Background
Over the last three decades, the maternal mortality rate has increased within the United States from 7.2 per 100,000 live births in 1987 to 18.5 per 100,000 live births in 2014 (1), making the United States one of only two countries with increasing maternal mortality rates in the world (2). For non-white individuals within the United States, the maternal mortality rates are even grimmer. Black women have a maternal mortality rate of 40.0 per 100,000 live births, compared to the 12.4 per 100,000 live births we see in white mothers (1).

The Southern Region of the United States is home to many of the states with the highest maternal mortality rates, with Louisiana having the highest rate nationally. The demographics of this region vary based on state and county; however, it starkly demonstrates racial disparities within maternal mortality. For example, Louisiana’s black mothers die at a 4.1 times higher rate than white mothers (3). There are many factors that contribute to maternal mortality and not all cases are preventable; however, it is believed that roughly 25-45% of maternal mortality cases are preventable in Louisiana alone (3). If so, why is it that mothers of minority backgrounds are at greater risk of dying than their white counterparts?

In this study we explore different social determinates of health that can impact and can help to explain the racial disparities seen in maternal mortality within the United States, focusing on the southern region. Poverty rates, insurance factors, provider access, and demographic differences between counties will be analyzed to identify any trends that exist and aid in explaining the vast racial disparity seen in the beginning of motherhood (4).

Methodology
To begin, polygon level data for the United States, obtained through the Tufts GIS Lab, was clipped to the region of interest. Next, the layer of county level polygions from the United States Census was added and clipped to fit the region. For all of the factors of interest, data from the United States Census containing rate and percentage information was joined to the county level maternal mortality data obtained from the GHDx data center and joined and cleaned. With shapefiles, choropleth maps were created depicting rates and differences in rates between different races. To add the depiction of provider care access, all gecoded hospitals in the region were added to the map as a shapefile obtained from the United States Census.

Results
Maternal Mortality is seen in the highest rates along the Mississippi River, a belt in southern Alabama, and scattered throughout Louisiana. The greatest rates, over 1 death per 100,000 live births, are seen hugging the Mississippi River in Arkansas, Mississippi, and Louisiana, in addition to western area of southern Alabama. The changes in maternal mortality from 2010 to 2014, show that the areas with the highest rates also have shown moderate to significant improvement. Areas with the largest increase in maternal mortality are scattered throughout the region, and heavily appear in counties between Dallas and Austin, Texas.

Poverty demonstrates to be a factor as the majority of the hardest hit counties for maternal mortality rates also have disproportionate poverty of blacks versus whites. These counties all have black poverty rates at or greater than 150 percent of their white residents, with some greater than 300 percent. In six counties the poverty difference is between 300 percent and 450 percent, with one county, Lowndes County, having a Black poverty rate is 1220% that of the White poverty rate, and the largest recorded on the map being 3500 percent.

Trends in uninsured populations are similar to that of maternal mortality; however, in Texas there are multiple counties with greater than 30 percent of their population uninsured. Kentucky has the best overall state uninsured rate with every county at or below 15 percent, but Louisiana and Mississippi are both largely 20 percent to 25 percent uninsured. The existence of hospitals does not play a strong pattern within the region, but trends in uninsured rates of maternal mortality, higher rates of poverty and zero to one hospitals.

Lastly, nearly every county in the region is dominated by white residents. Counties with the majority of non-white residents are along the Mississippi River in Arkansas, Mississippi, and Louisiana. There is an additional belt of predominately non-white counties in the southern half of Alabama consistent with the highest rates of maternal mortality and disparity in poverty rates.

Looking at the Western part of Texas, there are high uninsured rates and few hospitals, but there are low maternal mortality rates, mostly white populations and few differences in white and black poverty rates. Understanding the difference between these areas and the counties along the Mississippi River in and the southern belt of Alabama may aid in understanding racial difference in maternal mortality rates.

Discussion
The patterns seen along the Mississippi River and in the southern belt of Alabama reinforce the data that minority populations, specifically black mothers, have higher rates of maternal mortality than white mothers. Looking further into the geospatial patterns of the social determinants of health observed (poverty, health insurance, provider access, and demographics) there are supporting patterns of disparity between black (and other non-white) populations and their white counterparts consistent with current literature.

Poverty demonstrates to be highly correlated in areas throughout the region, but specifically near the Mississippi River and the identified Alabama belt, with nearly all counties having black poverty rates of 150 percent or more than the white poverty rates in the same counties, and the six counties of even greater disparity identified previously. These disparities in poverty additionally match with the counties that have a majority non-white population. This overlap would suggest that densely populated areas of non-white residents demonstrate greater poverty, and thus greater disparity compared to whites in the county and region at large. These areas would be locations for policy makers and researchers to target future efforts.

The lack of patterns in hospital existence in nearly all of the most affected areas for maternal mortality tends itself to further research. While hospitals may exist we do not have data to understand if providers are concentrated as employees of the hospitals or if the county residents can get to such hospitals-both of which could use geopolitical research for better understanding.

Lastly, while the percentage of individuals, regardless of race, not possessing health care in 2014 does not exceed 20 percent in the main areas of focus along the Mississippi River and the southern belt of Alabama, it cannot be ruled out as a contributing factor because of the lack of disaggregated data on the basis of race. It should be noted that the change of maternal mortality rates from 2010 to 2014 accompanies the passage for the Affordable Care Act in March of 2010 by providing/insuring access for uninsured individuals.

Maternal Mortality and Social Determinates of Health for Parishes with Increased Maternal Mortality from 2014 to 2018

Race of Majority Residents, 2014

Maternal Mortality per 100,000 Live Births, 2014

Maternal Mortality Rate per 100,000 live births