Pavement Uniformity Index

IOWA DOT
SMARTER | SIMPLER | CUSTOMER DRIVEN

A METHOD TO EVALUATE PERFORMANCE UNIFORMITY FOR HIGHWAY PAVEMENTS

Iowa DOT Pavements

- 11,092 miles of “Primary” pavements (Interstates, US & Iowa Highways)
  - Backbone of state transportation network (total of 115k miles including streets and county roads)
  - Carries 63% of all vehicle traffic in the state
- Asset value - $14.2B
- 3,922 management sections
  - Vary 0.1 mile up to 18+ miles
  - Limits based on construction history
- Extensive section data available

Opportunity

Detailed data available

- Data collected every 1/100th mile (52.8 ft)
  - 1M+ records each cycle
  - 30+ attributes
- Typically aggregated to management section
  - Data too dense to be used for most purposes

Project Goals

1. Dig into the detailed pavement measurements
2. Make something useful

I learned from talking to our engineers that it might be useful to gain an understanding of performance variability within management sections

I set out to create a Pavement Uniformity Index

Data

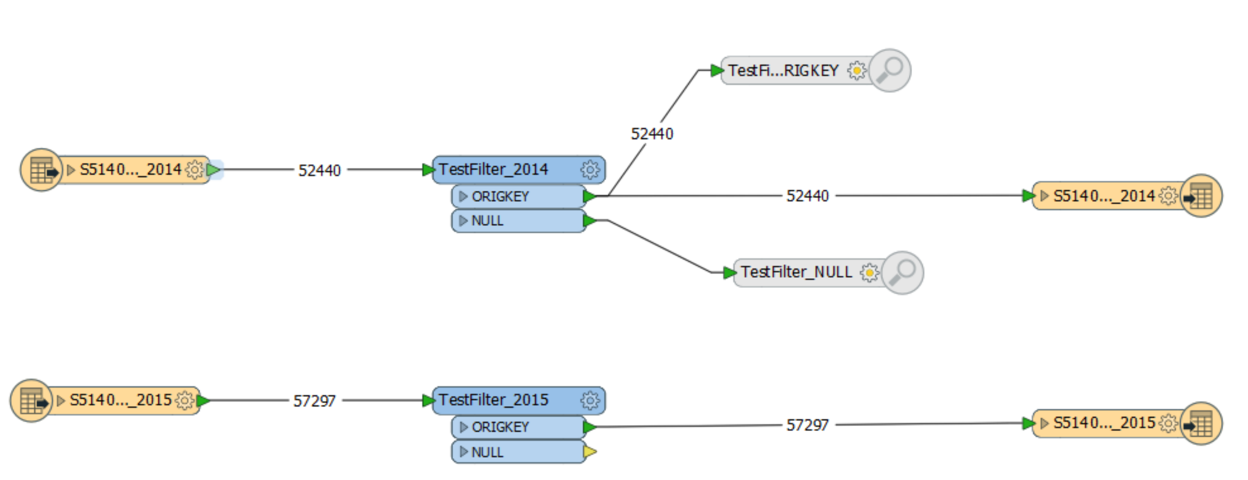
The easy part?

- Managed in DOT Oracle database
- Collected since late 1990's

Used FME to obtain data

Section data - Excel

Quality questions



Data

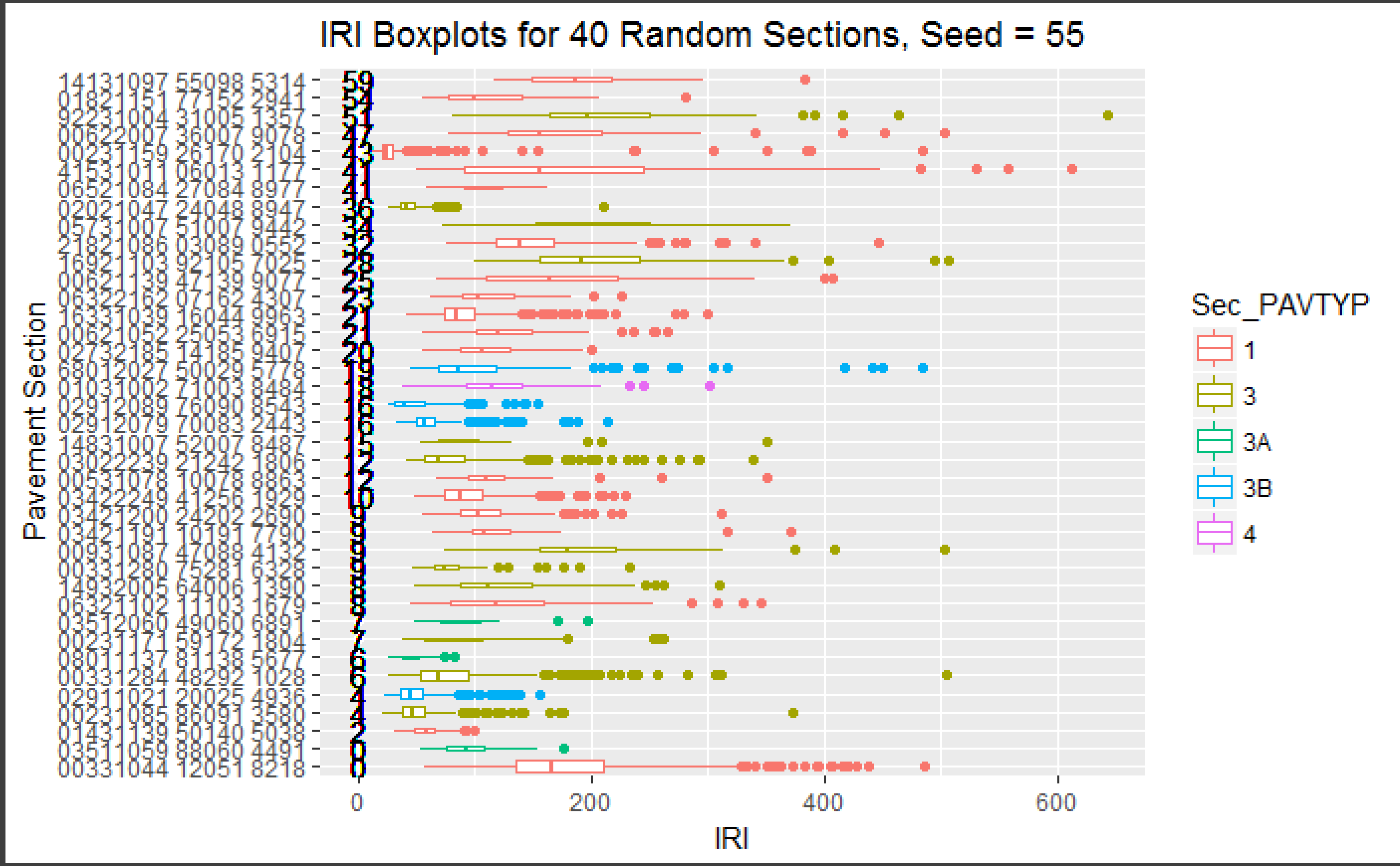
Key Attributes

- Ride (IRI)
- Rutting
- Cracking

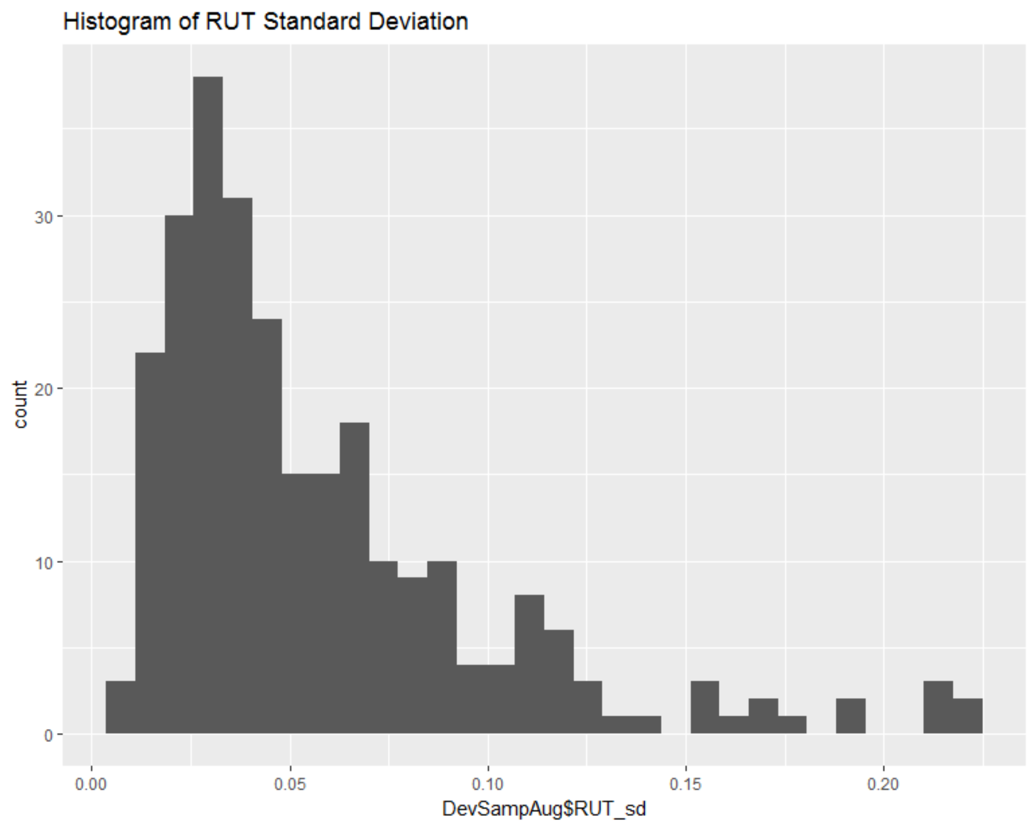
Exploration

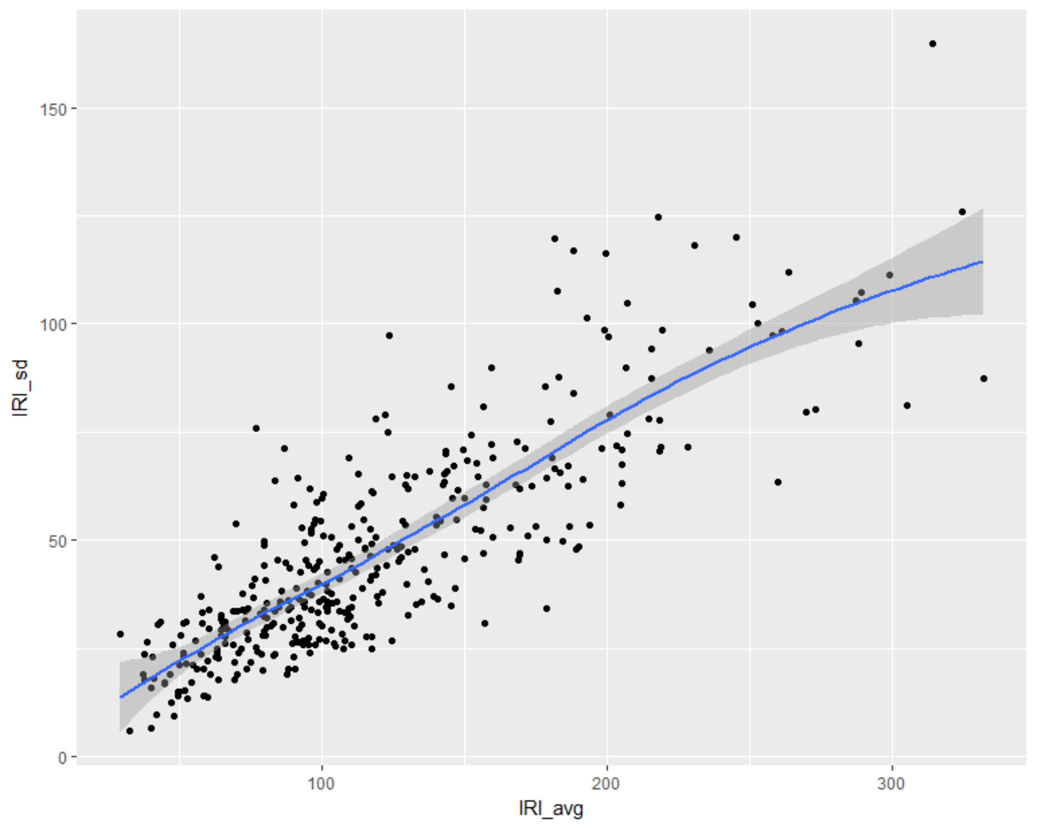
Sampling

- Random sample of 392 management sections and their associated data (105,479 points)
- For some visualizations, sub-samples were generated



Exploration





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Exploration

Findings:

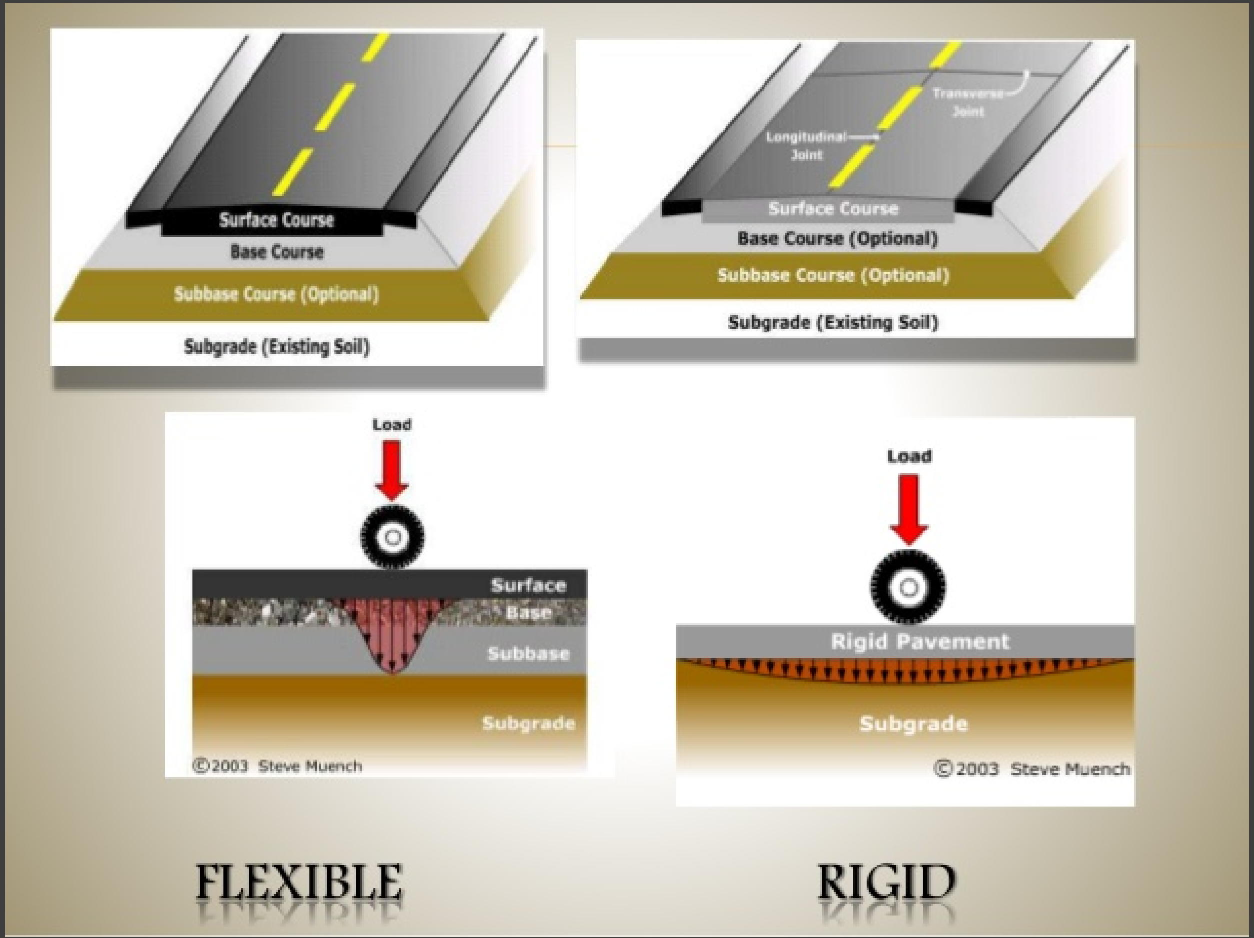
- Remove newer segments (0-2 years)
- Eliminate city segments (1,811 segments, 3,140 miles)
- All distresses have different scales
  - Rutting - 0.1 inch
  - IRI - inches/mi
  - Cracking - mix of length and area
- Some differences by pavement type (rigid, flexible, composite)

Pavement Types

Iowa DOT mix:

- Rigid (Concrete) – 33%
- Flexible (Asphalt) – 16%
- Composite – Asphalt over Concrete – 51%

Trivia Time - Iowa is unusual in having a high percentage of rigid pavements



Cracking

Four major types

- Transverse, Longitudinal, Wheelpath, Fatigue

Four classifications

- Low, Medium, High, Sealed

Variations depending on pavement type

Engineers say: Lx2+A ÷ total area = % Cracking

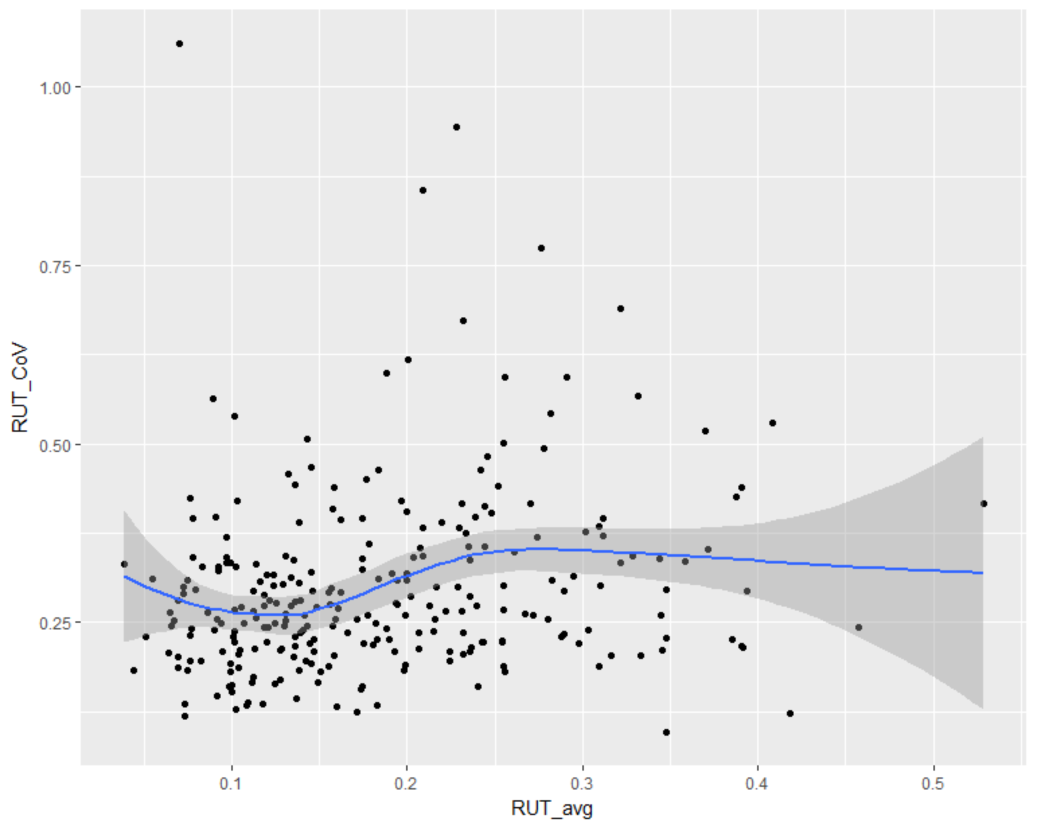
Methods

Use Coefficient of Variation since

- SD often depends on mean value
- Scales all different

Formula: $c_v = \frac{\sigma}{\mu}$

- Calculated for EACH section



Index Calculation Method

Raw Score

$$PUI_{raw}\begin{cases}\dfrac{(c_v[IRI]+c_v[Crack\%])}{2}, & Pavement\ Type = Rigid\\ \dfrac{(c_v[IRI]+c_v[Crack\%]+c_v[RUT])}{3}, & Pavement\ Type = Flexible\end{cases}$$

Final Pavement Uniformity Index value (PUI) on 1-10 scale

- Based on deciles of the empirical distribution of PUI_{raw}
- Highest 10% of all values have PUI score of 10

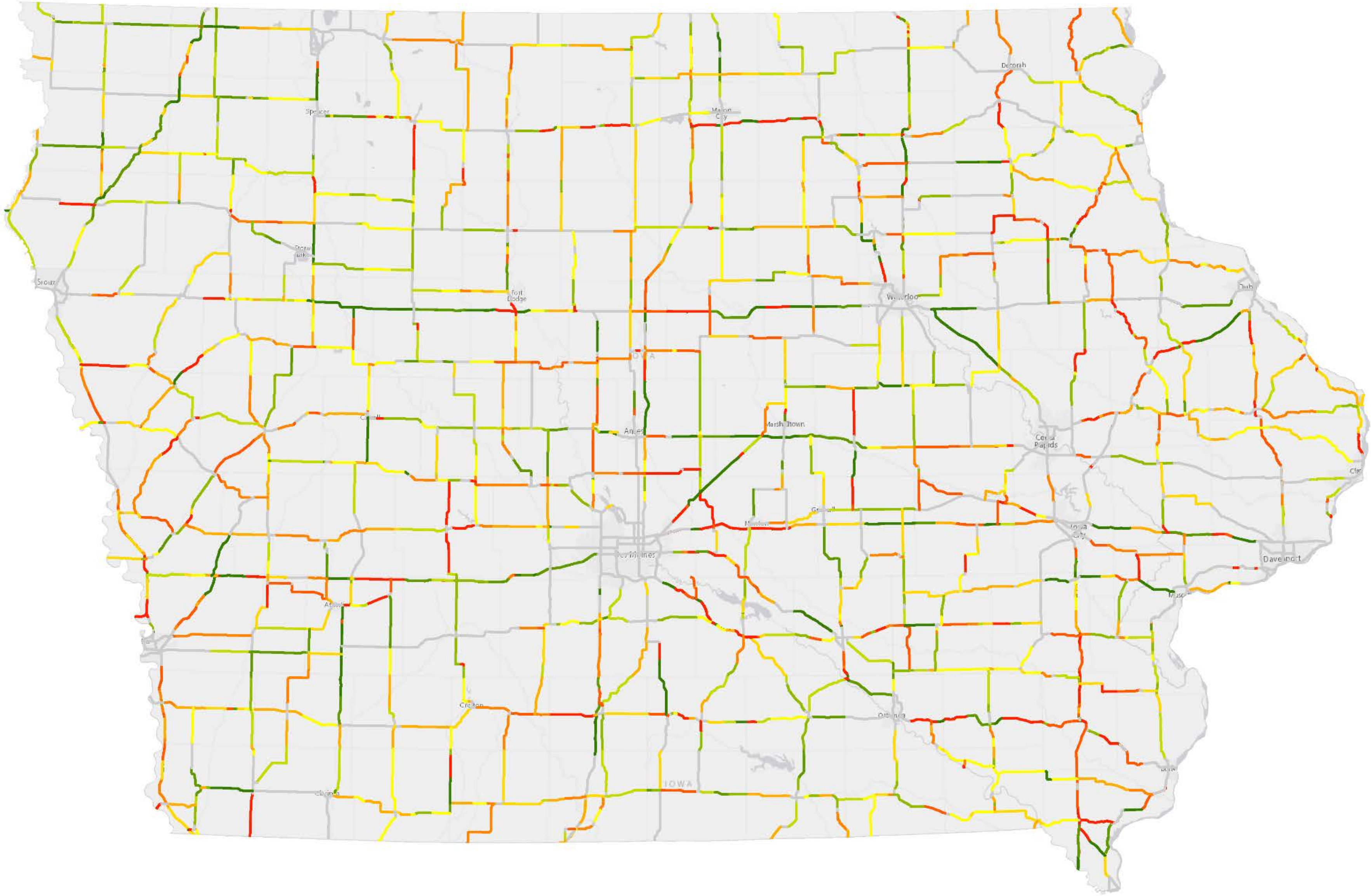
Results

Risk Matrix

- High Risk (red shading): 1,383 mi
- Medium Risk (yellow): 3,046 mi
- Low Risk (green): 3,522 mi

Provides information regarding level of investigation needed to design a treatment

Condition Index	Uniformity Index 1	2	3	4	5	6	7	8	9	10
100	114	84	17	39	39	45	66	125	96	53
90	334	251	123	120	146	197	244	297	305	248
80	286	162	89	118	150	199	171	173	154	248
70	62	29	145	188	209	190	208	78	45	124
60	2.1	56	207	252	176	115	61	20	49	101
50		83	119	118	111	61	34	17	25	27
40		43	32	57	26	55	23	9.4	25	4.4
30		16	8.2		5.2	3.8	11		24	
20								1.4		
10					1.7					

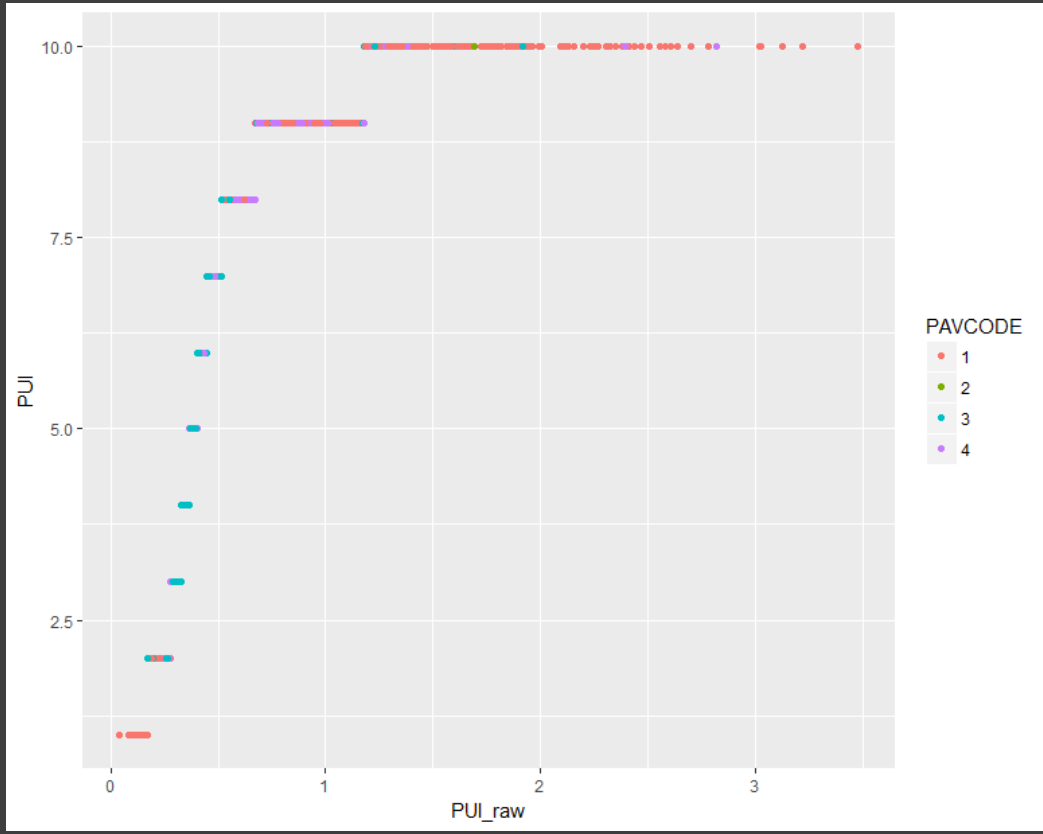

Decorah
Creston
Ottumwa
Davenport

Results

1. Aid in researching needs for a given segment
2. Use to help evaluate pavement deterioration models
3. Easily implemented in SQL – will be in “production” in near future

Future Work

1. Distribution of cracking percent by pavement type
2. Spatial component
3. Temporal component



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