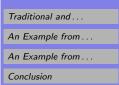
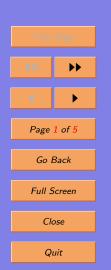
Points on Operational Semantics

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1. Traditional and Operational Approaches

- Traditional approach to science:
 - we develop deep theoretical notions, models, and theories;
 - we also try re-describe the abstract notions in observable terms.
- Problem with traditional approach: sometimes, we do not know how to check our abstract theories.
- Example: superstring theory.
- Alternative approach: reformulate all the notions and theories in directly observable (operational) terms.
- Examples:
 - special relativity (Einstein);
 - quantum physics (Heisenberg).



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2. An Example from Fuzzy Techniques

- *Problem:* there are many different fuzzy analogs of logical operations (t-norms, t-conorms, etc.)
- Why it is a problem:
 - fuzzy logic is usually not formulated as an operational theory,
 - so it is not always clear how to relate membership degrees $\mu(x)$ to something directly observable.
- Alternative approach:
 - start with an operational definition, and
 - select the most adequate t-norms and t-conorms based on these definitions
- A frequency interpretation leads to $a \cdot b$ (independence), $\min(a, b)$ and $\max(1 + b 1, 0)$ (Frechet inequalities).
- An expert marking degrees on a *scale* leads to scale-invariance hence $\min(a, b)$ (maximally scale-invariant) and fractionally linear t-norms.
- Empirical analysis: we cannot get exact values of $\mu(x)$ hence interval-valued fuzzy sets.



3. An Example from Computations

- Fact: in modern physics, we need operators, functionals, etc., objects of higher order.
- Related problem: in computations, we produce approximate (close) values;
 - for real numbers, closeness is easy to describe;
 - for *operators*, there are many different norms, and it is difficult to agree on the most adequate one.
- Solution: analyze the problem operationally:
 - which quantities we will be able to observe?
 - these are the quantities that we want to be computed as accurately as possible
- Resulting approach: domain theory.
- Additional advantage: faster computations no need to waste time on computing non-observable features.



4. Conclusion

- Fact: operational semantic is known and successfully used in physics.
- Fact: operational semantics is under-used in knowledge representation and processing.
- Conclusion:
 - we should learn more about operational semantics, and
 - we should use operational semantics more.

