Data Analytics to Improve Decision Making in Radiology Body Imaging Operations

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Background

The University of Washington Medical Center currently offers a full complement of radiology tests and imaging procedures. The Body Imaging department conducts both diagnostic and therapeutic procedures performed on the abdomen, chest, and pelvis areas.

Figure 1. The project focuses on the scheduling of physicians for body imaging scan reading activities

Current State:

- Section Chief of Body Imaging manually creates monthly schedule for physician staffing
- Large number of scheduling variables and physician scheduling preferences are difficult to accommodate
- Lack of insight into case demand trends omits the opportunity to effectively staff physicians and minimize the number of late scan readings
- Lack of transparency in scheduling operations

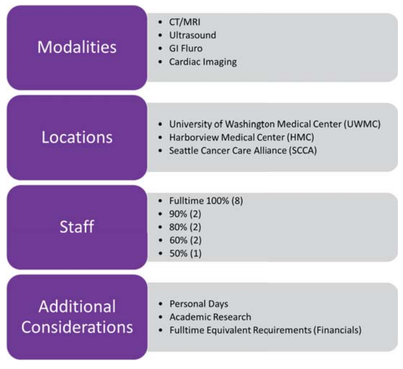


Figure 2. Variables that must be taken into consideration when scheduling physicians for scan reading in the Body Imaging department. Physicians can only be scheduled for certain modalities if they are qualified.

Opportunity

Goal Statement:

Improve the UWMC Radiology Body Imaging scheduling process by designing a data visualization tool that has the potential to minimize late cases per day and increase employee satisfaction by revealing inefficiencies in current scheduling operations.

Objectives:

- Provide insightful data to improve staffing practices
- Facilitate transparency in scheduling decision making process
- Allow for adaptability for the addition of new features
- Display data in such a way that easy to understand/interpret
- Increase employee satisfaction
- Reveal current and future issues in scheduling practices

Solution

The Data

A comprehensive data set was supplied to the UWMC BI Design Team containing information regarding each case read per day for the past five years.

The dataset contains the following information:

- Case location
- Modality type
- Radiologist physician information
- Scan reading duration
- Completion date and time

The Approach

Using systems analysis techniques, the UWMC BI Design Team decided to use R + Shiny to develop a data analysis tool to provide insights into improving the efficiency and transparency of the Body Imaging scheduling operations.

R is a programming language and environment that can be used for data and statistical analyses.

Shiny is a web application framework for R that can be used to create interactive user-interfaces for R programs.

The Development [R + Shiny]

Data Analysis
- Identify variables
- R
  - Data wrangling
  - Data exploration
  - Preliminary data plotting
  - Determined relevant plots

Programming
- R Team
  - Constructed code to generate plots
- Shiny Team
  - Initial user interface design

Visualization
- Design heuristic principles
  - Color scheme
  - Labels, font and size
  - Plot design
  - Content arrangement

Validation
- Compared output data to actual data
- Debugging
- Comment and organize code to facilitate handoff to client
- Tool user manual

ScanSight

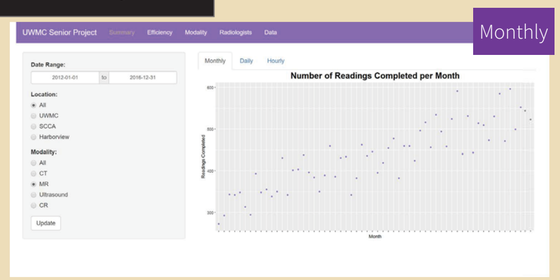
ScanSight generates data visualizations that advises the user in making scheduling decisions that optimize the efficiency of the body imaging department.

ScanSight accepts the following user inputs:

- Date Range
- Location
- Modality
- Day of the week

Versatility is a key feature of the ScanSight application. The user can manipulate multiple inputs simultaneously to analyze any number of scenarios and answer a variety of questions. **Ex: Analyze the number of MR cases read at SCCA on Wednesdays in July 2016.**

Summary Tab

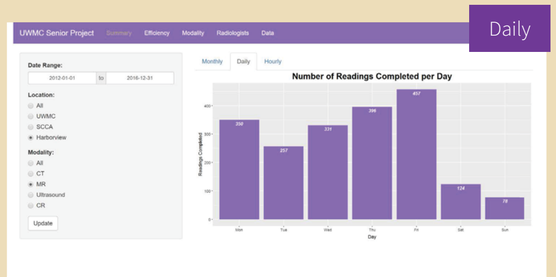


Design

Due to the high number of points, a scatter plot was deemed to be the most effective way to represent the data. The monthly plots broadly describes the system based on trends and patterns.

Purpose

- Identifies seasonal, annual, and other time trends in the number of cases read during a certain time period. This data can be useful in determining future scheduling techniques.
- Measures impact of systematic changes, such as the hiring of new staff or new technology implementations, in terms of how many cases were completed since the change occurred.



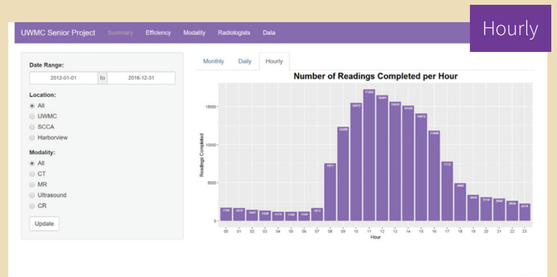
Design

The sample size and the need to compare individual data points, means that a simple bar chart with the number of cases read pasted on the bars satisfied the purpose of this sub-tab

Purpose

- Identifies which days of the week are significant to consider when scheduling certain modalities and locations.
- Displays the number of cases read during the week for certain modalities, locations, and date ranges to identify "hot spot days" that may require further investigation.

For example, if Tuesdays at UWMC are significantly higher than all other days, the department may look further into the causes behind this spike, and remedy it by scheduling intelligently to balance out the cases read and increase case reading efficiency throughout the week.



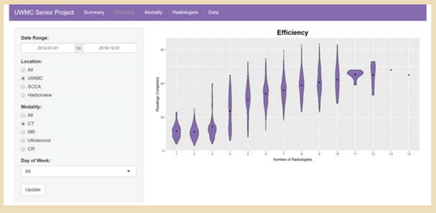
Design

A bar chart was selected to enable a simplistic comparison between different hours of the work day.

Purpose

- Identifies case reading trends and possible inefficiencies within an individual work day.
- For example, the data can provide insight into opportunities to impose a staggered staffing schedule to meet changes in demand.

Efficiency Tab



Description

The efficiency plots determines the number of cases read as a function of how many radiologists were scheduled to work per user input. The efficiency tab accepts user inputs and finds all variations of the number of radiologists working, then displays number of cases read.

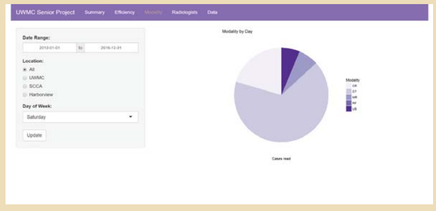
Design

Violin plots were selected to view the probability density of the data, allowing the user to make scheduling changes with higher knowledge of the uncertainty and outliers associated with the data.

Purpose

These plots can be used to determine the optimal number of staff to maximize the number of cases read while minimizing operating expenses. The user can find this optimal number for any number of user-input combinations, so that if the user wished to find the best number of CT radiologists to schedule at SCCA on Wednesdays, ScanSight can determine this number for the user.

Modality Tab



Description

The modality charts present proportions of modalities based on user inputs (date, location, day).

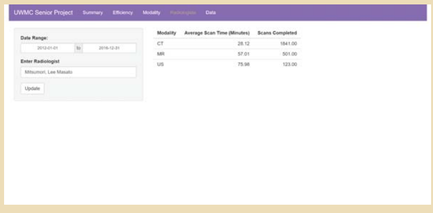
Design

Pie charts convey proportional relationships effectively and in a user-friendly manner.

Purpose

The modality plots provide a venue for comparative analysis across modalities as a function of user inputs. For example, selecting Thursday at Harborview may yield a significant proportion of CT scans relative to all the other modalities. These analyses can be used to determine similar possible inefficiencies and lead to better scheduling practices.

Radiologist Tab



Description

The radiologist tab provides two statistics for each radiologist's certified modalities for a specified date range. The table displays the number of scans completed and average time per scan.

Design

Tables are the simplest and most practical way to display raw data.

Purpose

After gaining insight into trends and possible inefficiencies from the previous tabs, scheduling decisions can be supported using the radiologist data. The following are two examples of how the tab can be used. First, the section chief may require highly capable CT radiologists for certain schedules, and can use the radiologist tab to compare radiologist performance. Secondly, the tab can be used as a measure for new radiologists or new radiologist scheduling procedures.

Data Tab

The data tab provides transparency by displaying all of the data that goes into generating the plots. The data tab provides easy access for viewing the Body Imaging staffing and case data, as opposed to the current data viewing method, which involves contacting the UWMC Radiology IT Department for the data.

Future Recs

- Connect data source to UWMC SQL database
- Incorporate forecasting
- Further analysis of late cases

Acknowledgments

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