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Reexamining fiat, bona fide and force dynamic boundaries for geopolitical entities and their placement in DOLCE

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Abstract. The purpose of this article is to reexamine the ontology of geopolitical boundaries so that they can be better represented in ontologies designed for the semantic web. Previous work on this subject has divided geopolitical boundaries into fiat, bona fide, and force dynamic categories. This article challenges the existence of bona fide geopolitical boundaries on the basis that many of them lie skew to physical discontinuities on the earth, maritime territorial claims do not follow physical discontinuities, and geopolitical boundaries are three-dimensional, not two-dimensional objects. This also allows for a necessary ontological distinction to be made between the geopolitical boundaries and their physical markers. This analysis is used to determine the placement of geopolitical boundaries, territory, states, and nations in the Descriptive Ontology for Linguistic and Cognitive Engineering (DOLCE). DOLCE has a cognitive bias making it particularly suitable for formulating an ontology of mind-dependent geopolitical entities. However, rather than distinguishing between the physical and nonphysical based on whether or not the entity in question has direct spatial qualities, this article puts forward that a distinction needs to be made based on whether or not an entity in question is made of matter. A material/immaterial distinction may be more intuitive for an ontology of "common sense".

Keywords: State, boundary, territory, DOLCE, nation

1. Introduction

Ontologists Barry Smith and Achille Varzi proposed an ontology of boundaries based on whether a boundary is an intrinsic discontinuity in reality or is created by fiat in a particular location by human cognition. This ontological theory was fleshed out in a series of articles (Smith, 2001; Smith & Varzi, 1997a, 1997b, 2000), and has been used in research in (usually physical) geographic ontology (Mark et al., 1999; Montello, 2003; Smith & Mark, 1998, 2003). However, this theory was applied to the ontology of geopolitical boundaries in the article "The cognitive geometry of war" (Smith, 1997) as part of an argument for relaxing the geometric constraints on the shape of "nations" for the purpose of reducing international conflict. This ontology of boundaries was also used to classify geopolitical entities based on their boundary types.

The purpose of this article is to reexamine the ontological classification of geopolitical boundaries from a geographic perspective so that they can be better represented in ontologies designed for the semantic web. Previous research on this subject follows Smith and Varzi's theory of fiat, bona fide and force dynamic boundaries (a kind of boundary introduced specifically for military and geopolitical

objects) and uses this classification of boundaries to classify geopolitical objects based on the kinds of boundaries they have. This article argues that there are no bona fide geopolitical boundaries, but rather that they are all of the fiat variety. Then the placement of geopolitical boundaries and territories within the Descriptive Ontology for Linguistic and Cognitive Engineering (DOLCE) is considered. DOLCE was produced by the Laboratory for Applied Ontology in Italy and is included in the library of ontologies prepared for the semantic web described in WonderWeb Deliverable D18 (Masolo et al., 2003).

DOLCE has a cognitive bias in the sense that "it aims at capturing the ontological categories underlying natural language and human commonsense" and its categories are considered "cognitive artifacts ultimately depending on human perception, cultural imprints and social conventions" (Masolo et al., 2003, p. 13). This makes DOLCE particularly suitable for a foundational ontology of mind-dependent geopolitical entities. However, DOLCE's distinction between physical and nonphysical entities is based on whether or not the entity in question has direct spatial qualities. This would make geopolitical boundaries physical entities. This would seem counter to the arguments to be given against the existence of bona fide geopolitical boundaries. An alternative solution that bases the physical/nonphysical distinction on whether or not the entity in question is made of matter is presented. This allows social objects, such as territorial boundaries, to remain social entities and fiat, and yet still have spatial location. However, such a solution prompts questions regarding the ontology's stance on physicalism, which cannot be resolved easily through a descriptive ontology's appeal to common sense, though the existence of immaterial social entities is often implied by natural language.

2. Distinguishing geopolitical entities

Political geography has many terms that are often used interchangeably in casual conversation. Terms such as "nation", "state" and "nation-state" are often used as synonyms outside the discipline, but convey different meanings to political geographers. This is problematic when terms are used in different ways in different research, and projects are evaluated across disciplines. In his article, Smith uses the term "nation" very broadly. In doing so, he does not distinguish between different kinds of political entities as they are usually distinguished in political geography. Making these distinctions can help clarify the kinds of entities to which Smith assigns different kinds of boundaries. Therefore, political geography's basic distinctions between states, nations, and nation-states will be briefly introduced and followed for the remainder of this article.

Unfortunately, political geographers themselves do not agree upon unequivocal definitions of these terms, much less a complete "ontology of political geography" to which one can refer for the entities and relationships considered in the domain. Nevertheless, distinguishing between states and nations is often one of the first topics in introductory textbooks on political geography. For instance, Glassner and Fahrer (2004) define a state as "an independent country consisting of a specific territory and citizens bound by a sovereign government that demands (but does not always obtain) their loyalty"[1] (p. 31). They contrast this with a "nation", which they (Glassner & Fahrer, 2004) define as "a reasonably large group of people with a common culture, a territory they view as their homeland, and sharing one or more important cultural traits, such as religion, language, political institutions, values and historical

[1] Glassner and Fahrer define "state" in terms of "country" but do not provide any definition of "country" in their text. In fact, whereas the term "state" has a multitude of definitions in political geography's literature, the term "country" suffers from an almost complete dearth of definitions, and may not be a term with any recognized technical meaning within political geography today.

Table 1
Summary of geopolitical terminology as used in Smith (1997) and in political geography

Referent	Term in Smith's usage	Term in political geography	Examples
The objective legal person of international law	Nation	State	Iraq, Russia, Sudan
A group of people with certain unifying cultural characteristics	Nation	Nation	The Kurds, the Uyghurs, the Tibetans
An objective legal person of international law whose population is predominantly members of a single nation	Nation	Nation-state	Japan, Iceland, Sweden

experience. They tend to identify with one another, feel closer to one another than to outsiders, and believe they belong together" (p. 33). The compound term "nation-state" refers to "a nation with its own State, a State in which there is no significant group that is not part of the nation" (p. 34).

Flint (2009) defines "state" as "a centralized set of institutions facilitating coercive power and governing capabilities over a defined territory" (p. 722), although he follows up by writing, "No one definition of the state is adequate given the way that states have varied in their form and function over time and space" (p. 722). Defining the state to be as an organization is also popular, as with Muir (1975), who writes that a state is "a particular form of organisation of people and territory", and both Short (1993, p. 91) and Paasi (1996, p. 39), who define the state as "a political organization covering a particular territory". Bottazzi and Ferrario (2009) used "The State of Italy" as an example of an organization that fits their DOLCE-based preliminary ontology of organizations. However, Robinson (2010) argues against states being organizations, but rather defines them as the objective legal persons of international law. That definition of "state" will be followed here. A summary of these terminological distinctions is provided in Table 1.

Ontology and knowledge engineering have recognized that terms such as "state" and "country" can have two different referents, a nonphysical geopolitical entity and a physical location (Guarino & Welty, 2004; Oberle et al., 2007). Here, states are nonphysical objective legal persons of international law that have a relationship with certain areas called their territory. This distinction is not specifically made in Smith's (1997) article. His article is concerned with territorial boundaries, and as such his classifications do not classify states and nations directly, but rather indirectly by the boundaries of their territory.

3. Overview of Smith's classifications

Smith (1997) proposes three classes of geopolitical boundaries: bona fide, fiat and force dynamic. According to this ontological schema, bona fide boundaries are intrinsic discontinuities in physical reality, such as the boundary between land and water on the surface of the earth. Fiat boundaries are the product of human cognition, such as political boundaries that follow lines of longitude or latitude. Force dynamic boundaries are more complicated and are characterized by elasticity. Smith writes that force dynamic boundaries demarcate the territory over which a certain group of people can exert influence. The boundaries surrounding ethnolinguistic groups and military units are included in this category. Force dynamic boundaries are introduced in the article presumably to deal with certain geopolitical situations.

Smith uses his classification of boundaries to organize geopolitical entities into categories based on the kinds of boundaries their territories have. Objects that have only bona fide boundaries are bona fide

objects, while those with at least one fiat boundary are fiat objects. Likewise, objects with at least one force dynamic boundary are force dynamic objects. Characteristically, the boundaries of force dynamic objects "are determined by the actual or potential dynamic actions of their respective constituent parts" (Smith, 1997, pp. 395 and 396) – for example, the area occupied by an infantry unit. Force dynamic objects are "characteristically transient, and tend to form systems with other third-type spatial objects in relation to which they are subject to a very high degree of reciprocal dependence in respect to their size, shape, location and degree of elasticity" (Smith, 1997, p. 396, internal parenthetical omitted).

4. Reexamination of Smith's classifications

Each of Smith's categories for geopolitical entities (bona fide, fiat and force dynamic) will be examined in turn. It is argued that despite what is suggested on many maps of the world, the territory of no state is bona fide. The territories of all states are fiat. The territories of nations can be either fiat or force dynamic. It is also important to distinguish a nation's current territory from its homeland, since the two may or may not be the same. The meaning of force dynamic boundaries is also extended beyond Smith's original meaning in order to characterize not only defensive arrangements, but aggressive action as well.

4.1. Bona fide states

Smith points to island states, such as Japan, Iceland and Britain, as examples of bona fide "nations". In this instance, Smith is using the term "nation" to refer to states as they are understood in political geography. However, the existence of bona fide states is problematic. To begin with, the term "bona fide state" does not explicitly recognize the distinction between the state itself and its territory. The state is a nonphysical geopolitical object, but its territory might be delineated by different kinds of boundaries. Further, this classification does not recognize the distinction between the boundary of the state's territory, such as the territory of the state of Japan, and the boundary of the island or islands its people may live on. Although the islands of Japan are formed by physical discontinuities between land and water (fluctuating with the tides), the boundary of the territory of the state of Japan is not that discontinuity, nor does it coincide with it, even though many political maps of the world do not show the maritime territory of each state. Many political maps color the states' land territory in contrasting colors, but color all the world's oceans a shade of blue (or sometimes shades of blue corresponding with bathymetry), rather than illustrating maritime territorial holdings.

In accordance with the Law of the Sea, Japan claims a territorial sea of twelve nautical miles (though in specific locations that distance can vary between three and twelve nautical miles), a contiguous zone of twenty-four nautical miles, and an exclusive economic zone of two hundred nautical miles. Therefore, it is possible for a person not to be on one of the physical islands of Japan and yet still to be within the territory of the state of Japan. The boundary of Japan's (or any state's) maritime holdings does not follow physical discontinuities in the earth's surface. Water flows freely into and out of a state's maritime territory.

Furthermore, the territory of many island states is not confined to a single island. Neither Japan, Iceland, nor Britain is so confined (especially considering the historic extent of the Japanese and British empires). They are "super-unitary entities comprehending non-contiguous parts" (Smith, 1997, p. 402). Today, Japanese territory is composed of four major islands: Hokkaidō, Honshū, Kyūshū and Shikoku. While there may be no problem with "Japan" being composed of multiple disconnected objects (see Smith (1995) concerning exactly this subject with regard to Japan and New Zealand, as well as to geopo-

litical territory composed of multiple disconnected objects within a single landmass, such as with the Holy Roman Empire), it is not the case that the territory of the state of Japan stops at the physical boundary of one island, and then starts again at the next. The territory of the state is connected across those physical discontinuities, and, moreover, it is only by human fiat that it is decided which islands are part of the territory of Japan and which are not.

The belief in bona fide state territory also seems to rest on the assumption that the territory of a state is a two-dimensional object. It is not. A state's territory is a three-dimensional object whose shape can be approximated by a wedge (see Fig. 1). Despite appearing as lines on maps, the boundary of a state is not a one-dimensional line, but a two-dimensional surface. Some geographic literature refers to this as a vertical boundary plane that "cuts through the air-space, the soil, and the subsoil" (Glassner & Fahrer, 2004, pp. 73–75). However, the term "plane" may imply that the boundary between states is, or must be, flat. This may be the case where a line, such as a line of longitude or latitude, is used to define a boundary (and therefore an extrusion of that line into the atmosphere would result in a flat plane), but might not most accurately describe the extrusion of a curve, arc or more "natural" line, such as one following a river.

The boundary surface runs directly from the center of the earth to the earth's surface. It is the product of human fiat and skew to the physical discontinuities of the earth's geologic structure. A state's boundary surfaces below the earth's surface are fiat. Whether the territory of a state extends to the center of the

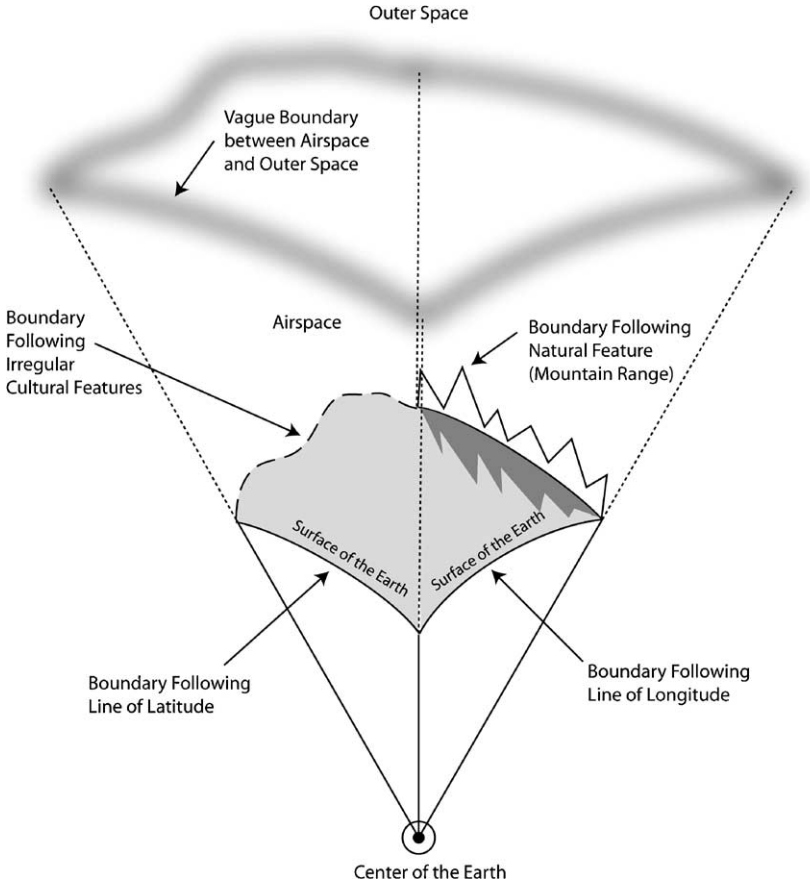

Fig. 1. Diagram of state territory.

earth or whether the center of the earth is merely used as part of the mathematical definition of the state's boundary surface (Cushing, 1920) is not relevant. If the territory of a state does not extend to the center of the earth, and instead only extends to a certain depth, that depth only serves to create another fiat boundary for the territory of the state.

The boundary surface also extends into the atmosphere above the earth, delimiting a state's airspace until at some altitude the state's airspace ends and outer space begins. The boundary surface separating the airspace from outer space is fiat. As of yet, no specific altitude has been unanimously accepted as the upper limit of a state's territory, but it can be said to be located (however, imprecisely) somewhere between the altitude where airplanes fly and the altitude at which the Space Shuttle orbits.[2] This makes the upper boundary for a state not only fiat, but possibly vague. Thus, it is impossible either to fly over or to tunnel under the boundary of a state's territory. Instead, one would always fly or tunnel through a territorial boundary surface, unless one flew over the state's territory at an altitude high enough to be in outer space.

4.2. Fiat states

Smith does claim that fiat states exist. He cites the African and Middle Eastern states as examples, because their borders are largely the result of colonial fiat and not due to physical discontinuities on the earth's surface. Much of the argument against the existence of bona fide state territory is an argument for the existence of fiat state territory, so it need not be repeated. However, it is very important to emphasize the difference between the nonphysical geopolitical boundary and whatever physical markers (natural or otherwise) might be on the earth's surface. Although some physical barriers (such as rivers or mountains) may suggest themselves as potential geopolitical boundaries between groups of people simply because they are obstacles to movement or expansion, the physical demarcation of the boundary is not the boundary itself. "Even where such a boundary is stipulated to follow some preexisting physical boundary, it must still count as institutional" because "The fiat which legitimises the boundary also stipulates the coincidence of the fiat boundary with the pre-existing bona fide boundary" (Galton, 2003, p. 157).

In the case of rivers, the physical discontinuity of the water and the bank may not even be used to mark the geopolitical boundary. Rather, the centerline of the river or the river's thalweg may be used to mark the geopolitical boundary. "The general rule is where a navigable river forms the boundary of conterminous States, failing any special arrangement, the middle of the channel or the 'thalweg', or its principal channel if it has more than one, is taken as the boundary line, although it may divide the river into two very unequal parts" (Cukwurah, 1967, p. 51). A geopolitical boundary may move with the natural movement of a river (as when the river meanders slowly), but when the river changes course suddenly (perhaps due to flooding or tectonic activity), the geopolitical boundary may remain fixed despite movement of the physical features on the earth's surface (Glassner & Fahrer, 2004).

Also, marking an unmarked geopolitical boundary on the surface of the earth does not convert it from a nonphysical fiat geopolitical boundary into a bona fide boundary. The stones or other markers are simply used to show human beings where the nonphysical boundary is located. Likewise, if one group or another stealthily moves the markers in the middle of the night, the geopolitical boundary surface does not move with it. Montello (2008) explains that "even when physical features mark administrative

[2]Several states with equatorial territories have tried to assert, through the Bogotá Declaration in 1976, that the geostationary orbit is their natural resource and that their sovereignty extends to cover the portion of the geostationary orbit that crossed over their territory. However, thus far, this declaration has had little or no practical effect and is unlikely to legally extend the territory of states to the altitude of geostationary orbit.

boundaries (quite common at various times and places), or have served historical roles in establishing boundaries, the features are generally not the boundaries, only markers for the boundaries" (p. 312, parenthetical in original[3]), and whether the boundaries of an administrative region coincide with physical discontinuities or not, the boundaries have only been placed there by cognition (Montello, 2003). Such situations require a distinction between the nonphysical and fiat geopolitical boundary surface and the physical markers. This is in contrast to Smith (1995), where the erection of boundary markers (such as border posts, watchtowers, barbed-wire fences, or garden posts) is claimed to convert an initially fiat boundary into something tangible and physical.

4.3. Force dynamic nations

Smith describes force dynamic boundaries and force dynamic objects by citing an example from tactical military engagement, namely infantry units. The area occupied by a given infantry unit is a force dynamic spatial object. Critically, Smith does not write that the infantry unit itself is a force dynamic spatial object, a clarification that does not seem so clearly made in the case of geopolitical entities. It is also important to note the use of the word "occupied" in the text. Units of infantry consist of individual persons. The area the unit occupies would be the sum of the areas occupied by the persons who constitute it. This would not be a force dynamic area. Instead, Smith is referring to the territory *controlled* by an infantry unit at a given time. This might be an area roughly corresponding to the effective range of its weapons. Of course, if an enemy infantry unit were within that range, the first unit could hardly be considered to control that area. In fact, that area might be violently contested!

Territory is "a fixed area from which rivals are driven (excluded) by the active efforts, or '*defense*', of the owner" (Brown, 1975, p. 58, emphasis in original). However, this understanding of territory may not completely capture the intention of force dynamic boundaries and may need to be expanded. In the case of the infantry unit, not only may it have a territory that it defends from invaders (such as with infantry units manning machine guns in fixed positions of the trenches of World War I) but also it may be actively advancing, invading, and attacking. In this case, the force dynamic area is constantly changing as the unit advances. It may not only be defending territory against intruders but also be acting aggressively and engaging targets as they come within range. The unit may even seek out targets not inside its force dynamic boundary and move toward them in order to engage them. This makes the force dynamic concept more clearly not only a fixed and defensive idea, but also useful for characterizing aggressive action as well.

Smith (1997) labels a geopolitical entity with force dynamic boundaries a "force dynamic nation". These are such entities as the "diaspora of Jews, of gypsies, of Saami and Inuit, of Swedes in Finland, of Slovenes in Carinthia, of Poles in the era of partition – whose members feel themselves (to different degrees) as one, but who have been denied or have renounced any claim to a physical territory over which they would maintain exclusive jurisdiction" (p. 396). In this case, Smith seems to be using the term "nation" in the same way political geographers do, but the "force dynamic" designation may be superfluous. A distinction still must be drawn between the group of people, the people's homeland, and the area the people might currently occupy, since, due to forced migration or other factors, these may not be the same. The area the nation has control over (even if it is a weak form of control, especially compared to the control a state might exert over a territory) may be force dynamic, but the nation itself is only a group of people and not a force dynamic geopolitical object.

[3]All parentheticals appearing in quotations for the remainder of this article are present in the original unless otherwise specified.

Definitions from political geography make it clear that nations are groups of people and not areas of any kind. While some definitions require a nation to have a homeland, it is not required that the nation occupy it. Thus, it would be a mistake to assume that the Kurdish nation is synonymous with its homeland or the land it might occupy at a given time. The boundary of the area over which a nation can exert influence may be force dynamic (even though potentially much weaker than the influence that can be exerted by other entities, such as military units), but the territory it considers to be its homeland may not be. The nation may have delimited its homeland with crisp fiat boundaries.

Strictly speaking, in order to locate the nation (and not its territory or homeland), one must locate its people. Substituting a portion of Johnston's (2000) definition of "community" for the word "nation" in Smith's (2000) definition, one can define a nation as "a social network of interacting individuals, usually concentrated in a defined territory, whose members are bound together by a sense of solidarity rooted in a historic attachment to a homeland and a common culture, and by being conscious of being different from other social networks of interacting individuals". Thus, one would map the nation of the Kurds by mapping each Kurd connected in the Kurdish social network.

In the geographic literature, nations can be classified by whether or not they are seeking to create their own states. If they are, geographers dub them "stateless nations", defined as "peoples living as a minority in one or more States who want a state of their own carved from the territory currently included in one or more States" (Glassner & Fahrer, 2004, p. 35). Again, the Kurds in the Middle East are an excellent example. Smith combines nations that have no desire for their own states (or have at least renounced the claim to them) and those that have the desire, but that for one reason or another have been denied that opportunity, into a single category. This seems reasonable in his ontology of territorial boundaries and in political geography, since if a group is simply described as a "nation", it is not clear what the people's prevailing attitude toward creating its own state is. Political geographers also do not systematically address how many or what percentage of the people in a nation must be interested in creating their own state in order to be considered a stateless nation. Certainly there could be situations where the vast majority of the nation was happy with the status quo of occupying land within the territory of one or more other states, but a vocal (and possibly violent) minority was interested in establishing its own state.

Force dynamic boundaries demarcate the area over which an entity is capable of exerting influence. This boundary of capability might coincide with, or be produced by, physical discontinuities in reality if the entity in question did not have the capacity to overcome that obstacle. To return to the tactical example, if an infantry unit did not have indirect fire capabilities, physical vertical boundaries might limit the area in which it could take action. Force dynamic boundaries may be fluid and changing, but they should not be confused with rapidly changing fiat boundaries. Fiat boundaries might be redefined weekly, daily, or with even greater frequency without changing their nature. Force dynamic boundaries are not created by the consensus of deliberative bodies, which could potentially reestablish fiat boundaries with whatever frequency they desired, but rather by the capabilities of entities and the way they interact. They may change very rapidly, as with the force dynamic boundary of a unit of AH-64 Apache helicopters moving across the desert, but they may also settle in a location for extended periods. If the balance of power between two entities is maintained for an extended period of time, the force dynamic boundary may become relatively stable, but will remain force dynamic.

A further distinction can be made between the area in which one is capable of taking action and whether one actually chooses to take action in it. One could have an artillery unit that had a force dynamic boundary based on the range and capabilities of its weapon system, but whose leadership had constrained the area where it was permitted to take action in a certain direction to be less than that of the

effective range of its weapons. Does the artillery unit's force dynamic boundary continue to correspond to its capabilities, or does the force dynamic boundary contract to follow the limitation imposed by its leadership? This question remains open.

4.4. Force dynamic states

States with force dynamic territorial boundaries were more common in the past than they are today. This has been explored in political geography through terms such as borderlands, border zones, and border regions ("Borderland", 2000; Agnew, 2000). In these situations, there is no crisp demarcation between geopolitical territories, and instead there is an area not quite under either's control that separates them. The Roman Empire and Chinese Empire are traditional examples of historic geopolitical entities with such a political boundary configuration (Agnew, 2000). Today, states are generally not allowed to claim the areas over which they can (merely) exert influence as their territory, but rather must define their territory by crisp fiat boundaries. If the nation of the Kurds were to establish a state of Kurdistan, likely the vague force dynamic boundaries of the territory over which the nation exerts influence would have to be codified into the crisp fiat boundaries of the territory of a modern state.

However, while geopolitical entities of much earlier eras are cited as examples of states with force dynamic boundary segments, this idea has not completely vanished in more modern times. For instance, prior to World War II, German scholars of the (now discredited) school of *Geopolitik* claimed that boundaries of the force dynamic sort (although they did not use the term) were the ideal kind for a vibrant and growing state, as opposed to the British Empire, which sought to define crisp boundaries around its imperial holdings (Dikshit, 2000).

The situation where a state has a complete and crisp fiat boundary enclosing its territory, but also has a larger force dynamic boundary, is not addressed. For example, even though the territory of the United States is defined by international boundaries, the area the United States is willing to defend and take action in is broader than those crisp boundaries. Recently, the United States has defended, and taken aggressive action in, parts of Iraq and Afghanistan. It sought to defend Saudi Arabia from Iraqi incursion during Operation Desert Shield, and operated in Kuwait and Iraq during Operation Desert Storm. The area the United States (and other states) will defend or operate in is variable across time and often vague. At times, the limit of this region may be unknown and debated. For instance, whether the United States should have intervened in the Russian invasion of Georgia, or if the United States should intervene if China were to attack Taiwan has been, and is, debated. This debate could be about where the force dynamic boundary of the area in which the United States is willing (or able) to take action in is located.

In the case of state territory, the state's territorial boundary surfaces enclose an area that is different in character from the area between the boundary surface and the force dynamic boundary. The area between the boundary surface and the force dynamic boundary is not the state's territory in the same way as the area bounded by the state's boundary surface. For instance, it could be said that the fiat boundary surfaces mark the area over which the state is sovereign. It is not sovereign over the territory between the boundary surface and force dynamic boundary. A different relationship appears to hold.

5. Geopolitical boundaries and territories in DOLCE

In the previous sections of this article, the ontology of geopolitical entities was approached from a philosophical standpoint. In this section, the objective is to use that analysis to place states, nations, and geopolitical boundaries into an existing upper-level ontology. DOLCE would seem particularly well

suited for use as a foundation for a geopolitical ontology for several reasons. Its goal is to describe the "the ontological categories underlying natural language" (Masolo et al., 2003, p. 7) and its categories are "cognitive artifacts ultimately depending on human perception, cultural imprints and social conventions" (Masolo et al., 2003, p. 7). Geopolitical entities such as nations, states, and territorial boundaries are not only articulated through natural language, but also are social entities formed by cultural imprints and social conventions. Additionally, the objective is to describe geopolitical entities accurately, and DOLCE is a descriptive ontology for "making *already formed* conceptualizations explicit" (Masolo et al., 2003, p. 7). However, boundaries are not well developed in DOLCE. D18 notes that boundaries are features of other objects, but there is no further explanation. Boundaries are important in many different domains of discourse, including the geopolitical, and thus this investigation may be able to extend and develop DOLCE in a previously unexplored way.

5.1. The existence of boundaries and their placement in DOLCE

The very existence of boundaries is not without philosophical controversy. Choosing whether or not to include boundaries in an ontology will have different mereotopological ramifications for the domain. Casati and Varzi (1999) write, "The choice between a boundary-based and boundary-free mereotopology can hardly be eluded, since the notion of external connection (connection without overlap) may change significantly depending on whether or not boundaries are included in the domain of reference" (p. 71). However, human perception, discussion, and acceptance of boundaries in the everyday world of the mesoscopic "is so natural and pervasive that it is hard to deny boundaries a central place in our conceptual scheme" (p. 72), and they "belong to the palette of basic ontological tools that we commonly use to describe the spatiotemporal world" (p. 72). DOLCE includes boundaries, and it would seem that this inclusion is appropriate in a descriptive ontology with a cognitive bias, regardless of whatever "deep and difficult questions" might arise later when "the duty of boundaries is taken seriously into account" (p. 72).

DOLCE divides *Endurant* into the categories *Physical Endurant* and *Non-physical Endurant*, depending on whether or not the endurant has direct spatial qualities. DOLCE begins to consider boundaries at the level below the division of the physical and the nonphysical. *Physical Endurant* is divided into the categories *Amount of Matter*, *Physical Object* and *Feature*. Examples of the category *Feature* are a hole, a gulf, an opening, a surface, a stain, and (critically for this discussion) a boundary. Members of the category *Feature* are "generically constantly dependent on physical objects (their hosts)" (Masolo et al., 2003, p. 23). While the general structure of these distinctions is also intended to hold for the category *Non-physical Endurant*, they were not fully developed in D18, since "the characteristics of non-physical features have not been considered yet"[4] (Masolo et al., 2003, p. 23). DOLCE includes boundaries as a "parasitic" feature on other objects, and not independent objects in their own right. A geopolitical boundary would need a host to generically constantly depend on. There can be no "boundary of the territory of Ruritania" without there being "a territory of Ruritania". As described in earlier sections, a state's territory is a wedge-shaped fiat part of the earth, atmosphere, and waters. Because DOLCE does not include a specific category for fiat parts of objects,[5] such as entity would be a *Non-agentive Physical Object* with fiat boundaries.

[4]If these general distinctions do hold for nonphysical entities as well, it will be important to consider how an entity without a direct spatial location can have a boundary, which also would not have direct spatial location.

[5]This contrasts with Basic Formal Ontology or BFO, which includes *Fiat Part of Object* as an *Independent Continuant* on the same ontological level as *Object*, *Object Aggregate* and *Boundary of Object*. Documentation of BFO can be found in Spear (2006).

5.2. DOLCE's distinction between physical and nonphysical

As mentioned above, DOLCE distinguishes between *Physical Endurant* and *Non-physical Endurant* based on whether or not the entity has direct spatial qualities. The implications of this distinction for geopolitical territories and boundaries are now considered, especially since, at times, this article has been using a notion of the physical/nonphysical that might be counter to DOLCE. If geopolitical territory and boundaries exist, or at least are accepted into an ontology for information system purposes, then it would seem difficult to deny that they have direct spatial locations. The fiat territory of Mexico and of the United States has a specific location, as does the Mexican/American border. This means that geopolitical boundaries and the territory they bound would be subclasses of *Physical Endurant*. Although the fiat territory of a state (including the land, rocks, and trees of the earth, as well as the air of the atmosphere and waters of the hydrosphere) does seem to be intuitively physical, the fiat geopolitical boundary that divides one state's territory from another seems intuitively nonphysical. After all, geopolitical boundary planes offer no barrier to movement, as one might expect a physical boundary to do. However, it seems difficult for a physical object to be delimited by a nonphysical boundary. If the object is physical, it would seem straightforward that its boundary is also physical, even if fiat. In some cases there may be an over association of fiat boundaries with the nonphysical. DOLCE, as it is described in D18, does not contain a distinction between physicality and materiality. Introduction of this distinction could allow the distinction between the physical and nonphysical to continue to be based on whether or not the object in question has direct spatial qualities, but then allow a further distinction between those entities that are made of matter and those that are not. This is discussed further below.

Categorizing the territory and territorial boundaries of states as physical entities would seem counter to the arguments that denied that there are any physical discontinuities in reality that form these entities. Rather, they are created through human cognitive fiat, and these nonphysical geopolitical boundaries are independent of physical boundaries whether they are colocated with physical boundaries or not. This is a clash between what DOLCE considers to be the characteristic difference between the physical and nonphysical, and the assumptions that may be made in other circumstances regarding what it means to be physical, nonphysical, or social. For example, following the arguments in the first part of this article, the geopolitical boundary between states could be regarded as a (nonagentive) social object. Examples of *Non-agentive Social Object* from D18 are laws, norms, shares, and peace treaties, but *Social Object* is not well developed in D18. The only axiom concerning it is that it is one-sidedly generically constantly dependent on *Society*. Geopolitical boundaries and geopolitical territory do fit this (minimal) qualification for being a *Social Object*, but such a classification would conflict with the inability of nonphysical objects to have direct spatial properties.

A resolution of these issues might simply be to accept the original DOLCE distinction between *Physical Endurant* and *Non-physical Endurant* and place geopolitical territory and boundaries as physical objects, however counterintuitive that might be (especially in a descriptive ontology of "common sense"). But, rather than *Endurant* being divided into *Physical Endurant* and *Nonphysical Endurant*, *Endurant* can simply be thought of as being divided into the categories "*Endurant with Direct Spatial Qualities*" and "*Endurant without Direct Spatial Qualities.*" When considered in this way, the placement of geopolitical boundaries in a category of *Endurant with Direct Spatial Qualities* seems far less objectionable (and even correct) than placing them in a category *Physical Endurant*, even though they have the same meaning in DOLCE. Figure 2 diagrams the suggested DOLCE placement of the geopolitical entities discussed in this article. The fiat part of the earth, atmosphere, and hydrosphere would play the role of

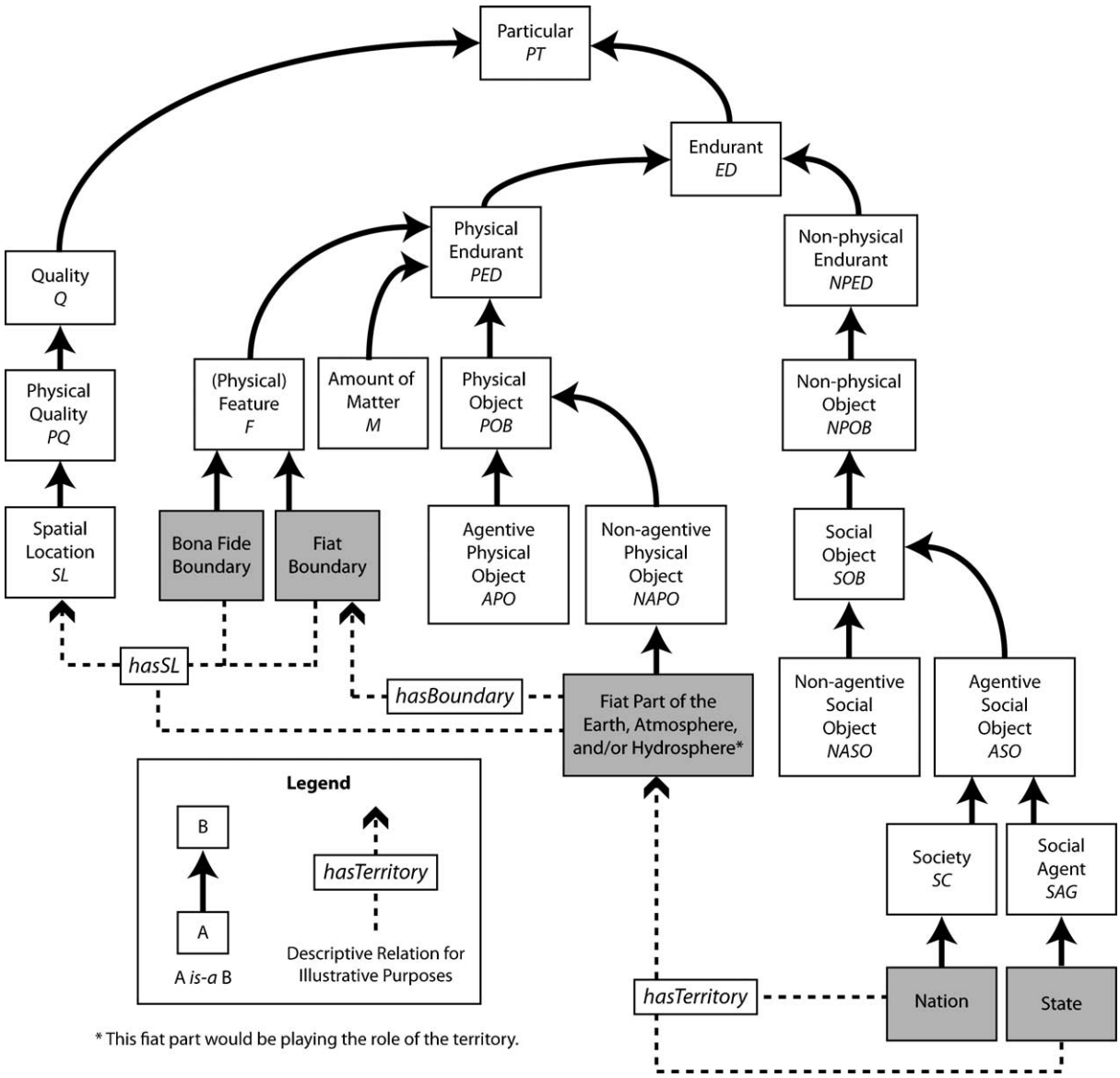

Fig. 2. The placement of selected geopolitical entities in DOLCE.

the territory of the state.[6] D18 does not specifically address where the category *Role* should be placed, but in other research, such as Bottazzi and Ferrario (2009), the category *Role* is considered as *Social Object*. This solution is, of course, open to further revision, as *Social Object* and implied categories such as (*Non-physical*) *Feature* receive more detailed investigation and axiomization.

[6]Or it could play the role of the territory of a nation, although states and nation "have territory" in different ways that require further investigation. For instance, nations do not typically have any atmospheric territorial claims, especially in the legal sense of international law. Moreover, the territory of states and nations can overlap and this does not necessarily have to cause conflict. The descriptive relation "hasTerritory" shown in Fig. 2 should be taken very generically. Further research could examine specifications of that relation, particularly with regard to how it can differ between entities.

5.3. *Nations, states and nation-states in DOLCE*

With the understanding that agentivity is a very preliminary part of DOLCE, and that there are still philosophical issues relating to agentivity that need be addressed in DOLCE (such as those described in Bottazzi & Ferrario, 2009, and Robinson, 2010), a few remarks can still be made concerning the placement of nations and states within the ontology. Nations do not have objective legal personality in international law – the definition of what it means to be a state. Instead, nations are groups of people with certain unifying cultural characteristics. In some situations, a nation's objective may be to fulfill the criteria of statehood and bring into being an emergent objective international person. If nations can have goals, objectives, beliefs, desires, and intentions, then this seems to argue for their agentivity, especially in DOLCE. DOLCE provides two different categories of agentive social objects, *Social Agent* and *Society*, although the distinction between these two is not quite clear, as discussed in Robinson (2010). For present purposes, a nation is categorized as a *Society*. Nations have human beings (belonging to the category *Agentive Physical Object*) who fit the nation's cultural/ethnic/linguistic criteria as members.

D18 provides "a legal person" as an example of the category *Social Agent*, and following Robinson (2010), *Social Agent* subsumes *State*, as the objective legal person of international law. Importantly, *State* does not have *Spatial Location*, though its territory certainly does. The territory of the United States has a spatial location, but the objective legal person of international law "the United States" is not located in space, though it is located in time. *State* is distinct from the category *Government*, which would be subsumed by the category *Organization*. Little need be said here on the subject of nation-states. At a basic level, if the majority of the human beings living within the boundary of a state's territory are citizens of that state, but are also members of a single nation, then that state is a nation-state.

National boundaries[7] and national territory warrant their own investigation, beyond that which can be conducted here. In one sense, since both the territory of nations and the territory of states are "territory", the same relationship may hold between the state and its territory as between the nation and its territory. Both states and nations may attempt to exclude intruders from this area by advertisement, threat, and/or attack. However, the relationship that a state has with its territory is different from the relationship between a nation and its territory. As one specific example, a state has a legal right to defend the territory under international law that the nation does not have. Furthermore, as mentioned above, the area a nation is currently occupying may not be its territorial homeland. In the event that a nation has been displaced from its homeland, there is a difference between the relationships that hold between it and the area it currently occupies and between it and its homeland.

5.4. *A physical/material distinction*

D18 explains that DOLCE is a descriptive ontology that "aims at capturing the ontological stands that shape natural language and human cognition. It is based on the assumption that the surface structure of natural language and the so-called commonsense have ontological relevance". The appeal to common sense might suggest that DOLCE does not intend to get "too complicated" in its representation of the world. However, common sense is a moving target (Masolo et al., 2003, p. 42), and there is certainly

[7]It is unfortunate that English uses the adjective "national" as the adjectival form of "state". In spoken English, states have national boundaries, national territories, and national militaries. This leaves no particular word for the boundary of a nation, the territory of a nation, or armed forces that might have been raised by a nation. For the purposes of this article the term "state" has been used as its own adjective. Thus, states have state boundaries, state territory, and state militaries. This leaves the term "national" as the adjectival form of "nation". This is a more consistent, although unconventional, usage of the term.

potential for disagreement regarding what is the most straightforward common sense interpretation of particular phenomena.

An alternative interpretation for geopolitical boundaries would involve challenging DOLCE's distinction between the physical and nonphysical, and replacing it with a distinction based on whether the entity is "made of" matter. It could be argued that such a distinction is more descriptive and "common sense" than one based on the possession of direct spatial qualities. The distinction between the physical and nonphysical could be extended with the distinction between the material and the immaterial. Material entities are made of matter, whereas immaterial entities are not, but both can be physical. Both material and immaterial entities could have spatial location. Nonphysical social entities can remain dependent upon societies, but additionally, some immaterial physical entities can be dependent upon societies as well. Such an ontological approach could capture the social nature of political boundaries more directly. Through such an approach, a geopolitical boundary would be physical, since it has direct spatial qualities, but immaterial, since it is not made of matter, and could also be social, since it is dependent upon societies. An ontology built on such assumptions might be able to capture the social nature of geopolitical boundaries in a more straightforward way than DOLCE currently does.

Introducing a distinction between those entities that are made of matter and those that are not may, however, prompt consideration of the ontology's position on the existence of social reality. A social realist ontology is one in which "social reality exists, that entities such as claims, prices, financial transactions, elections, trials, and weddings are not mere fictions and that our talk of such entities is not a mere collection of roundabout ways of talking about other things" (Smith, 2008, p. 42). However, a social realist solution has the possible disadvantage of a denial of physicalism, the belief that "whatever exists or occurs is ultimately constituted out of physical entities" (Shoemaker, 1999, p. 706). This could seem counter to general scholarly opinion, especially in the field of international relations and geopolitics, where Wendt (2004) explains, "most of us at least tacitly accept an ontology of physicalism, or materialism, which is the view that, ultimately, reality is made up of purely physical stuff (matter)" (p. 290). Regardless, determining which position (whether or not there are immaterial social entities) is the "common sense" position remains open. Natural language does imply the existence of immaterial social entities, but this may or may not be correct in an ultimate metaphysical sense (which is left for further dedicated philosophical investigation). However, in ontologies that do not have any particular restrictions on the postulations of entities (such as DOLCE), taking a social realist position may gain an element of simplicity for practical ontological purposes. For example, a "common sense" social object such as the boundary between the United States and Mexico could exist and have properties (such as length and spatial location) within an ontology-enabled geographic information system. It would not be necessary to construct a social fictionalist theory and indirectly account for the border through human behaviors and beliefs.

6. Conclusions and future research

With the revisions and extensions presented in this article, the fiat, bona fide, and force dynamic boundary distinctions can better describe the boundaries of geopolitical entities, such as the territories of nations and states. When the distinctions between geopolitical entities and the areas people may occupy are examined, the boundaries they have were shown to be more complex than the physical boundaries of islands, rivers, or ridges of mountain ranges. This article has revised and extended this theory of geopolitical entities by distinguishing between states and nations, distinguishing between nonphysical

states and their territories, and considering the state's maritime territorial holdings and the territory's three-dimensional structure. Through those clarifications, an argument against bona fide state territory was made.

Consideration was given to the placement of these geopolitical entities in DOLCE. Its distinction between the physical and nonphysical is based on whether or not the entity has direct spatial qualities (such as location). Thus, in DOLCE, even fiat geopolitical boundaries need to be classified as physical entities. However, this distinction between physical and nonphysical entities need not be accepted. A distinction based on being made of matter was discussed, and a recommendation made for the inclusion of a distinction between the material and the immaterial in addition to the distinction between the physical and the nonphysical. If the ontology is being developed for reasons other than academic metaphysical research, the practical purpose to which the ontology will be put may be an important factor influencing the position taken with regard to the existence of immaterial social entities.

Building an extensive and expressive domain ontology for political geography is left to future research. Additionally, this article has only provided preliminary notes on the relationships that geopolitical entities might have with their territory. This subject deserves more detailed treatment, and is especially relevant to the subject of geography.

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