# Assignment 5: Causal Relationship Discovery

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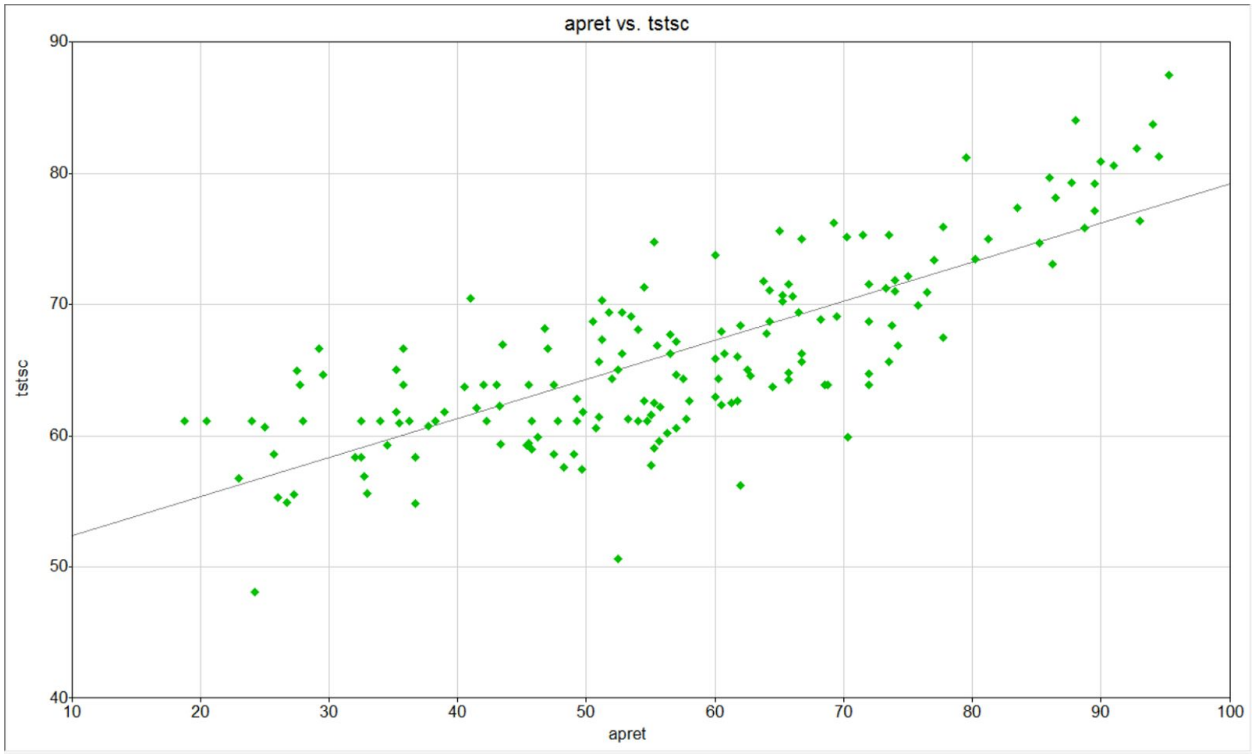
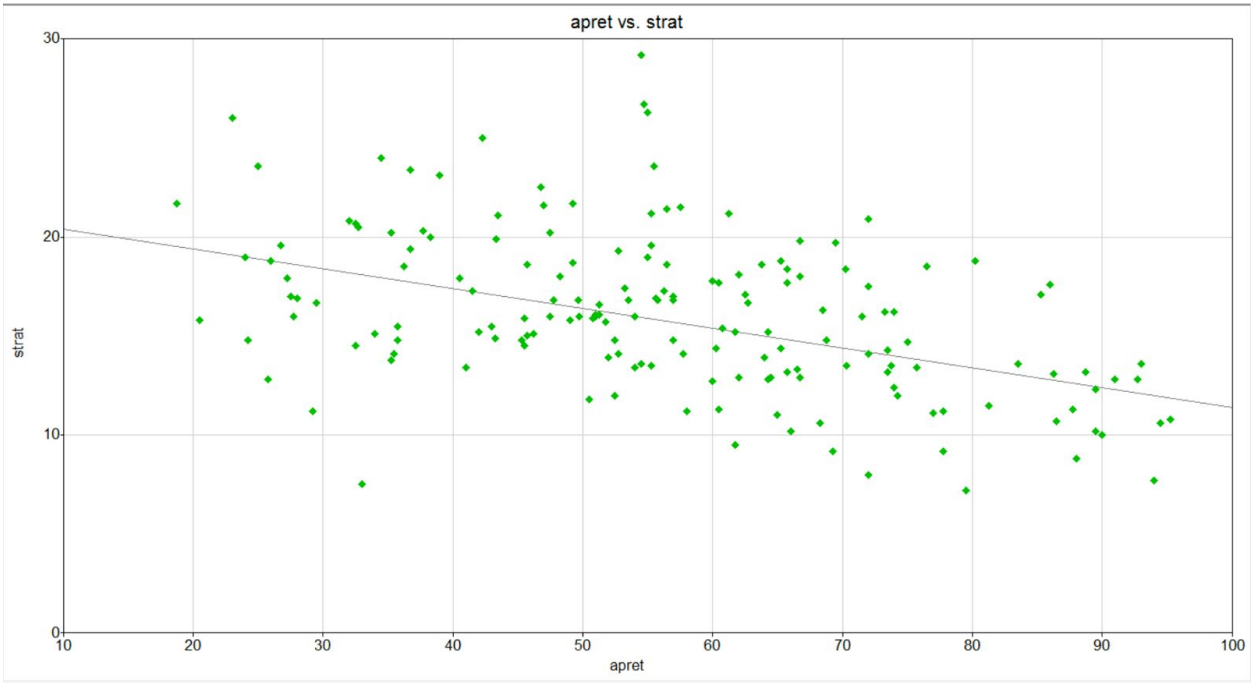
In the article, the two authors tried to find out the reasons for low freshman retention rate in US colleges. One apparently robust finding in this article is that student retention is directly related to the average test scores and high school class standing of the incoming freshmen.

## Observation

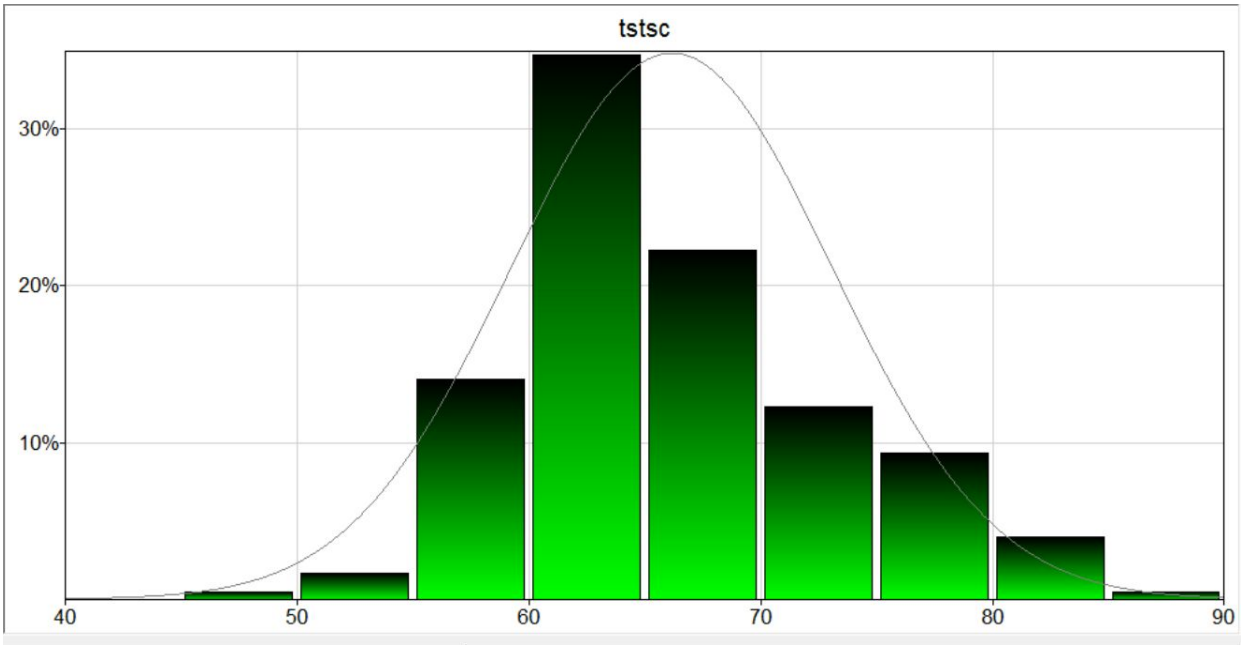
As we can see from the directed acyclic graph (DAG), both tstsc (test score) and strat (student teacher ratio) are parents of apret (average retention rate). Here we first plotted apret vs. tstsc and it is obvious that there is a linear relationship between apret and tstsc, though this relationship is not very strong.

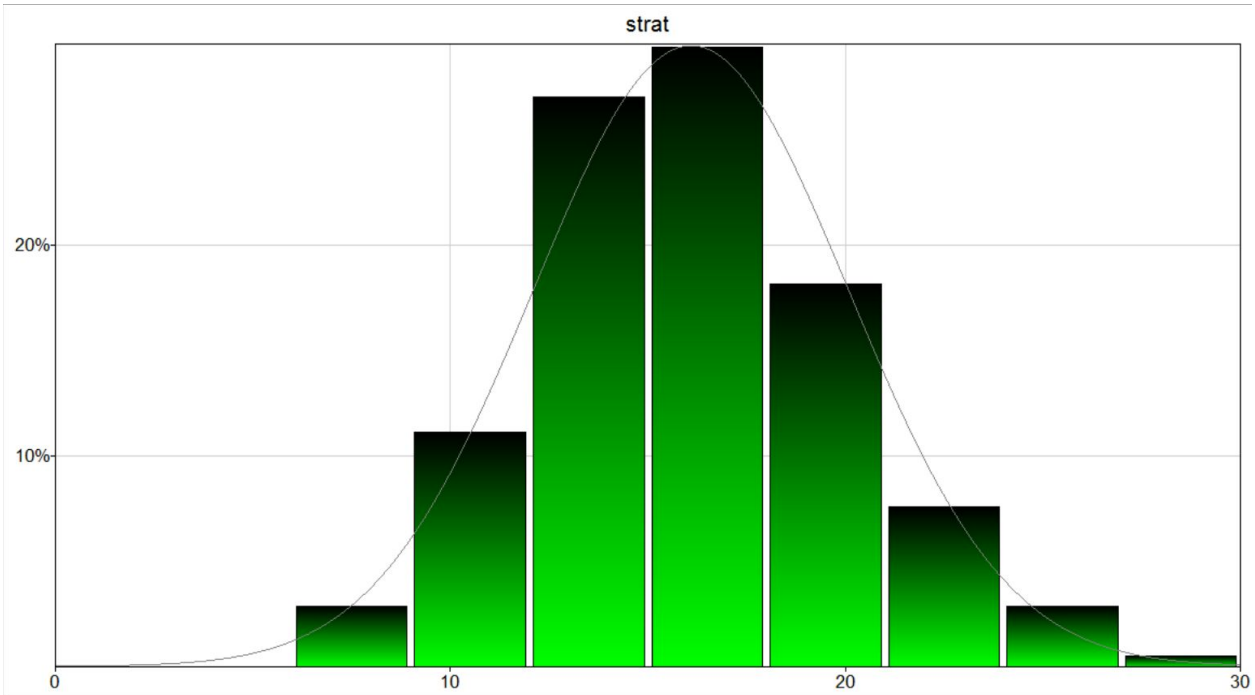


There also seems to be a linear relationship between apret and strat as illustrated by the plot, this relationship is not as strong as that of apret vs. tstsc.




Further investigation into the distribution of tstsc and strat led to the observation that tstsc is slightly skewed-right while strat appears to more normal distributed. (Normal fit is displayed in both histograms)



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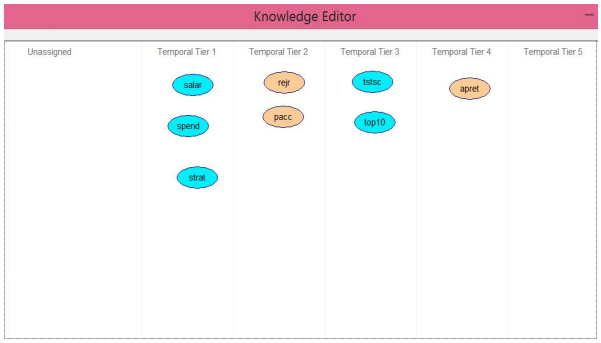
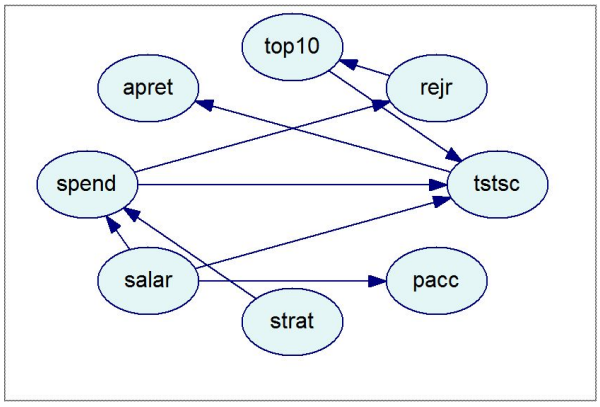
|  | Background knowledge:<br>Tier 1: salar, spend, strat<br>Tier 2: rejr, pacc<br>Tier 3: tstsc, top 10<br>Tier 4: apret |
|  | Significant level = 0.01<br><br>Retention rate has a correlation with tstsc while top10, spend and salar have connection with apret through this tstsc. |

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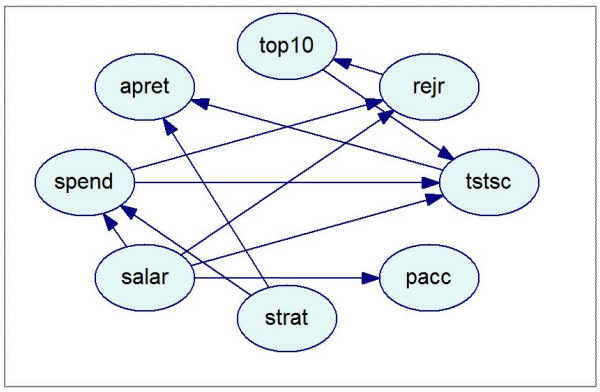
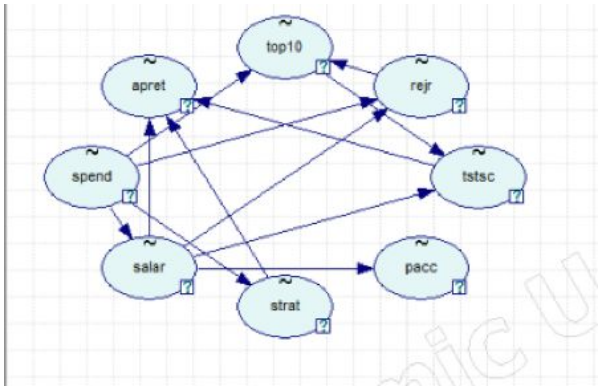
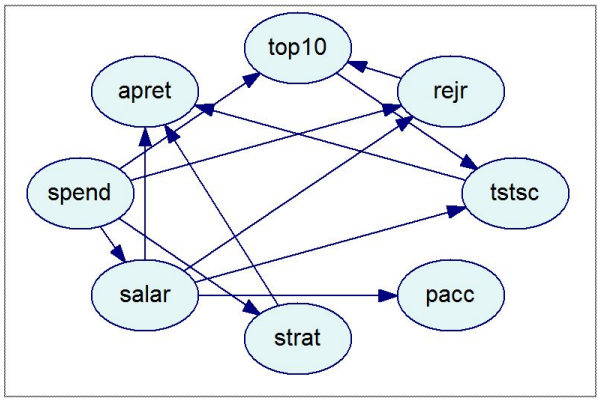
|  | Significant level = 0.05<br><br>Retention rate has a correlation with tstsc and strat while top10, spend and salar have connection with apret through these two attributes. |
|  | Significant level = 0.07<br><br>When the significant level set to 0.07, salary has causal influences on average freshmen retention rate and rejection rate. The causal influence from spending to the average test score is no longer existent. Instead, spending has causal influence on top10, rejection rate, salary and strat. |
|  | Significant level = 0.1<br><br>Retention rate has a correlation with tstsc, salar and strat while only spend and top 10 have connection with apret through salar/tstsc. |

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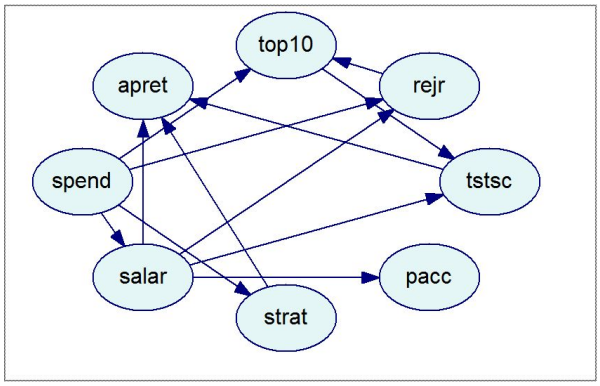
|  | Significant level = 0.15<br><br>Retention rate has a correlation with tstsc, salar and strat while only spend and top 10 have connection with apret through salar/tstsc. |

From the four graph, we noticed that as the significant level increases, apret has more and more parent nodes. When significant level is only 0.01, tstsc is the only possible cause of apret while as significant level increases to 0.05 and 0.1, strat and salar comes into play. We might infer that tstsc has a stronger relationship with apret than strat and then salar. No matter what the significant level is, top10 is always leading to tstsc, so we may infer that top10 is a non-negligible influencing factor.

## Conclusion

Based on the five patterns with different significant level (0.01, 0.05, 0.07, 0.1 and 0.15), we found that the average test scores (tstsc) is directly causally related to the average freshmen retention rate (apret), which is as the same as the conclusion from Druzdzel and Glymour (1992). However, we didn't find direct causal relation between the average freshmen retention rate (apret) and class standing (top10). From the observation of the graph created using the standard significance level (0.05), we can see the student teacher ratio (strat) and the average test scores (tstsc) are two factors that directly related to the average freshmen retention rate while when the standard significance level are 0.07, 0.1 and 0.15, salary is also related to the average freshmen retention rate directly.