The Relationship between the Age and the Safety Conditions of a Bridge

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Introduction

Safety is an important indicator when evaluation a bridge. Driving on a bridge that does not meet the safety criteria may cause serious consequences. In the dataset, four variables are used to measure the safety level of a bridge, including bridge railings, transitions, approach guardrail, and approach guardrail ends.

After plotting the distribution of the bridges, it can be seen that a large number of bridges in Wisconsin have at least one feature that does not meet the safety criteria. A natural thought of the reason that some bridges become unsafe to drive on is these bridges may be old. So here I define a bridge built 50 years ago as old and investigated the probability a bridge be defined conditioned on its age. Then, the distribution of bridges being old and not safe, and being new but not safe are mapped.

Results
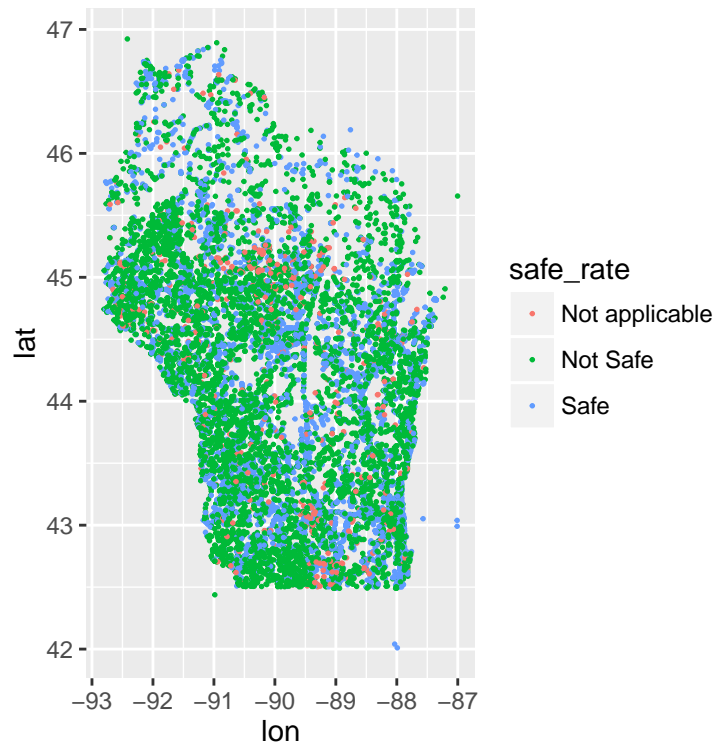
Figure 1
Figure 1 shows the safety condition and the location of each bridge. Each dot in Figure 1 represents a bridge. And the color of the dots represent the safety condition of the bridges.

From figure 1, it can be seen that many of the bridges in Wisconsin have at least one feature that does not meet the currently acceptable standards. There are many reasons that can cause this. For example, the

design and construction of the bridge do not meet the requirement, or a bridge is too old which lead to the damage of the bridge. Based on the existing data, I choose to investigate the relationship between the age and safety condition. Here a less-than-50-year-old bridge (built after 1967) will be defined as "new", and others will be defined as "old". And the age and safety condition are combined and mapped.
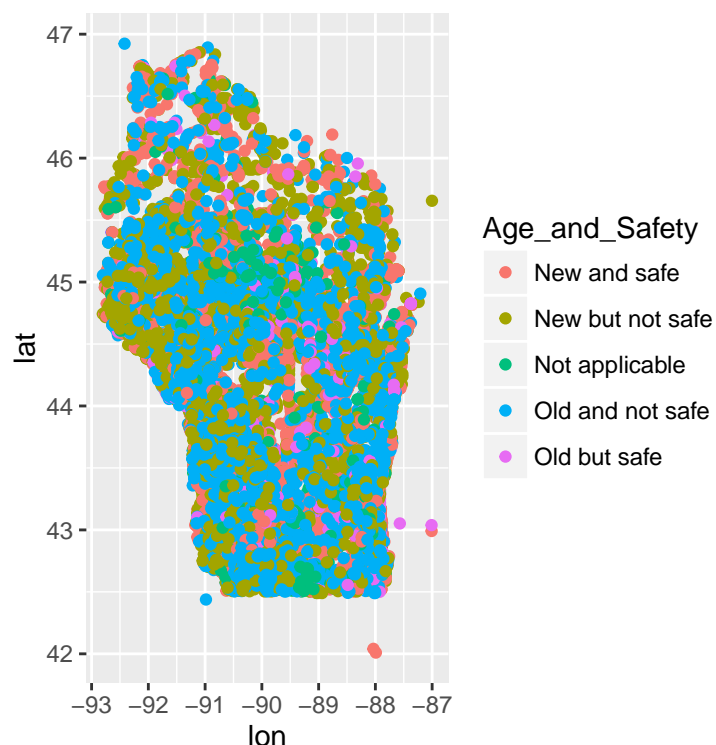
Figure 2

Figure 2 shows the distribution of bridges grouped by age and safety condition

It can be seen from Figure 2 that although there are many unsafe bridges older than 50 years old, the number of new and unsafe bridges is also not small. So the probabilities of a bridge being unsafe conditioned on its age are calculated.

There are 3889 old bridges and 76% of them have at least one feature that does not meet the acceptable standards while there are 9614 relative new bridges and 47% of them have at least one feature that does not meet the acceptable standards.

A chi-squared test is used to find that the probabilities of a old bridge being unsafe and a new bridge being unsafe are different. (chi-square = 927.52, df = 1, p-value < 2.2e-16).

So next step is to know where are these old and not safe bridges distributed. A map was plotted to show the distribution pattern.

Old_and_Not_Safe
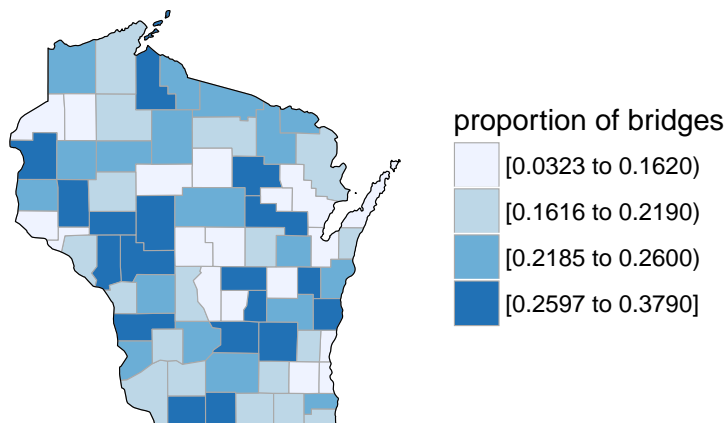
Figure 3

Figure 3 shows the proportion of old and unsafe bridges in each county.

From Figure 3, it can be seen that if we divided Wisconsin into top, middle, bottom three part, counties with higher proportion of old and unsafe bridges are concentrated in the middle part of Wisconsin except for the center of Wisconsin. It seems the reason that bridges in these counties being unsafe have something to do with the old age.

To show the possible reason for bridges in other counties being unsafe, a map showing the distribution of new but unsafe bridges is plotted.

New_but_Not_Safe
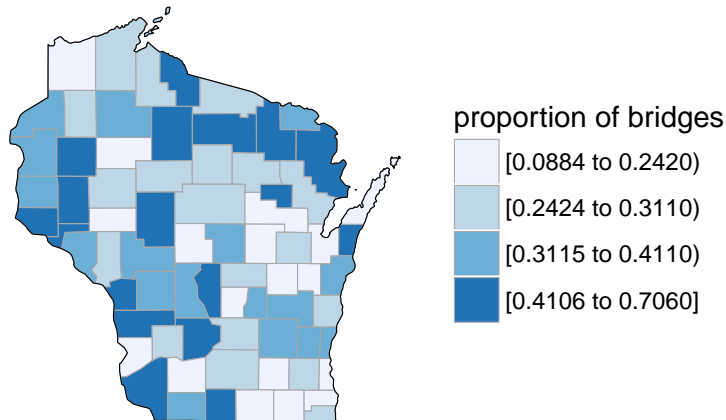
Figure 4

Figure 4 shows the distribution of new but unsafe bridges

The figure 4 shows that counties in northwestern Wisconsin tend to have higher proportion of bridges that are new but unsafe. The reason why new bridges does not meet the acceptable standards need more investigation.

Conclusion

From figure 1, it can be seen that there are many bridges in Wisconsin having at least one feature that does not meet the acceptable standards, which is considered as unsafe.

Based on figure 2 and the chi-squared test, it can be seen that the bridges older than 50 years old are more

likely to be unsafe than the bridges younger than 50 years old. The possible reasons can be the current safety standards are not the same as that 50 years ago, or the old bridges are damaged. But we need more relative data to investigate this.

From figure 3 and 4, it can be seen that the distribution of bridges being old and unsafe and bridges being new and unsafe are different. The counties in the mid-eastern side and mid-western side of Wisconsin have higher proportion of bridges being both old and unsafe while counties in northwestern Wisconsin have higher proportion of bridges being both new and unsafe. It is weird for a relative new bridge to be unsafe. Possible reasons can be the design and construction do not meet the requirement. It worth more investigation but more data are needed.