Using the Analytical Hierarchy Process (AHP) to Evaluate Target Signatures

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THE BIGGISH FIVE

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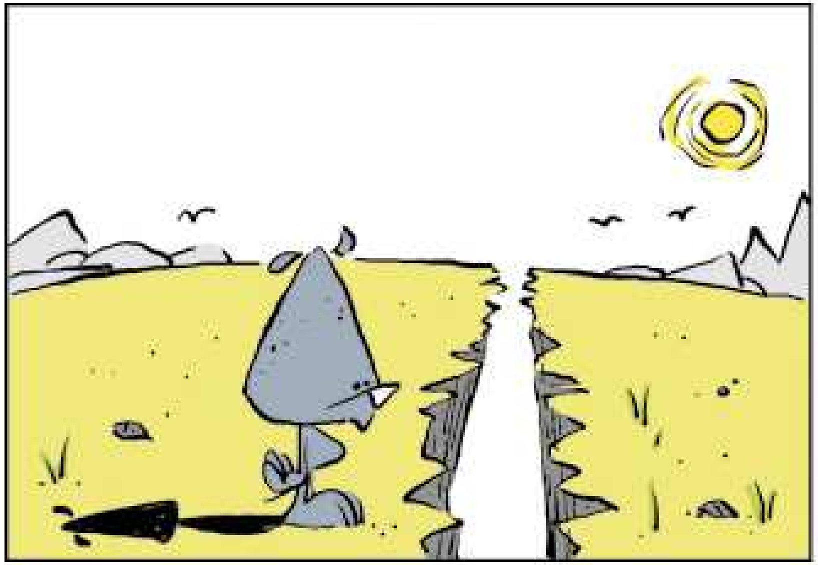

- Introduction
- Describing AHP (short)
- Work through example
- Conclusion

Field Evaluation of Camouflage Uniforms

- Problem statement:
  - Different patterns, different environments: which pattern is the best?
  - Different colours, different patterns: which combination is the best?

- Non-scientific method
  - “It's my personal opinion that the MarPat Desert performed the best. In many shots it effectively disappears. The DCU rates number two……..“

- Scientific method

Field Evaluation of Camouflage Uniforms

Current techniques:

- Cumulative Probability of Detection (Sweden, WTD52)
- Sliding Scales (USA)
- Law of Comparative Judgment (Thurstone)

- Analytic Hierarchy Process (AHP)

The Analytical Hierarchy Process (AHP)

- AHP developed by Thomas L. Saaty, 1980
- AHP extensively used as decision support tool in the financial/commercial world
- Based on assigning weights on importance of different factors for a number of alternatives
- Calculating the Eigenvector and Eigenvalue in order to determine the rank

Pattern Designs

- Four different camouflage pattern designs:

Pattern1	Pattern2	Pattern3	Pattern4
			
			

Field Evaluation
- Setup

Field Evaluation
- Questionnaire

EVALUATION 1

Setup		The Best One	Score	Comments ?
1	1	Left ✓	7	
	2	Right		
2	3	Left	5	
	1	Right ✓		
3	4	Left	7	Too green
	1	Right ✓		
4	2	Left ✓	3	
	4	Right		
5	3	Left ✓	5	
	2	Right		
6	3	Left ✓	3	
	4	Right		
7	5	Left	7	
	1	Right ✓		
8	5	Left ✓	(1)	
	2	Right		
9	5	(✓) Left	3	
	3	Right		
10	5	Left ✓	3	
	4	Right		

The "score" is selected from the following table, by completing the following statement:

The colours of the best uniform fit the colours of the scene ____________ the colours of the other uniform.

1	….as good as….
3	….marginally better than….
5	….much better than….
7	….a lot better than….
9	….extremely better than….
2,4,6,8	*Intermediate values*

Data Analyses
- AHP Calculations

$Aw = \lambda_{\max} w$

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Data Analyses
- AHP Results

		AHP (weights for each observer)					
		Obser-ver1	Obser-ver2	Obser-ver3	Obser-ver4	Obser-ver5	Obser-ver6
WEIGHTS	Pattern1	63	50	51	62	56	49
	Pattern2	4	12	7	24	8	14
	Pattern3	13	9	16	8	9	8
	Pattern4	20	29	26	5	26	29
CR		38	19	8	31	4	29
λ_{max}		5.00	4.50	4.13	4.83	4.11	4.77

Highly inconsistent
High CR

Very consistent
Low CR

Data Analyses
- AHP Results

		AHP (weights for each observer)						AHP (averaged weights)						LCJ
								CR > 0		CR < 20		CR > 20		
		Obser-ver1	Obser-ver2	Obser-ver3	Obser-ver4	Obser-ver5	Obser-ver6	Rank	Std Dev	Rank	Std Dev	Rank	Std Dev	6 Obser-vers
WEIGHTS	Pattern1	63	50	51	62	56	49	58	6.2	53	3.2	62	7.8	-2.27
	Pattern2	4	12	7	24	8	14	10	7.1	9	2.6	12	10.0	0.60
	Pattern3	13	9	16	8	9	8	11	3.3	11	4.0	10	2.9	0.92
	Pattern4	20	29	26	5	26	29	21	9.2	27	1.7	16	12.1	0.64
CR		38	19	8	31	4	29	4		5		3		
λ_{max}		5.00	4.50	4.13	4.83	4.11	4.77	4.10		4.13		4.08		

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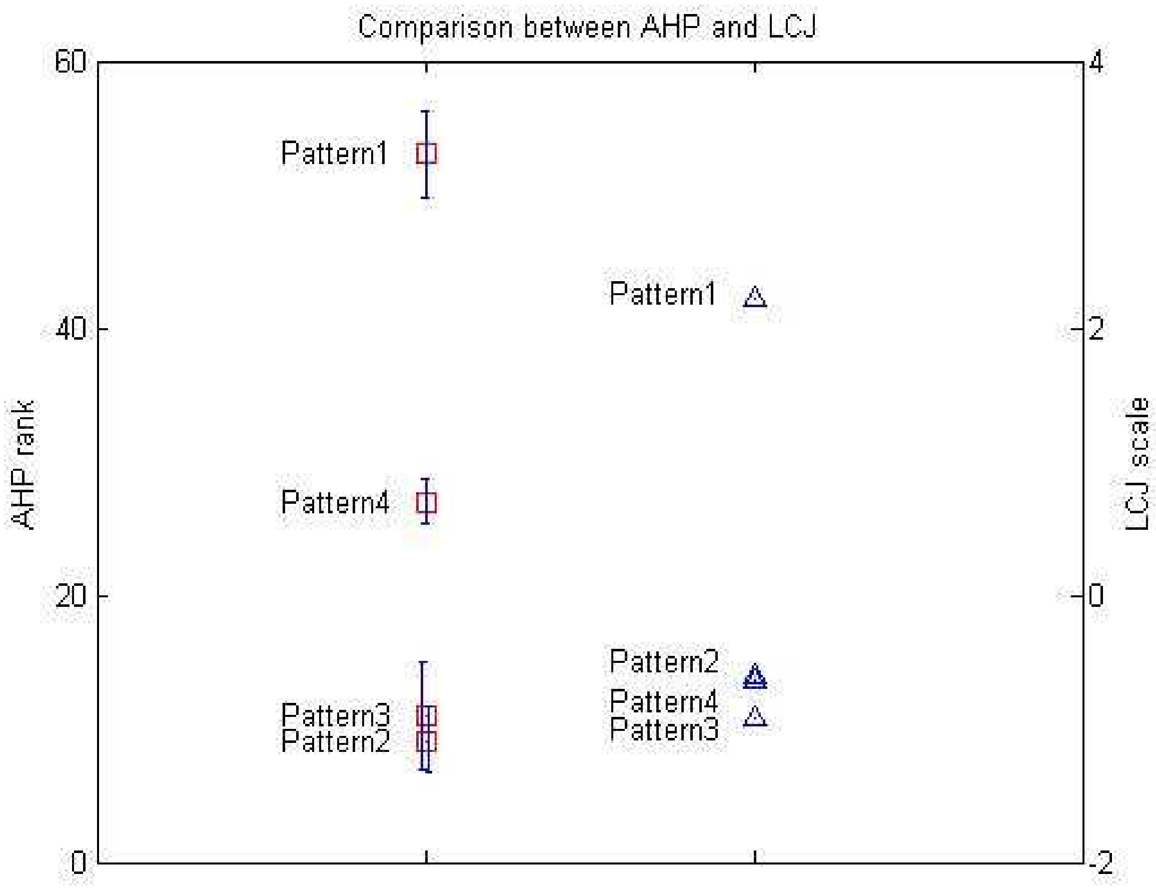
Data Analyses

- Using the geometric mean: If Observer1 says AB=5, Observer2 says BA=5, then don't want to be biased towards the larger number (as is the case using the arithmetic average), the geometric mean will make it "1".
- Using the geometric mean to calculate the "A-matrix" entries is a way of "forcing" consistency. Saaty warned against this "forcing".
- All cases indicates Pattern2 and Pattern3 to perform the same

Data Analyses
- AHP (CR<20) and LCJ



Data Analyses
Results (CR<20)

Pattern1 (53)	Pattern4 (27)	Pattern3 (11)	Pattern2 (9)
			
			

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Conclusions

- Advantages of AHP
  - Provides a scientific performance measure for a pairwise comparison of multiple samples
  - Absolute, linear scale
  - Does not require a large number of observers
  - Live trials as well as photo-simulations
- Disadvantages of AHP
  - Time consuming when number of alternatives is large
  - Difficult for large objects (vehicles) and installations

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