How Uncertainty-Related Ideas Can Provide Theoretical Explanation for Empirical Dependencies: A Preface

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In some situations, we have a perfect knowledge of the corresponding processes. Based on this knowledge, we can, based on the current and past measurements results, predict the future state of the system – and, if needed, decide on the best way to control the system so as to get to the desired future state. This is the situation, e.g., in describing the trajectory of a spaceship.

In many other application areas, however, we not do have a perfect knowledge of the situation, so we have to rely on empirically determined dependencies, dependencies that often have no convincing theoretical explanations. Because of this lack of explanations, practitioners are somewhat reluctant to use these dependencies – since, without convincing theoretical explanations, these empirical dependencies may (and sometimes do) turn out to be accidental coincidences which only hold for some cases and are not satisfied in other situations. It is therefore desirable to come up with a theoretical explanation of these dependencies.

The problem of finding and explaining empirical dependencies is made more complex by the fact that measurements and observations come with uncertainty, as a result of which the measurement results provide only an approximate picture of the corresponding processes.

In this book, we collected several papers explaining how we can take this uncertainty into account when providing the desired theoretical explanations. Most of these papers have been presented, in different years, at annual International Workshops on Constraint Programming and Decision Making and at other related workshops that we were organizing. This volume presents extended versions of selected papers from these workshops.

These paper provide explanations of empirical dependencies in different application areas:

- decision making [1], where the authors explain how the status quo bias is useful,

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- electrical engineering [3], where the authors explain why class D audio amplifiers work so well,
- image processing [15], where the authors explain why representing contour segments by fragments of straight lines, circles, and hyperbolas works well,
- geological sciences [6, 7], where the authors explain the ubiquity of gamma distribution in seismology and the observed absence of large triggered earthquakes,
- logic [10, 19, 20], where the authors explain why we use "and", "or", "not" and not other operations, how to describe the degree of implication, and why either "and"- or "or"-operations are approximate,
- pedagogy [5, 18], where the authors explain why we all have similar learning potential and explain the empirical effect of repetitions on short-term and long-term learning,
- physics [2, 11, 12], where the authors explain quark confinement, the presence of galaxy superclusters, and the minimum entropy production principle of non-equilibrium thermodynamics,
- psychology [4, 9, 13, 14], where the author explain why we use certain number systems, why we use 3 basic colors and 4 basis tastes, how to avoid echo chamber phenonemon, and how to achieve family happiness,
- quantum computing [8], where the authors provide one more explanation of effectiveness of quantum computing, and
- transportation engineering [16, 17], where the authors explain empirical formulas describing the current strength of the road pavement and how this strength deteriorates with time.

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