Review of: "A Probability-Based Algorithm for Evaluating Climbing Difficulty Grades"

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Potential competing interests: No potential competing interests to declare.

The paper "A probability-based algorithm for evaluating climbing difficulty grades" by Quentin Ansel presents a novel mathematical model to estimate the difficulty grade of climbing routes. It introduces a probabilistic approach that addresses the subjectivity and variability inherent in climbing grade estimation. The paper is structured into several key sections:

Introduction: It sets the context for the need of a probabilistic model in climbing grade estimation, highlighting the limitations of current grading systems.

The Mathematical Model: This section elaborates on the construction of the model, which includes:

- **Energy Associated With a Climbing Grade**: The paper proposes a system where climbing difficulty is equated to an energy value, measured in real numbers.
- **Bouldery vs. Endurance Sections**: Different grading systems for short, powerful sections (bouldering) versus longer, endurance-focused sections (route climbing) are discussed.
- **Different Association Rules**: The paper details how different sections of a climb and rests are mathematically combined to determine the overall difficulty.
- **Introducing Probability Distributions**: This part introduces the concept of probabilistic distributions to account for the variability in climbers' perceptions of difficulty.

Application: The model is applied to compare some of the world's hardest climbing routes, demonstrating its practical utility.

Conclusion: Summarizes the findings and the potential impact of this model on the climbing community.

Datasets: Information on the datasets used for the model's development and validation is provided.

Key Points:

- The paper addresses a significant gap in climbing literature by providing a quantitative, probabilistic model for grade estimation.
- The model's novelty lies in its combination of real-number energy values with probability distributions, offering a more nuanced view of climbing difficulty.
- It potentially offers a more objective and consistent method for grading climbing routes, which has traditionally been a

subjective process.

- The application of the model to real-world climbing routes illustrates its practical relevance and potential impact on climbers and route setters.

Overall, the paper is well-structured, methodologically sound, and presents a significant contribution to the field of climbing science. It is particularly notable for its innovative approach to a longstanding problem in the climbing community – the subjective nature of climbing grades. This research has the potential to revolutionize how climbing grades are determined and understood, benefiting climbers, route setters, and researchers alike.