

The Great Devonian Controversy - Polarization and Confirmation

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Polarization dynamics can be studied within different computational frameworks [4, 3, 5]. Here, one framework of formal argumentation is used to carry out a detailed case study in argumentative polarization. First, a major, well documented scientific controversy is qualitatively logically reconstructed. Second, the reconstructed debate is quantitatively analyzed by means of computational methods in order to (i) identify and (ii) explain polarization dynamics.

The Great Devonian Controversy is a scientific debate among 19th century geologists. It started as a disagreement confined to the interpretation of plant fossils in the Culm strata of north-west Devon and ended with the establishment of a new geological period, the Devonian. In the beginning, opinions seem to be divided over a single question, namely whether, the fossil plant bearing Culm strata in north-west Devon are Cambrian or Coal Measures in age. Taking a closer look, it becomes clear that there are whole belief systems at stake, even at the very beginning. In the course of the debate, not only dating hypotheses are debated, but also background assumptions and evidential claims, as for example "Are there fossils characteristic of the Coal Measures?" and "Is there a huge gap in the sequence of Devonshire strata?". Each main participant has its own belief system, differing from the belief systems of the others and changing over time (in all of its components). Due to repeated belief revisions by all participants, finally, a consensus between most but not all participants is achieved.

The reconstruction of the Great Devonian Controversy relies on [10] and makes use of [11]. For 11 time steps, the debate is reconstructed as a dialectical structure and partial positions are identified for each main participant, in accordance with [1].

First of all, polarization is assessed for each time step. In accordance with [5], four definitions in terms of groups are used, namely community fracturing, distinctness, group consensus and size parity. In this study, groups are defined exogenously, e.g. by acceptance of certain dating hypotheses, methodological or evidential claims. For each time step, the following questions are answered:

1. How many (sub)groups can be defined? (Community fragmentation)
2. How are participants distributed over groups? Are all groups more or less comparably sized? Or is there one dominant group? (Size parity)

3. To what extent do positions of members of the same group differ? (Group Consensus)
4. Are there shared beliefs between members of different groups? (Distinctness)

As a second step, in order to understand polarization dynamics, belief dynamics are analyzed in terms of confirmation. For 11 time steps and each main participant, degrees of confirmation are calculated for the dating hypotheses given background assumptions and evidence, before and after the belief revision. Three different confirmation measures are used, namely one absolute confirmation measure and two relevance confirmation measures:

1. $DOJ(h|e)$. The concept of justification of a hypothesis given the available body of evidence, $DOJ(h|e)$, is taken from [2].
2. $Z_P(h, e)$, substituting DOJ for probability P and extending the definition in order to include non-contingent hypothesis. $Z_P(h, e)$ has been firstly defined in [6].
3. $F_P(h, e)$ substituting DOJ for probability P . $F_P(h, e)$ has been firstly defined in [9].

The choice of confirmation measures is in accordance with theoretical claims about confirmation as partial entailment taken from [7] and [8] .

Hence, in analyzing the dynamics of a major historic scientific debate in terms of confirmation, this study contributes in achieving an explanatory model and fundamental understanding of belief and polarization dynamics.

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