UT/ITC Module 11: MSc Research Skills
Assignment 2: Critical Reading

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A major activity during your research career is reading papers describing previous research. These are usually dense, information-rich documents, and it can be difficult to identify the most important information and place it in context. This exercise is to read a research article critically, extract the most important information, and write a critical evaluation.

After completing this exercise you should be able to:

1. Find the most important information in a research paper and summarize in your own words;
2. Critically evaluate, in your own words, it using a SWOT ("Strengths–Weaknesses–Opportunities–Threats") approach.

1 Assignment

Your thesis supervisor, PhD advisor, or module coordinator will select a research paper directly relevant to your thesis topic or research theme.

Read the paper, and then (1) answer a list of questions about the paper (§2), (2) write a SWOT analysis of the paper (§3).

In general there should be no reason to directly quote the paper; you need to summarize and interpret in your own words:

> 1. The aim of the paper is to present a set of conditions under which all conflicts in the world can be ended once and for all …

If you feel it's important to include the author's own words, these **must** be shown in quotation marks, e.g.,

> 1. The authors state that their general objective is to "bring about eternal universal world peace" …

There is no need for a citation here, because it refers to the single paper you are reading. If you use a quote from a different paper in the SWOT, you need an in-text citation and list of references, as in Exercise 1 of this module.

The exercise will be graded on the following points:

40 points How well the main points of the papers are **identified** and **summarized** in the student's *own words*;

40 points The **argumentation** and **depth** of the SWOT analysis (10 points each for S, W, O, and T);

20 points How **clearly** and **succinctly** the text is written.

Required output

Identify yourself with your name, course, and ITC e-mail ID.

For example:

> Student: Yipi Ma (`y.p.ma@student.utwente.nl`); AES.2

Include the **full journal reference** so that the instructor can compare it with the original. This should be a recognized reference format, similar to the reference list in the "Literature Review" assignment.

For example:

> Oliver, M. A.; Webster, R.; & Slocum, K. 2000. *Filtering SPOT imagery by kriging analysis. International Journal of Remote Sensing* **21**(4):735–752.

Submit the text document as a PDF or MS-Word document to the assignment in Blackboard, with your e-mail ID and exercise number as file name and the appropriate extension.

> For example, `y-p-ma_ex2.pdf`

2 Comprehension

Answer the following **numbered questions**, each in **one numbered paragraph**; be **concise** and **specific**. Grading is one point per question.

1. **Why** was this research done?
2. What is the **novelty** (if any) claimed by this paper?
3. What **methods** do the authors use to address the problem?
4. What is the **result** of applying these methods?
5. What **conclusions** do the authors draw from their results?
6. According to the authors, what should be the **follow-up** to this research?

3 Evaluation

Evaluate the paper using the SWOT ("Strengths–Weaknesses–Opportunities–Threats") approach, **one paragraph** per item; again be **concise** and **specific**. Grading is one point per item.

Strengths — What does this paper do well? How well are they able to prove their point?

Weaknesses — What are weaknesses in their approach?

Opportunities	What possibilities does the work reported in this paper now open up? What should the be the follow-up?
Threats	What would make this work irrelevant or unimportant? Are other approaches more promising?

4 Sample discussion points

This section lists some questions listed under each heading of the assignment, as examples of what might be discussed – this is shown clearly by the notation *for example*. These may give you some ideas on points to be addressed in the answer; you are *not* supposed to take these as a definitive list! Other questions may be more suitable for your assigned paper.

4.1 Comprehension

1. **Why** was this research done?

   For example:

   - What is the **motivation** for this research?
   - Is the paper mainly to develop or improve **methods** or to answer some **question** about the "real world"?
     - If about methods, what is wrong with existing methods?
     - If about the "real world", what was not (or imperfectly) known?
   - What is the **research problem**? I.e. something not known that this research will address.

2. What is the **novelty** (if any) claimed by this paper?

   For example:

   - Does the paper propose an **entirely new research field** or **paradigm**?
   - Does the paper ask a **new question** (no one has asked it before)?
   - Does the paper propose a **new approach** to answering the question?
   - Does the paper propose an **improvement** on **existing methodologies**?
   - Does the paper propose a **better answer** to the current answers to the question?

3. What **methods** do the authors use to address the problem?

   For example:

   - Are there experiments?
   - Are there case studies?

- Are there computer simulations or models applied?
- Do the authors propose new mathematical or statistical methods or computer algorithms?

4. What is the **result** of applying these methods?

   For example:

   - For a field study, what information was collected?
   - For a simulation, model, processing etc., what was the result of the process?

5. What **conclusions** do the authors draw from their results?

   For example:

   - Is the result claimed to be of general interest or only applicable to the author's own case?
   - Do the authors identify problems that they could not solve and which remain for others?

6. According to the authors, what should be the **follow-up** to this research?

   For example:

   - Are some of the research questions posed for this research **unsolved**?
   - Are there now **new** research questions as a result of this research?
   - Are there **practical** measures that should be taken, based on the research results?

4.2 Evaluation

For the SWOT ("Strengths–Weaknesses–Opportunities–Threats") approach, you might consider some of these questions as starting points; however these are *not* to be answered in a numbered list.

1. How **significant** is the research **problem**?

   For example:

   - Is the work just dealing with some small part of a problem?
   - Is the problem real, or artificial?
   - Is the problem well-known and unsolved?
   - Do we really care if the problem is solved?

2. How **significant** is the **contribution** to solving the problem?

   For example:

   - Are the authors aware of the relation of their work to existing literature? If not, it's likely they are just repeated previous work.
   - Are the results surprising, i.e. seriously challenging previous results or received wisdom?
   - Does the work give us new or significantly improved tools?
   - Does the work tell us something really new about an application or about the "state of nature"?
   - Does the work have practical applications or has that been left for someone else to work out?

3. Are the claims **valid**?

   For example:

   - Has the work been carefully done? Have important details been omitted (or not reported)?
   - If there is an experimental design, is it suitable for the problem?
   - Are the methods correct for the problem?
   - Are the mathematics, statistics, algorithms etc. correct?
   - Do the results support the author's conclusions?
   - Are there confounding factors that the authors should have considered, but didn't?
   - If the authors are comparing their work to previous work, are they making fair comparaisons, or is it a case of "apples and oranges"?
   - If the authors make generalizations from their study, are these valid? Do the authors sufficiently consider the differences between their situation and the more general one?
   - Are the claims exaggerated or too modest?

5 Sample assignment

Exercise 2: Critical Reading
Student: Yipi Ma (y.p.ma@student.utwente.nl); AES.2
Journal paper: Oliver, M. A.; Webster, R.; & Slocum, K. 2000. *Filtering SPOT imagery by kriging analysis. International Journal of Remote Sensing* **21**(4):735–752.

Comprehension

Why was this research done?

The authors proposed a novel filtering method for multispectral imagery (here, SPOT) and investigated (1) how to implement it, (2) how successful it would be.

What is the novelty (if any) claimed by this paper?

Geostatistics provides the tools for investigating scales of spatial dependence among the DN values of the pixels in an image. From the variogram the analyst can detect at which spatial scales there is variability, and then these can be mapped by kriging to reveal spatial patterns at these scales. The novelty claimed is that this method can reveal spatial scales, unlike the *ad hoc* approaches of other filtering methods. In particular, they claim that the variogram can reveal and differentiate nested structures, i.e., several scales of variability.

What methods do the authors use to address the problem?

They use NDVI as their principal example, so this index was first calculated from the SPOT near-infrared and red bands. NDVI was chosen to look for spatial structure of vegetation intensity. The study area is about 10 km x 10 km near Columbus, GA (USA), the image has about 20 m x 20 m pixels, and is mostly vegetated.

Experimental omnidirectional variograms were computed for the DN values of band 1, the log(DN) for bands 2 and 3, and for NDVI. 1D variograms along rows and columns were also computed to see if there was evidence of anisotropy; none was found, so the variograms were then computed as averages of the row/column variograms. After visual inspection various single and nested variogram models were fit to the empirical variograms, and compared by their goodness-of-fit (residual sum of squares) and the Akaike Information Criterion (Table 2). A “best” model was selected.

The next step was a ground survey of vegetation classes of 100 pixel-sized vegetation plots (matching the image pixel size) along 10 transects,

thus each transect was 2 km. The vegetative cover in each plot was coded into classes. Indicator variograms were computed for each class; this resulted in the cumulative probability of a transition from one class to another, which was fit with an exponential variogram model to give a typical scale of transitions.

Ordinary Kriging (OK) using the fit nested model was then applied to the grid, slightly offset to avoid predicting at the pixel centres. OK was then applied separately with the short- and long-range components of the nested model.

What is the result of applying these methods?

The best variogram model was a nested double-exponential model; ranges varied somewhat among the rows/columns and average, but not too much; they also varied among the three bands and NDVI. The short range for NDVI was on the order of 15 pixels (parameter $\approx$ 5, x3 for effective range of an exponential model), i.e., about 300 m, and the long range on the order of 165 pixels, i.e., 3.3 km.

The ground survey of short-range transitions matched the short range variogram almost exactly, effective range 300 m. This confirmed the variogram interpretation.

The three OK maps revealed different features of the NDVI: (1) best single prediction, (2) short-range structure (i.e., high-pass filter), (3) long-range structure (i.e., low-pass filter).

What conclusions do the authors draw from their results?

Variogram analysis and modelling is well-suited for determining nested spatial structures and filtering images by kriging. The big advantage over other filtering methods is that spatial scales are objectively determined by the image.

According to the authors, what should be the follow-up to this research?

They do not propose any followup.

Evaluation

Strengths

The overall problem of image filtering to reveal structures at different scales is important; it has been addressed many times by various filtering method but not prior to this paper by variogram analysis and nested structures of spatial dependence.

An innovative method of image analysis is proposed and successfully applied to a test case, with clear and easily-interpreted results.

The theory of the variogram and kriging is well-explained. The theory of nested variation, how to estimate its components, and how to derive kriging weights, is carefully developed with equations and explanatory text.

The selected test area is appropriate to illustrate the method.

Weaknesses

There is no comparison with other multi-scale filtering methods. They are not compared either theoretically or practically (in the case study) with the proposed method of the paper.

Variograms are computed by averaging row and column variograms; no diagonal elements are included, although the variogram is advertised as "omnidirectional".

Only one test area is considered, so the wider applicability of the method is unknown.

Opportunities

The method can be applied to a variety of scenes and its ease of application and performance evaluated. Interpretations of single bands or band combinations related to features other than vegetation intensity can be made and evaluated for their help in image interpretation. The method can be (semi-)automated, to find appropriate scales and produce filtered maps.

Threats

Many filtering methods are available, and this one requires knowledge of fairly sophisticated geostatistical analysis. Variogram modelling is an art and an inexperienced analyst can produce incorrect results.