Stat 6950 Project Proposal

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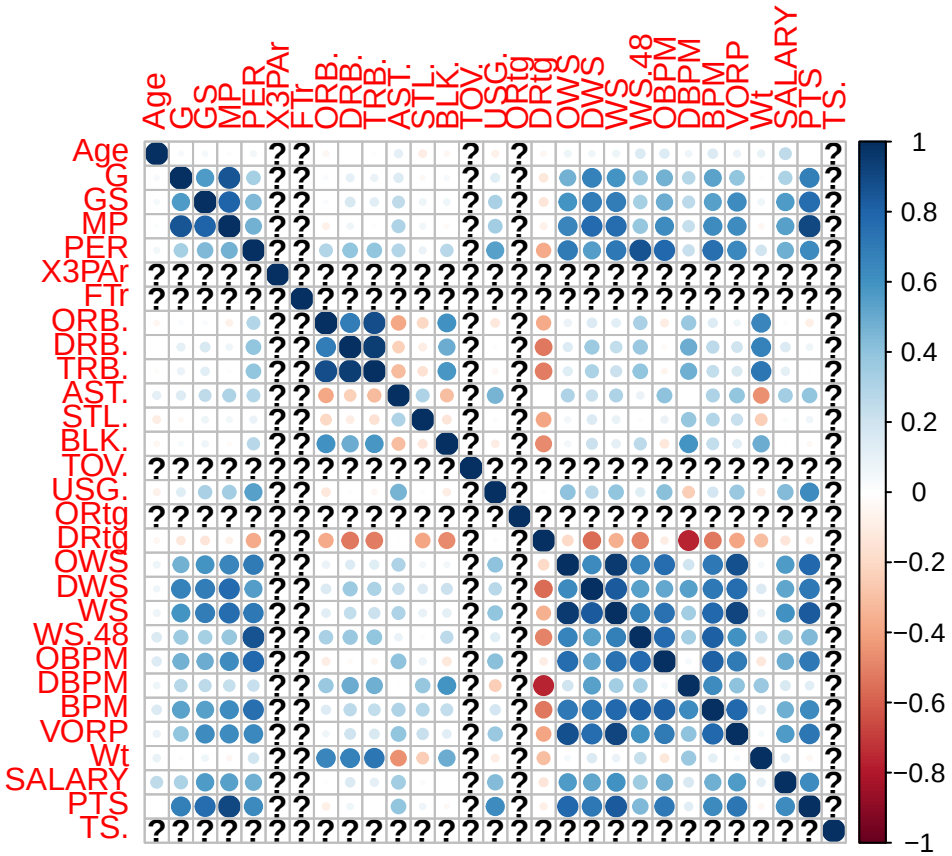
Exploratory Data Analysis

Our data comes from four different datasets. We used three of Riguang Wen's datasets from figshare.com – `players cv`, `players salary`, and `players stat`. We also used a dataset called `NBA RS 2020-1950 Stats` uploaded to zenodo.org by Pablo Gomez and Sandra Giral. From these datasets, we considered the following variables.

Variable	Description	Type	Source
Player	Name of player	Character	`players stat`
Age	Age of player	Numeric	`players stat`
G	Games played	Numeric	`players stat`
GS	Games started	Numeric	`players stat`
MP	Minutes played	Numeric	`players stat`
PER	Player efficiency rating	Numeric	`players stat`
PTS	Points	Numeric	`NBA RS 2020-1950 Stats`
X3PAr	3PA/FGA	Numeric	`players stat`
FTr	FTA/FGA	Numeric	`players stat`
TS	True shooting percentage	Numeric	`NBA RS 2020-1950 Stats`
ORB	Offensive rebounds	Numeric	`players stat`
DRB	Defensive rebounds	Numeric	`players stat`
TRB	Total rebounds	Numeric	`players stat`
AST	Assists	Numeric	`players stat`
STL	Steals	Numeric	`players stat`
BLK	Blocks	Numeric	`players stat`
TOV	Turnovers	Numeric	`players stat`
USG	Usage percentage	Numeric	`players stat`
ORtg	Offensive rating	Numeric	`players stat`
DRtg	Defensive rating	Numeric	`players stat`
OWS	Offensive win shares	Numeric	`players stat`
DWS	Defensive win shares	Numeric	`players stat`
WS	Win shares	Numeric	`players stat`
WS.48	Win shares per 48 minutes	Numeric	`players stat`
OBPM	Offensive box +/-	Numeric	`players stat`
DBPM	Defensive box +/-	Numeric	`players stat`
BPM	Box +/-	Numeric	`players stat`
VORP	Value over replacement player	Numeric	`players stat`
Pos	Position	Factor	`players salary`
Ht	Height in inches	Numeric	`players salary`
Wt	Weight in pounds	Numeric	`players salary`
PwrSix	Power Six College?	Indicator	`players cv`
International	International Player?	Indicator	`players cv`

Variable	Description	Type	Source
Salary	Salary in dollars	Numeric	`players salary`

Immediately we can recognize that some variables are functions of others and therefore do not need to be considered. Specifically, `BPM = OBPM + DBPM`, so there is no need to include `BPM` in our model. Similarly, `WS = OWS + DWS` and `TRB = ORB + DRB`, so we can exclude `WS` and `TRB` from consideration if we include `OWS`, `DWS`, ORB and DRB in our model. Some other multicollinearity issues will likely arise given the correlation matrix of the numerical variables under consideration below. Some examples of potential issues are the correlation between `WS` and `PER` as well as that of `MP` and `G`.



Also in the numeric variables are signs of non-normality. Of the 27 numeric variables considered after the exclusion of `BPM`, `WS` and `TRB`, 11 had medians that had 10% or more in difference of the mean, possibly indicating asymmetry. Of these, only the boxplots of `G` and `GS` did not signify outliers, though histograms of the data did show skewness. Histograms of the others (`FTr, ORB, AST, BLK, OWS, DWS, VORP, Salary`, and `PTS`) were all right-skewed.

We can see that the distribution of salary is heavily skewed to the right. We expect to transform this variable to perform linear regression. After attempting several transformations such as an inverse and square root, a log transformation seems most appropriate, althought not perfect. We will consider other transformations and the Box-Cox method during the analysis:

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
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```

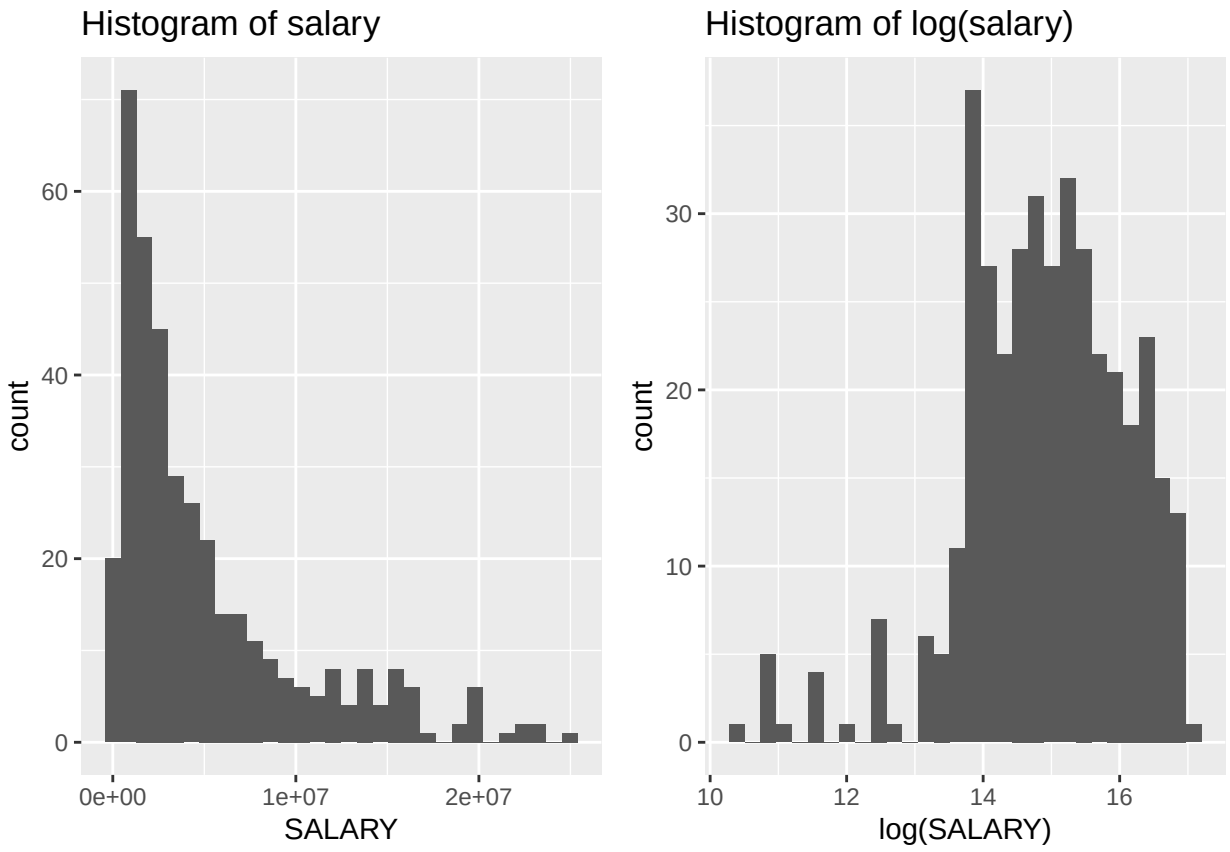

When looking at the covariates, many appear to be normally distributed and satisfy the assumptions used by the linear model. Some have a right skew, including many counting stats such as rebounds, blocks, and points. Games started is fairly uniformly distributed from 10-70, with a higher density from 0-10 and 70-82. Games played has a left skew. We will experiment with log, inverse, square root, and squaring transformations. We would prefer approximately normal distributions of the covariates, to help obtain normally distributed residuals, and to avoid high leverage cases affecting the mean function.

We did make some transformations for categorical variables as well. NBA players are often discussed as either American or International, so we created a new variable labeling each player as one of these based on the place of birth. Additionally, we created the "Power Six" variable to see whether this has any indication; this may not be independent of American/International, and other predictors.

We also look at the relationships between salary and each of the predictors individually. There appears to be a relationship between salary and many of the covariates individually, including simple stats such as minutes and points, as well as advanced stats like PER (Player Efficiency Rating), and Box +/-. There are many covariates that have a marginal relationship with salary. For some of them such as minutes, a marginal linear relationship seems appropriate; for others, such as VORP, a marginal linear relationship may not be appropriate. As discussed earlier, trying to transform variables and account for the multicollinearity in covariates will be some of the challenges of this project.

Some covariates, such as offensive rebounds, do not appear to have a strong marginal relationship with salary; we will investigate whether these still may affect salary through interactions with other variables.

After plotting boxplots of salary by each level of the categorical variables, salary does seem to vary across different levels of the variables. We plan to evaluate whether these relationships remain useful in the full model. Position and international each have a small number of levels; the team factor has 30 levels. We will evaluate whether this can be useful with all 30 levels, if there are ways to reduce this by grouping teams by things such as conference affiliation or market size, or if it is not useful at all in a model with less than 400 observations.

This dataset is pretty broad, which leaves us open to many possibilities for modeling approaches. As mentioned before, it seems likely we will transform the y variable in some way, possibly with a Box-Cox approach. We are certainly dealing with some multicollinearity in covariates and will need to use tools such as AVPs and VIFs to account for this. Also, interaction effects seem plausible; for example, would a change in the number of rebounds per game be associated with the same change in salary for both guards and centers? We do not initially expect any time series or any weighted linear regression.

One key figure for us is the matrix measuring correlations between the covariates, seen previously. In many datasets, one would expect some degree of correlation between predictors. In this NBA dataset, however, many of the advanced metrics available are functions of some of the simpler statistics. We will need to use this knowledge to account for multicollinearity and avoid unintentionally putting extra weight on some of the covariates.