficult (Sauerbeck and Johnen, 1977) since many roots, particularly those of pasture species (Ellis and Barnes 1973), are fragile and too fine to be recovered by wet sieving. Furthermore, the interface between the root and the soil is not easy to determine and legume derived N will exist not only as live intact root but in a variety of other forms, often termed rhizodeposits (Whipps 1990).

An approach is accordingly required which enables "in situ" labelling of N in the legume root system under undisturbed conditions coupled with subsequent recovery and measurement of that legume N in all of the inter-related below-ground fractions.

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Example : 2 of 4

Stage 2 = regular font, **Stage 3 = bold font**

Sophisticated techniques exist to label roots with ^{15}N via exposure of shoots to an atmosphere containing labelled NH3 (Porter et al. 1972; Janzen and Bruinsma 1989) **but such techniques would not be suitable for labelling a pasture legume within a mixed sward.** Labelled N_2 atmospheres (Warembourg et al. 1982; McNeill et al. 1994) have been used to label specifically the legume component of a mixed sward via N_2 fixation in nodules. **However, these techniques require complex and expensive enclosure equipment, which limits replication and cannot be easily applied to field situations; furthermore, non-symbiotic N_2 fixation of label may occur in some soils and complicate the interpretation of fate of below-ground legume N.**

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Example: 3 of 4

Stage 2 = regular font, **Stage 3 = bold font**

The split-root technique has also been used to introduce ^{15}N directly into plants by exposing one isolated portion of the root system to ^{15}N either in solution or soil (Sawatsky and Soper 1991; Jensen 1996), **but this necessitates some degree of disturbance of the natural system.** Foliar feeding does not disturb the system and has the additional advantage that shoots tolerate higher concentrations of N than roots (Wittwer et al. 1963). Spray application of ^{15}N-labelled urea has been successfully used to label legumes "in situ" under field conditions (Zebarth et al. 1991) **but runoff of ^{15}N-labelled solutions from foliage to the soil will complicate interpretation of root-soil dynamics.** Russell and Fillery (1996), using a stem-feeding technique, have shown that in situ ^{15}N-labelling of lupin plants growing in soil cores enabled total below-ground N to be estimated under relatively undisturbed conditions,

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Example: 4 of 4

Stage 2 = regular font, **Stage 3 = bold font,** *Stage 4 = italicized*

but they indicated that the technique was not adaptable to all plants, particularly pasture species. Feeding of individual leaves with a solution containing ^{15}N is a technique that has been widely used for physiological studies in wheat (Palta et al. 1991) and legumes (Oghoghorie and Pate 1972; Pate 1973). The potential of the technique for investigating soilplant N dynamics was noted as long as 10 years ago by Ledgard et al. (1985) following the use of ^{15}N leaf-feeding in a study of N transfer from legume to associated grass. *The experiments reported here were designed (i) to assess the use of a simple ^{15}N leaf-feeding technique specifically to label in situ the roots of subterranean clover and serradella growing in soil, and (ii) to obtain quantitative estimates of total below-ground N accretion by these pasture legumes.*

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New vs. Old Information

Old information should come near the beginning of a sentence; new information should come near the end. Which of the following is easier to understand? Why?

1. Legumes form symbiotic associations with N^2-fixing soil-borne bacteria of the Rhizobium family. The division of inner cortical root cells and the formation of a nodule are signalled when compatible bacteria invade legume root hairs, which happens when symbiosis begins.

2. Legumes form symbiotic associations with N^2-fixing soil-borne bacteria of the Rhizobium family. The symbiosis begins when compatible bacteria invade legume root hairs, signalling the division of inner cortical root cells and the formation of a nodule.

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Reasons for Citations

Avoid plagiarism

Demonstrate knowledge of the field

Develop your argument by referring to sources

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Types of Citations

Information prominent:

- The wool industry is experiencing difficulties (Smith 2000).

Author prominent:

- As Smith (2000) pointed out, the wool industry is experiencing difficulties.

Weak author prominent info:

Several authors have reported that the wool industry is experiencing difficulties (Smith 2000; Wilson 2003; Nguyen 2005).

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Reporting Verbs

Use reporting verbs to show the researcher's commitment to his/her statement:

100% committed to an idea:

- argue, show, assert, declare, maintain

Asking a question:

- ask, question, wonder, speculate

Report without comment:

- remark, think, state, mention, claim, consider,

Hedging:

- suggest, concede, admit, speculate

Illustrating an idea:

- define, explain, describe, illustrate

Making an observation

- comment, observe, conclude

Example: Author prominent: (e.g.: Smith (2009) argues that...)

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Reporting Verbs (II)

Information prominent: (e.g. The results suggest that the mass of the Higgs particle might be 120-140 GeV.)

imply	might be	**WEAK**
suggest	could be	
provide evidence	may be	
indicate	was	
show	should be	
demonstrate	is	**STRONG**

Logical Flow

Use titles, subheadings, and introductory sections to set up expectations. Meet the expectations quickly.

Move from general to specific information.

Put old information before new information.

Put the subject and verb in the first nine words of a sentence.

Discussion Section

There should be a close fit between the Discussion section and the Introduction.

The issues raised in the Introduction should be discussed here.

Information in the Discussion Section

Reference to the purpose

Review of main findings, agreement (or not) with hypothesis and with findings of other researchers

Explanation of findings, supported by literature.

Limitations of the study

Implications of the study

Recommendations for future research.

Contrary Results

Any findings that do not support your study or that seem to contradict its outcomes must be reported, discussed, and explained.

Strength of Claim

WEAK:

The presence of an IRE motif implies that GmDmt I;I mRNA **might be stabilized** by the binding of IRPs in soybean nodules when free iron levels are low.

STRONG:

The presence of an IRE motif **demonstrates** that GmDmt I;I mRNA **is stabilized** by the binding of IRPs in soybean nodules when free iron levels are low.

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The Title

Informative but concise

Prominent keywords

Use a statement, if appropriate.

Avoid ambiguous noun phrases.

Which Title is Better?

Soybean seedling growth suppression

Suppression of soybean seedling growth

Effects of added calcium on salinity tolerance of tomato

Calcium addition improves salinity tolerance of tomato

The Abstract

Brief context (background information)

Main purpose of the study and scope

Indicate the methodology

Give the most important results

Concluding statement or recommendation

Parts of Abstract

Can you identify the parts of this abstract?

Background

Objective

Materials

Method

Results

Conclusions

Abstract

Clostridium difficile has rapidly emerged as the leading cause of antibiotic-associated diarrheal disease, with the transcontinental spread of various PCR ribotypes, including 001, 017, 027 and 078. However, the genetic basis for the emergence of C. difficile as a human pathogen is unclear. Whole genome sequencing was used to analyze genetic variation and virulence of a diverse collection of thirty C. difficile isolates, to determine both macro and microevolution of the species. Horizontal gene transfer and large-scale recombination of core genes has shaped the C. difficile genome over both short and long time scales. Phylogenetic analysis demonstrates C. difficile is a genetically diverse species, which has evolved within the last 1.1–85 million years. By contrast, the disease-causing isolates have arisen from multiple lineages, suggesting that virulence evolved independently in the highly epidemic lineages.

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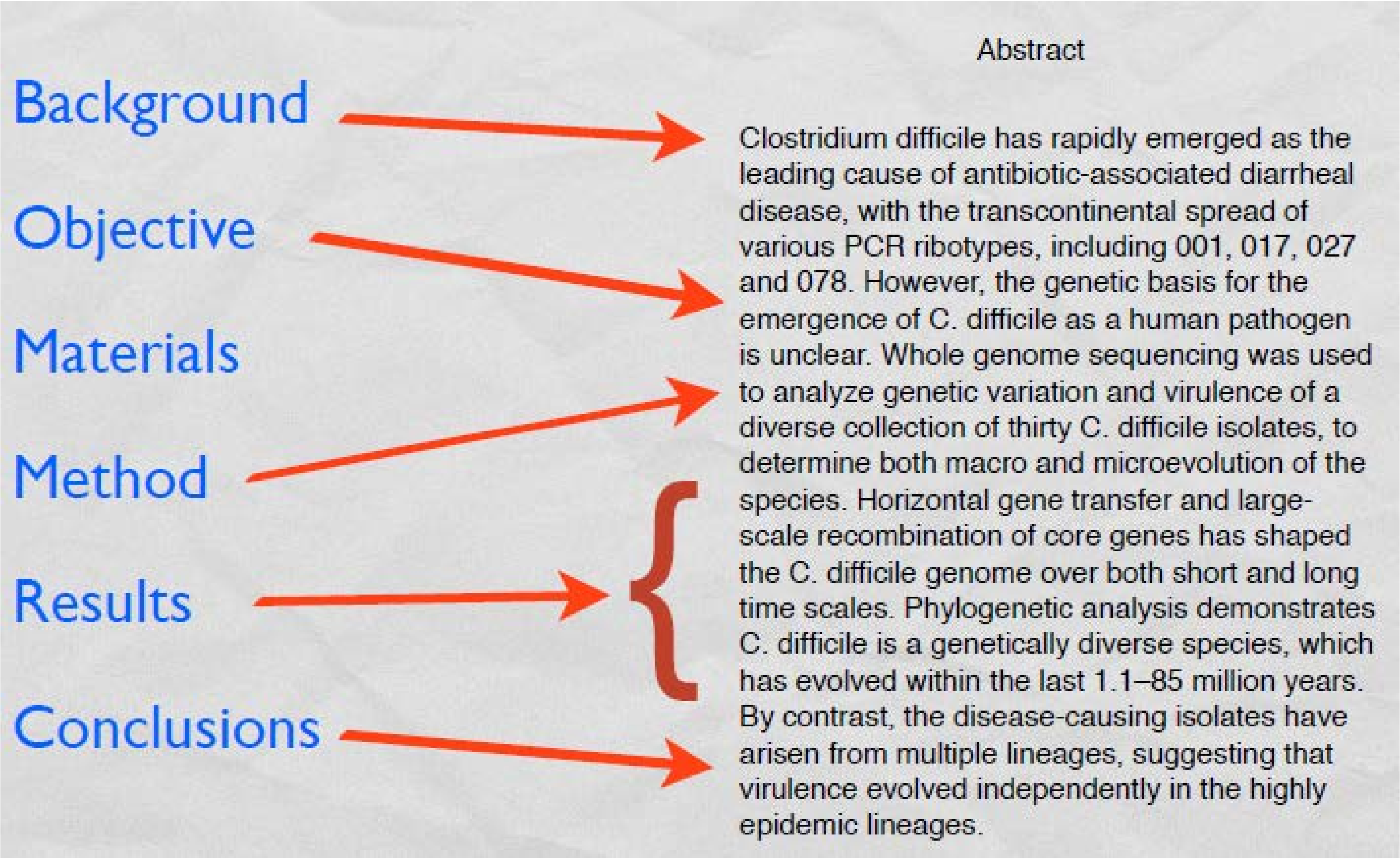
Abstract Parts Identified



Abstract

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Which Abstract is Better & Why?

1. Clostridium difficile has rapidly emerged as the leading cause of antibiotic-associated diarrheal disease, with the transcontinental spread of various PCR ribotypes, including 001, 017, 027 and 078. However, the genetic basis for the emergence of C. difficile as a human pathogen is unclear. Whole genome sequencing was used to analyze genetic variation and virulence of a diverse collection of thirty C. difficile isolates, to determine both macro and microevolution of the species. Horizontal gene transfer and large-scale recombination of core genes has shaped the C. difficile genome over both short and long time scales. Phylogenetic analysis demonstrates C. difficile is a genetically diverse species, which has evolved within the last 1.1-85 million years. By contrast, the disease-causing isolates have arisen from multiple lineages, suggesting that virulence evolved independently in the highly epidemic lineages.

2. In this paper we study the accuracy of photometric redshifts computed through a standard SED fitting procedure, where SEDs are obtained from broad-band photometry. We present our public code hyperz, which is presently available on the web. We introduce the method and we discuss the expected influence of the different observational conditions and theoretical assumptions. In particular, the set of templates used in the minimization procedure (age, metallicity, reddening, absorption in the Lyman forest, ...) is studied in detail, through both real and simulated data. The expected accuracy of photometric redshifts, as well as the fraction of catastrophic identifications and wrong detections, is given as a function of the redshift range, the set of filters considered, and the photometric accuracy. Special attention is paid to the results expected from real data.

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The First One is Better.
The Second Has Missing Parts

Background

Objective ?

Materials

Method?

Results?

Conclusions?

Abstract

In this paper we study the accuracy of photometric redshifts computed through a standard SED fitting procedure, where SEDs are obtained from broad-band photometry. We present our public code hyperz, which is presently available on the web. We introduce the method and we discuss the expected influence of the different observational conditions and theoretical assumptions. In particular, the set of templates used in the minimization procedure (age, metallicity, reddening, absorption in the Lyman forest, ...) is studied in detail, through both real and simulated data. The expected accuracy of photometric redshifts, as well as the fraction of catastrophic identifications and wrong detections, is given as a function of the redshift range, the set of filters considered, and the photometric accuracy. Special attention is paid to the results expected from real data.

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Reference for Visuals

Slide	Reference
2	http://www.123rf.com/photo_3094103_young-woman-working-on-computer-outside.html
9	Piraro, D. (1997). http://flowingdata.com/2012/06/01/tennis-racket-mountain-range/
18	Harris, S. (2013). http://www.sciencecartoonsplus.com/pages/gallery.php
33	The Daily Galaxy. (2007-07-10). http://www.dailygalaxy.com/my_weblog/2007/07/beyond-einstein.html
34	Piraro, D. (2012). http://www.thecomicstrips.com/subject/The-Isaac+Newton-Comic-Strips.php

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