Technique: Reverse Outlining (for a Scientific Article)

The Hixon Writing Center at Caltech

How to reverse outline: Along the margin of a document, note in as few words as possible the main topic/point of each paragraph (or sentence)

Reverse outlining can be useful to:

- ❑ Take notes on a published article to sum up the main topics and takeaways
- ❑ Annotate an exemplary article that you might like to emulate by extracting their sequence of ideas to make an outline that you can reference
- ❑ Apply to your own writing (see bottom of next page)

Topic categories typical in scientific papers:
While reading an article, you can sum up each paragraph (or sentence or two) at the highest level with the following common topics typically found in each section:

Abstract

- Background info/context
- Motivation
- Gap in knowledge
- Your solution
- Major findings/results
- Significance
- Broader implications

Introduction ("Why")

- History of broader field
- History of subfield
- Motivation
- Need
- Gap in knowledge
- Problem to address
- Related work
- Limitation of prior work
- Definitions
- Existing knowledge
- Purpose of this work
- ______________________(other?)

Methods ("How")

- Design choices
- Models setup/parameters
- Theory description
- Equations/algorithms
- Experimental method/procedure
- ______________________(other?)

Results ("What")

- Output of simulations
- Results from experiments
- Data from observations, calculations,
- Info from literature or others' work
- Performance evaluations
- End Products
- Deliverables
- ______________________(other?)

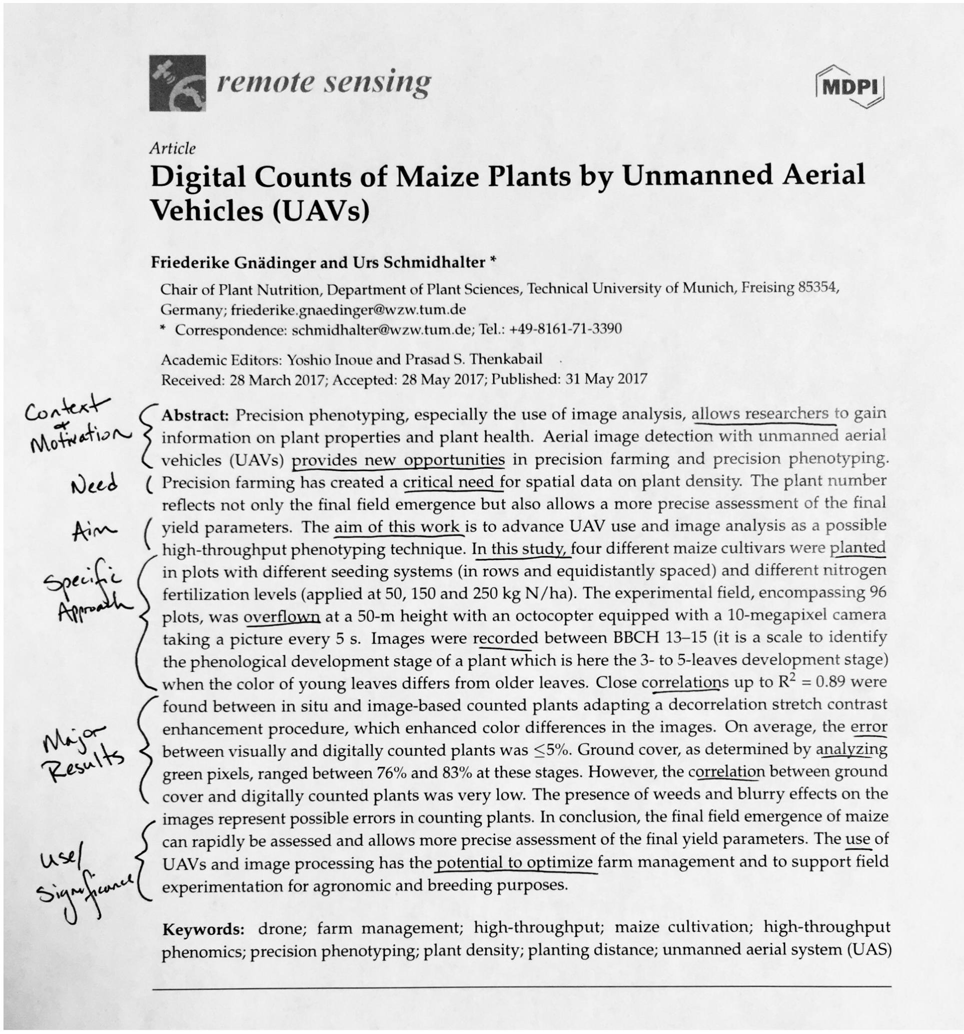
Discussion/Conclusion ("So What")

- Interpretation of results
- Implications
- Limitations
- Significance/importance
- Pros/cons, advantages/disadvantages
- Impact
- Uses of end product
- Use of information
- Applications
- Next steps/future directions
- ______________________(other?)

Note: Feel free to define other tag words or be more specific to your subject (e.g., "limitations of X algorithm," "problems with existing X method," or "useful applications of X procedure in Y situations").

Example: Reverse outlining an existing article

- Read or skim for key terms that give you a sense of the bigger picture topic (see underlined words in example below).
- Sum up each sentence or set of sentences along the left margin using as few words as possible, whether using your own wording or choosing from amidst the typical categories listed above (see topics noted below in left margin of example article).



remote sensing MDPI

Article

Digital Counts of Maize Plants by Unmanned Aerial Vehicles (UAVs)

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Abstract: Precision phenotyping, especially the use of image analysis, allows researchers to gain information on plant properties and plant health. Aerial image detection with unmanned aerial vehicles (UAVs) provides new opportunities in precision farming and precision phenotyping. Precision farming has created a critical need for spatial data on plant density. The plant number reflects not only the final field emergence but also allows a more precise assessment of the final yield parameters. The aim of this work is to advance UAV use and image analysis as a possible high-throughput phenotyping technique. In this study, four different maize cultivars were planted in plots with different seeding systems (in rows and equidistantly spaced) and different nitrogen fertilization levels (applied at 50, 150 and 250 kg N/ha). The experimental field, encompassing 96 plots, was overflown at a 50-m height with an octocopter equipped with a 10-megapixel camera taking a picture every 5 s. Images were recorded between BBCH 13–15 (it is a scale to identify the phenological development stage of a plant which is here the 3- to 5-leaves development stage) when the color of young leaves differs from older leaves. Close correlations up to $R^2 = 0.89$ were found between in situ and image-based counted plants adapting a decorrelation stretch contrast enhancement procedure, which enhanced color differences in the images. On average, the error between visually and digitally counted plants was ≤5%. Ground cover, as determined by analyzing green pixels, ranged between 76% and 83% at these stages. However, the correlation between ground cover and digitally counted plants was very low. The presence of weeds and blurry effects on the images represent possible errors in counting plants. In conclusion, the final field emergence of maize can rapidly be assessed and allows more precise assessment of the final yield parameters. The use of UAVs and image processing has the potential to optimize farm management and to support field experimentation for agronomic and breeding purposes.

Keywords: drone; farm management; high-throughput; maize cultivation; high-throughput phenomics; precision phenotyping; plant density; planting distance; unmanned aerial system (UAS)

Source for example article: Gnädinger, F.; Schmidhalter, U. Digital Counts of Maize Plants by Unmanned Aerial Vehicles (UAVs). *Remote Sens.* **2017**, *9*, 544.

How to apply reverse outlining to your own writing:

- ❑ Reverse outline a draft to check that your ideas flow as you intend or to double check that the structure matches your original outline (if you had one).
- ❑ If reorganizing or repurposing a prior document, reverse outline to identify which topic ideas in a prior document fit appropriately into your outline for the new version.
- ❑ Use the wording of your reverse outline notes to write topic sentences or section headings.

Want to talk to someone about the information in this handout or how to apply it to your own writing? Make an appointment to come into the HWC and talk with a professional or peer tutor: writing.caltech.edu/tutoring