Analytical Hierarchical Process

Introduction

Thomas Saaty developed the Analytic Hierarchy Process (AHP) in the 1970s as a decision-making process. It breaks down complex judgements into a hierarchy of criteria and options to simplify them. Pairwise comparisons are used by AHP to determine the relative importance of criteria and preferences among choices. It provides a structured approach to decision making by combining qualitative and quantitative data to objectively prioritise options. The strength of AHP is its capacity to deal with a wide range of difficulties in a variety of sectors by quantifying subjective judgements and assisting in consistent, rational decision-making.

Application

This Python code implements the Analytic Hierarchy Process (AHP) methodology for decision-making. AHP simplifies complex decisions by structuring them hierarchically and using pairwise comparisons to evaluate criteria and alternatives.

Libraries Used

- NumPy facilitates numerical operations and array handling, vital for mathematical computations and data manipulation.
- Fractions allows precise representation of rational numbers, maintaining accuracy in calculations.
- Rasterio empowers the reading and writing of geospatial raster data, enabling interaction and manipulation of various geospatial formats.
- Matplotlib aids in data visualization, offering tools to create a wide array of static and interactive plots and graphs.

Code Functions

Pairwise Comparison: Allows users to input judgments of relative importance between criteria or alternatives in the decision hierarchy.
Normalization: Normalizes the pairwise comparison matrix to derive priority weights for criteria and alternatives.
Consistency Check: Verifies the consistency of judgments using the Consistency Index (CI) and the Consistency Ratio (CR) to ensure reliable decisions.
Eigenvalue Calculation: Determines the principal eigenvector to obtain the priority vector for criteria and alternatives.
Final Ranking: Aggregates priority vectors to create a final ranking of alternatives based on the weighted priorities of criteria.

Usage Instructions

1. Input the pairwise comparisons for criteria and alternatives.
2. Run the file including normalization and consistency check functions.
3. Results will be displayed.

Project Demo (UI)

Entering all the data

```
How many attributes do you have?
```

```
How many attributes do you have? 3
Enter the name of attribute 1: Drainage Density
Enter the file path for Images 1: D:\GIS Data\Rs Paper\Drainage_density_1000.tif
Enter the name of attribute 2: Lineament Density

Enter the file path for Images 2:
```

```
How many attributes do you have? 3
Enter the name of attribute 1: Drainage Density
Enter the file path for Images 1: D:\GIS Data\Rs Paper\Drainage_density_1000.tif
Enter the name of attribute 2: Lineament Density
Enter the file path for Images 2: D:\GIS Data\Rs Paper\Data\Rc_swabi_lineament_den.tif
Enter the name of attribute 3: Geology
Enter the file path for Images 3: D:\GIS Data\Rs Paper\Data\swabi_geology.tif

Enter your judgments as fractions or decimals (e.g.1 to 9 or 1/9.):

How much more important is Drainage Density than Lineament Density?

Drainage Density vs Lineament Density:
```

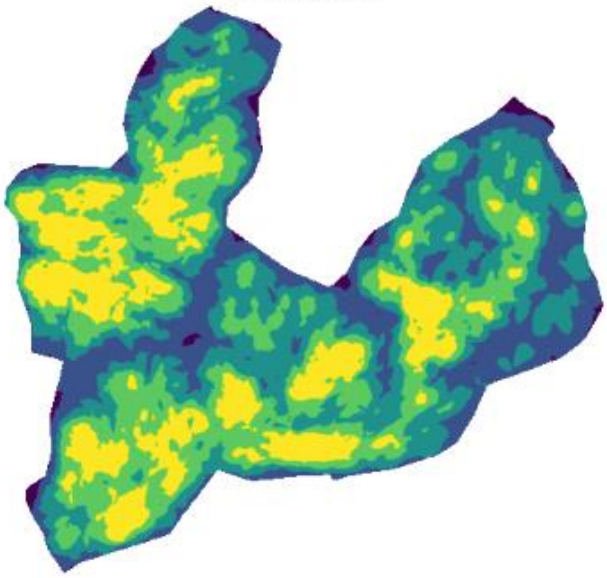
Entered all the data

```
How many attributes do you have? 3
Enter the name of attribute 1: Drainage Density
Enter the file path for Images 1: D:\GIS Data\Rs Paper\Drainage_density_1000.tif
Enter the name of attribute 2: Lineament Density
Enter the file path for Images 2: D:\GIS Data\Rs Paper\Data\Rc_swabi_lineament_den.tif
Enter the name of attribute 3: Geology
Enter the file path for Images 3: D:\GIS Data\Rs Paper\Data\swabi_geology.tif

Enter your judgments as fractions or decimals (e.g.1 to 9 or 1/9.):

How much more important is Drainage Density than Lineament Density?
Drainage Density vs Lineament Density: 6
How much more important is Drainage Density than Geology?
Drainage Density vs Geology: 8
How much more important is Lineament Density than Geology?
Lineament Density vs Geology: 3
```

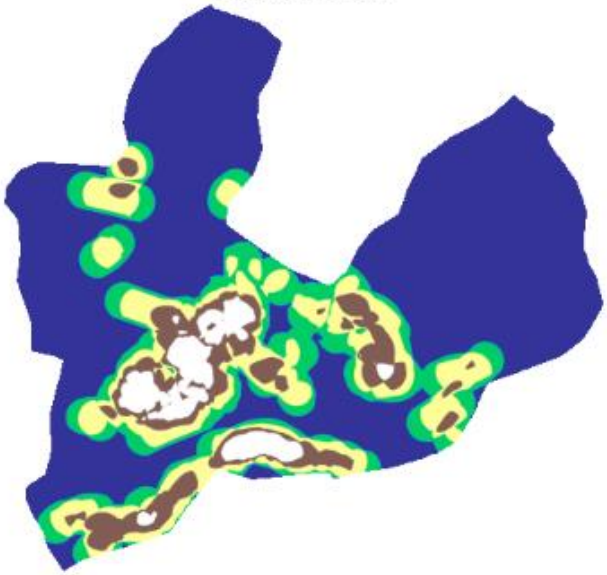
Summary

```
 SUMMARY

Pairwise Comparison Matrix:
[[1.         6.         8.        ]
 [0.16666667 1.         3.        ]
 [0.125      0.33333333 1.        ]]

Weights of Attributes:
Drainage Density: 0.7612
Lineament Density: 0.1662
Geology: 0.0726

Lambda Max: 3.073513525473338
Consistency Index (CI): 0.036756762736668946
Consistency Ratio (CR): 0.06337372885632578
Matrix is consistent.
```

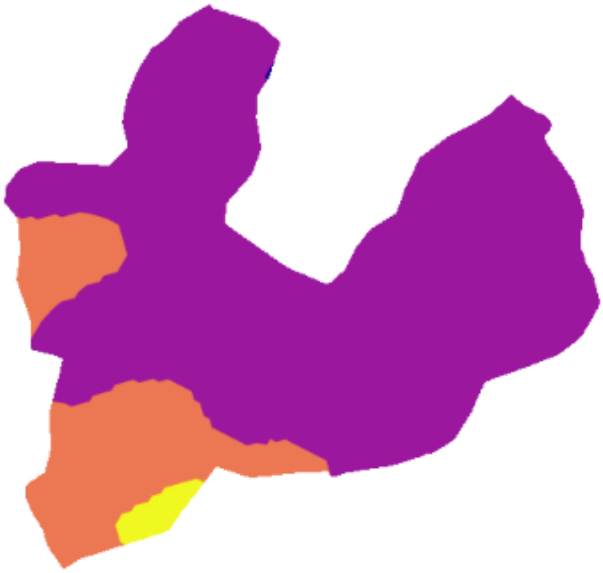
Drainage Density

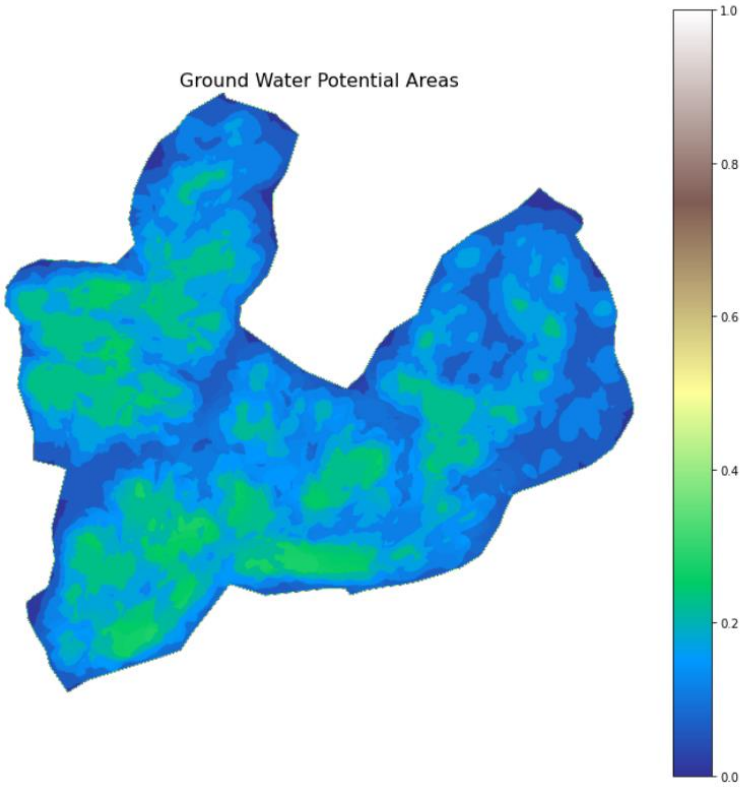


Lineament Density



Geology





The Final output changes if the input is changed e.g

```
SUMMARY

Pairwise Comparison Matrix:
[[1.         0.16666667 7.        ]
 [6.         1.         3.        ]
 [0.14285714 0.33333333 1.        ]]

Weights of Attributes:
s: 0.2608
w: 0.6494
g: 0.0898

Lambda Max: 3.8250555308583545
Consistency Index (CI): 0.41252776542917724
Consistency Ratio (CR): 0.7112547679813401
Matrix is not consistent.
```