ELECTRIFYING INNOVATION &
INSPIRING TO HIGHER PEAKS

2023 Annual Conference

June 5–7, 2023
Crowne Plaza Desmond Hotel
Albany, New York

NYHiMA
AHiMA Affiliate
New York Health Information
Management Association

Application of Machine Learning and Geographical Information Systems in Home Health Care
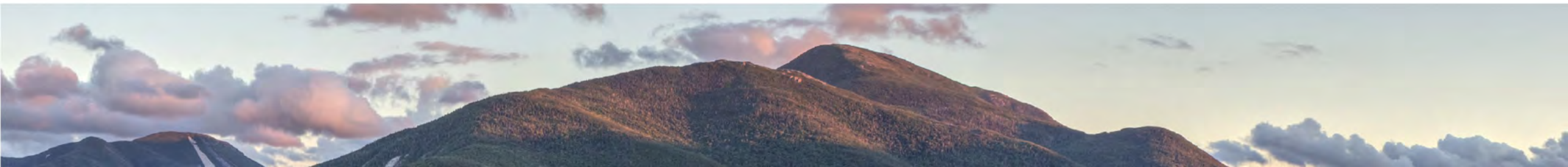
Presenters:
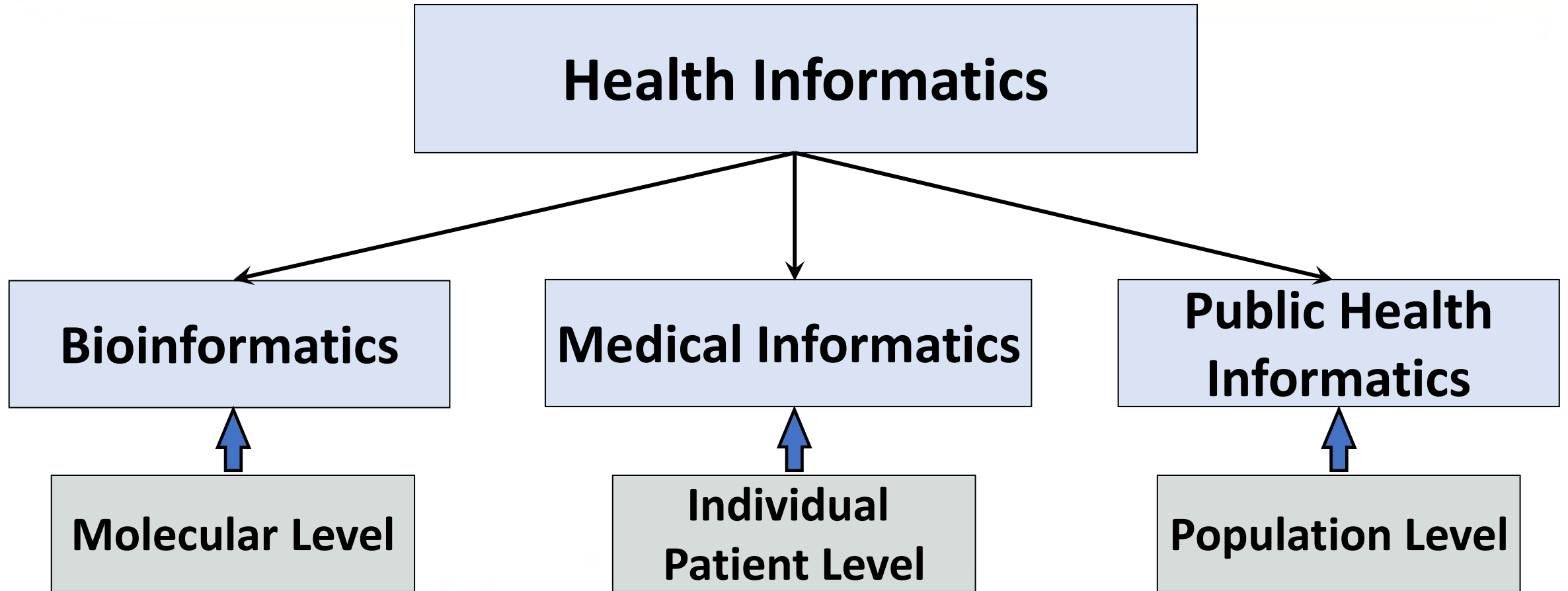
David Patrishkoff M.S. LSSMBB
Nova Southeastern University, Fort Lauderdale, FL

Arif Rana Ph.D., Ed.S., M.S., M.P.H., M.A., M.P.A.
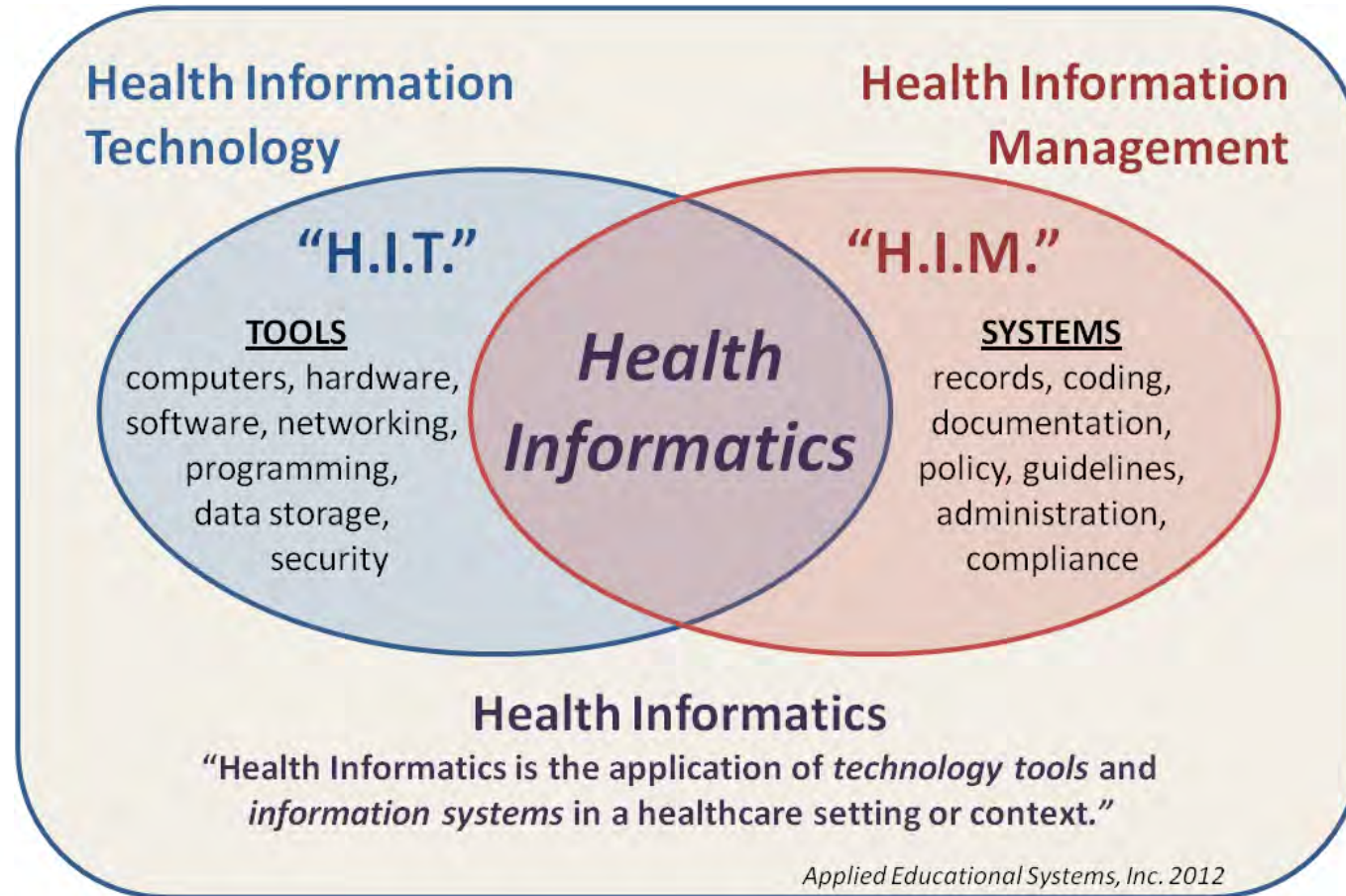SUNY Polytechnic Institute, Utica, NY

What is Health Informatics?


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                    Health Informatics


   Bioinformatics      Medical Informatics      Public Health
                                                 Informatics


   Molecular Level        Individual             Population Level
                        Patient Level
```
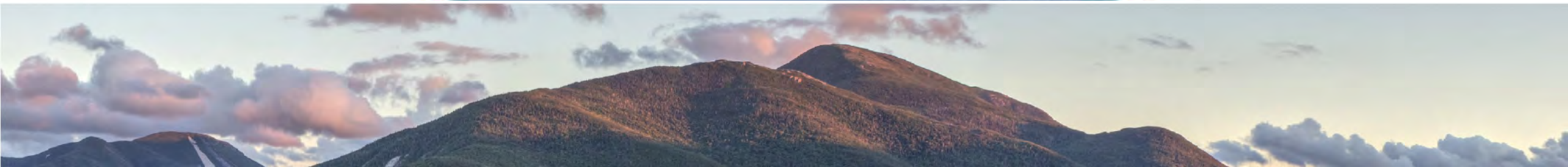
ML and AI can significantly support all these segments

HIT and HIM Overlaps in Health Informatics

HIT is only taught at the Associate degree level

HIM is taught at every Academic degree level

Health Information Technology

Health Information Management

"H.I.T."

TOOLS
computers, hardware, software, networking, programming, data storage, security

Health Informatics

"H.I.M."

SYSTEMS
records, coding, documentation, policy, guidelines, administration, compliance

Health Informatics
"Health Informatics is the application of *technology tools* and *information systems* in a healthcare setting or context."

Applied Educational Systems, Inc. 2012

Session Objectives

1. Describe the Home Healthcare Challenge

2. Show Geospatial visualizations for Hospital Star ratings and Home Health Care (HHC) performances

3. Describe how Machine Learning and AI technology can provide real-time personalized medical advice to patients and their caregivers

4. Describe a No-Nonsense approach for high-quality care in HHC and Hospitals
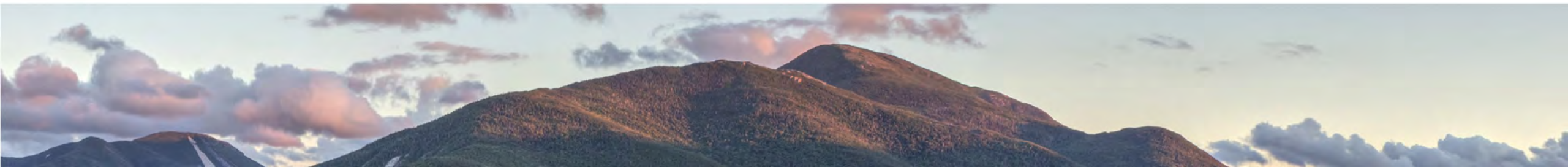
# 1. Describe the Home Healthcare Challenge

2021 US Census Estimates

AI Image created by DALL-E

- There are almost 56 million adults in the United States that are 65 or older, which is the fastest-growing age group.
- 90% of them want to safely "age in place."
- Approximately 4.5 million patients receive home health care services (HHC) per annum
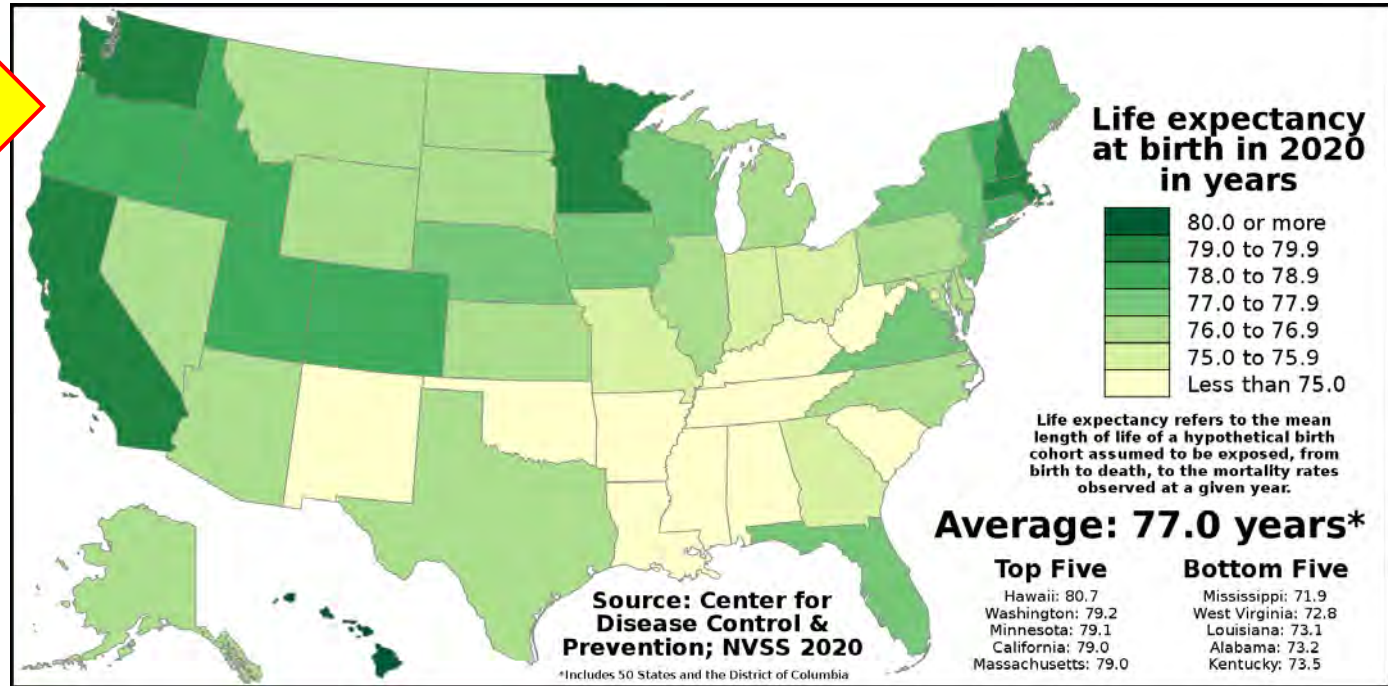- 8.3 million residents reside in long-term care facilities.
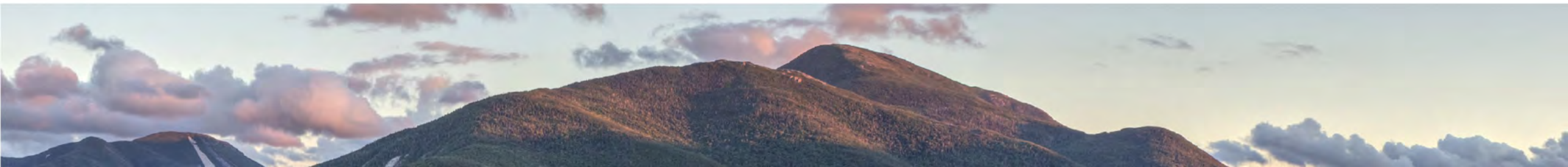
People are Living Longer but encounter Challenges in Sustaining a High Quality of Life
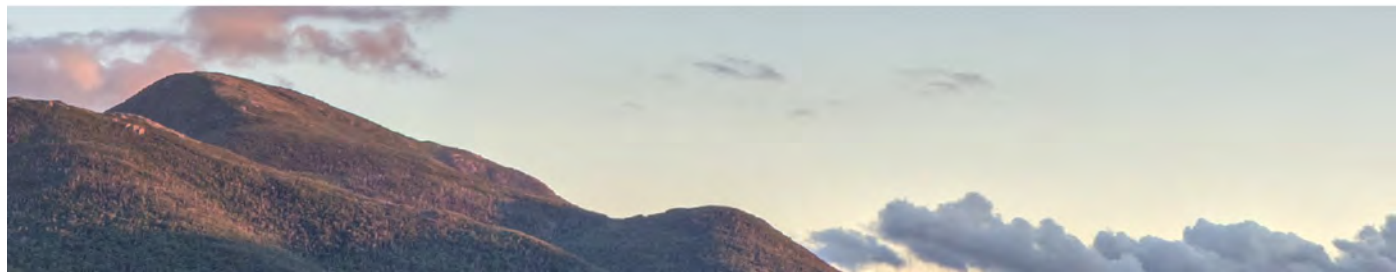
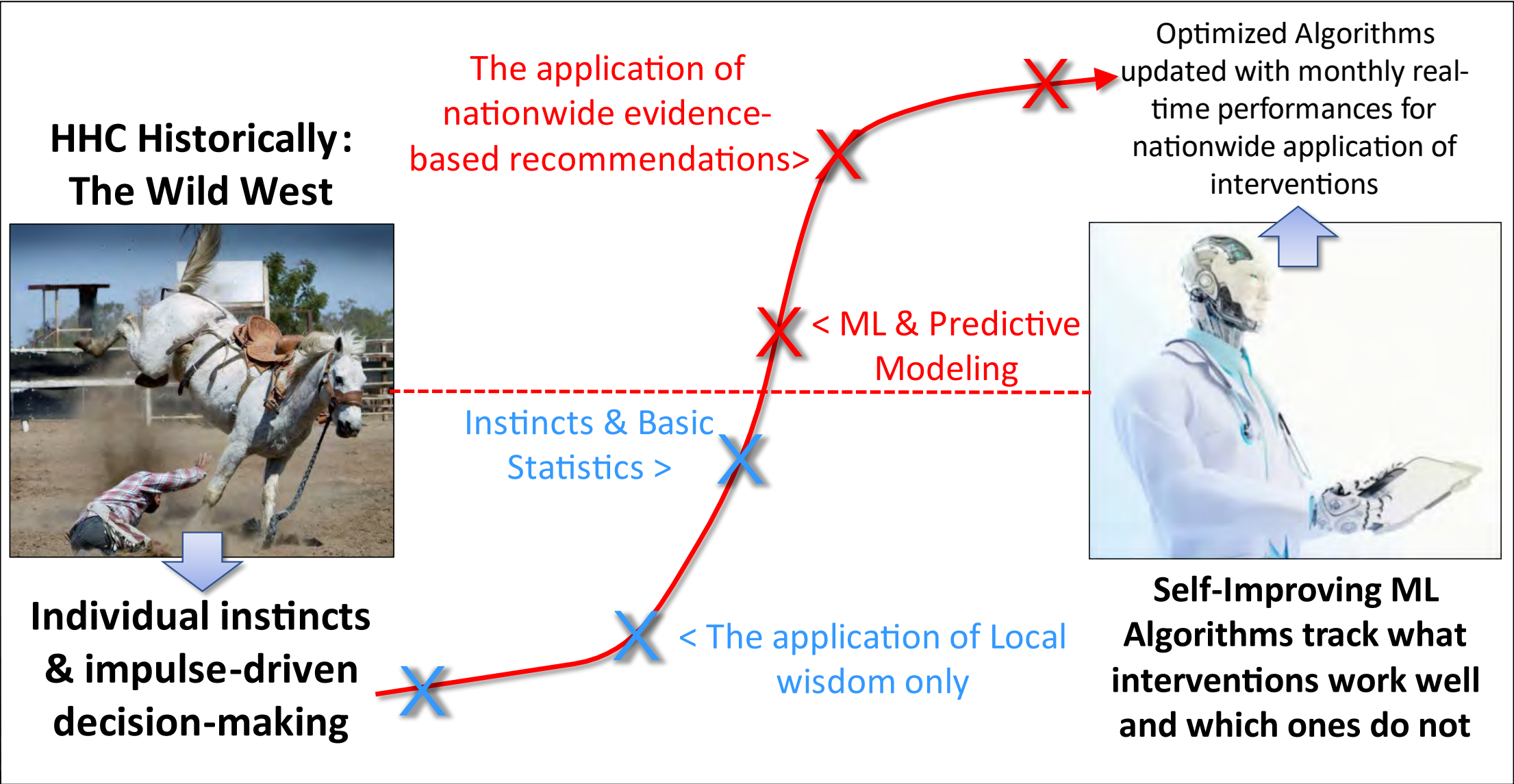Life Expectancy in the USA 1900-2019
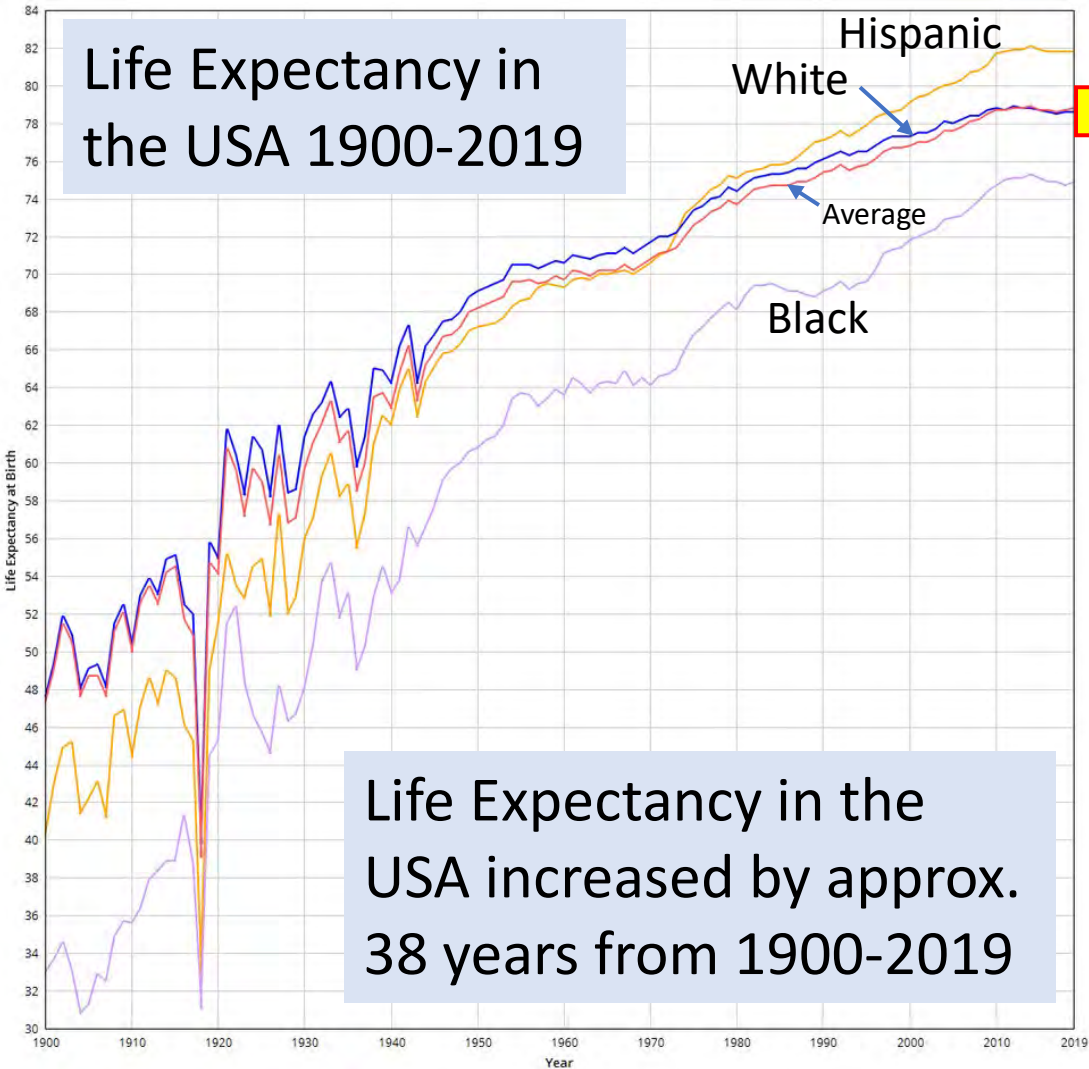
Life Expectancy in the USA increased by approx. 38 years from 1900-2019

The Opportunity for Machine Learning (ML) and AI in Home Health / Chronic Care

2. Show Geospatial visualizations for Hospital Star ratings and Home Health Care (HHC) performances
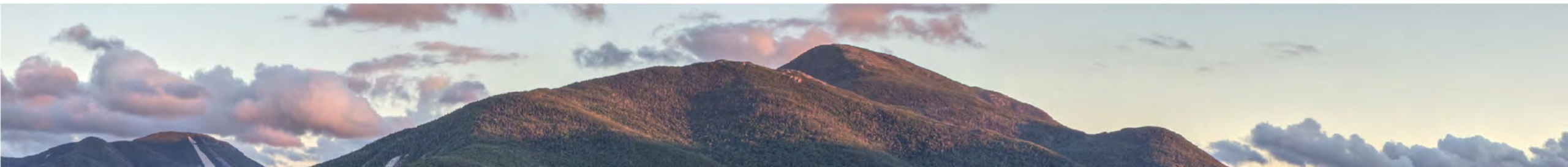
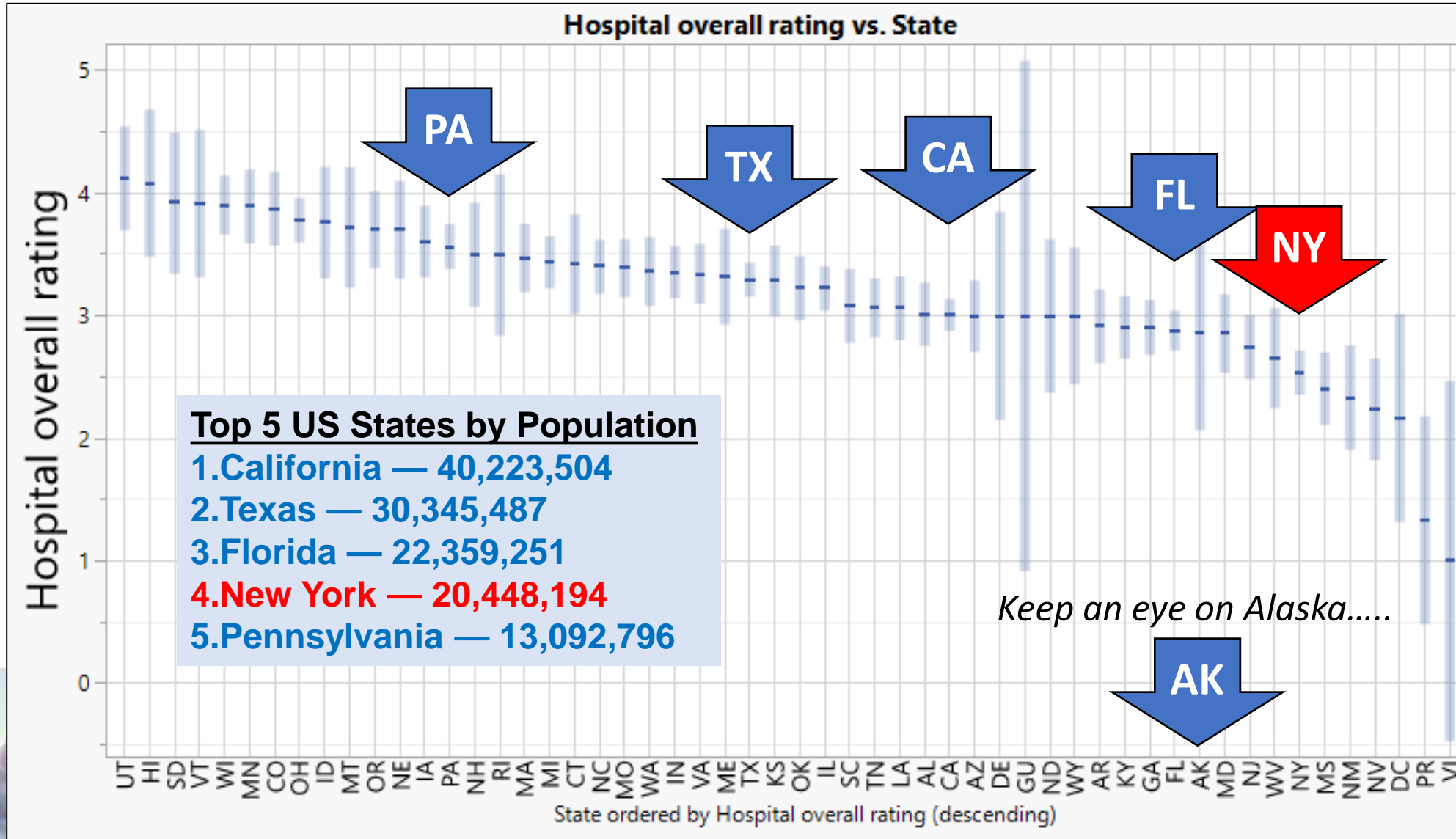# The Five Measure Groups used to Calculate
Hospital Star Ratings

1. Mortality*

2. Safety of care*

3. Readmissions

4. Patient experience

5. Timely and effective care

Note: If any of the above 5 measures are missing, as for 2229 of 5318 total hospitals, the overall star rating is not calculated for that specific hospital

*Medical errors are the 3rd leading cause of death in the USA – Per John Hopkins

Average Hospital Star Rating with Confidence Intervals (CIs) by State

Non-overlapping 95th percentile CIs identify statistical significance

Top 5 US States by Population
1. California — 40,223,504
2. Texas — 30,345,487
3. Florida — 22,359,251
4. New York — 20,448,194
5. Pennsylvania — 13,092,796

Keep an eye on Alaska.....

Geospatial Visualizations: A mix between Analytical and Creative Visualizations
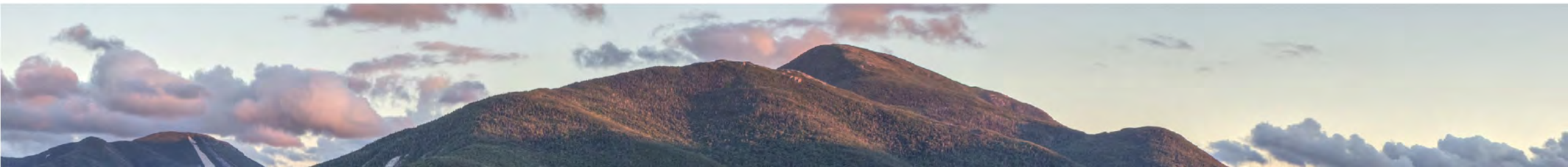

Analytical

Geospatial Visualizations

Creative

AI Images created by DALL-E

Where are the 5318 Hospitals in the USA Located?

Highest Density of the 5318 Hospitals is shown in Red

Number of Hospitals per State
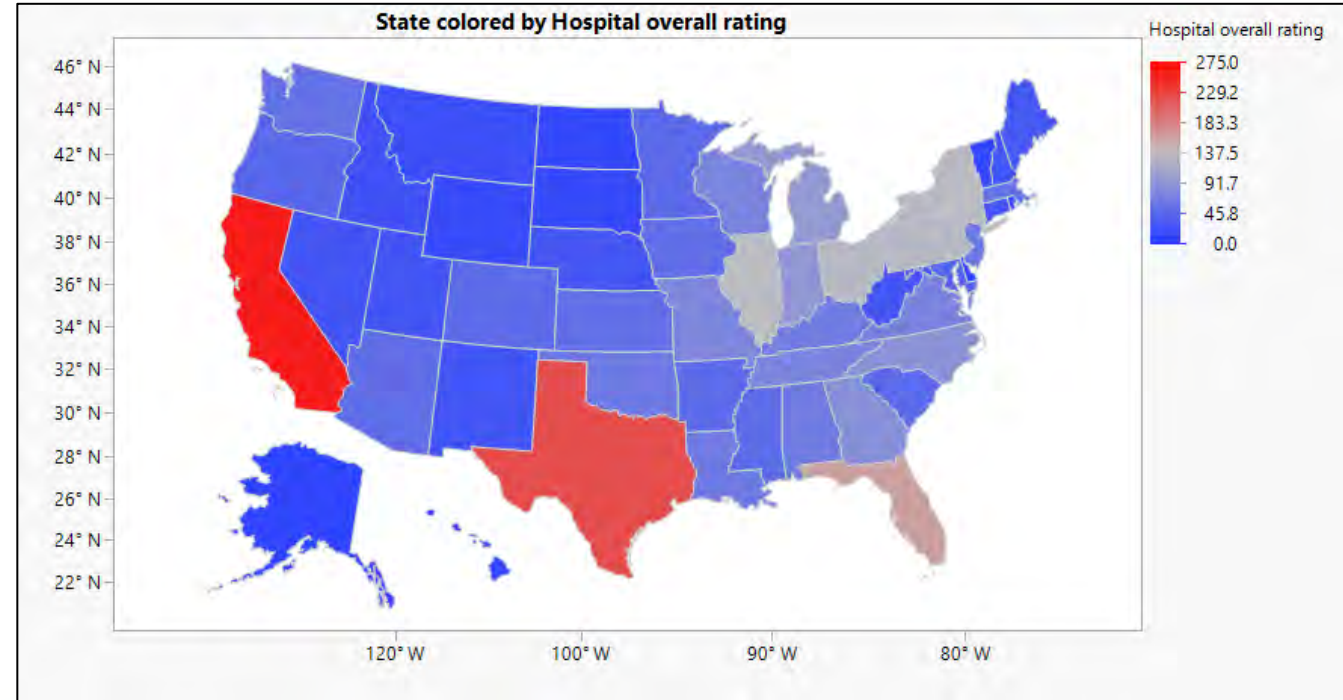

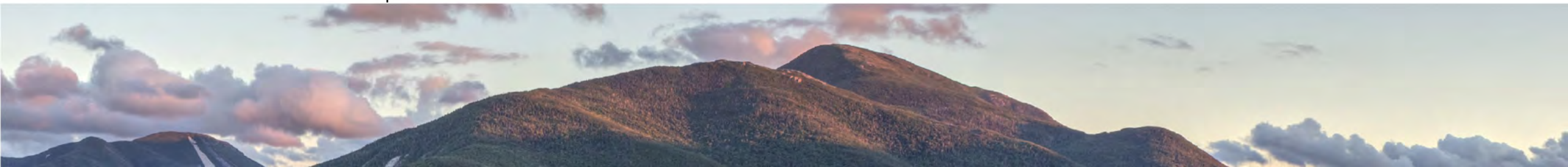Chart created with Maptitude Software

Chart created with JMP Software from SAS

3088 of the 5318 Hospitals in the US currently have a CMS calculated Star Ratings
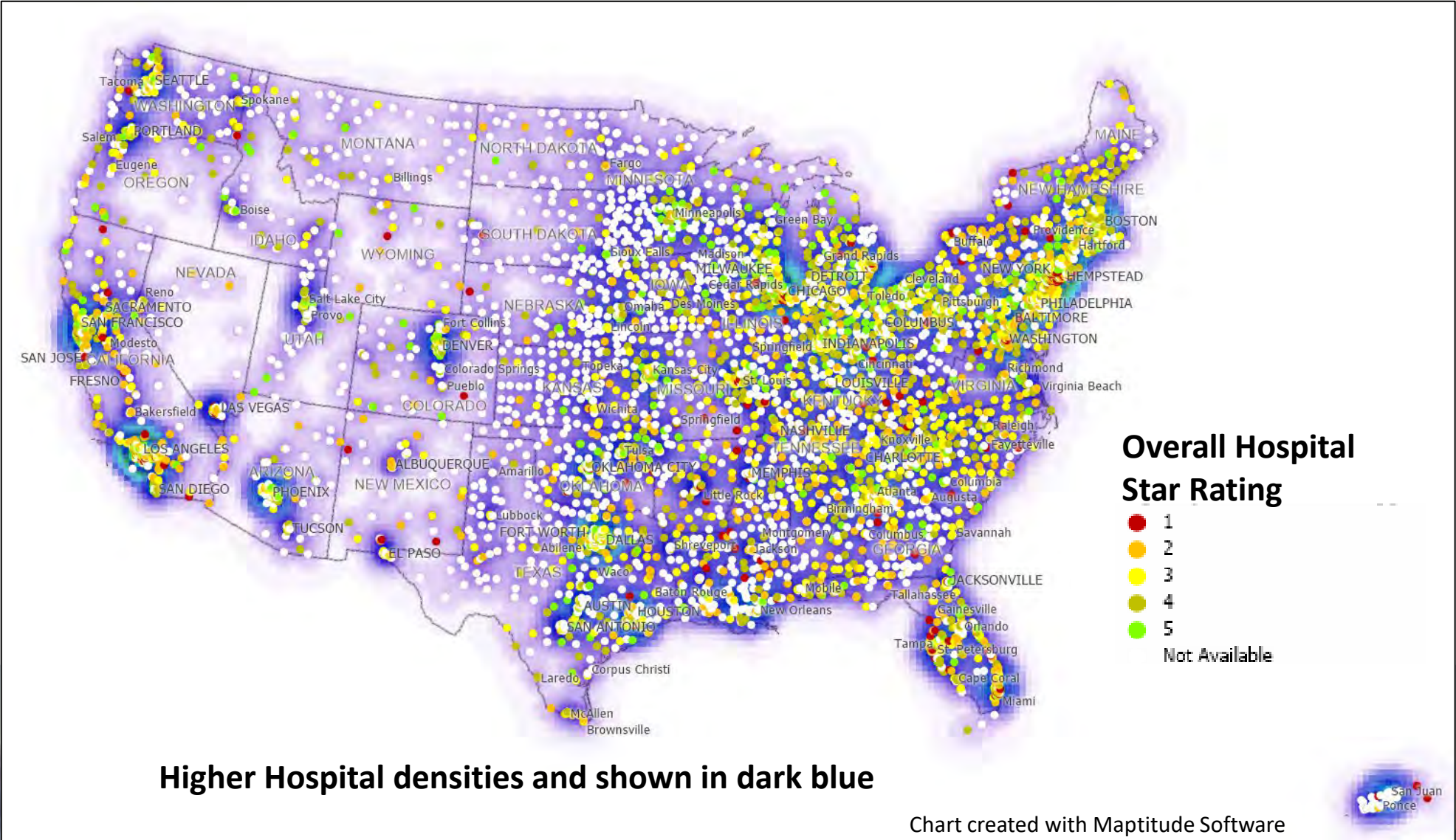
Overall Hospital Star Rating	# of Hospitals
NA	2229
1	191
2	689
3	889
4	889
5	430

Overall Hospital Star Rating

- 1
- 2
- 3
- 4
- 5
- Not Available

5318 Hospitals were assessed. Only 3088 had enough information available to calculate a star rating.

Higher Hospital densities and shown in dark blue

Chart created with Maptitude Software

Hospital Star Ratings vary greatly by State

Median Hospital Star Rating per State
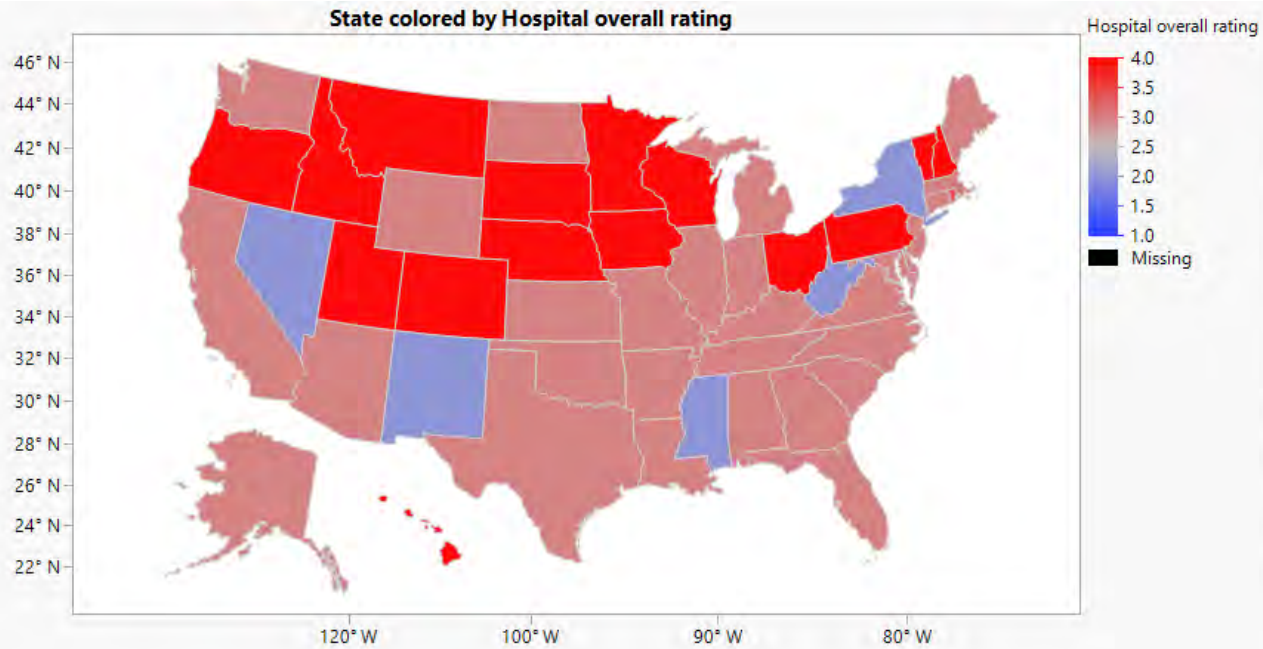
The Maximum Hospital Star ratings per State.
All but 4 states have a hospital with a 5 rating.

Charts created with JMP Software from SAS

Hospital Star Ratings vary greatly by State

The lowest Hospital Star rating per State.
All but 19 states have a hospital with only 1-star rating.

The Range of Hospital Star ratings per State.
all but 19 states have a star rating range of 4.
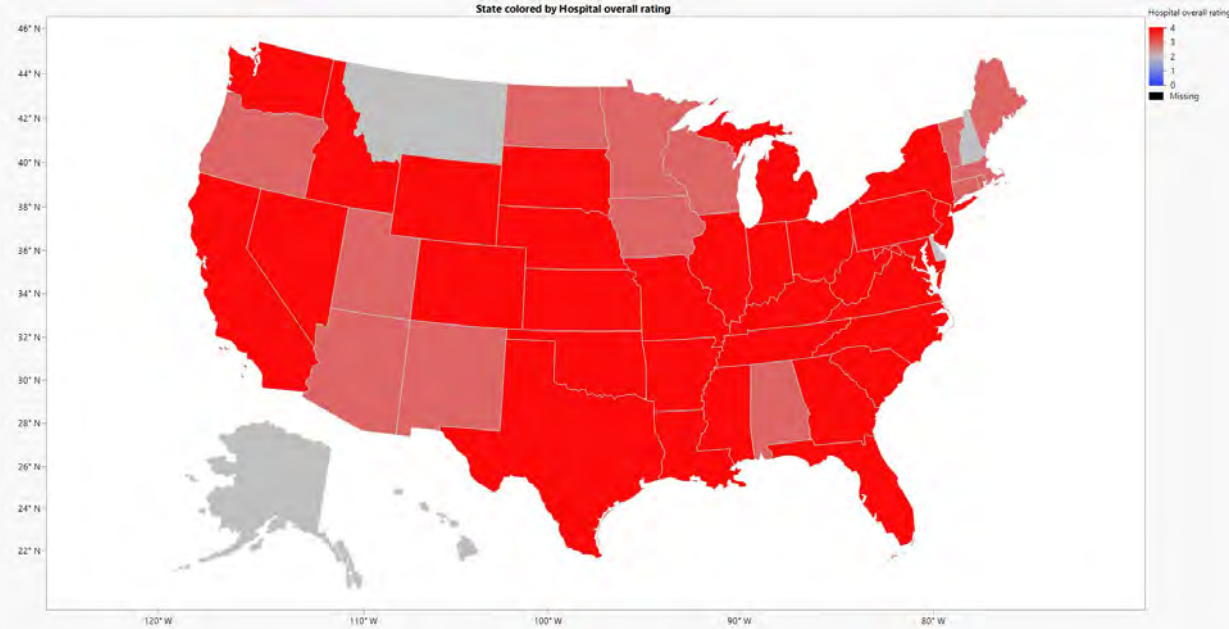
Charts created with JMP Software from SAS

3D Geo Displays uniquely identify different Population Datasets of Interest
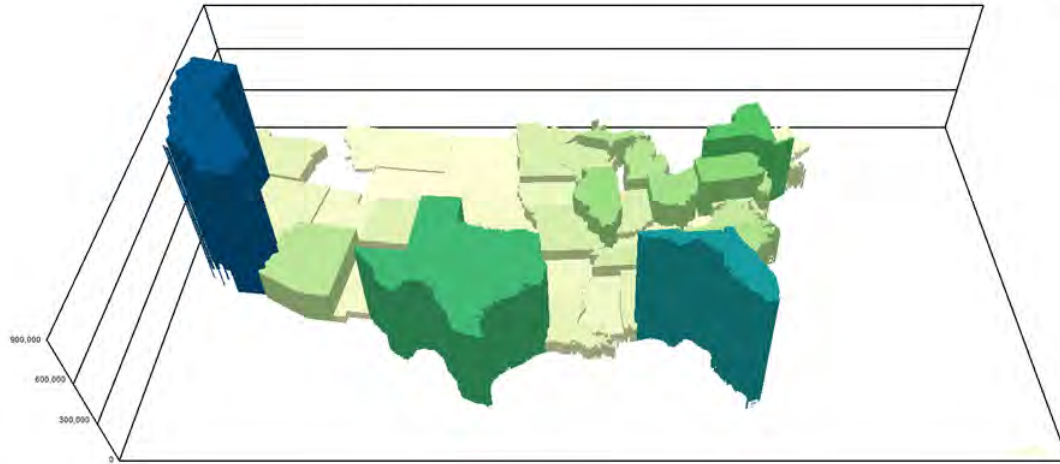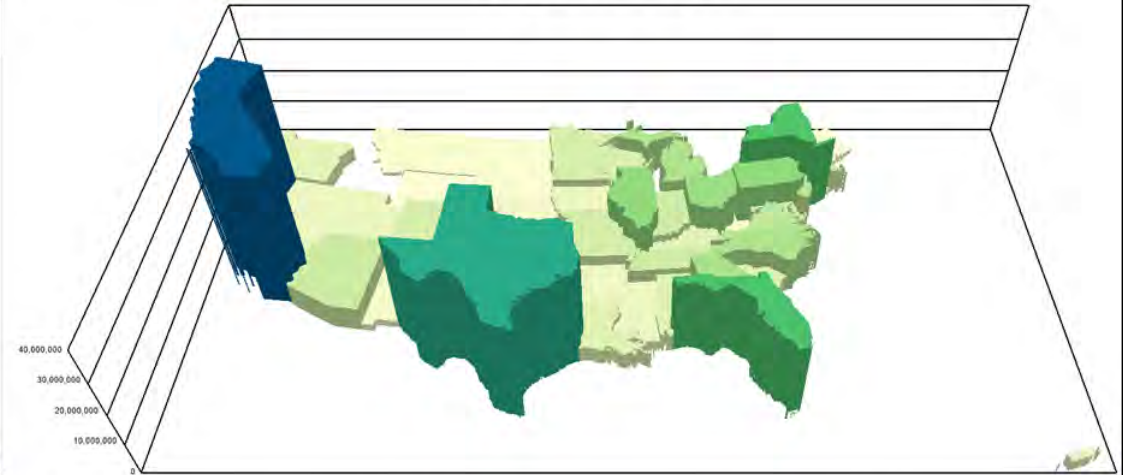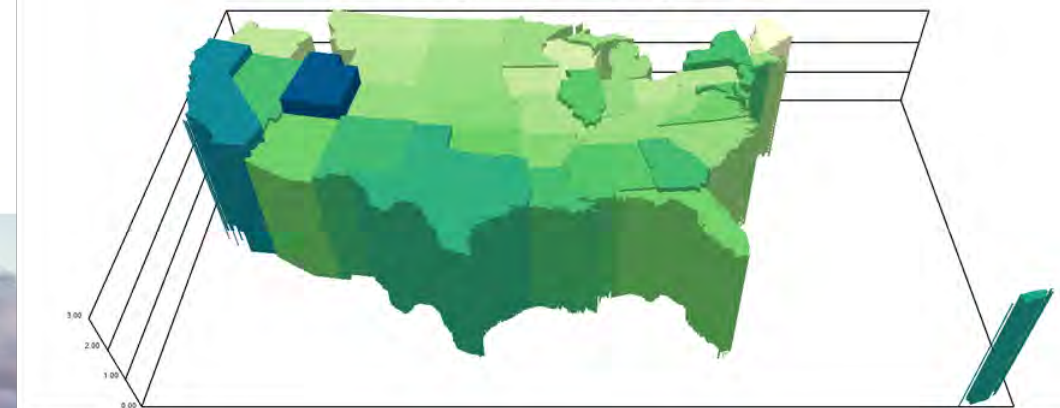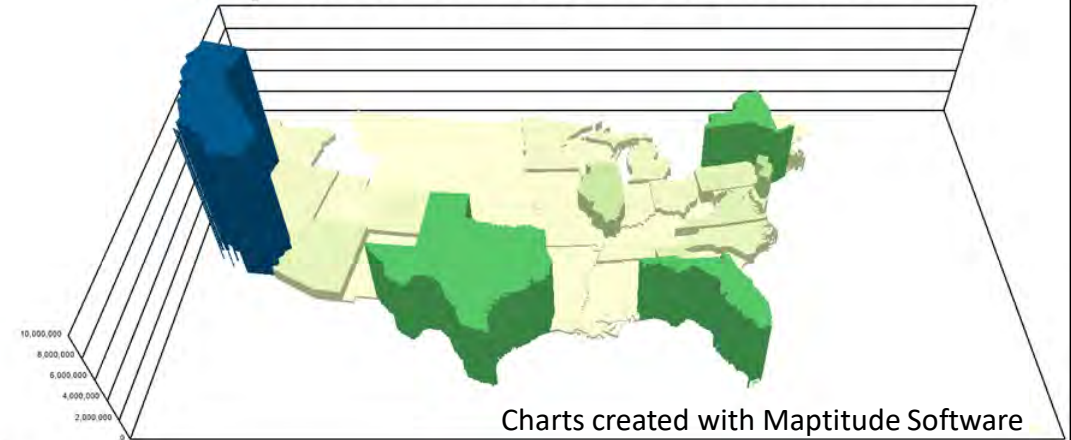
Charts created with Maptitude Software

3D Geospatial Display Styles

Median Household Income by State

$90,000

$60,000

$30,000

$0

Chart created with Maptitude Software
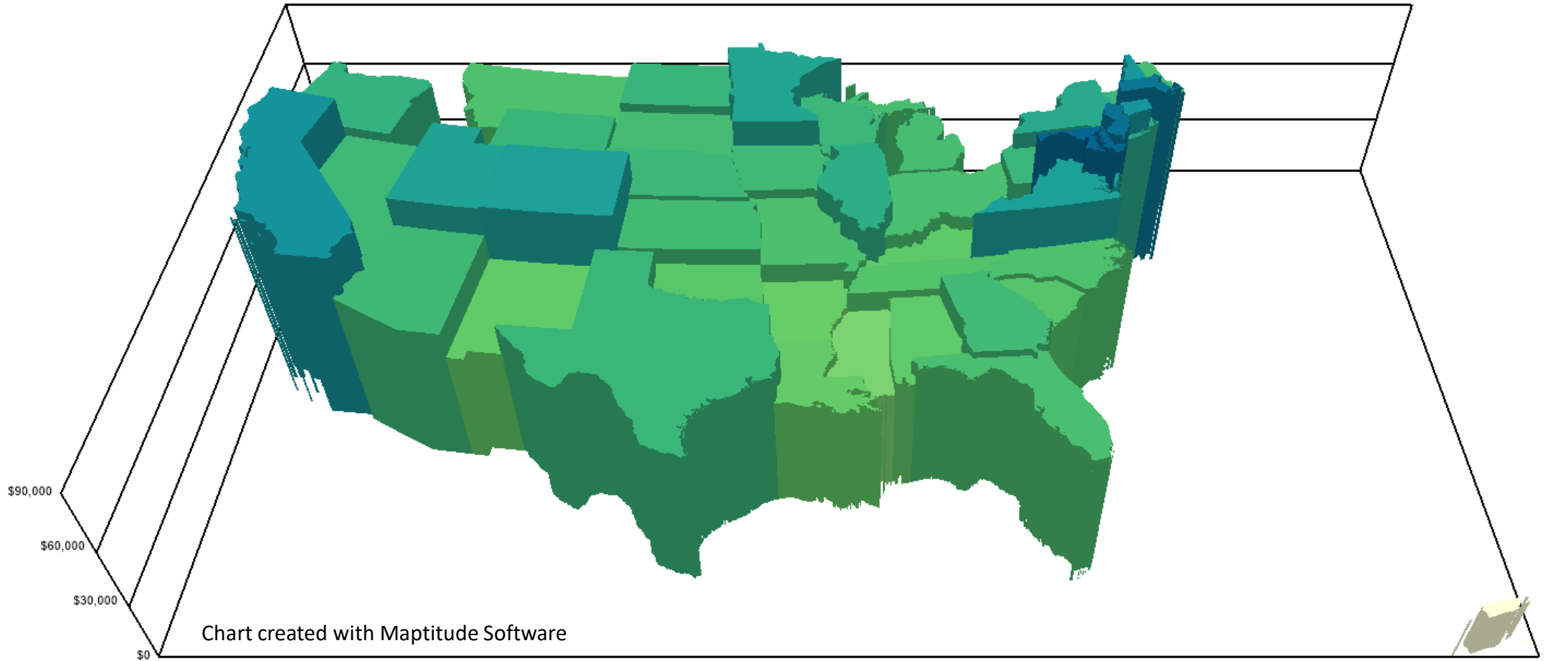
Hospital Density and Star Ratings for the 184 NY Hospitals (132 are Star rated)

The darker Blue, Green, yellow, and orange colors show higher areas of Hospital Density
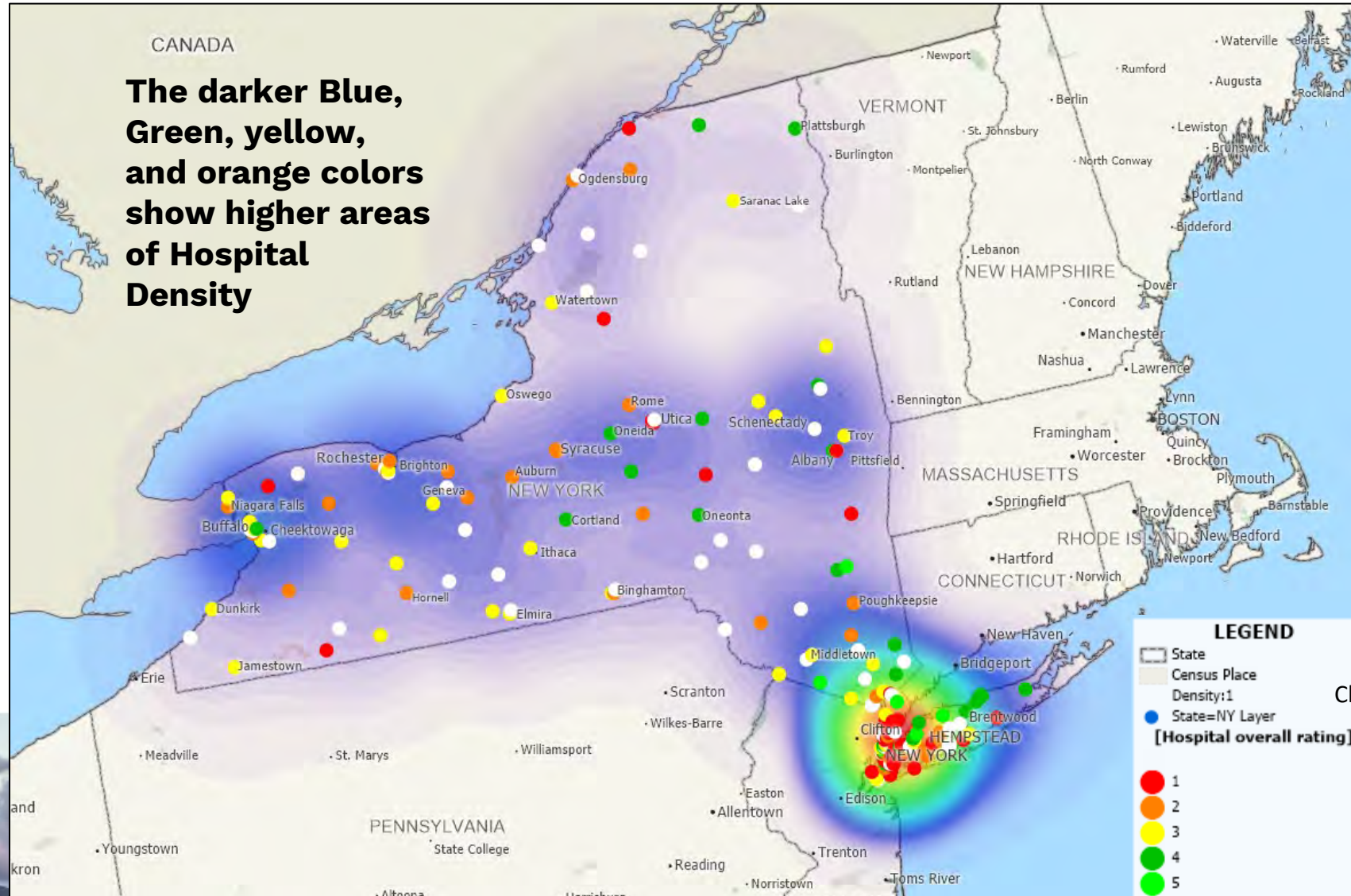
Hospital Star Rating	# of Hospitals
NA	52
1	34
2	33
3	33
4	24
5	8

Chart created with Maptitude Software

LEGEND
State
Census Place
Density:1
State=NY Layer
[Hospital overall rating]

- 1 (red)
- 2 (orange)
- 3 (yellow)
- 4 (dark green)
- 5 (light green)

Long Island Area- New York State Hospital Star Ratings
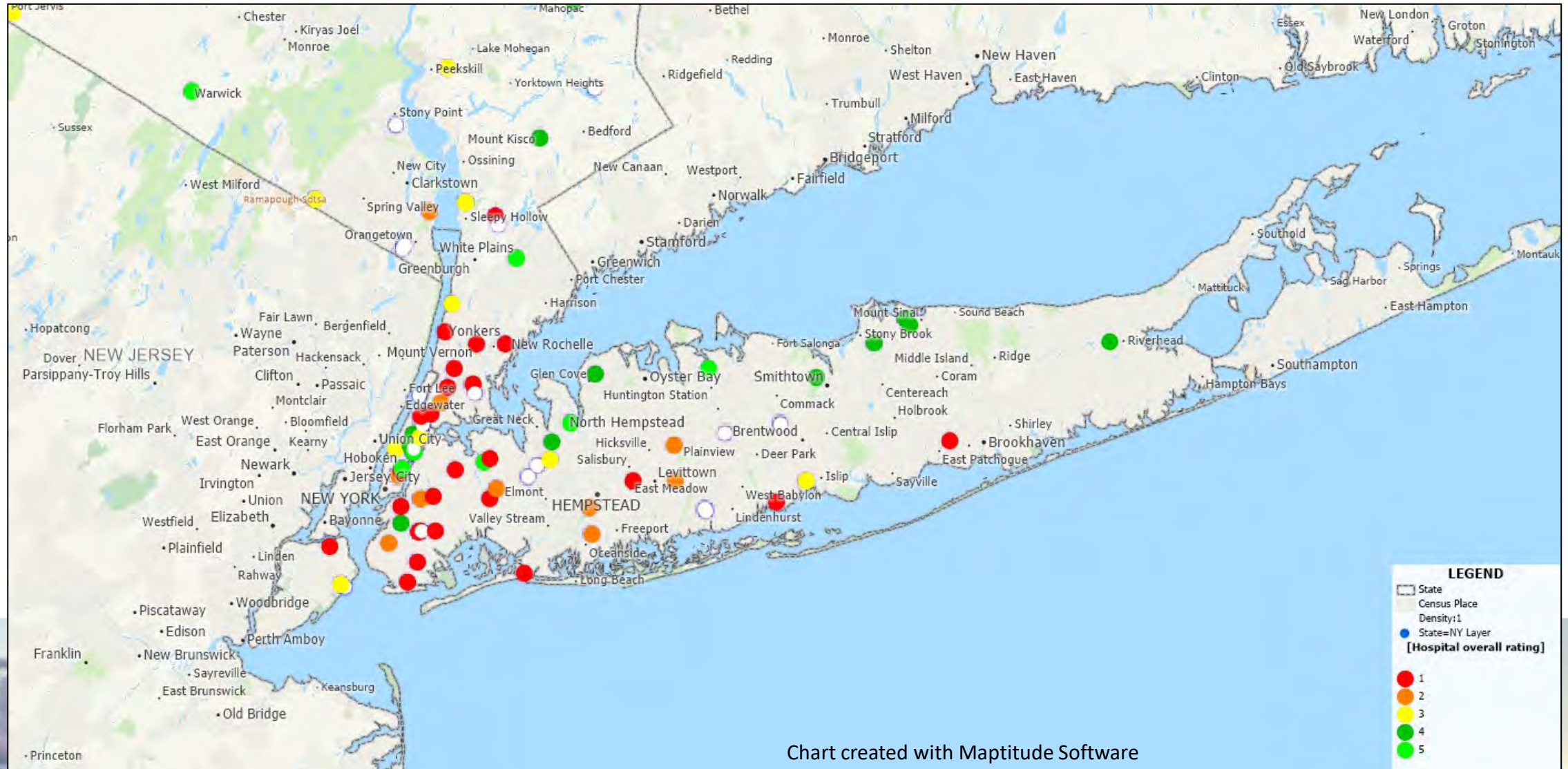
Chart created with Maptitude Software

Home Health Star Ratings (CMS.gov)

- The Centers for Medicare & Medicaid Services (CMS) built the [Care Compare](#) website at [Medicare.gov](#) **as a key tool to help consumers choose the best health care provider**. Care Compare provides tools like "star ratings" that summarize Hospital and HHC provider performance measures.

- There are two types of home health star ratings:

    1. **Quality of Patient Care (QoPC) Star Rating** is based on **7 OASIS performance measures** from Medicare claims data. CMS continues to update them quarterly based on new data posted on Care Compare from 7831 of 11,646 HHC Providers.

    2. **Patient Survey Star Ratings** are based on **20 questions** in **four groupings** of questions for patients from 5281 of 11,646 HHC Providers (https://homehealthcahps.org/). 994,525 total Survey responses were captured.

The 7 measures that are part of the Quality of Patient Care Star Rating

1. Timely Initiation of Care
2. Improvement in Ambulation
3. Improvement in Bed Transferring
4. Improvement in Bathing
5. Improvement in Shortness of Breath
6. Improvement in Management of Oral Medications
7. Acute Care Hospitalization

Data file used for analysis: **HH_Provider_Apr2023.xlsx**

QoPC Star Rating	# of HHC Providers
NA	3815
1	156
1.5	542
2	791
2.5	1081
3	1235
3.5	1245
4	1285
4.5	1006
5	490

Average Quality of Patient Care Star Ratings with Confidence Intervals (CIs) by State
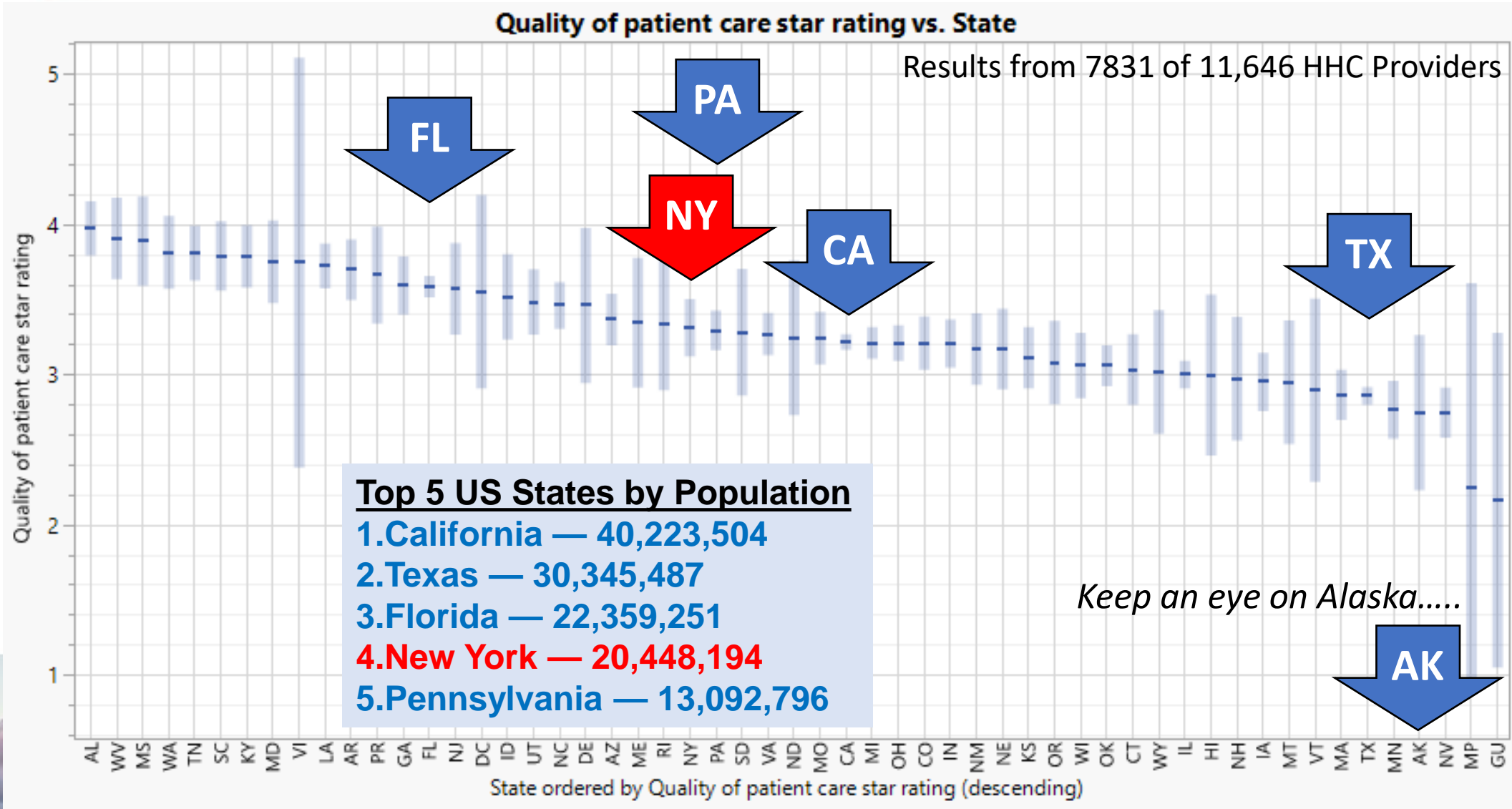
Quality of patient care star rating vs. State

Results from 7831 of 11,646 HHC Providers

Non-overlapping 95th percentile CIs identify statistical significance

Top 5 US States by Population
1. California — 40,223,504
2. Texas — 30,345,487
3. Florida — 22,359,251
4. New York — 20,448,194
5. Pennsylvania — 13,092,796

Keep an eye on Alaska.....

State ordered by Quality of patient care star rating (descending)

Quality of Patient Care Star Rating by State

State colored by Quality of patient care star rating

Quality of patient care star rating
4.0
3.5
3.0
2.5
2.0

Results from 7831 of 11,646 HHC Providers

Charts created with JMP Software from SAS
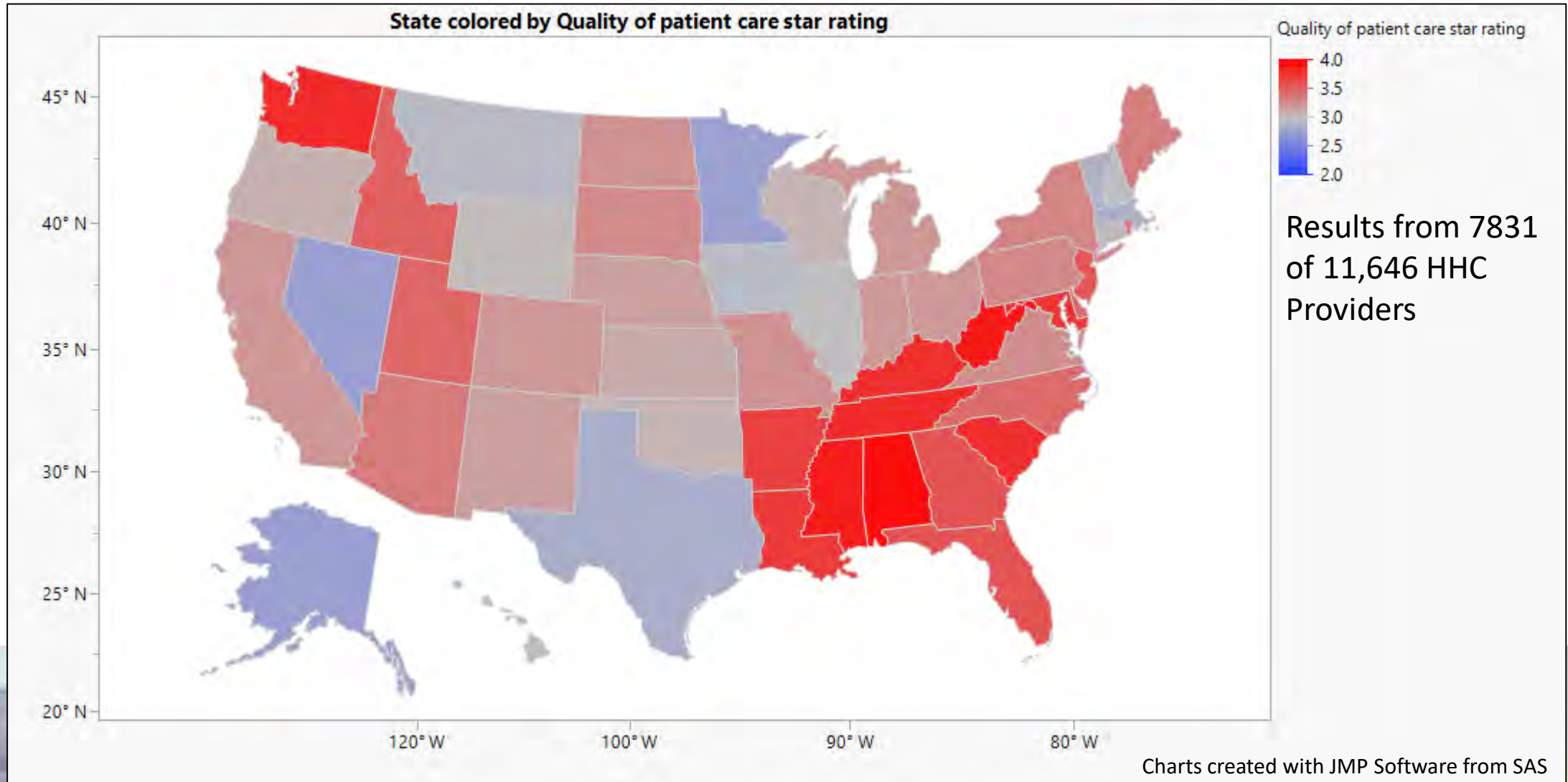
The HHC Patient Survey Star Ratings include four of the measures reported on Care Compare

1. Care of Patients (Survey items: Q9, Q16, Q19, and Q24)

2. Communication Between Providers and Patients (Survey items: Q2, Q15, Q17, Q18, Q22, and Q23)

3. Specific Care Issues (Survey items: Q3, Q4, Q5, Q10, Q12, Q13, and Q14)

4. Overall Rating of Care Provided by the Home Health Agency (Q20)

all information about the Patient Survey Star Ratings on the HHCAHPS website.
HHCAHPS Survey results are updated each calendar year quarter.

The Average HHC Provider Patient Survey Star Ratings by State
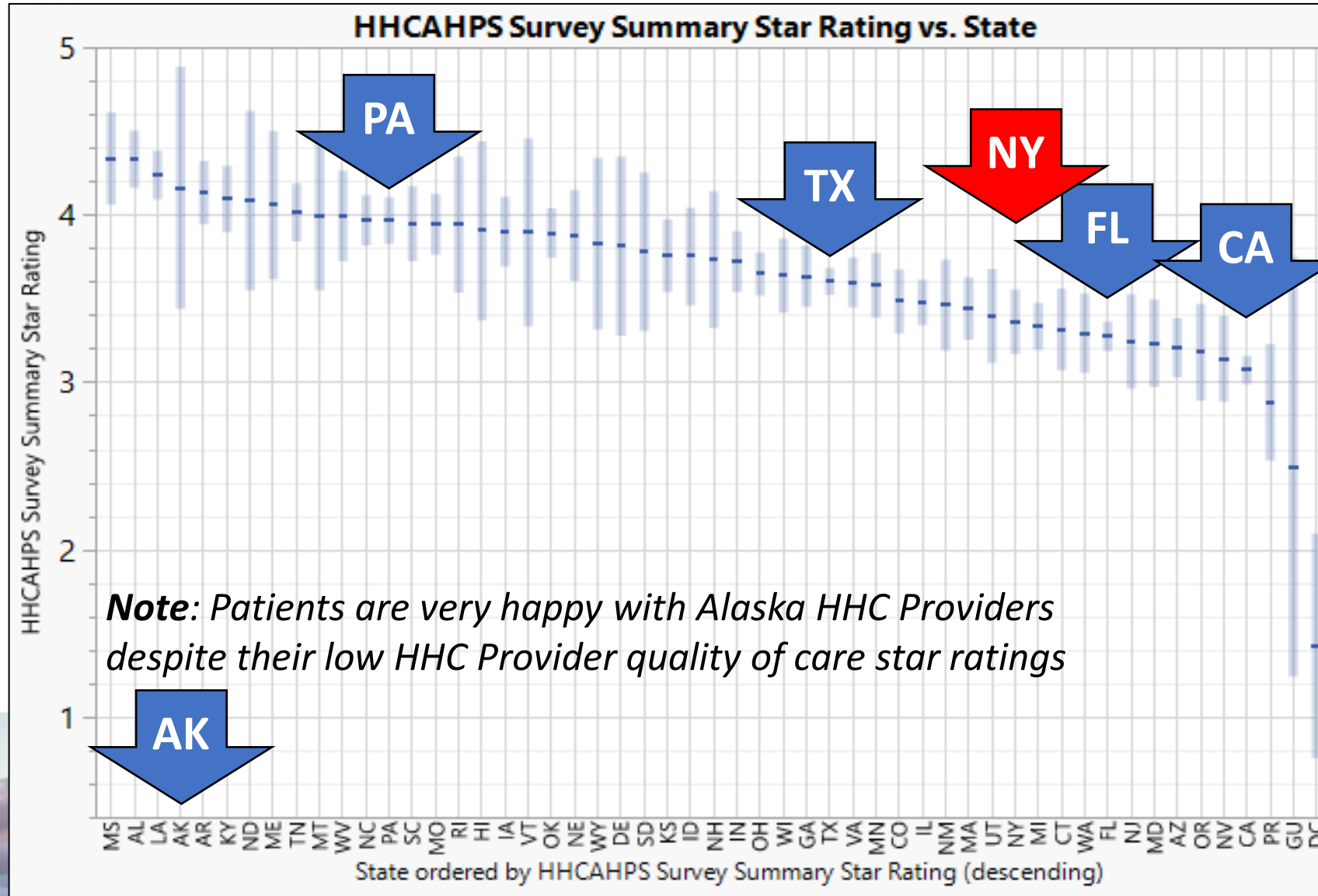
HHCAHPS Survey Summary Star Rating vs. State

Note: Patients are very happy with Alaska HHC Providers despite their low HHC Provider quality of care star ratings

Top 5 US States by Population
1. California — 40,223,504
2. Texas — 30,345,487
3. Florida — 22,359,251
4. New York — 20,448,194
5. Pennsylvania — 13,092,796

Ratings calculated from 5281 (45%) of 11,646 HHC Providers

Comparing the Results for 3 Different Star Ratings by State

The highest ratings are shown in green ovals
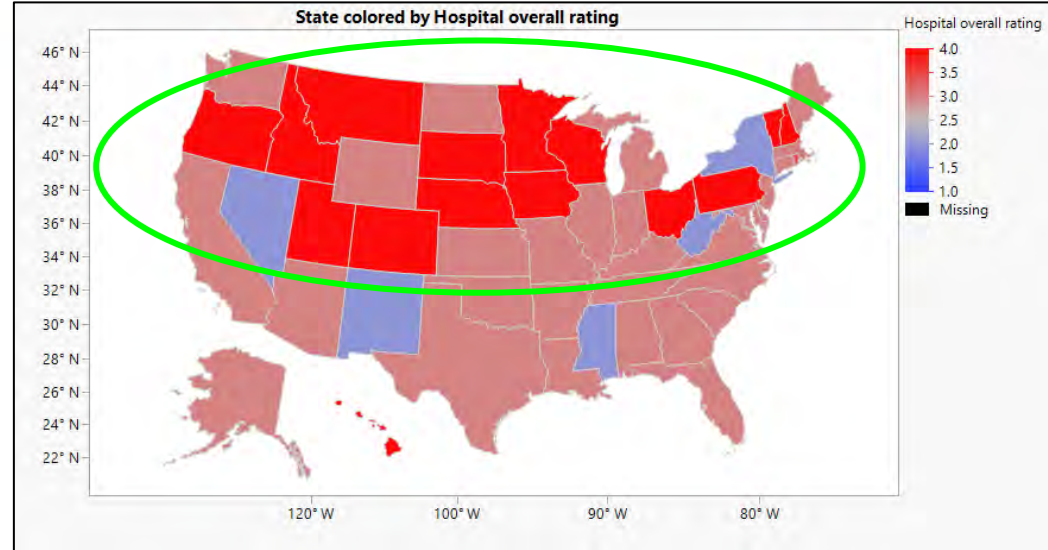
Hospital Star Ratings

Not much agreement between 3 Star Rating Systems

HHC Patient Satisfaction Star Ratings
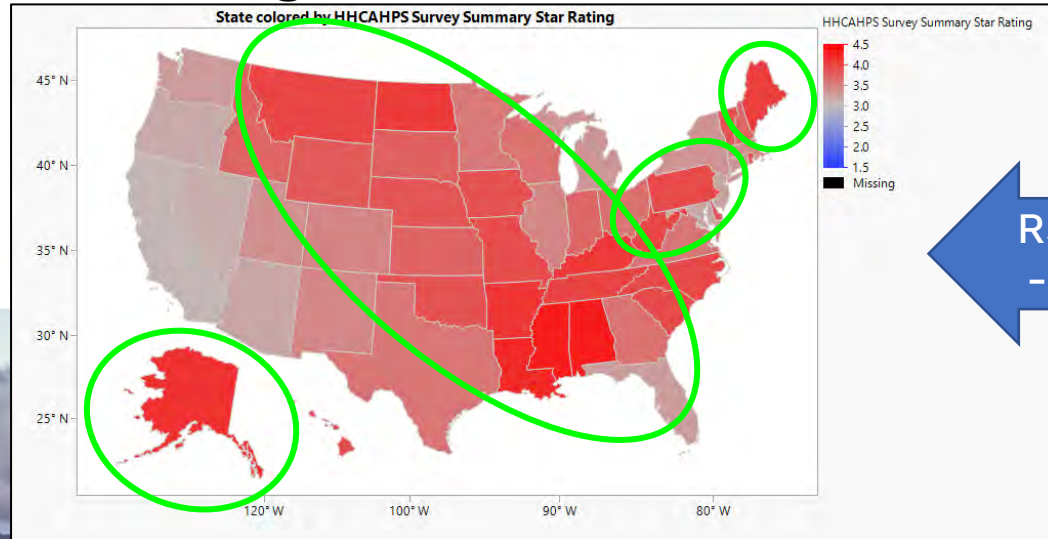
HHC Quality of Care Star Ratings
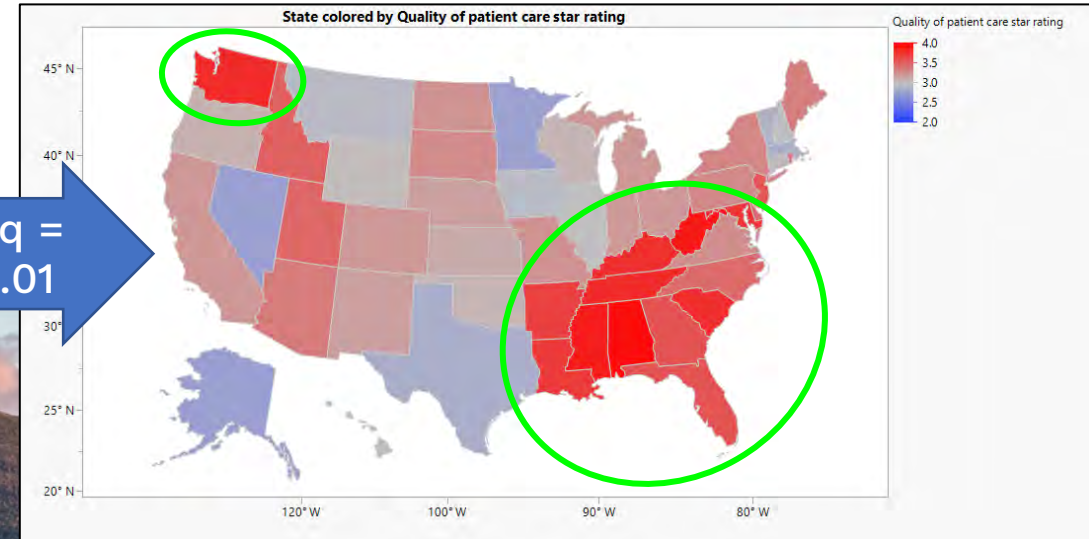
State colored by Hospital overall rating

State colored by HHCAHPS Survey Summary Star Rating

RSq = -0.01

State colored by Quality of patient care star rating

3. Describe how Machine Learning and AI technology can provide real-time personalized medical advice to patients and their caregivers

What is Machine Learning (ML)?

- **Machine Learning** (ML) is a subset of Artificial Intelligence (AI) that enables machines to learn from data and make predictions or decisions on new data it has not yet seen
  - **Training**: This is the process by which a ML model learns from data
  - **Models**: Models are mathematical representations of a real-world process
  - **Algorithm**: An algorithm is a procedure that is followed in order to create a model
  - **Prediction**: Prediction here doesn't refer to the future, but for unseen data
  - **Learning**: Recognizing patterns and making intelligent decisions from the input data
  - **Model Evaluation**: Testing how well the model was trained using new unseen data
  - **Generalization**: The model's ability to offer predictions on previously unseen data

What is Artificial Intelligence (AI)?

- Artificial Intelligence (AI) is a branch of computer science that aims to *mimic* human intelligence.
- **Two Main Types of AI:**
  1. Narrow AI: AI that's designed to perform a single task, like recommending songs on Spotify or answering questions on Siri. This is the type of AI is everywhere.
  2. General AI: AI that can understand, learn, adapt, and implement knowledge in a wide range of tasks. Currently, General AI is largely theoretical and doesn't exist yet.
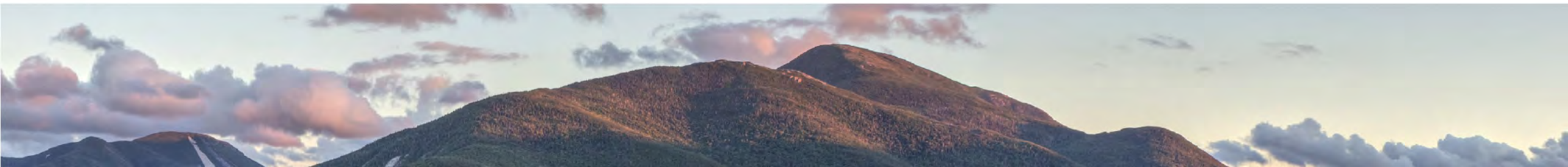
Some Examples of Potential Narrow AI HC Coach Apps with human vitals tracking and tailored 24/7 Support

Pain management

Disease & comorbidity management

HHC ADL improvement management

Cognitive Behavioral therapy and exercises

Depression management

Personal nutrition, exercise, and lifestyle advice

Personal meditation guidance, tips, and scheduling

Provide 2nd opinions on all health matters

Research and recommend best practices and therapies for similar case mix situations

Provide HC alerts to you your caregivers, and others

Recommend the best local doctors for your needs

Stress & Sleep management

Recommend the best hospitals for your needs

Personal motivation, progress tracking, & feedback to meet your HC goals

Age-related aches & pain tips

Answer any HC question

Narrow AI apps will merge over time to create a Powerful Personal General AI Health Coach / Assistant

No-Code Data Science (ML/AI) is Possible

NO-CODE DATA SCIENCE

Advanced Analytics, Visualizations, Machine Learning, and AI with Open-Source Software

David Patrishkoff

Robert E Hoyt
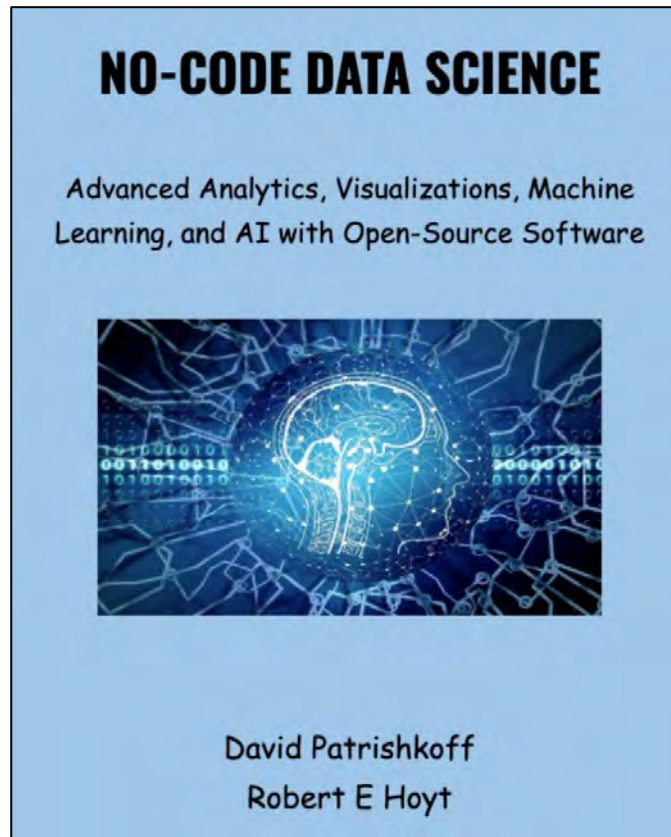
- No-Code open-source Software (Orange) can apply ML to tabular data, text mining, and image analysis
- Learn Predictive modeling with no programming / coding required
- Free monthly workshops, as we complete our 500-page book this summer
- Certification levels available in the Fall of 2023

Our 8-Step DISCOVER Process to Successfully Master Predictive Modeling

1: Define Research questions, Problem, and Goals

2: Integrate, Collect and import High Quality Data

3: Scrub, Clean, and preprocess the data

4: Cultivate Insights With Exploratory Data Analysis

5: Optimize models with fine-tuning techniques

6: Verify model performance with optimal metrics

7: Explain insights effectively to stakeholders

8: Reevaluate model to counteract model drift

- Supported by comprehensive instructions for each step

Orange accesses 200+ Python Libraries with No-Code Visual Programming (widgets)

Orange predictive modeling Workflow for this regression problem
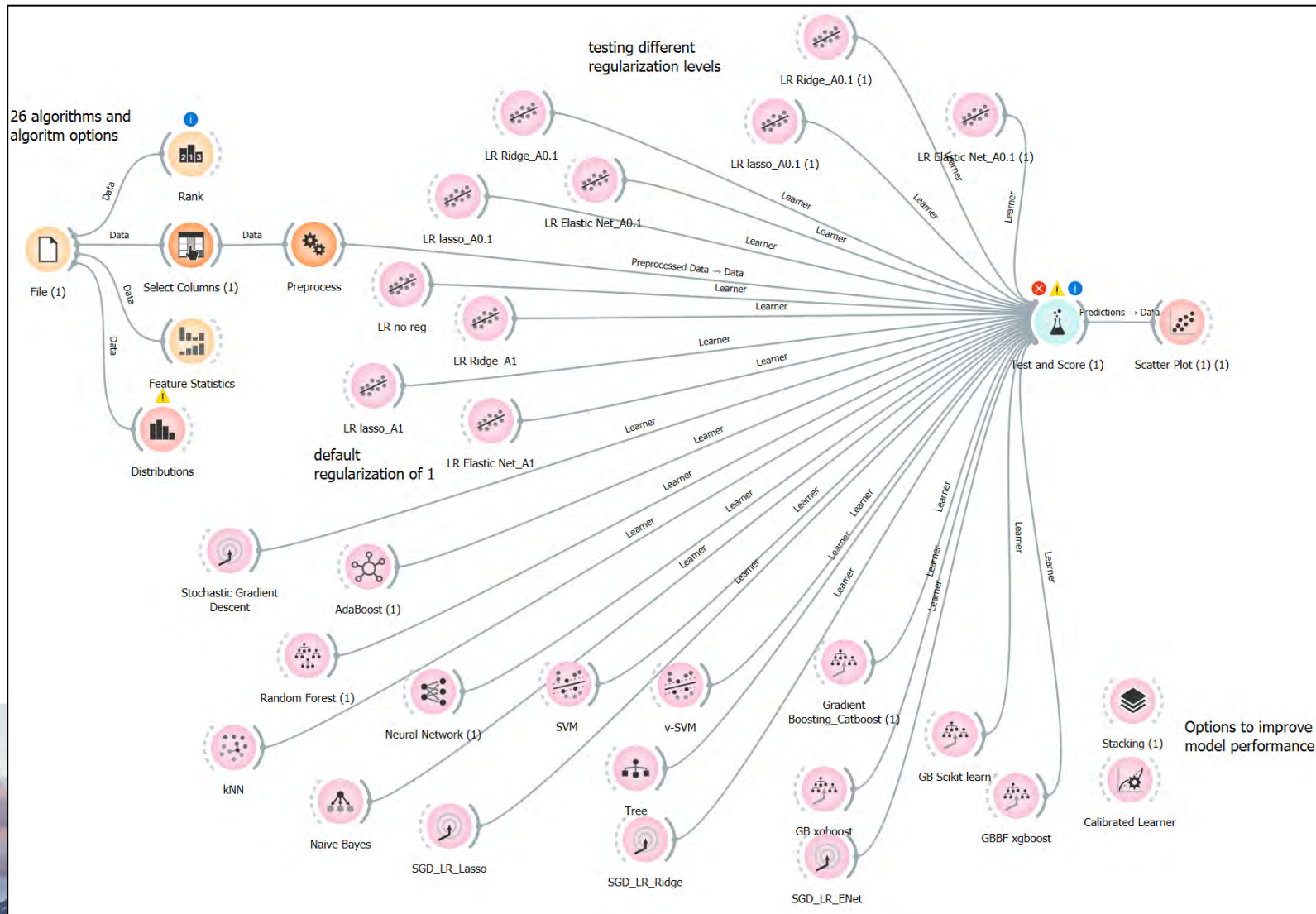
- Individual Orange widgets are dedicated to data preparation, visualizations, advanced analytics, and predictive analytics tasks.
- They can be arranged into many unique workflows to facilitate unique analysis tasks that are documented and repeatable for new datasets.

Orange Predictive Modeling for the Quality of Patient Care Star Rating, Predictor Ranking, and Scatter Plot for the Top Predictors

The top 10 rated predictive Algorithms

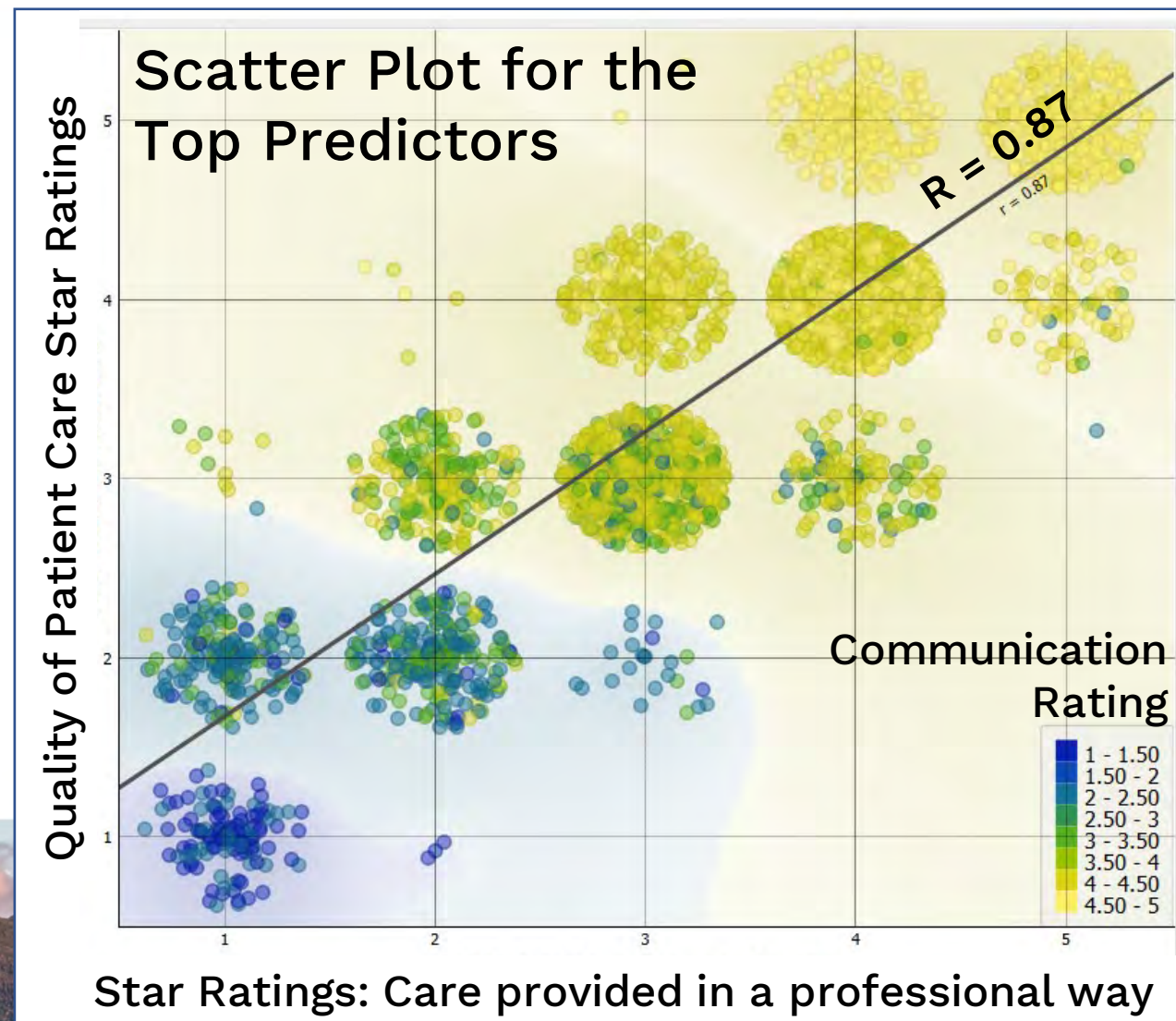| Model	MSE	RMSE	MAE	R2	CVRMSE
AdaBoost (1)	0.006	0.077	0.006	0.994	2.144
Gradient Boosting_Catboost (1)	0.007	0.087	0.039	0.992	2.400
GB xgboost	0.008	0.090	0.018	0.991	2.488
kNN	0.008	0.090	0.014	0.991	2.493
Random Forest (1)	0.008	0.090	0.016	0.991	2.505
Tree	0.009	0.096	0.013	0.990	2.673
GB Scikit learn	0.026	0.162	0.097	0.972	4.491
LR Ridge_A1	0.079	0.281	0.249	0.916	7.779
LR Ridge_A0.1	0.079	0.281	0.249	0.916	7.779

The Top Ranked Survey Question Groups

		#	Univ...reg.
1	N Star Rating for health team gave care in a professional way		15063.839
2	N Star Rating for health team communicated well with them		10729.495
3	N Star Rating for how patients rated overall care from agency		10647.592
4	N Star Rating team discussed medicines, pain, and home safety		7350.815

Scatter Plot for the Top Predictors

$R = 0.87$

$r = 0.87$

Quality of Patient Care Star Ratings

Communication Rating

1 - 1.50
1.50 - 2
2 - 2.50
2.50 - 3
3 - 3.50
3.50 - 4
4 - 4.50
4.50 - 5

Star Ratings: Care provided in a professional way

Viewing 3D Data Landscapes: The Top 2 Predictors versus the HHC Quality of Patient Care Star Rating

R-Squared for the Regression surface: 94.9%
Care Compare data from 7831 of 11,646 HHC Providers

HHC Quality of Patient Care Star Rating

% that got better at Bathing

% that Improved at Moving & Walking around
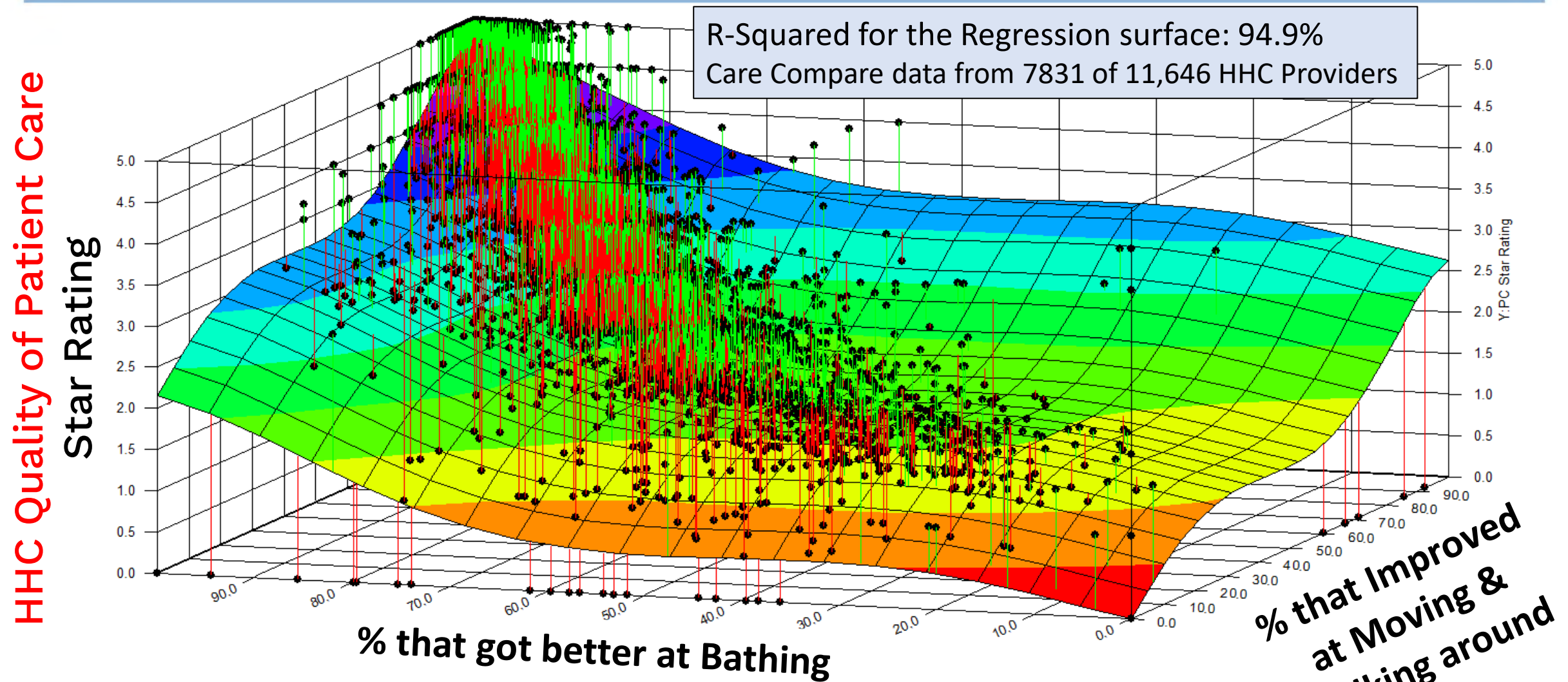
The Overall Star Rating improved as the top 2 Predictors improved

Orange Predictor Ranking for 17 Predictors of HHC Overall Patient Survey Star Ratings

Rank - Orange

			#	Univ...reg.
1	N	How often patients got better at walking or moving around		18339.119
2	N	How often patients got better at bathing		18195.407
3	N	How often patients got better at taking their drugs correctly by mouth		16261.470
4	N	How often patients got better at getting in and out of bed		11511.286
5	N	How often patients' breathing improved		10915.835
6	N	How often the home health team began their patients' care in a timely manner		1909.951
7	N	How often the home health team determined whether patients received a flu shot for the current flu season		652.273
8	N	How often physician-recommended actions to address medication issues were completely timely		550.265
9	N	Discharge to Community Observed Rate		526.855
10	N	Changes in skin integrity post-acute care: pressure ulcer/injury		406.003
11	N	How often the home health team taught patients (or their family caregivers) about their drugs		329.246
12	N	How often home health patients had to be admitted to the hospital		237.945
13	N	Application of Percent of Long Term Care Hospital Patients with an Admission and Discharge Functional Assessment and a Care Plan that Addresses Function		159.641
14	N	Percent of Residents Experiencing One or More Falls with Major Injury		46.447
15	N	Potentially Preventable Readmissions Observed Rate		40.909
16	N	How much Medicare spends on an episode of care at this agency, compared to Medicare spending across all agencies nationally		34.051
17	N	How often patients receiving home health care needed urgent, unplanned care in the ER without being admitted		12.468

≡ ? 📄 | → 9133 | - → 9133 | 17 | 17

Only 5 of the 17 Predictors have any significant impact on the HHC Overall Patient Survey Star Ratings

Orange Predictive Modeling Scatter Plot for the Top 3 Predictors of HHC Overall Patient Survey Star Ratings

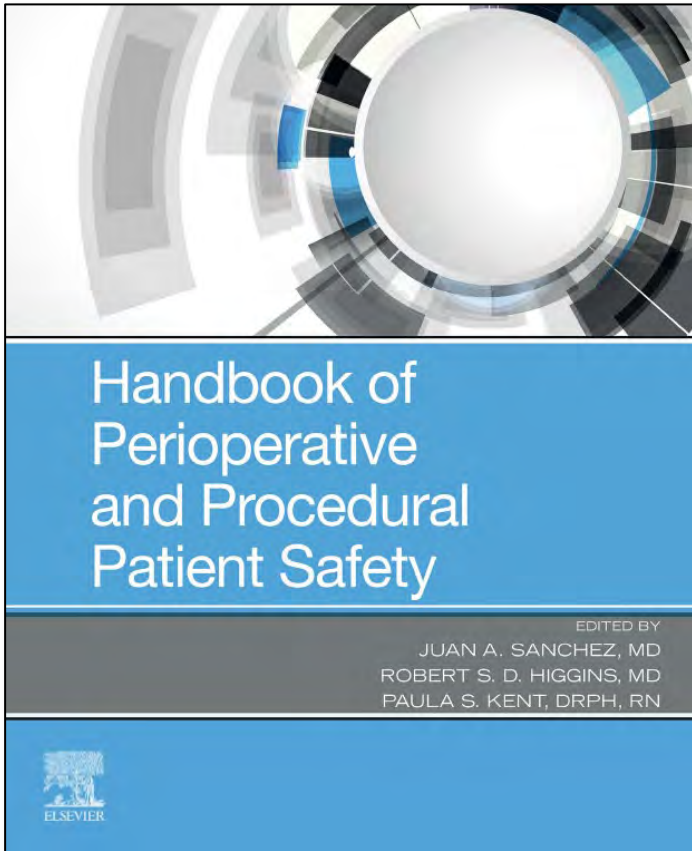Scatter Plot displaying information from the Top 3 Predictors
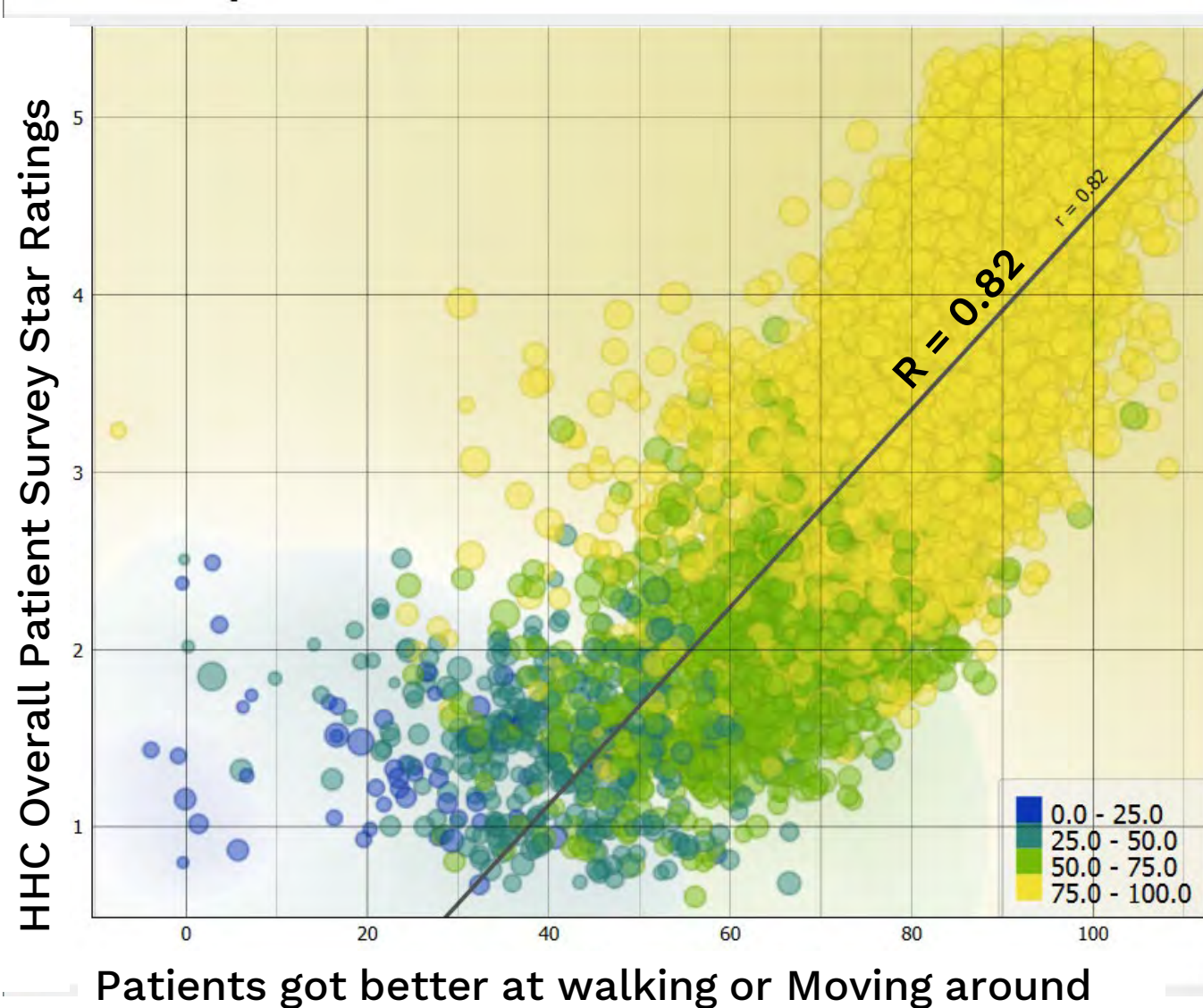
< Patients got better at taking their drugs correctly by mouth (symbol size coded)
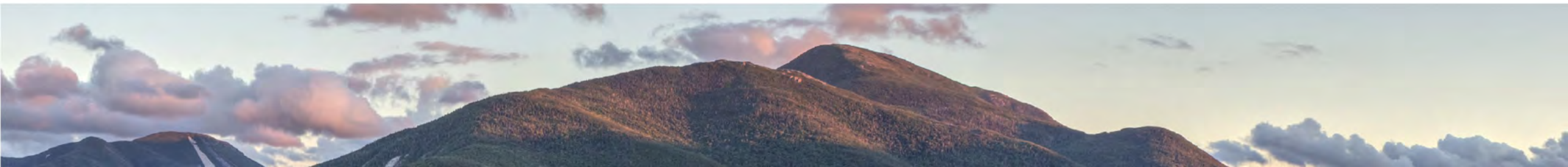
< Patients got better at Bathing (color coded)

R = 0.82

r = 0.82

HHC Overall Patient Survey Star Ratings

Patients got better at walking or Moving around

0.0 - 25.0
25.0 - 50.0
50.0 - 75.0
75.0 - 100.0

4. Describe a No-Nonsense approach for high-quality care in HHC and Hospitals

John Hopkins endorsed Case Study Story

Handbook of Perioperative and Procedural Patient Safety

EDITED BY
JUAN A. SANCHEZ, MD
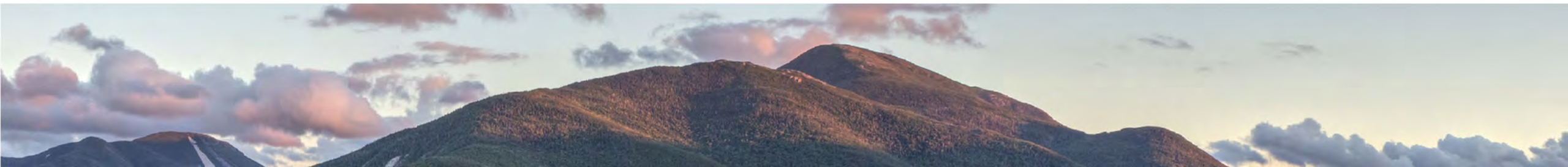ROBERT S. D. HIGGINS, MD
PAULA S. KENT, DRPH, RN

ELSEVIER

- Lessons Learned from a perioperative safety and quality change management model
- A case study for applying a Hybrid Process Improvement method to Improve low hospital star ratings and patient safety issues

Hybrid Process Improvement method to Improve low Hospital Star Ratings

High Reliability Organizations

Lean Six Sigma Process Excellence

Cultural Risk Mitigation

- The best strategies can be incapacitated with a self-destructing organizational culture
- Hybrid continuous improvements provide insights and address problems from multiple perspectives
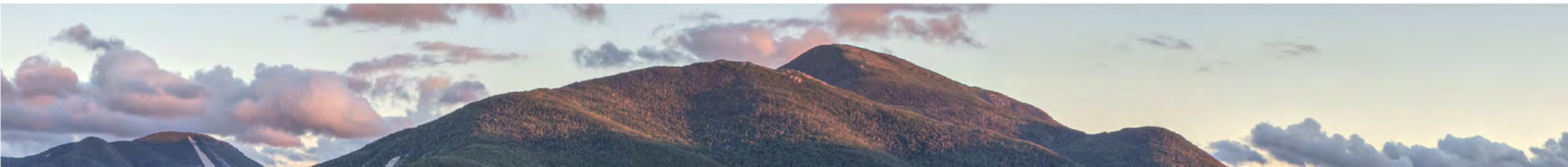
Organizational Cascading SWOT Analysis
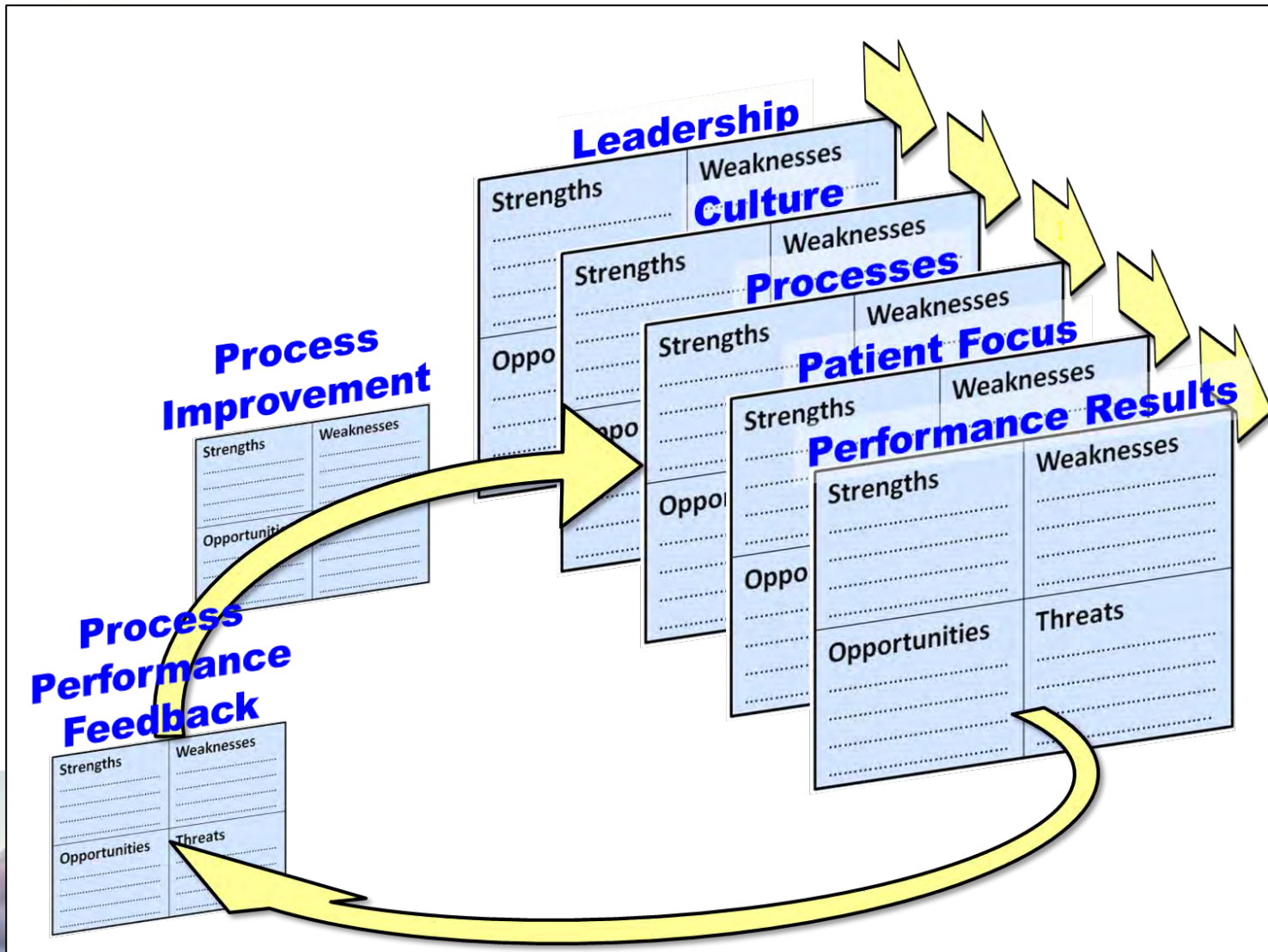
- High Quality and safe patient care is only achieved when SWOT analysis is carried out at all levels of the organizational cascade and feedback loops

Conclusion

1. Advanced No-Code analytics and Geospatial analysis will be become essential skills for all HIM professionals

2. US hospital and home health care provider ratings vary greatly

3. Healthcare organizations need to put a higher priority of process excellence, patient safety, and quality care

4. Patients should guard against substandard care providers –AL can help

5. Provided with nationwide data, ML and AI can offer caregivers and patients with tips, motivations, and valuable second opinions

6. In time, ML and AI could serve as valuable personal health coaches

Any Questions?

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A Summary Explanation of how to Conduct Successful Predictive Modeling

Assuming that a high volume of relevant and accurate data has been collected, cleaned, prepped, feature engineered, dummy encoded with high VIFs eliminated, and otherwise 100% readied for predictive modeling, follow these additional steps:

1. Determine the best method to use for your training and test data split

2. Conduct model screening with every possible algorithm and algorithm option

3. Optimize the model's performance with hyperparameter optimization, possible threshold shifting, and ensemble model building

4. Use specific model performance metrics to determine the best model

5. Rank the most important predictor variables and explain them to stakeholders

6. Use that best model to predict outcomes for new patients