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Data Theory, Discourse Mining and Thresholds

David L. Sallach and Jonathan Ozik

Argonne National Laboratory
Center for Complex Adaptive Agent Systems Simulation
sallach@anl.gov, jozik@anl.gov

University of Chicago
Computation Institute
sallach@uchicago.edu, jozik@uchicago.edu

Abstract

The availability of online documents coupled with emergent text mining methods has opened new research horizons. To achieve their potential, mining technologies need to be theoretically focused. We present data theory as a crucial component of text mining, and provide a substantive proto-theory from the synthesis of complex multigames, prototype concepts, and emotio-cognitive orientation fields. We discuss how the data theory presented informs the application of text mining to mining discourse(s) and how, in turn, this allows for modeling across contextual thresholds. Finally, the relationship between discourse mining, data theory, and thresholds is illustrated with an historical example, the events surrounding the 1992 civil war in Tajikistan.

Dynamic Data from Discourse Mining

In the domain of policy modeling and the historical analysis that supports it, the tactics employed by actors as well as actor decisions require complex and highly situated considerations. As a result, data that is structural and largely static in nature has obvious limitations in informing the modeling process (Moore & Shellman 2008). Rather, such applications require data that is dynamic and multi-vocal (Levine 1988).

The vast corpus of available online text provides an essential resource in this domain, and has begun to be applied in a wide range of issues including genocide, terror threats, WMD proliferation and international conflict in general. Such modeling efforts have taken the form of automated coding that characterizes events, actor types and relationships as data (Schrodt, Davis, and Weddle 1994; Thomas 2000; Diesner 2008), which has been further facilitated by the parallel rise of text mining (Konchady 2006; Feldman & Sanders 2007).

Notwithstanding the potential of text mining as a social science methodology, there are unresolved issues that remain to be addressed. Our present focus is on the issues of semantic meaning and use, which text mining inevitably raises.

Semantic Complexities

Semantic issues have been confronted before, in areas such as natural language (Wierzbicka 1999; Talmy 2003; Schlenker 2005), data modeling (Hammer & McLeod 1978; Codd 1979) and web semantics (Walton 2006; Allemang & Hendler 2008). While progress has been made to varying extents in these areas, each initiative has also demonstrated the difficulties inherent in efforts to model semantic processes.

The complexities of natural language semantics arise from a variety of sources (cf., Wierzbicka 1999; Talmy 2003). Unlike formal languages, terms are not formally defined; rather, they have multiple senses. Vagueness and ambiguities are not only allowed, but can often be actively and strategically used by communicants. Indexical terms, those that are defined only through communicative context, abound. Meanings are attributed differently in different regions, time periods, subcultures and settings. This description is far from exhaustive, even before noting that communication is often used to conceal or distort information, as well as to convey it.

Conflict and Mediation Event Observations (CAMEO), is a second generation event data framework, used in conjunction with automated coding systems (Gerner, *et al*., 2002; Schrodt, *et al*., 2005) Discussions of CAMEO, specifically its design and specification, provide examples of the types of issues that can arise in text mining approaches aimed at the policy modeling domain.

For starters, CAMEO researchers have designed standardized codes down to four or more levels of specificity, but many of the actors and events relevant to the domain of policy modeling often remain diffuse, contentiously defined and continuously evolving, thereby, eluding such categorizations. For example, while countries are typically regarded as discrete (Schrodt, *et al*., 2005:5), anomalies proliferate, including discontinuities between national boundaries and ethnic and religious population distributions, and also the fact that standardized codes are subject to politics (e.g., the treatment of Taiwan and other contested areas; Schrodt, *et al*., 2005:6).

More generally, a number of difficulties arise as part of the coding process itself, including: 1) trying to eliminate ambiguities rather than capture meanings by recognizing

how and for what purpose they are used, 2) attempting to treat terms as cue categories, rather than seeking to benefit from underlying indexicality, 3) using codes like RAD to indicate religious fundamentalism and/or political radicalism within multiple religious movements, and thereby disregarding the differences between (and within) such movements, as well as their spatial and temporal variations, and 4) ignoring potential biases in the sources of information (cf., Gerner, *et al.,* 2002:4) rather than identifying them and treating them as data.

As an additional point, from an epistemological perspective, the most problematic characteristic of such strategies of inductive generalization is the idea that, among the diverse actor types, relationships and events, there are crisply defined *building blocks* that can be identified and that the collection of these units can provide sufficient insight into the complexities of history (Gerner, *et al.,* 2002:1). Here we propose that, rather than relying on the contentious assumption that semantic patterns house such an implicit order, it is more productive to face the vagaries of data via data theory.

Data Theory

Although data theory originated from empirical psychological experiments, it was from the outset seen as including the inferential classification of actors (Coombs 1964:vii), i.e., all knowledge, including observation, is the result of theory and/or assumptions. As Coombs (1964:5) writes, "we buy information with assumptions."[1] Jacoby (1991:3,5) further elaborates that "any empirical investigation rests upon assumptions about the meaning of the observations it employs" and that "all measurement is theory testing."[2]

An interesting insight of Coombs is his view of data as relations between points in a space. Thus data theory can use geometrical representations of inferential classifications as a comparative framework that potentially reveals "interesting and suggestive interrelations" (Coombs 1964:3). In this way data theory can be seen to relate to and benefit from the more recent insights of Gardenfors (2000) and Widdows (2004) on the geometries of thought and meaning (e.g., prototype concepts, semantic spaces).

Our position is that, for effective policy domain modeling, a substantive domain theory should underlie text mining activities. In the following sections we propose such a proto-theory. Our data theory addresses notions of preferences, preference orderings, similarities and comparisons. Judgment is interpreted as a proximity relation. Our approach also extends to positive and negative emotions, and how they are directed toward the components of a (sometimes fluid) semantic space. One of the most valuable contributions of our approach, we posit, is the incorporation of contextual transitions (or thresholds) within policy domain models.

Patterns and Concepts

Over the course and breadth of scholarly interpretation, scholars and practitioners alike have identified countless social patterns that are considered to have influenced historical events. Prior to conceptualization, while they are yet in the tacit realm of social practice, social actors identify and distinguish these patterns (Luhmann 2002). As issues arise involving specific consequences, patterns become more explicit, are labeled and, frequently, become sources of contention. In no sense can these concepts be regarded as simply given. As a result, the process of their scientific identification is as socially immersed as are the effects attributed to them.

Social patterns exist at various scales, assuming diverse forms in particular locations and times. As scholars seek to generalize and rationalize these 'labels', they become more abstract, conceptual and more broadly applicable. Examples of such social concepts and their definitions are illustrated in Table 1. However, in practice, labeled instances tend to remain socially and historically distinct and, label notwithstanding, actors situated within that time and place recognize and respond to its uniqueness.

Pattern	Description
Civilization	Civilization is a quasi-coherent skein of cultural elements, institutions and practices that thrives and evolves in regions of varying sizes over centuries.
Culture	Culture is an accumulation of ideational artifacts and resources, as well as concepts and scenarios that suggest how the ideational resources may be applied.
Social Structure	Social structure is an integral configuration of historically-specific groups, institutions and practices that constrains and enables human activities.
Practice	Social practice can be best conceived as habitual, non-reflective activity, socially reinforced by its shared nature.
Discourse	Historical discourse is created by public use of large-scale communication processes.
Organization	Organizations are intentional social formations designed to achieve broader social goals.
Movement	Movements are broad, diffuse formations that seek to reform or transform existing social structures.
Network	Social networks are formations that are

[1] As an aside, this view is consistent with Popper's view of science as a process of conjecture and refutation.

[2] We note that Schrodt recognizes that automated coding frameworks (e.g., CAMEO) may benefit from experimentation with theoretical perspectives (Schrodt, *et al.,* 2005:20).

	effectively represented by graphs, which makes available a set of statistical and methodological tools for their analysis.
Tribe	A tribe is a small informal social unit with a low division of labor.
Group	Social groups are formed through frequent and multi-faceted interaction.
Social self	A social self is defined by the collectivities with which it is engaged.

Table 1. Multi-Scale Social Patterns

The sociological use of such socially emergent concepts necessitates at least two caveats. First, as long as the utilization of such concepts is informal and qualitative, they never entirely escape their origin as labeled patterns. They remain part of a non-standardized and dynamic semantic field, rather than rising to the level of a scientific construct. As such, they specifically cannot serve as building blocks. One limitation of social scientific practice is an inclination to treat situated and endogenously mutable labels as if they were well-defined mathematical concepts. Identification of such mathematical constructs remains one of the important goals of twenty-first century social science. It is also an objective to which computational social science has the potential to contribute.

The social patterns described in Table 1 are neither mutually exclusive nor exhaustive. Rather, they are concepts that are frequently used by social scientists, some of which have also become common in public discourse.

Given multiple levels of social scale depicted in Table 1, there are two strategies by which they might be reasonably modeled. The first, and most common, is to identify relevant social entity types and model each individually. This strategy has been repeatedly undertaken, and, as discussed above, suffers multiple limitations. Social entities proliferate while each historical instance manifests in a somewhat different form, combining unique features and characteristics. To be applied to particular problems or policy issues, such abstractions must then be translated into the historically specific forms under investigation. The more complex the translation the more that it tends to degrade the potential explanatory power of the generalization.

Therefore, such situated concepts must be seen as cultural products best understood in the context of the underlying social processes that produce them. This is the second approach, a generative strategy (cf., Epstein 2007), which is still in its methodological childhood. From a generative, synthetic perspective, it is *interactive* and *endogenously interpretive processes* that: 1) produce and employ the pattern-based concepts that 2) serve as indicators of emergent macro processes and that, therefore, 3) require representation, analysis and, ultimately, modeling. A framework capable of addressing the meaning-oriented social forms in Table 1 will need to support this modeling strategy. With this requirement in mind, we proceed to present our proto-theory for the domain of policy modeling.

Games, Concepts and Emotions

While a satisfactory, fully articulated domain theory,does not currently exist it is possible to suggest several interrelated concepts that might inform such a future theory. The three concepts considered below, complex mutligames, prototype concepts and emotio-cognitive orientation fields, are intended to suggest a conceptual substrate out of which cultures, nations, alliances and the other concepts summarized in Table 1 can be generated.

While space does not permit further justification of their selection (as opposed to other possible contenders), their indication will nonetheless serve the purposes at hand. That is, the concepts described here can illustrate how a domain theory may be able to guide and focus, a text mining activity (in this case), in ways that surpass the more familiar concepts that are readily at hand. Indeed, the process of assessing and supplanting domain theory contenders and/or their conceptual components is likely to constitute a major process by which more compelling social theories will be identified.

Complex Multigames

The traditional game-theoretic focus on analytical solutions has tended to emphasize formalisms that are relatively simple and static. To be of theoretical and practical use in social simulation, game-theoretic models must be more intricate, and richly dynamic. The resulting models, necessarily guided by social theory, will inevitably be considerably more complex in ways that are further considered below.

Human actors play multiple games, select among available games, shift from one to another, misunderstand what game their counterpart is playing, act in ways that are (more or less) effective simultaneously within multiple games, etc. Therefore, a game formalism should be able to support multiple interacting games. An early qualitative study (Long 1956), describes the concept:

> [A] local community can be usefully conceptualized as an ecology of games … The games give structure, goals, roles, strategies, tactics, and publics. Players in each game make use of players in the others for their particular purposes . . . The interaction of the games produces unintended but systematically [effective] results for the ecology.

Long focuses primarily on industry and professional roles but, as described below, the ecology of games may be

more usefully conceived more abstractly, in the form of complex multigames (Sallach 2006).

Types of Multigames. Specifically, for present purposes games are classified into three categories: cooperation, competition and coercion. The first type, cooperative games, involve a kind of mutual support that is seen in families and tribes, among neighbors, and within communities. Types of support in cooperative games vary, but accounting is not strict, the game tends to be mutually reinforcing over time and commonly results in virtuous spirals (Carse 1986). A second type, competitive games, are familiar economic games, involving complementary benefit, relative advantage, arm's-length accounting, and often durable, self-reinforcing exchange relations (see Osborne & Rubinstein 1990, for examples of such games). The third type, games of coercion, involve the exchange (or threat) of force and violence. Reciprocity is frequently anticipatory, and comparative accounting tends to be exaggerated, resulting in a vicious spiral. Complementarity often takes the form of innovative tactics or novel defenses. When recurrent balance emerges, any of the three types of games can stabilize over time.

These three primary types of games can equally be described in terms of the resources exchanged within them. From this perspective, in addition to reciprocal types of interchanges, where the details primarily concern frequency, quantity and/or quantitative conversion, there are asymmetrical exchanges in which one type of resource is used to acquire, or respond to, another. Force is used to gain material benefits, for example, or money is used to gain affinity benefits. Therefore, each asymmetrical game draws upon (at least) two types of resources. It may be that such asymmetric games are less likely to stabilize than are the games with a more shared focus but, even if this is true, they remain vital as a source of social creativity and transformation.

Can the social patterns described above arise from the complex games of diverse types? To the extent that this is feasible, it suggests a specialized focus for discourse exploration. Specifically, text mining with a multigame oriented focus, directed at concepts such as types of games being played, actors/players/roles within games, game moves and strategies, and the payoffs or consequences of games, would benefit policy modeling activities.

Prototype Concepts

Prototype concepts are an empirical discovery of cognitive science (Rosch 1978; 1983). They can be modeled as radial structures in high-dimensional space, where an individual prototype concept possesses a (possibly idealized) exemplar at its core and more idiosyncratic representatives reside along the radians, differing from the exemplar in various dimensional directions. This representation of semantic concepts is counter to the more classical set-based understanding of the classification of concepts, where a concept simply consists of a flat set of concept examples.

Prototype effects have been identified in concepts of many types: e.g., birds and animals, human emotions and social relationships. Thus, robin, love and friendship are clearly better exemplars of their categories than, for example, ostrich, ennui and third cousin, respectively. Even mathematical objects manifest prototype effects in ways that are highly revealing. Two and four are seen as prototypical even numbers, for example, as opposed to, say, 112 or 4,516.

As mentioned above, a prototype concept is constructed from a set of (sometimes irregular) dimensions. Picking the specific example of a prototype concept of an affinity relationship, it might vary along axes of: 1) the extent of relationship, 2) the number of common acquaintances, 3) the shared areas of interest, and 4) the immediacy & symmetry of reciprocity. As values vary along these (and potentially other) dimensions, the nature of the relationship will be considered more (or less) prototypical.

An important point here is that in human cognition and reasoning, concept exemplars form a *reference point* (or region) relative to which situations and actions can be assessed (Rosch 1983). Thus, prototype concepts and reference point reasoning can be seen as defining one form that concepts take under the limits of bounded rationality.

In the domain theory suggested here, diverse games and their elements can be formulated in prototype form, allowing models of endogenous actors who assess their strategic options through geometric reasoning.

Orientation Fields

The arousal, expression and self-organization of affectivity focuses human activity, in both conscious and unconscious ways (LeDoux 1996). As noted by Darwin (see, for example, Darwin 2002) and by modern researchers (Wierzbicka 1999), forms of emotional expression span cultures and species.

Emotion is also essential to the operation of memory (LeDoux 1996). Diverse social referents, people, events, objects, concepts, and cultural creations, are remembered, not only in terms of a cognitive representation, but also with emotional content. A mature individual is likely to be able to call up thousands of entities and events with their associated feelings. Each person may be viewed as having a field of feelings, maintaining and evolving it in response to diverse events.

Emotio-cognitive orientation fields can be used to represent the interaction of human emotion and semantic concepts (see Sallach 2008). The orientation fields of individuals are surrounded by the orientation fields associated with salient groupings, or collectivities. Throughout their lives, human beings are enveloped, to varying degrees, within such orientation fields (which they,

in turn, help shape). These fields interact, and can be widely held across multiple scales. Throughout history, shared orientation fields have provided a defining basis for social groups and structures. At both the individual and collective levels, orientation fields are entangled with, and give force to, the semantic concepts that frame the historical discourses of interest.

Proto- Theory for Discourse Mining

Returning to the data-theoretic perspective, what is being proposed here is that discourse mining focus upon the inference of emotional attachments and repulsions to diverse games, their participants and outcomes, and the concepts by which such games (and their components) are defined, proposed and played by participants at multiple scales. The resulting fields of orientation and action can then be generated by endogenous action rather than by 'building blocks' and other forms of presupposition.

Discourse Mining and Thresholds

The purpose of this section is to suggest how the preceding conceptual and epistemological considerations can apply to policy-oriented domains in a concrete way. In particular, it considers how discourse mining, with elements of the proto-theory presented above used as a focus, can enable models capable of adapting to contextual thresholds.

The events leading up to and during the civil war in Tajikistan (1991 through the mid 1990s, see Figure 1) pass through a number of fundamental contextual changes, or thresholds (see Kleveman 2003 and Roy 2007 for more detailed accounts). The first such threshold occurs in the time period when the unorganized protests (protesting the newly elected president with ties to the old Soviet era administration in an election perceived to be unfair) become organized (the Pamiris and Gharmis form an opposition). Another threshold occurs around the time the neo-Soviet government fails. Finally, when Dushanbe falls to the newly regrouped neo-Soviets, yet another threshold is seen.

What is common to all of these transitions is how fundamentally the actors (e.g., Pamiris and Gharmis emerge as legitimate players), games played (e.g., non-violent protests transition into more violent forms of coercion), and as a result, the discourses (e.g., the emerging opposition portrayed as an Islamic radical power grab), change. Attempting to analyze the events with the help of traditional text mining techniques, where the analyzed texts are relevant accounts and news sources, would result in a number of difficulties. First, at each transition, the coding schemes would require fundamental redesigns. This is, in essence, the creation of a new analysis model for each phase of the system under study. We, on the other hand, propose a modeling approach where aspects of the model, such as the relevant actors, types of games played, etc., can be generated and modified endogenously based upon data, effectively allowing for analysis models that can span thresholds. Second, for an adequate attempt at discourse mining (and not simple keyword searches), some form of a representation of the orientations of the various actors would be necessary. This would allow for tracking the aforementioned emotional attachments and repulsions to diverse games of the relevant parties and, as a consequence, also the changes. Third, the use of only classical concept representations, as opposed to prototype concepts, would make it difficult to incorporate the actors' shifts and reassessments in the face of new situations via, for example, reference point reasoning.

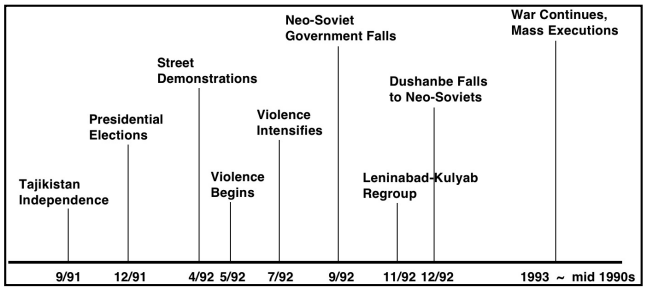

Figure 1: Major events surrounding the civil war in Tajikistan (1991 - mid 1990s).

It is a great strength of computational modeling that it can effectively combine the various components of the discourse mining proto-theory presented here. Such models can explore how actor orientations, as indicated by their commitment to their geospatial interests and also to their categorizations of potential allies and adversaries, influence their orientations and, thereby, the view of strategic options available to all concerned actors (cf., Vane 2000; 2006). It is the strength of discourse mining that such inferences can be parameterized and explored using empirically existing patterns of communication and action, and enable endogenous adaptation to fundamental contextual changes.

Conclusion

The history of science is a recurrent story of finding the limits of common sense categories and assumptions. Because of the inherent complexity of their domain, the social sciences are still relatively early in this process of discovery. Their difficulties further arise from the fact that the focal domains are also socially and politically charged. By recognizing a theoretical basis (such as the example of oriented multigames in the present discussion) as the focus of discourse mining, it will be possible to move beyond empirical generalization and toward theoretically grounded social science.

Achieving intellectual distance is never easy, and particularly so when facing issues collectively defined as vital. Nevertheless, both scientific progress and the need to effectively address such objectives require that we take full advantage of the exceptional tools that have now become possible. As part of the process, the utilization and

advancement of social theory will be necessary to realize the full potential of these methods.

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