REFLECTIONS ON THE "MORE LIKELY" APPROACH TO PROBABILITY ASSESSMENT

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INTRODUCTION

If a decisionmaker (DM) were confronted with a situation involving two events A and B where he/she judged that B was twice as likely as A, the DM would eventually calculate probabilities of 2/3 and 1/3 respectively. Event A has weight 1 and B weight 2 for a total weight 3. Generalising this idea to more than two events results in routine calculations of probabilities as demonstrated below in Table 2. The first step is to rank the events from least to most likely as in A, B, …… E. Then, successive pairwise assessments are made that judge how much more likely event B is compared to the least likely predecessor event A as in B/A. Then C/B and so on through to the most likely event in the analysis. In this case E. Suggestive qualitative to quantitative ranges are shown in Table 1.

TABLE 1: QUALITATIVE TO QUANTITATIVE ASSESSMENTS

Qualitative Assessment	Pairwise Range	Percentage Likelihood Gain
Equally likely events	1.00 – 1.00	Zero
Slightly more likely	1.00 – 1.25	Up to 25%
Moderately more likely	1.25 – 1.75	25% to 75%
Significantly more likely	1.75 – 2.00	75% to 100%

Wider ranges as in 2 – 3 times more likely can be utilised, as necessary. Assume we have a 5-event problem, with events ranked from least to most likely as in A, B, C, D and E. The DM then compares events B and A (i.e. B/A) and determines whether it is equally, slightly, moderately, or significantly more likely than A. The DM makes similar judgments moving up the ranking. To set the stage, we first assume that the DM makes the judgment that (apart from the equally likely assessment for events C and D) all likelihood gains are in the 1 – 2 range which is almost certainly correct encompassing all the more fine-tuned judgments as outlined in Table 1. Resulting probabilities are derived in Table 2.

TABLE 2: PROBABILITIES FOR INITIAL ASSESSMENTS

Events or Scenarios	Likelihood Ratios	Pairwise Range		Compound Likelihoods		PROBABILITIES				More Likely Values	
		Low	High	Low	High	P(Low)	P(High)	Average	%	Average	%
A	Base ⇒ 1	1.00	1.00	1.00	1.00	0.200	0.053	0.126	12	Base	Base
B	B/A	1.00	2.00	1.00	2.00	0.200	0.105	0.153	15	1.21	1.25
C	C/B	1.00	2.00	1.00	4.00	0.200	0.211	0.205	21	1.34	1.40
D	D/C	1.00	1.00	1.00	4.00	0.200	0.211	0.205	21	1.00	1.00
E	E/D	1.00	2.00	1.00	8.00	0.200	0.421	0.311	31	1.52	1.48
				5.00	**19.00**	**1.000**	**1.001**	**1.000**	**100**		

Now suppose the DM fine-tunes the "correct" 1 – 2 ranges using the narrower Table 1 assessments of slight, moderate, and significant. Illustrative probabilities are derived in Table 3.

TABLE 3: PROBABILITIES FOR THE MORE REFINED ASSESSMENTS

Events or Scenarios	Likelihood Ratios	Pairwise Range		Compound Likelihoods		PROBABILITIES				More Likely Values	
		Low	High	Low	High	P(Low)	P(High)	Average	%	Average	%
A	Base ⇒ 1	1.00	1.00	1.00	1.00	0.107	0.070	0.088	9	Base	Base
B	B/A	1.75	2.00	1.75	2.00	0.188	0.139	0.164	16	1.86	1.78
C	C/B	1.25	1.75	2.19	3.50	0.235	0.243	0.239	24	1.46	1.50
D	D/C	1.00	1.00	2.19	3.50	0.235	0.243	0.239	24	1.00	1.00
E	E/D	1.00	1.25	2.19	4.38	0.235	0.304	0.270	27	1.13	1.13
				9.32	**14.38**	**1.000**	**0.999**	**1.000**	**100**		

Taking the Table 3 probabilities as the "correct" ones (using more refined information) we see that the easier judgments from Table 2 are within 4% of these more correct values. This is heartening since once the initial "ballpark" probabilities are determined from the almost certainly correct but broad ranges, fine-tuning is made easier with an axiomatically correct distribution for reference.

HE likens such fine-tuning of a probability distribution to tuning a radio – the correct frequencies reveal themselves in harmony with the DM's intuitions.

A final insight is gained by assuming the likelihood gains between adjacent events in the ordering are all the same apart from the equally likely events C and D. Resulting percentage probabilities are shown in Table 4.

TABLE 4: PERCENTAGE PROBABILITIES

Events or Scenarios	More Likely Factor		
	Slightly	**Moderately**	**Significantly**
A	17	10	6
B	18	15	11
C	21	21	21
D	21	21	21
E	23	32	40
	100	**99**	**99**

The percentage gains between adjacent events in the ordering are respectively about 10% (1.1), 50% (1.5) and just less than 100% (say 1.9) respectively. Note too that the "ballpark" probabilities in Table 4 can be slightly adjusted in line with the DM's judgments to accommodate the 100% axiom. The results of Table 4 show that significantly different distributions can be derived using the "more likely" approach to probability assessment.

CONCLUSIONS

The DM can assign any pairwise range felt appropriate as in say 1.1 – 1.5 where equally likely is excluded as is the higher side of the moderately more likely range. The Low and High probabilities show the direction of any necessary pairwise changes to those yielding the initial "ballpark" distribution.