Personas, Social Distance, Dimension Reduction, and Power Diagrams

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Abstract: This paper seeks to expand upon Burnett's use of conceptual spaces to explain the communication of personas between interlocutors. This conceptual space framework, developed by Gardenförs, creates a geometric diagram to model contextual categorization. Critically, in certain contexts, some personas are more salient than others as their categorization depends on continuous and categorical perception. In response, this new conception will rely on the idea of identities as prototypes. The persona is regarded as the most general form of persona, allowing for a more intuitive representation of personas. In this diagram, the prototype is the primary member of a Voronoi cell to a set of variants rather than an approximal member. This diagram will have more explanatory power by plotting it in dimensional space representing social power relations more generally. This paper incorporates existing frameworks within computational geometry like dimension reduction, Delaunay triangulations, and power diagrams to flesh out Burnett's ideas.

1. Introduction

This paper builds a few conceptual geometric diagrams as alternate ways of thinking about personas within semantics. First, I summarize Burnett's account. Next, I explain the necessary parts of conceptual spaces, as conceived by Gardenförs, to build a fuller conception of personas. I then use dimensional reduction and power relationships within society to lay out a more general version of conceptual spaces and personas. Next, I explain Delaunay triangulations, shortest paths, and dimensional perspective to judge the relatedness of personas. Finally, I introduce the notion of a power diagram to describe more complex relationships between personas.

1.1. Burnett's paper

Burnett's paper attempts to construct a new semantic and pragmatic analysis for the terms "dyke" and "lesbian" . Burnett illustrates "dyke" as a disempowered persona in contrast to "lesbian". "Lesbian"'s power originates from its mainstream familiarity, and thus, those considered lesbians receive better treatment from formal institutions. Burnett then analyzes "dyke" as a slur and concludes that the term is unpluggable from its offensive meaning by outside members because of its taboo nature. Then, to explain personas between in-group and out-group members more clearly, she uses Gardenförs' conceptual spaces framework to geometrically model these ideas. Her configuration allows speakers/listeners to communicate their social positions based on their assumption of listeners/speakers. To a bigot, a "dyke" and a "lesbian" fall under the same category. Importantly, she concludes that mainstream institutions support mainstream groups, in this case, lesbians, and going against this grain and exhibiting features of a "dyke" can be potentially harmful. I will focus on these last two conclusions within this paper. First, the idea that a bigot cannot meaningfully pick apart the difference between a "lesbian" and a "dyke" is false. Next, societal power relations properly separate personas.

2. Personas and Voronoi Tessellations

Gardenförs introduced the idea of conceptual spaces to describe cognitive processing more clearly. Gardenförs' book "Conceptual Spaces" binds modern notions of psychology to geometry to provide an alternate approach to the existing approaches, symbolic logic and connectionism, which explain cognitive phenomena. The symbolic approach considers cognition to be equivalent to symbolic manipulation while connectionism models cognition through simulated neural networks. His new theory of conceptual spaces intends to combine these notions into one. This desire for combination roots from symbolic representations' inability to model more abstract concepts, something Gardenförs views as necessary to properly model cognition. This is especially true for a notion like personas, which relies heavily on human cognitive comparison and is not modeled intuitively through symbolic logic.

Instead, Gardenförs uses a geometric framework to model cognition. When one plots concepts into dimensional space, those dimensions represent aspects of the concept and allow for gradability. Splitting up that space separates different parts of a concept into necessary slots. These features are useful for personas because, to understand a single persona, it takes knowledge of social context in multiple dimensions. Additionally, these differences are not often clearly distinct from one another.

Gardenförs's ultimate intent in developing this framework is to allow researchers the ability to use his framework to perform experiments and model other ideas. When I describe the framework below, I want to note that when Gardenförs describes his idea of conceptual spaces, he means for researchers to construct these diagrams through experimentation. Because of this, it makes the most sense to construct persona-based geometric figures based on the social experiences of people within these groups rather than based on theory alone. Sociological experimentation is necessary to capture the intricacies of these phenomena.

2.1. Gardenförs's Properties

In the third chapter of Gardenförs's book, he describes properties. He begins by describing the difference between properties and concepts. A property recognizes invariance amongst objects. To Gardenförs, a property is defined with the aid of a single dimension or a small number of integral dimensions forming a domain (as defined in section 1.8), while a concept is based on several separable subspaces (Gardenförs 2000). Immediately, one should note that Burnett used only three integral definitions to plot the difference between lesbian and dyke: overt sexual desire for women, anti-mainstream or feminine masculinity. The low amount of dimensions signals that these terms are closer to properties than concepts. However, surely, personas should have a greater number of dimensions and resemble concepts more closely than properties. It seems more intuitive to describe overt sexual desire for women, anti-mainstream or feminine masculinity as properties rather than lesbian or dyke. In fact, within the same chapter, Gardenförs states "the semantics (and to some extent even the grammar) of the linguistic constituents is severely constrained by the structure of the underlying conceptual space," elucidating the necessity of capturing the dimensionality of space in a careful, intricate manner.

Then, Gardenförs goes on to specify that the properties necessary to be modeled are natural properties. Natural properties stand in contrast to abundant and sparse properties, which represent uselessly common and

uselessly rare traits, respectively. From here he defines "criterion p" as "natural property is a convex region of a domain in a conceptual space", meaning that properties must be completely separate from one another. Burnett does a great job of identifying the traits which separate these phenomena through personal experience and study of comics, but it seems as though there needs to be some sort of more stringent method of selecting dimensions.

To handle the psychological phenomenon of categorization, Burnett introduces the idea of a prototype. A prototype is the most representative member of its group's properties, situating it in the center of a conceptual space. I will be using the identities of people as the prototypes within Voronoi regions in my framework. I intend to have a Voronoi diagram which can compare the slurs of different groups of people, rather than the slurs for one group of people, as with Burnett.

To Gardenförs, prototypes accurately model mental categorization. After all, humans categorize objects through comparison to other objects. In most cases, there is an object which is the most general form of an object to which other objects compare. For example, a chair could be considered a prototype. The most prototypical version of a chair would perhaps be a simple desk or table chair. From here, there are variations like a recliner, wheelchair, or lawn chair, which all vary in their closeness to their prototype. These similarity judgments occur when people compare a reference object to some prototype, and these forms of membership are graded. These judgments form from the psychological relationship between stimulus and the response (Gardenförs 2001).

This idea holds with the categorization of groups of people by other groups of people. Psychologically, people have pre-existing beliefs about certain groups of people due to their exposure and its manner to a group of people. Generally, groups of people who are most socially distant from one another have categorizations based on stereotypes. These stereotypes keep people from seeing others clearly and with complexity. The further the distance, the fuzzier the properties (Gardenförs 2000).

2.2. Voronoi Tessellations

The concept of Voronoi Tessellations is critical to Gardenförs' notion of dimensionality as well as Burnett's framework for understanding personas. Voronoi diagrams are a data structure used within computational geometry frequently to perform point location in a manner that is efficient in time and storage. The most important property for this diagram is for each Voronoi cell; every point within that cell is closer to the Voronoi site than to any other site. Because of this definition, one can see why Gardenförs would have found it an optimal geometric structure for comparing concepts. Like most data structures within computational geometry, the Voronoi diagram relies on convexity. A shape is convex if, for every point p, there is a line segment completely within the shape to every point q. As explained by Gardenförs, convexity allows properties to be compared.

This structure relies on the notion of prototypes. To model prototypes conceptually, the prototype occupies the absolute middle of the conceptual spaces. All approximal members of the same category fit into the same space yet not in the exact center. Their distance from the center shows their difference from the prototype, and the direction of their difference shows the quality of their difference. In Burnett's paper, Burnett uses "lesbian" and "dyke" as separate Voronoi cells.
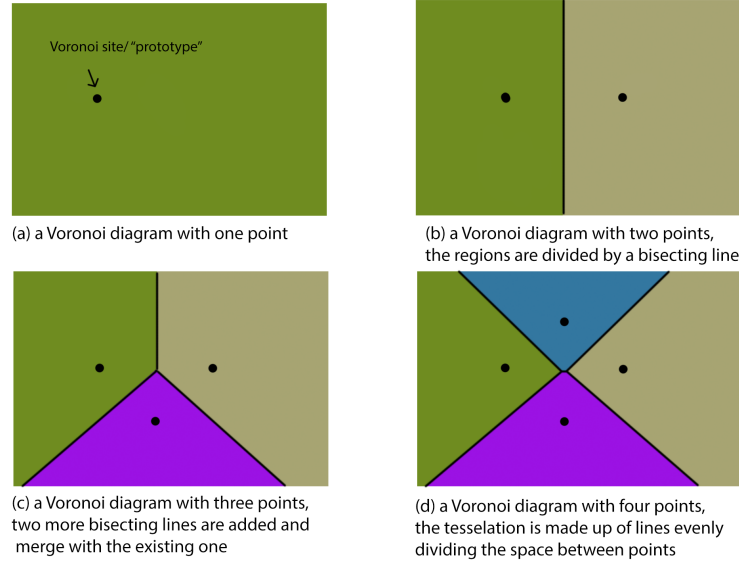
(a) a Voronoi diagram with one point

(b) a Voronoi diagram with two points, the regions are divided by a bisecting line

(c) a Voronoi diagram with three points, two more bisecting lines are added and merge with the existing one

(d) a Voronoi diagram with four points, the tesselation is made up of lines evenly dividing the space between points

Figure 1: Voronoi Diagram

Voronoi diagrams are often described in terms of two dimensions, like most basic geometric shapes, yet as their dimensions increase, the greater the explanatory power they hold. For Burnett's paper, she gave three dimensions which she posited were the dimensions that showed the difference between the term "lesbian" and the slur "dyke", which are each associated with separate personas. Each term became their own prototype where other points, which could represent individuals, could be plotted to determine their membership within that persona. However, although this figure gave a more intuitive and visual understanding to the differences between the word "lesbian" and the word "dyke", it overlooks the fact that "lesbian" is a prototypical version of the word "dyke". In the diagrams I provide below, this problem is solved.

Here, I'll provide a quick definition for these Voronoi diagrams, which I will use when describing extensions of these diagrams later on.

For the Voronoi diagram Vor(P) of a set of points P the following holds:
A point q is a vertex of Vor(P) if and only if its largest empty circle CP(q) contains three or more sites on its boundary.
The bisector between sites p_i and p_j defines an edge of Vor(P) if and only if there is a point q on the bisector such that CP (q) contains both p_i and p_j on its boundary but no other site. (Berg 2008).

As explained above, this definition only really means that for each site, every point within its cell is closer to that site than any other site. Later, this will give us the ability to judge whether or not various data points belong with certain prototypes versus other prototypes.
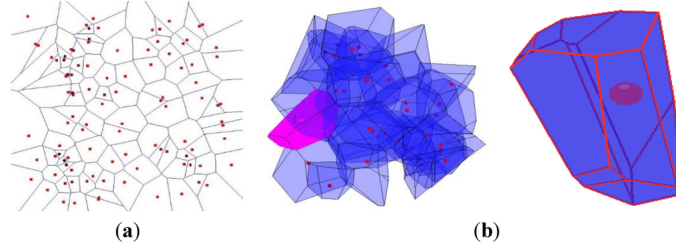
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Figure 2: Multidimensional Voronoi Diagram (Ying 2015)

3. Solutions

3.1. Dimension Reduction and Delaunay Triangulations

In this section, I'd like to introduce the notion of dimension reduction. Dimension reduction can be done in many different ways, like tsne, PCA, etc, but the result is reducing a large dimensional data set to a more interpretable lower dimension structure. Normally, dimension reduction occurs with large datasets where researchers are trying to glean important features from a vast matrix of seemingly random features.

However, in our case, we will use dimension reduction to conceptualize a larger version of the persona-Voronoi construction. In our Voronoi diagram, we will have three dimensions to graph identities and their personas. This diagram is constructed along three dimensions: social, political and economic. This is a generalization of power within society; power can typically be held politically, socially, and economically by groups. And even more typically, a group that holds onto one of these groups of power holds on to others. However, this is an ideal way to graph how society disenfranchises different groups. However, this system is more complex, and along each of the three dimensions, there are specific dimensions and dimensions of those dimensions of each type of power. Burnett's examples of dimensions could exist along these dimensions somewhere.

Now that we have the idea of our structure in place, we must ask whether or not this explains how personas view each other more robustly. Measuring the distance between personas is more easily done if we apply Delaunay triangulations. A Delaunay triangulation is a dual graph of a Voronoi diagram. Essentially, each site in the Voronoi diagram becomes a node in a Delaunay triangulation, which is a graph with unweighted, bidirectional edges. These sites become connected by edges that bisect the edges of each Voronoi cell of the graph. See Figure 3.

Now, to properly measure the distance between personas, one only needs to construct a Delaunay triangulation from the Voronoi diagram and measure the distance along the path connecting some persona p to another persona q.

The shortest path constructed can also tell you important information about the differences between these two personas. Whichever dimension the path travels upon for the greatest length will be the dimension in which there is the greatest distance.

Of course, one could construct this triangulation from the three-dimensional Voronoi diagram,, but one could also construct it along the n-dimensional data structure described above. In this case, there would be a great deal of information regarding the differences between groups.
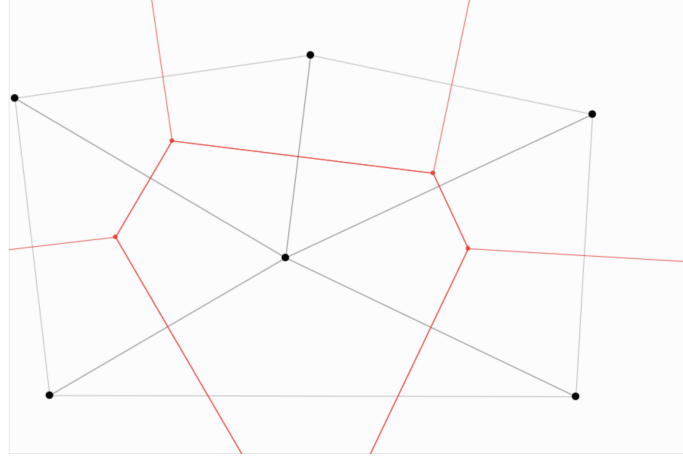
Figure 3: Delaunay Triangulation

Also, to make this idea clearer, we can conceptualize it on a smaller scale. If we simply have the case where we have three dimensions - social, political, and economic. If we then plot three identities, white, black and Latinx, we could immediately understand that black and Latinx would rank fairly low in all dimensions compared to white. But if we were to reduce the dimensions to two dimensions, the algorithm (in theory) would pick the two dimensions which show the greatest difference in the plotted personas. We would likely end up with a social dimension and an economic/political dimension. The social dimension would show more variance, and the economic/political dimension would become one access as those two aspects behave more similarly. This result would show us that there is a greater difference between blacks and Hispanics socially than economically and politically.

3.2. Power Diagram

To display personas in a more accurate manner, where identity is the site of the Voronoi cell and the personas are points within this region, I will introduce power diagrams.

A power diagram is simply a weighted version of the Voronoi diagram. This weighting takes place by treating the diagram's points as circles rather than points.

In Gardenförs' more recent paper Reasoning about Categories in Conceptual Spaces, he uses this system to describe differences in species. It accounts for more complex situations between points on the diagram by making the points circles instead. With Region Connection Calculus, he defines five different base relations which allow for more complex relationships between personas. I'll use four of them (for simplicity's sake). These base relations are DR (discrete), EQ (identical), PP (proper part), and PO (partial overlap). DR (discrete) means the two circles are entirely separate. EQ (identical) means the circles are identical. PP (proper part) means that one of the circles fully contains the other. PO (partial overlap) means that one of the circles partially overlaps the other.

The example that I provide comes from the specific example given by Gardenförs.

So, in my example, African-American, Caucasian, and Latinx are all prototypes within their regions. The term black exists within African-American as it is likely the most prototypical term for African-Americans.
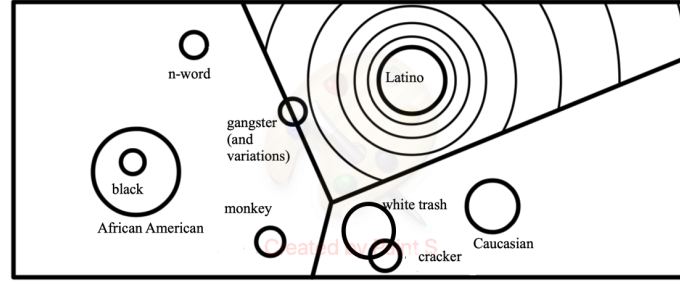
Figure 4: Power Diagram Example (derived from Gardenförs 2001)

Next, there are two terms: the n-word and monkey (which were difficult to type out), which exist within the region for African Americans. Although, because the dimensions are unlabeled, it is unclear how to judge these terms. However, this idea can be abstracted away through the idea that there is greater dimensionality for African Americans, although reduced to view this diagram conceivably. Next, there is the term 'gangster', which bridges the regions for Latinx and African American; this is because there is overlap in the use of the term for the two groups of people. For Caucasian, there are two other terms within its sphere, white trash, and cracker. As you can see, there is overlap between these two categories as the two terms have similar meanings, and both describe Caucasian people who are poorer.

The circles around Latinx exist to show how prominent overlapping categories could potentially be.

4. Conclusion

In conclusion, a more general form of personas within conceptual spaces would model personas according to their power within mainstream society. There are clearly more dimensions to their categorization than this, but these can be abstracted away through dimensional reduction but still understood and modeled in smaller contexts. Additionally, to model more complex relationships between personas, one could use power diagrams and Regional Connection Calculus, which use circles instead of points.

To judge the differences of personas between different groups of people, one could construct a Delaunay Triangulation over the Voronoi Diagram and use the shortest path to measure distances.

These ideas arise from the inconsistencies and lack of explanatory power of Burnett's model.

References

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