Leveraging the alignment between machine learning and intersectionality: Using word embeddings to measure intersectional experiences of the nineteenth century U.S. South

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A B S T R A C T

Machine learning is a rapidly growing research paradigm. Despite its foundationally inductive mathematical assumptions, machine learning is currently developing alongside traditionally deductive inferential statistics but largely orthogonally to inductive, qualitative, cultural, and intersectional research—to its detriment. I argue that we can better realize the full potential of machine learning by leveraging the epistemological alignment between machine learning and inductive research. I empirically demonstrate this alignment through a word embedding model of first-person narratives of the nineteenth-century U.S. South. Situating social categories in relation to social institutions via an inductive computational analysis, I find that the cultural and economic spheres discursively distinguished by race in these narratives, the domestic sphere distinguished by gender, and Black men were afforded more discursive authority compared to white women. Even in a corpus over-representing abolitionist sentiment, I find white identities were afforded a status via culture not allowed Black identities.

> *At any rate, as our Caucasian barristers are not to blame if they cannot* quite *put themselves in the dark man's place, neither should the dark man be wholly expected fully and adequately to reproduce the exact Voice of the Black Woman.*
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> —Tawawa Chimney Corner, 1892[1]

1. Introduction

Academia exists within disciplinary silos, yet several powerful interdisciplinary ideas have managed to bridge disciplines. Intersectionality is one of these ideas. A theory about how social categories intersect with each other and with systems of power to produce unequal lived experiences, intersectionality has provided a language to connect multiple disciplines and subjects under the same theoretical and epistemological framework (Collins & Bilge, 2016). Inferential statistics, or the use of statistics and quantitative data to deduce properties of an underlying population distribution, similarly connects multiple disciplines and subjects under the same *methodological* and epistemological framework. These two unifying frameworks, however, represent nearly mutually exclusive research agendas. This chasm is largely driven by epistemology: as a radically deductive method, the epistemology of inferential statistics is, by and large, inconsistent with the epistemology of intersectionality. Machine learning, or the use of computers to do

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[1] Cooper 1892, III

complex tasks without explicit instructions, has recently become another disciplinary-spanning framework. As a radically inductive method, machine learning is foundationally compatible with the epistemology of intersectionality.

To the detriment of all, machine learning is currently developing alongside inferential statistics but largely orthogonally to the intersectionality paradigm and other cultural and qualitative research. Intersectional and culture scholars should not abandon computational methods to inferential statistics. Instead, I argue we can better realize the full potential of both machine learning and intersectionality by leveraging the alignment between the two.

Using a diverse collection of nineteenth-century first-person narratives from the U.S. South, I empirically demonstrate one way scholars can leverage this alignment. Using word embeddings, one machine learning method, I quantitatively and visually mapped the relative positions of four social categories (Black and white men and women) within five social institutions (the polity, the economy, culture, the domestic, and authority), formally modeling intersectionality while staying true to its epistemology. Through this inductive computational analysis, I found that in this corpus, identities based on race were most distinguished by cultural discourse, identities based on gender were most distinguished by discourse about the domestic, and the economy vector revealed the differing gender schemas ascribed Black and white women. Black men, additionally, were afforded more discursive authority compared to white women, even as white women had real authority over Black men. A complementary close reading of several texts contextualized and confirmed these findings. Even in a corpus composed largely of abolitionist and anti-racist sentiments, white identities were afforded a social status via culture not allowed Black identities, establishing a deep discursive divide between the races.

2. Intersectionality

Intersectionality is a theoretical framework for understanding how social identities and categories combine and interact with systems of social, cultural, economic, and political power to create distinct, and unequal, lived experiences. While the specific concept of intersectionality is most often traced to Kimberlé Crenshaw's legal treatise (1989), the attention to multiple intersecting identities reaches back centuries. In an early articulation of intersectionality, Anna Julia Cooper described how gender and class mediated the experience of slavery and racial oppression in her book *A Voice From the South* (Cooper, 1892). From Claudia Jones (1949), the Combahee River Collective (1983), and the anthology *This Bridge Called My Back* (Moraga & Anzaldua 1984), to Patricia Hill Collins (2009), Sirma Bilge (Collins & Bilge, 2016), and Jennifer Nash (2018), scholars and activists of color, led by Black feminists and womanists, have since developed the theory of intersectionality into a powerful academic and social justice framework.

The theory and application of intersectionality have proliferated in the past decade. Because it is a traveling theory (Said, 1983), precisely defining intersectionality in a way that encompasses its many uses is challenging (Collins, 2015). In this paper I treat the concept of intersectionality as a potentially unifying research paradigm (Hancock, 2007) with five features. First, we can only understand one identity or social institution through its relation to other identities and social institutions. Second, identity is an embedded experience: the same person may experience the same aspect of their identity in a different way depending on the social institution it is embedded within. Third, there is no a-priori hierarchy to identities or social institutions; the nesting and hierarchy of experiences, identities, and institutions are situationally specific. Fourth and relatedly, context is key to measuring and understanding the situationally-specific nesting of those categories. Fifth, social categories are neither discrete nor additive but instead are mutually reconstitutive—the intersection of identities changes the very meaning of each intersecting identity.

Claiming a virtually impervious incompatibility between traditional inferential statistics and intersectional research (see, e.g., Nielsen, Marschke, Sheff & Rankin, 2005), intersectional scholars have thus far favored qualitative methods (e.g., Collins, 2009; Hochschild, 1989; Smith, 1987). Quantitative methods can dynamically complement qualitative and intersectional research, however, if—and only if— the method can align with its epistemological and ontological commitments (McCall, 2005; Stewart & Sewell, 2011; Sen & Wasow, 2016; Zuberi, 2008). Additionally, inferential statistics are not the entirety of quantitative methods. Scholars have used non-inferential quantitative methods, for example, to formally and inductively measure culture and meaning structures via texts, including Galois lattices (Mohr & Duquenne, 1997), multidimensional scaling (Martin, 2000), and network analysis techniques (Carley, 1994). As these approaches are foundationally inductive and relational, they are generally more suited to intersectional research compared to inferential statistics. Partially because of academic silos, however, intersectional scholars have not yet incorporated these methods into their research agenda.

3. Machine learning and high dimensional data

Machine learning is rapidly supplanting both traditional inferential statistics and dimensional and clustering techniques in the social sciences. While machine learning is currently being developed to augment inferential statistics, the mathematical assumptions of machine learning—both unsupervised and supervised approaches—are, I claim, better equipped for use in the type of inductive, exploratory, and contextual research traditionally conducted using qualitative methods.

Researchers working within the inferential statistics paradigm typically use deductive logic to propose a general mathematical relationship between one or more variables, testing whether the proposed mathematical model fits one or more cases.[2] The machine learning paradigm requires the inverse inductive logic. The researcher gathers data, chooses an algorithm to uncover (or *learn*)

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[2] There are ways to use this approach inductively, for example the multimodal approach (Young & Holsteen, 2017). Even in the multimodal approach, however, the reasoning remains the same: assume a mathematical model and test whether it fits, or explains, the data. In the multi-model approach, you simply do this many times.

patterns in the data, and then proposes a more general theory based on those patterns. While both inferential statistics and machine learning can be used in either deductive or inductive ways, this foundational mathematical difference is imperative.

Scholars who have used machine learning to replicate or replace traditional inferential statistics, for example, have been frustrated with the uninterpretable parameters from machine learning models and the absence of standard statistical significance measures (Boelaert & Ollion, 2018). Social statisticians have further found that simple logistic regression models virtually always outperform the most sophisticated machine learning algorithms for the types of questions typically addressed using inferential statistics, leading to questions about the efficacy of these complex algorithms for social research (e.g., Salganik et al., 2020).

Embracing its inductive framework, scholars of culture have alternatively embraced machine learning methods as a way to uncover the complex ways culture and categories formally interact to shape society (e.g., Mohr, Wagner-Pacifici & Breiger, 2015, 2013). Unsupervised machine learning methods, for example, are used to identify clusters of features representing emergent patterns in complex data. Supervised machine learning models can take multiple features (or variables) as input, identifying clusters of features that most accurately predict an outcome variable (such as income, or labeled text) while revealing emergent relationships among variables. In these ways, machine learning is more closely related to dimensional analysis. Machine learning, however, can incorporate much more complex representations of data compared to traditional dimensional analysis, using thousands or even millions of dimensions to represent a wide array of data, including texts, images, maps, and networks.

It is precisely this confluence that makes machine learning a powerful approach for research outside of the traditional inferential statistics paradigm. Machine learning merges a foundationally inductive logic with rich and complex representations of traditionally qualitative data. Fully leveraging these aspects of machine learning—as opposed to its purely predictive capabilities—requires a fundamentally different logic than that used in traditional inferential statistics: different types of questions, approaches to data, and epistemologies. One of the research paradigms that is well positioned to better leverage the full potential of machine learning is intersectionality. I use a corpus of first-person narratives from the nineteenth century U.S. South to empirically demonstrate the affordances arising from the alignment between machine learning and inductive, cultural, and intersectional research.

4. Intersectionality and the nineteenth century United States

The nineteenth century U.S. is an ideal case study to demonstrate the capability for machine learning to capture and illuminate intersectionality. As detailed above, the first articulations of the theory of intersectionality in the United States appeared in the writings of Black women who experienced slavery, reconstruction, and post-reconstruction in the Americas. Slave narratives, such as Harriet Jacobs's *Incidents in the Life of a Slave Girl*, the writings of activists such as Sojourner Truth, and political and social critiques from writers and scholars such as Anna Julia Cooper, Ida Alexander Gibbs, and Mary Church Terrell articulated and theorized the gendered and sexual dimensions of slavery and racist oppression not captured in the stories and writings from Black and white men.

Historians have further described the gendered dimensions of slavery and racist oppression during this era. The role of Black women within plantation homes and in reproduction and child rearing, for example, meant that Black women experienced less spatial mobility (Camp, 2005; White, 1987) and more and different types of health issues compared to Black men, but were often able to avoid the most difficult physical work when they were pregnant or breastfeeding (White, 1987). Black women were also exposed to sexual violence, humiliation, and control in ways not experienced by Black men (Jennings, 1990; Stevenson, 2013).

The differences in lived experiences between white and Black women were more extreme. While white women were both allowed power in, and constrained to, the domestic sphere, Black women were responsible for childrearing and reproduction for both Black and white families while also subject to similar work responsibilities as Black men. Not allowed a separate domestic sphere, Black women constructed different family structures and ideals, and used the domestic as a form of imaginative rebellion (Tate, 1996). White women used slavery for social and economic empowerment (Jones-Rogers, 2020), which converged with racist ideology to create competing and racialized versions of gender that often led to violent conflicts between white and Black women (Glymph, 2003). Black women were also hyper-sexualized by society, and sexual abuse at the hands of enslavers, compounded by their intimate relationship with the children of enslavers, led to further jealousy, bitterness, and violence from white women enslavers (Jennings, 1990; Stevenson, 2013; White, 1987).

To re-construct these diverse experiences of slavery and reconstruction, historians have scoured the archives, reinterpreting preserved documents and republishing documents that were almost lost to history.[3] Because of the work done by historians and archivists, we now have access to a large collection of diverse narratives from this era. Leveraging the power of the collective voice as told through these diverse narratives, I expand the analysis of race and gender beyond the practical experiences of individuals and examine the way different subjectivities were discursively located in relation to one another and to broader social institutions during this period.

My corpus came from the digital publishing initiative *Documenting the American South* (DocSouth), housed at the University of North Carolina at Chapel Hill.[4] From this initiative I selected two collections. "First-Person Narratives of the American South" includes a compendium of diaries, autobiographies, memoirs, travel accounts, and ex-slave narratives written by Southerners, with a focus on material written by African Americans, women, enlisted men, laborers, and Native Americans. "North American Slave Narratives" is a

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[3] Scholars such as Tony Morrison and Saidiya Hartman have additionally used fictionalized narratives to fill gaps in the archives—specifically Black women's experience of slavery.

[4] https://docsouth.unc.edu/ (accessed 2 July 2020)

collection of all the existing autobiographical narratives of fugitive and former slaves published in English up to 1920, as well as many biographies of fugitive and former slaves and some significant fictionalized slave narratives published in English before 1920.[5] These documents were purposefully selected by the collection curators to convey the everyday experience of those living in and around the U. S. South whose voices are often not heard, or not heard as loudly. The everyday experiences, interactions, and processes described in these narratives are not typically recorded in traditional surveys, or even most interview methods, and they capture the experiential processes at the center of intersectional and ethnographic research.

After removing duplicates and multiple editions of the same narrative,[6] my final corpus included 414 documents containing over eighteen million total words. I use the term *corpus* to refer to this collection of documents and the term *document* to refer to any of the bounded texts within, which in this corpus are principally books. Relevant metadata included with the DocSouth collection are date of publication and the author name. To this metadata I constructed two additional variables. I coded the gender of the author by the author's first name, or, when the gender was not clear from the first name, by looking at biographical details of the author. I also coded a race variable, indicating whether the narrative was by or about Black persons. If the document was included in the "North American Slave Narratives" collection, I automatically coded it as being by or about Black persons. I then hand-coded the "First-Person Narratives of the American South" collection by examining the title and author, and when it was not clear from these fields I skimmed the document itself to determine whether it was by or about Black persons.[7] Of the 414 documents, 41 were written by white women, 82 by white men, 48 by Black women, and 243 by Black men or about Black persons, predominantly men.

Any analysis that uses text as data is sensitive to the content of the corpus. This corpus is not representative of the general discursive field in the nineteenth century U.S. In particular, this corpus includes many abolitionist documents and is thus likely more sympathetic to the anti-slavery cause, and the Black community more generally, compared to a random collection of texts from this period. The findings presented below should be interpreted as representing a particular slice of nineteenth century U.S. discourse, one that is focused on the everyday experience of living during this period, and one that leans abolitionist.

5. Word embeddings to model social categories and institutions

I used word embeddings to capture discursive representations of intersectional subjectivities as conveyed in this corpus. Word embeddings are a machine learning technique that takes a corpus as input and outputs a high-dimensional vector space model of the corpus. A vector is an object that contains components (typically numbers) that represent data within a set space (for example, x,y coordinates on a two-dimensional plot). Word vectors are simply sets of numbers that represent the meaning of the word based on the context in which the word appears across a corpus. Using one of many word embedding algorithms (e.g., Globerson, Chechik, Pereira & Tishby, 2007; Lebret & Collobert, 2017; Levy & Goldberg, 2014; Mikolov, Sutskever, Chen, Corrado & Dean, 2013), word embedding models build a vector representation of each word based on all the words that occur directly before and after the target word. Each word vector is then given a fixed location in relationship to all other vectorized words in the corpus. Words that are semantically similar to each other (e.g., frog and toad) will be closer to one another in this set space. The relative proximity of word vectors—a measurement of semantic similarity—is typically measured through cosine similarity scores (the angular distance between two vectors).

Scholars have found that in addition to mapping linguistic similarities, word embedding models can reveal shared cultural stereotypes, such as associations between *criminal* and *poverty*, or *feminine* and *weak* (Bolukbasi, Chang, Zou, Saligrama & Kalai, 2016). Social scientists have since leveraged these models to reveal complex shared cultural associations and identities, including gender, racial, and ethnic stereotypes over long periods (e.g. Garg, Schiebinger, Jurafsky & Zou, 2018), suggesting that word embedding models promote "a radical view of intersectional identity" (Kozlowski, Taddy & Evans, 2019: 915).

Building specifically on Kozlowski et al. (2019), I used word embeddings to map the shared cultural associations around Black and white men and women as represented in the DocSouth narratives. To produce the word embedding model, I used the Skip-Gram flavor of Word2Vec, a group of models that uses shallow, two-layer neural networks to construct the word embeddings (Mikolov et al., 2013).[8] I used all words that occurred a minimum of ten times in the corpus, I set the number of dimensions for each word at 100, and I set the contextual window at five (the number of context words observed in each direction, respecting sentence boundaries).

Word embedding models allow for vector addition and subtraction to construct new vectors, called a resultant, that are a combination of positive (addition) and negative (subtraction) vectors. For example, the high-dimensional vector for the word *bank* captures multiple meanings of the word, e.g. bank as a financial institution and the bank that is the side of a river. To isolate the financial meaning of the vector *bank*, one could subtract the *river* vector from the *bank* vector, which would, in effect, remove the river bank meaning dimensions from the *bank* vector, keeping the financial bank meaning dimensions. Similarly, the words close to the vector

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[5] The slave narratives are not exclusively about the U.S., but the majority are about U.S. experiences and, in particular, experiences of the U.S. South.

[6] If an updated narrative was published with some new material, I kept the later version and removed the earlier version.

[7] The DocSouth documents written by white authors about Black men and women were either biographies or fictionalized slave narratives, written from the perspective of the subjects. I coded the race variable based on the subject of the text to capture this narrative perspective. The primary method I used, word embeddings, makes no distinction based on author. This way of coding race is thus more compatible with the way word embeddings represent text. I used the gender and race variables to structure the close reading step.

[8] Compared to the other Word2Vec flavor, CBOW (Continuous Bag of Words), Skip-Gram potentially represents rare words better and is more appropriate for smaller corpora.

resulting from adding the vectors *united* and *states* will be similar to the country denoted by the compound word *United States*. Importantly, vector addition reconstitutes the meaning of each added vector—adding *united* and *states* reconstitutes the meaning of both *united* and *states*—making it ideal to capture intersectional identities.

The theory of intersectionality asserts that identities are shaped via their embeddedness in institutions and systems of power. Using vector addition, I operationalized intersectionality along two dimensions: (1) four multiple intersecting *social categories* (Black and white men and women) and (2) four intersecting *social institutions* that organize access to social and cultural power (the polity, the economy, culture, and the domestic). To vectorize social categories, I created a list of words for women (e.g., *women, woman, girl*), men (e.g., *men, man, boy*), Black (e.g., *black, negro*), and white (e.g., *white, caucasian*) (see Appendix for a full list of words in each category). I then summed the vectors resulting from the vector addition over every possible combination of pair-wise categories (e.g., *women + black*) and divided the resultant by the number of total possible pairs for each pair-wise category combination (Kozlowski et al., 2019). This resulted in four averaged vectors representing four intersectional identities: Black women, white women, Black men, and white men.

I calculated the cosine similarity between each vector in the word embedding model separately for these four vectors, resulting in a number between zero and one indicating the similarity of every word in the corpus to each averaged social category vector. The word *dainty*, for example, had a cosine similarity of 0.52 to the white women vector, 0.45 to the Black women vector, 0.33 to the white men vector, and 0.25 to the Black men vector, indicating the word *dainty* was closest to, or most sementally similar to, the white women vector and was furthest from the Black men vector in this corpus.

The four social institutions represent the main spheres of power frequently theorized in sociology and related disciplines, particularly those focusing on the eighteenth and early nineteenth centuries and the shift from agrarian to industrial capitalism. The *economy* (Marx, 1992), the *polity*, and *culture* (Weber, 1946) are the core theorized institutions organizing access to power in the nineteenth and twentieth centuries. To these domains feminist theorists, as well as critical theorists such as Habermas, Fanon, and Marcuse, added the importance of the *domestic*, with access to the empowered public sphere or relegation to the disempowered private sphere determined by relations of power. I constructed the polity vector by adding *nation* and *state* to capture words similar to nation-state; the economy vector via *money* as the most succinct way to capture the class dimension of the economic sphere; the culture vector via *culture*; and the domestic vector by adding *housework* and *children* to capture the reproductive nature of the private sphere. I then extracted the fifty vectors with the highest cosine similarity to each of the four social institutions, providing a high-dimensional discursive representation of each institution.

The final calculations consisted of the average cosine similarity between the four social category vectors and the fifty vectors representing each social institution. To calculate the 95 percent confidence intervals for each of these measurements I used the bootstrap method, drawing random sentences with replacement from the corpus to construct forty artificial corpora, each with the same number of sentences as the original corpus, and repeating the above calculations on each artificial corpus. The 95 percent confidence interval spans the second lowest and second highest calculation across these forty corpora, indicating statistical significance (Antoniak & Mimno, 2018; Kozlowski et al., 2019, 934–5). I graphically represent the numbers and measures from the above calculations in multiple two-dimensional graphs to inductively visualize how relationships among social categories and institutions morph as discursive/institutional contexts shift. I present a difference of means plot to visualize the magnitude and statistical significance of the measures.

I followed this word embedding analysis with a targeted close reading of the text, examining how the vectors representing the social institutions were used differently by Black and white men and women, or when describing Black and white men and women. This complementary close reading placed the word vectors back into their full discursive context to provide both qualitative validity and depth to the analysis.

Table 1
Words with the highest cosine similarity to four social institution vectors.

Polity	Economy	Culture	Domestic
country	cash	endowments	babies
vassalage	sum	refinement	girls
commonwealth	debts	thrift	houseservants
municipalities	refund	acquirement	houseful
nonslaveholding	greenbacks	intellectual	fellowservants
graingrowing	defray	competence	waitingmaids
afroamericans	funds	refinements	milking
civilised	pay	attainments	washerwoman
adjudication	dues	mediocrity	sabbathday
bankruptcy	savings	talent	fieldwork

Note: Polity is the resultant from adding *nation* and *state*, the economy is the *money* vector, culture is the *culture* vector, and domestic is the resultant from adding *housework* and *children*.

Source: Word embedding model trained on the collections "First-Person Narratives of the American South" and "North American Slave Narratives" from *Documenting the American South*.

6. The discursive field

Table 1 shows the ten vectors most similar to each of the social institution vectors, indicating the semantic meaning of these institutions in this corpus. The polity vector captures political entities (*country, commonwealth, municipalities*) and national economic phenomenon (*graingrowing, bankruptcy*). The word *afroamericans* is closely related to the polity vector, capturing this new social and political identity. The economy vector is related more to the practical economic context, including *mortgaging, cash, debts, repayment, industry,* and *earnings*. The culture vector primarily indicates social status indicators of cultured individuals, such as *endowments, refinement, intellectual*, and *competence*. The domestic vector represents housework (*houseful, waitingmaids, milking, washerwoman*), reproduction (*babies*), and work done by enslaved people (*houseservants, fellowservants, fieldwork*).

To visually represent the dimensions of this overall discursive field, I used Principal Component Analysis (PCA) to project the 200 vectors representing these four social institutions onto two dimensions. PCA identifies patterns between dimensions of large or complex data, producing orthogonal components of high-dimensional data that maximizes interpretability but minimizes information loss. The first two principal components for this 4×200 matrix explained a total of 74% of the variance (48% for the first component and 26% for the second component).
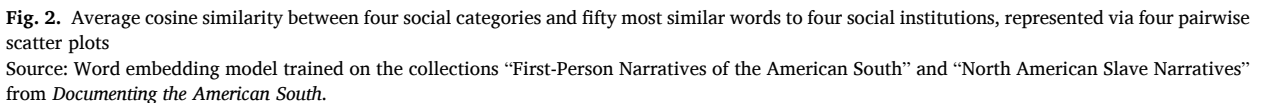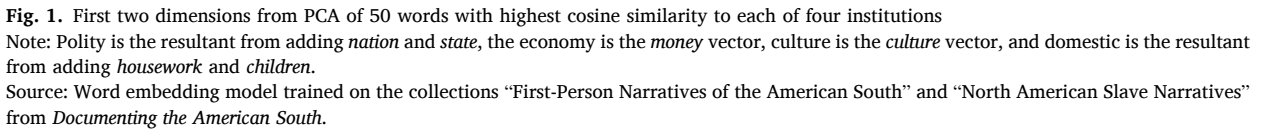
Fig. 1 visualizes these two primary components. The fifty vectors most similar to the domestic institution are clustered on the bottom right, the economy vectors on the top right, the polity vector on the top left, and the culture vector on the bottom left. I interpreted the first dimension (the x-axis, capturing 48% of the total variance) as capturing practical versus aspirational discourse. Individuals and nations must meet their practical needs: they need to eat and have shelter, and nations must produce in order to meet these needs. Practical discourse is captured on the right side of the axis, with clusters of words indicating practical concerns around money (*buy, earnings, dues*) and domestic work (*chores, babies, ironing, milking*). Once these needs are met, both individuals and nations can have more aspirational desires, such as a thriving democracy or individual intellect. This aspirational discourse is captured on the left side of the axis, with clusters of words around the polity (*commonwealth, republic, nation, civilized*) and individual status or culture (*respectability, preeminence, intellect, acuteness*). The second dimension (the y-axis, capturing 26% of the variance) captures the community versus the individual. Culture represents the individual version of the aspirational orientation (bottom) compared to the community represented by the polity (top), while the domestic (bottom) represents the individual or household needs compared to the community needs represented by the economy (top).
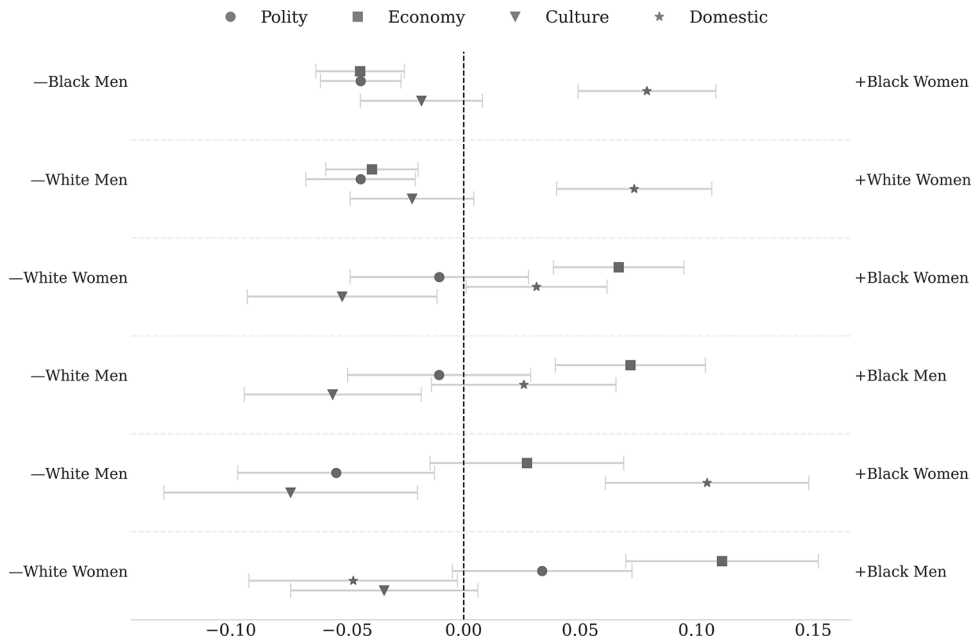
7. Visualizing intersectionality

Figs. 2 and 3 visualize the results, from two different perspectives. Based on the two dimensions found in the PCA above, Fig. 2 is organized into four scatter plots, showing the relative placement of the four social categories relative to culture vs. the economy (lower left), culture vs. the polity (upper left), domestic vs. the economy (lower right), and domestic vs. the polity (upper right). The 200 vectors capturing the institutional space are also plotted along these dimensions, providing the institutional backdrop that the social categories are mapped within. Fig. 3 visualizes the same data but as differences between means across all six social category pairs, showing the 95 percent confidence interval for each pair across the four social institutions. While Figs. 2 and 3 convey almost the same information, their differences in perspective are important. Fig. 2 presents this information in a way that is more true to intersectional research (D'Ignazio & Klein, 2020), showing the word embedding results spatially, with the social categories presented both relationally and embedded within the four social institutions. Fig. 2 additionally visually conveys how the salience of social categories are shaped by social institutions, with racial identities spatially clustered together when the cultural context is emphasized (left side), and gender identities spatially clustered together when the domestic context is emphasized (right side). Importantly, the relevance of these social institutions to race and gender were not specified prior to the visualization, but were allowed to emerge inductively. Fig. 3, alternatively, visually abstracts the results away from the embeddedness and spatial clustering to convey more precisely the magnitude and significance of the differences across contexts.

Together, Figs. 2 and 3 suggests that in these narratives, Black and white women were discursively differentiated from Black and white men via the domestic sphere (Fig. 2 right subplots, Fig. 3 rows 1 and 2), while Black men and women were discursively differentiated from white men and women by the cultural sphere (Fig. 2 left subplots, Fig. 3 rows 3 and 4), though this vector also had interesting intersectional dynamics, as Black men were pushed closer to the culture vector compared to white women given their proximity to words such as *selfsupport*. The political and economic spheres also had interesting intersectional dynamics. Black men and white women were similarly close to the political sphere (Fig. 3 row 6), while Black men and white men were closer to the political sphere compared to their same-gender counterparts (Fig. 3 rows 1 and 2). Black women were nearly the same distance from the economy vector compared to white men (Fig. 3 row 5), while Black men and women were closer to the economy vector compared to their alternate race counterparts (Fig. 3 rows 3 and 4). In sum, culture discursively separated the races, the domestic discursively separated the genders, and the economy and the political separated both race and gender, with Black women equally close to the economy vector compared to white men, and Black men almost as close to the polity vector compared to white women.

Returning to the overall discursive space created by these four social institutions (see Fig. 1), Fig. 2 suggests that Black women were closest to practical discourse (the economy and the domestic) and white women were closest to individual discourse (culture and the domestic). Black and white men were alternatively distinguished along Fig. 1's diagonal, with Black men closer to the collective and practical cluster (the economy), white men were closer to the individual and aspirational cluster (culture), and white and Black men were equally distant to the aspirational and collective (the polity) and the practical and individual (the domestic).

Fig. 1. First two dimensions from PCA of 50 words with highest cosine similarity to each of four institutions
Note: Polity is the resultant from adding *nation* and *state*, the economy is the *money* vector, culture is the *culture* vector, and domestic is the resultant from adding *housework* and *children*.
Source: Word embedding model trained on the collections "First-Person Narratives of the American South" and "North American Slave Narratives" from *Documenting the American South*.

Fig. 2. Average cosine similarity between four social categories and fifty most similar words to four social institutions, represented via four pairwise scatter plots
Source: Word embedding model trained on the collections "First-Person Narratives of the American South" and "North American Slave Narratives" from *Documenting the American South*.

● Polity   ■ Economy   ▼ Culture   ★ Domestic

Fig. 3. Differences between mean cosine similarity for six pairwise social categories across four social institutions
Note: The markers indicate the differences in average cosine similarity between the pairwise category vectors (category on the right—category on the left) and the fifty words most similar to the polity, culture, the economy, and the domestic vectors, respectively. The lines indicate the boot-strapped 95% confidence interval. If the line does not overlap with zero (the dotted vertical line), the difference between means is statistically significant at minimum at the $p < 0.05$ level.
Source: Word embedding model trained on the collections "First-Person Narratives of the American South" and "North American Slave Narratives" from *Documenting the American South*.

8. Vectors in context

Figs. 1–3 visually represent the intersectional discursive space emerging from this corpus. Discourse, of course, is much more complex than can be represented in two-dimensional space, even with the multiple dimensions represented in Fig. 2. In a final step I placed the patterns represented above back into their full discursive context via a close reading of the text. To move from vector representations of a corpus back to the text I calculated raw counts of the fifty closest words to the culture and economy vectors by document (see Table 1) to identify documents and paragraphs where these institutions were more frequently discussed across different types of authors and subjects.[9] In addition to contextualizing the word embedding models, the discussion below demonstrates why word embeddings are so powerful, as word frequencies on their own do not always adequately capture discursive dynamics and differences.

8.1. (White) culture

In this corpus, the words closest to the culture vector most often indicated marks of distinction in a social rating system important to the U.S. South (see Table 1). Words such as *gentility, refinement, endowments*, and *acumen* are all individual traits that conferred social status in the South, and in this corpus these words were largely reserved for describing white people. The exceptions to this pattern are informative and help prove the rule. Of the top ten documents that contained the highest frequency of these culture words, nine were written by or were explicitly about Black persons, particularly Black men. The book with the highest quantity of culture words, *A Tribute for the Negro* (1848) contained 415 culture words (at 2.2 culture words per 1000 words, this novel also had the second highest proportion of culture words in this corpus). William Armistead, a white Quaker and abolitionist, wrote the book to explicitly argue that those of African descent were capable of occupying a position in society far above that which had been given to them. Armistead seems to have been aware of the importance of these status words to the white population, and as such, these status indicators were central to the book. The book *Men of Mark: Eminent, Progressive and Rising* (1887), written by ex-slave and one-time president of the State University of Kentucky, Reverend William J. Simmons, contains the second most number of culture words at 256 (0.86 per 1000 words,

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[9] As word embedding models discard all document level information, including document length, longer documents, and documents with higher frequencies of word categories (e.g., culture words) contribute more to the vector relationships shown in the visualiations above. Raw frequencies are thus more closely related to how word embeddings represent text compared to normalized frequencies. I used raw frequencies to structure my close reading, but report both raw and per document normalized frequency below.

which puts the book in the 90th percentile for proportion of culture words). Similar to *A Tribute for the Negro*, the purpose of this book was to show to the world "that the Negro race is still alive, and must possess more intellectual vigor than any other section of the human family." By accentuating their use of these culture-as-status words, Armistead and Simmons were consciously and explicitly associating these words directly with Black individuals in order to elevate their status in the eyes of whites. Also included in the top ten are the autobiographies of Frederick Douglass (118 culture words, 0.5 words per 1000, in the 80th percentile) and Booker T. Washington (99 culture words, 1.15 per 1000, in the 95th percentile), authors well-known and celebrated by both Black and white audiences.

The full distribution of the frequency of culture words across documents, and a close reading of key passages in these narratives, affirms the discursive association between culture-as-status and being white. Fig. 4 shows the distribution plot of the count of culture words by document separately for those by or about Black persons and those by whites. The majority of documents by and about Black persons are clustered around the lower end of the distribution, with a long right tail (discussed above). The distribution for the documents by white authors is less skewed, with more texts in the middle of the distribution.

Examples from the middle of the distribution shown in Fig. 4 illustrate how these status words were weaved into the majority of white narratives in a way not done in the majority of Black narratives. The narrative *My Imprisonment and the First Year of Abolition Rule at Washington* (1863) by white Southerner and popular hostess Rose O'Neal Greenhow, which contains forty-three culture words, exemplifies the use of these social distinction words by a white author. In the following passage, Greenhow lamented the loss of refinement when Washington (where she lived for many years) was emptied of white Southerners during the war:

> "… I should consider it a great trial to be obliged to live in this city under the present régime, for, according to my peculiar political ideas, all the refinement, all the intellect, which once constituted the charm of Washington society, has departed with my brethren of the South … "

This sentiment is repeated in other white narratives. Confederate soldier Wharton Jackson Green used culture words 71 times in his narrative *Recollections and Reflections* (1906) to describe different types of white Southerners, including Southern soldiers, and, quoted below, teachers, students, and his wife, respectively:

> "They were erudite, not to say recondite, teachers, and all attained celebrity in their new sphere of action."

> "As a rule, they had reached years of ordinary discretion, and leaving their boyish tricks and sportive tendencies behind them, had come there with fixed purpose to absorb the modicum of erudition within range of reach, before entering the great arena which they saw just ahead."

> "… erudite without pedantry, charitable without parade, soft of speech but duly assertive, stickler for the social proprieties but void of prudery, ever genial but never frivolous."

He used *refinement* even more often to describe the homes and people he met in his travels, who were virtually always white, and he consistently related these status words directly to their education and "superior culture."

Compare these uses of status words to the use of culture words in many of the narratives by or about Black men and women. In *Twenty-Two Years a Slave* (1857), Black abolitionist Austin Steward uses culture words 71 times. Where Green and Greenhow used the words *gentility* and *refinement* liberally, Steward used the word *gentility* once and *refinement* three times, and each time the word was used to describe white people or the white world. For example, Steward used the word *gentility* as a way to distinguish the status of house servants and field hands:
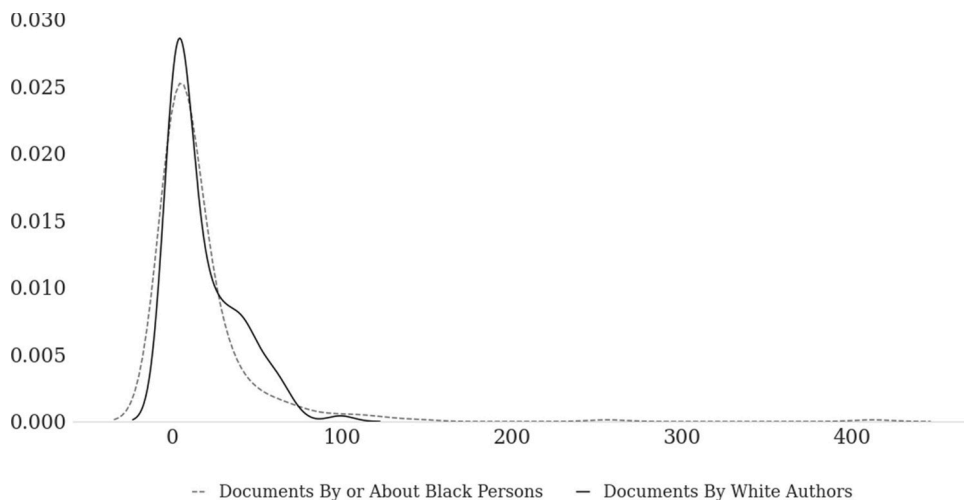
Fig. 4. Distribution plot of the count of culture words by document for documents by or about Black persons and documents by white authors
Note: Culture words include the fifty words with the highest cosine similarity to the *culture* vector from the word embedding model.
Source: "First-Person Narratives of the American South" and "North American Slave Narratives" from *Documenting the American South*.

"The field hands, and such of them as have generally been excluded from the dwelling of their owners, look to the house servant as a pattern of politeness and gentility. And indeed, it is often the only method of obtaining any knowledge of the manners of what is called "genteel society;" hence, they are ever regarded as a privileged class; and are sometimes greatly envied, while others are bitterly hated."

Gentility was a status that was not open to enslaved people, except, and only partially so, when they worked in close proximity to white owners of enslaved people. Steward used the word *refinement*, alternatively, to describe the work of white abolitionists as a call to arms for the Black race:

"Have they [white abolitionists] more at stake in that mighty struggle than we, that they should leave their homes of refinement and comfort, take their lives in their hands and bravely contend for their rights, surrounded by scenes of blood and carnage? Certainly not."

Where white people were celebrated for gentility and refinement, the traits celebrated in Black people much more often related to frugality and the ability to cultivate economic wealth. The title of one narrative suggests how these words were typically used in slave/ex-slave narratives: *From Slavery to Wealth. The Life of Scott Bond. The Rewards of Honesty, Industry, Economy and Perseverance* (1917). Written by ex-slave Scott Bond and co-authored by Daniel Arthur Rudd and Bond's second son, Theophilus, the book, like many others of its time, celebrated the potential for Southern agriculture to lead to Black (economic) success. This book contained 59 culture words, but they were not the same words used to describe white men and women. The culture words in this book instead largely centered on cultivating both the land and the individual to produce wealth as well as on thrift as a desirable trait. In particular, Bond used the word *cultivate* to describe growing crops alongside his use of it to describe individual traits, discursively associating agricultural practice to individual status: "I had found out long ago that such information as he was imparting was of great benefit to those who received it and cultivated the spirit it called up." He also extolled the benefits of hard work and thrift: "The soil is unsurpassed in fertility, and fortunes await the energy and thrift of the husbandman." In contrast to Green's focus on the erudition, refinement, and gentility of white Southerners, Bond described traits that helped Black people advance after the war:

"The great strides made by the Negro in these first fifty years, has opened his eyes to the possibilities of advancement and convinced him that merit can and will compel its reward. … They have taught him self-reliance and a desire for team work. They have taught him thrift. They have given lessons in integrity and high moral purpose. They have prepared him for the struggle in the climb up the rugged mountain of excellence, and make him think that in the not distant future, he will take his place among his fellow citizens as a man wherever manhood and sterling qualities count, and that he has a message for the world i.e., 'If a man will he may.'"

Note that in the quoted passages, particularly those from the white authors, race is not always explicitly referenced. The word embedding model suggests that culture words were more strongly associated with white men and women compared to Black men and women; this association was produced not always via passages directly connecting race and culture (although these passages existed), but via the more complex representation of words and their meaning in high-dimensional vector space. As an additional intersectional dynamic, Black and white men were described using culture words not used to describe Black and white women, such as *thrift* and *selfsupport*, pushing Black men slightly closer to the culture vector compared to Black women, and white women further away compared to white men. A qualitative reading of select documents and paragraphs supported the pattern indicated by the word embedding model: particular culture words (e.g., *gentility, refinement*) were used as markers of status in the U.S. South, and in these narratives this status was readily accessible to white but not Black identities.

8.2. The (Black) economy

The complexity of moving between word embedding models and word frequencies is repeated when examining the economic sphere. The distribution of economic words across documents written by Black and white women were almost identical, with 62 economic words on average in documents written by white women and 57 on average for those written by Black women. The ways these words were used in the narratives, however, reinforce the stronger association between Black women and the economy vector shown in Figs. 2 and 3. Black women who, according to white gendered schema, should be insulated from the economy, were instead also associated with hard work and frugality, alongside Black men. The word *industry* typifies the distinct gendered schema afforded white and Black women in this corpus. *Industry* was used to describe positive traits of both Black and white Southern women, but when used to describe Black women, it was more often used in relationship to economic earnings. For example, the book *Biographical Sketches and Interesting Anecdotes of Persons of Colour* (1826) celebrates enslaved person Nancy Pitchford because, "At the time of her death, she had acquired, by her industry and care, more than four hundred dollars, the whole of which, after paying the expences eof her last sickness and funeral, she left by will, to charitable purposes." Black women throughout this book were frequently recognized for their economic industriousness. Abolitionist and activist Sojourner Truth was keenly aware of the privilege she had when she made money: "I thought I would work and put some money in a savings bank. Well, I lived with the best people in the city; and though I was only careful of my earnings, it came to me that I had robbed the poor. My industry had doubtless kept some poor wretches from paying work. I felt it, and I said, 'Lord, I will give all back that ever I have taken away.'"

When the word *industry* was used to describe white Southern women, it conveyed their ability to manage the domestic realm, not to make money. For example, in *Country Life in Georgia in the Days of My Youth* (1919), white Southerner Rebecca Latimer Felton said of her grandmother: "The mother of eleven children, all reaching maturity, except two that lived to eleven and twelve years, her industry, her management and her executive ability in caring for and carrying on her household affairs are still wonderful memories…" She described her mother's traits in a similar way: "Along about midday the husbands began to come, some afoot, others on horseback. And

the dinner, was a spread that tested the skill and industry of the hostess to be sure." In these examples (and there are many more), the word *industry* nudges white women closer to the domestic vector and further from the economy vector.

These findings confirm what historians have long described, suggesting that word embedding models do indeed empirically capture real intersectional associations and can provide a new method and lens to explore these associations. With this face validity confirmed, one final analysis examined an additional discursive relationship that is more complex: the intersection of gender and race with *authority*.

9. The complex relationship between race, gender, and authority

Recent scholarship has complicated the relationships between gender, race, and authority in the nineteenth century. White women used enslaved people as a source of real social and economic empowerment, providing themselves a measure of supremacy within an otherwise patriarchal society (Glymph, 2003; Jones-Rogers, 2020). In this case, we might expect white women to be discursively closer to authority compared to Black men and women in this corpus. At the same time, Black men were afforded a measure of real and symbolic authority over Black women, adhering to the gender schema of the time but also used as a tool to divide and thus better control enslaved people, who outnumbered and physically overpowered the white population in many geographical areas (Burnard, 2018; White, 1987). In this case, we might expect Black men to be discursively closer to authority compared to white women.

To assess whether word embeddings can provide an additional lens to explore the discursive relationship between authority, race, and gender, I calculated the average distance between the four social category vectors and the fifty vectors most similar to the *authority* vector. Fig. 5 shows the differences in means between the six pairwise social categories. In these narratives, the authority vector distinguished by gender, *not* by race. Black and white men were significantly closer to the authority vector compared to their same-race counterparts, while Black and white women and Black and white men were equally close to the authority vector. Importantly, Black men were significantly closer to the authority vector compared to white women. This discursive association between Black men and authority highlights the uneasy relationship between authority, race, and gender in the nineteenth century U.S. South: white women had real power and authority over Black men, but Black men were afforded more discursive authority compared to both Black and white women. This tension between actual and discursive authority, as suggested by historians, likely served to enforce both gender and racial hierarchies, while helping to quell unrest and rebellion from Black men. This discursive authority is hinted at in the archival collections. The word embedding approach leverages the collective discourse to provide new perspectives on these latent discursive dynamics, such as that between race, gender, and authority.

10. Discussion

Using word embeddings as an example of one machine learning method, I analyzed intersectional experiences and discursive associations as conveyed via a diverse collection of first-person narratives from the nineteenth century U.S. South. Empirically, I found that, even in a corpus composed largely of abolitionist or abolitionist-friendly narratives, social status via culture discursively
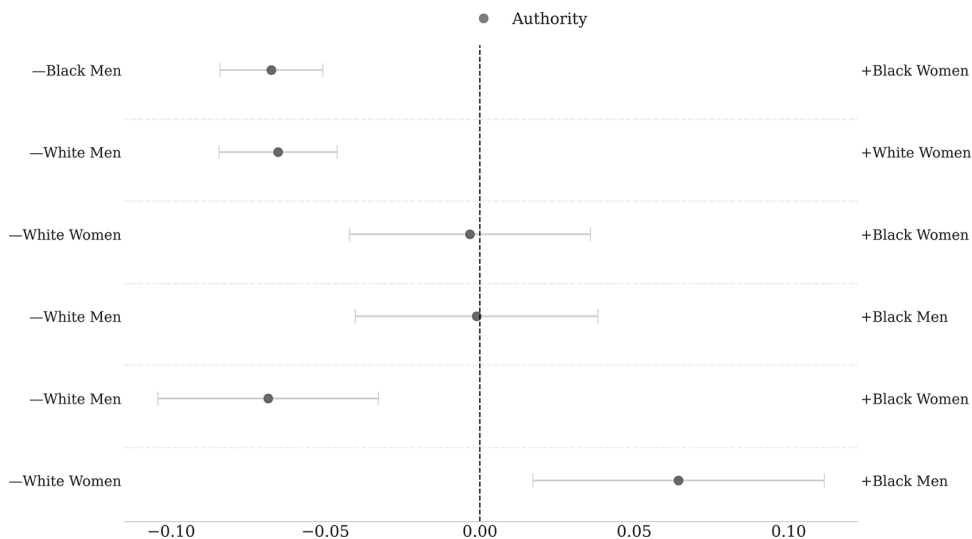
Fig. 5. Differences between mean cosine similarity by six pairwise social categories and the fifty vectors closest to the authority vector
Note: The markers indicate the differences in average cosine similarity between the pairwise category vectors (category on the rights—category on the left) and the fifty words most similar to the *authority* vector. The lines indicate the bootstrapped 95% confidence interval. If the line does not overlap with zero (the dotted vertical line), the difference between means is statistically significant at minimum at the $p < 0.05$ level.
Source: Word embedding model trained on the collections "First-Person Narratives of the American South" and "North American Slave Narratives" from *Documenting the American South*.

distinguished social identities based on race. Additionally, Black women, while not using more economic words to describe their experiences compared to white women, were nonetheless discursively closer to the economic sphere compared to white women, representing the racialized gender schemas during this period. Importantly, I also found Black men were discursively closer to the sphere of authority compared to white women, contributing a new type of evidence to explore the discursive relationship between authority, gender, and race during this era.

This analysis confirms two dynamics historians have long claimed: (1) even as Black people were inching toward political and economic equality with whites in the South, they remained deeply and discursively culturally separated from their white counterparts, and (2) Black women were ascribed a different gendered schema compared to white women, as they were significantly more embedded within the economic realm. Confirming the potential power of this approach to measuring intersectionality, this analysis also illuminated a more complex discursive dynamic: even while white women had more real power and authority over Black men, Black men were ascribed more discursive authority compared to white women in this corpus.

In this analysis I embedded four social categories within five social institutions. There are, of course, many other social categories and social institutions that are relevant to intersectional experiences during this century. Class and sexuality, for example, shaped the experience of those of all races during this century and are not captured in the four social categories mapped here. Religion and violence were important institutional domains shaping society in this era, and again are not captured in this analysis. The power of this approach, however, is its ability to incorporate virtually any domain that is represented in discourse in a comparative way. Future research could expand this analysis to other social domains, or build comparisons to other countries or other centuries. In particular, historians have noted the difficulty in studying the role of sexuality in the experience of enslaved people, as these experiences are virtually absent from the archives. Additional studies could leverage the collective voice from first-person narratives to potentially illuminate discursive associations around sexuality from this period.

Methodologically, this analysis illustrates how machine learning, with its mathematically inductive logic and its ability to incorporate high-dimensional representations of complex data, affords researchers the ability to quantitatively examine complex categories and everyday processes in a way that affirms inductive, qualitative epistemology, including intersectional principles. Machine learning can augment and enhance the intersectionality research paradigm in powerful ways, providing a method that allows for macro-comparisons of intersectional experiences across contexts, without losing the depth of qualitative analysis. Word embeddings are, of course, just one machine learning approach. Future research could explore how other machine learning approaches and methods could be used to further enhance and develop the intersectionality research paradigm specifically, and cultural and qualitative research more broadly.

Importantly, the analysis presented here suggests that the full potential of machine learning may *not* be in using these methods to replace or augment questions and logics from the inferential statistics community (e.g., Salganik et al., 2020), but rather in the alignment between machine learning and inductive and non-positivist qualitative logics, including intersectionality. Fully realizing this alignment is not, of course, without serious challenges. First, the research community must continue to develop standards around robustness and sensitivity checks to ensure the validity of downstream interpretations and conclusions from this type of analysis (e.g., Antoniak & Mimno, 2018). Second, machine learning, and in particular word embeddings, requires a massive amount of high-dimensional data. Collecting and digitizing data on this scale presents logistical and ethical challenges, and in many cases, these data simply do not exist at the scale needed to accurately capture the social world (Risam, 2018). Reconstructing the historical perspective and experiences of those typically excluded from historical and scientific records—or those that chose not to record or archive their perspective—is in all cases difficult, and in some cases impossible. In the contemporary era these data are more reliably being archived, but using and analyzing these data is fraught with privacy, ethical (Bailey, 2015), human rights (Eubanks, 2018), and social justice (Benjamin, 2019; Noble, 2018) concerns. The research community needs to do more work to carefully and ethically incorporate these voices and experiences into the scholarly record. Finally, while machine learning can enhance traditional qualitative methods and close reading it should not supplant these methods. The research community should continue to develop best practices for how to combine the broad, corpus-level associations uncovered via machine learning with the precision and context provided via close or qualitative reading, potentially producing a more powerful overall methodological approach to intersectionality.

As machine learning matures into its disciplinary-spanning paradigm, we have a responsibility to ensure it develops in a scientifically sound way. Intersectional scholars and scholars of culture simply can not abandon computational methods to the statistics crowd, who have thus far been left frustrated with the inability of machine learning to replicate inferential logics. We have the opportunity—and obligation—to rigorously harness the inductive power of machine learning to enhance traditionally qualitative research and in turn, use qualitative logics to extract more analytical power out of machine learning. Put starkly, the future of machine learning in the social sciences may depend on it.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.poetic.2021.101539. A

replication repository with the code and data needed to reproduce the analysis can be found here: https://github.com/lknelson/
measuring_intersectionality.

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