

THE COLLEGE OF NEW JERSEY

Mathematics and Statistics

2014

$\pi$





“It's been a great ride. Thanks to all of the wonderful professors and all of the great students in the department. Each and every one of you made this experience so special. Good luck to everyone!”

-Ryan McMichael

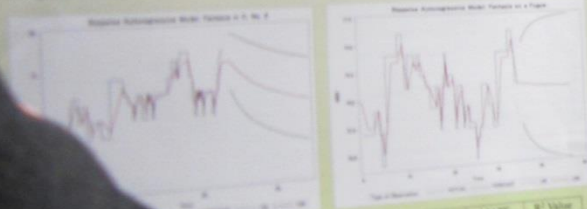
"You say A, but you meant B, then you write C, yet the correct answer is D."

## Series Analysis

Prerna Nakra  
University of New Jersey

### Results: Stepwise Autoregressive

Again, forecasting 30 notes in the opening section of each composition, here are the following Stepwise Autoregressive models.



### Conclusions

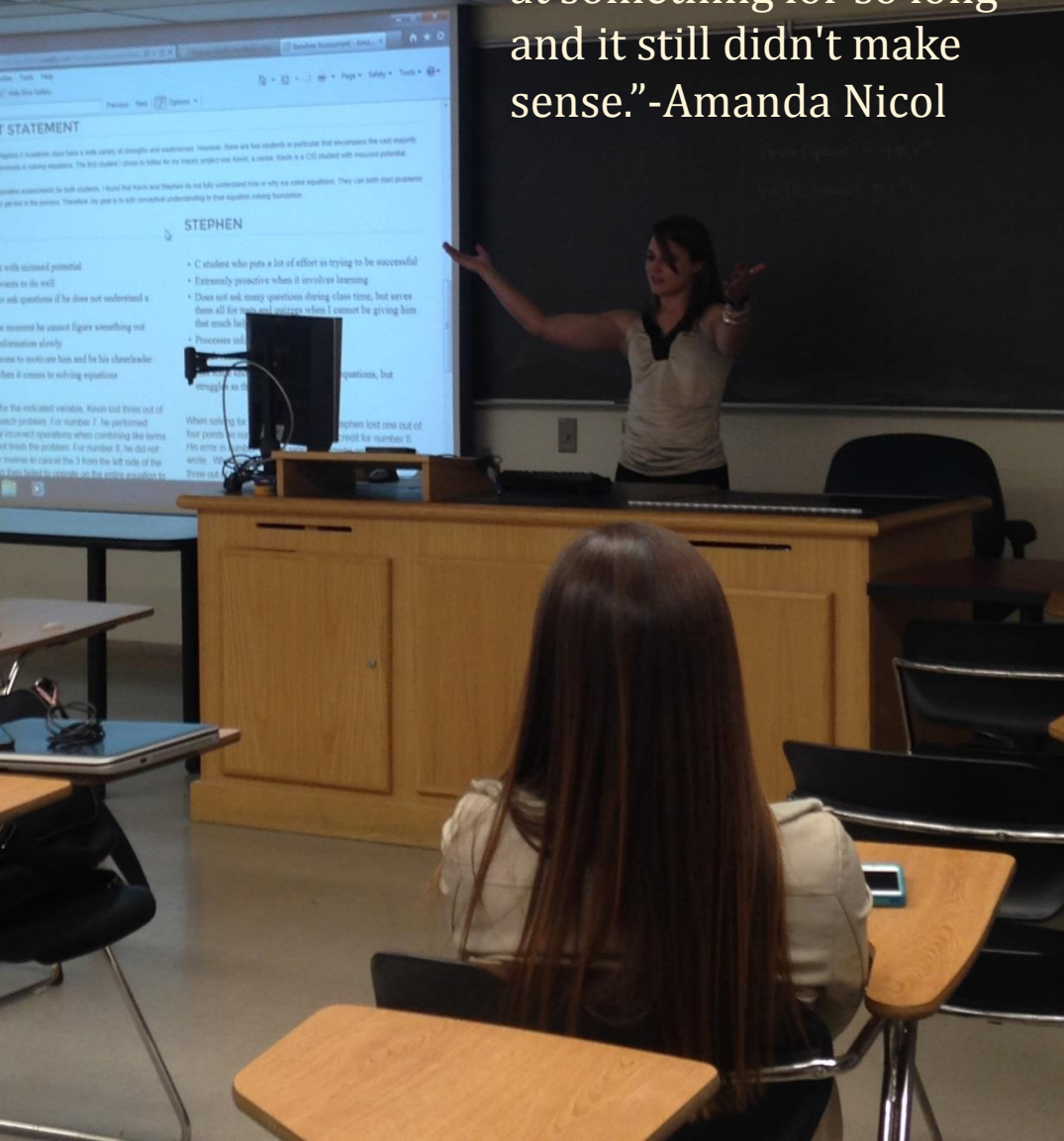
It is clear that music becomes less and less predictable over time, due to the fact that the notes are getting further away from each other. However, the Hub-Winters model seems to be more accurate for a short period of time (approximately 2 seconds), with the MAPE and R<sup>2</sup> values being higher and R<sup>2</sup> being lower than those of the other models.

These results indicate that they are not as good at predicting precise notes as the Hub-Winters model. Again, this is only for a short period of time (approximately 2 seconds). The Hub-Winters model is slightly longer than the other models. The results of the survey suggest that in general, people are more inclined to predict notes in the short term. This was shown by most participants choosing the Hub-Winters model. This was also shown by most participants choosing the Hub-Winters model. This was also shown by most participants choosing the Hub-Winters model. This was also shown by most participants choosing the Hub-Winters model.

### Future Work



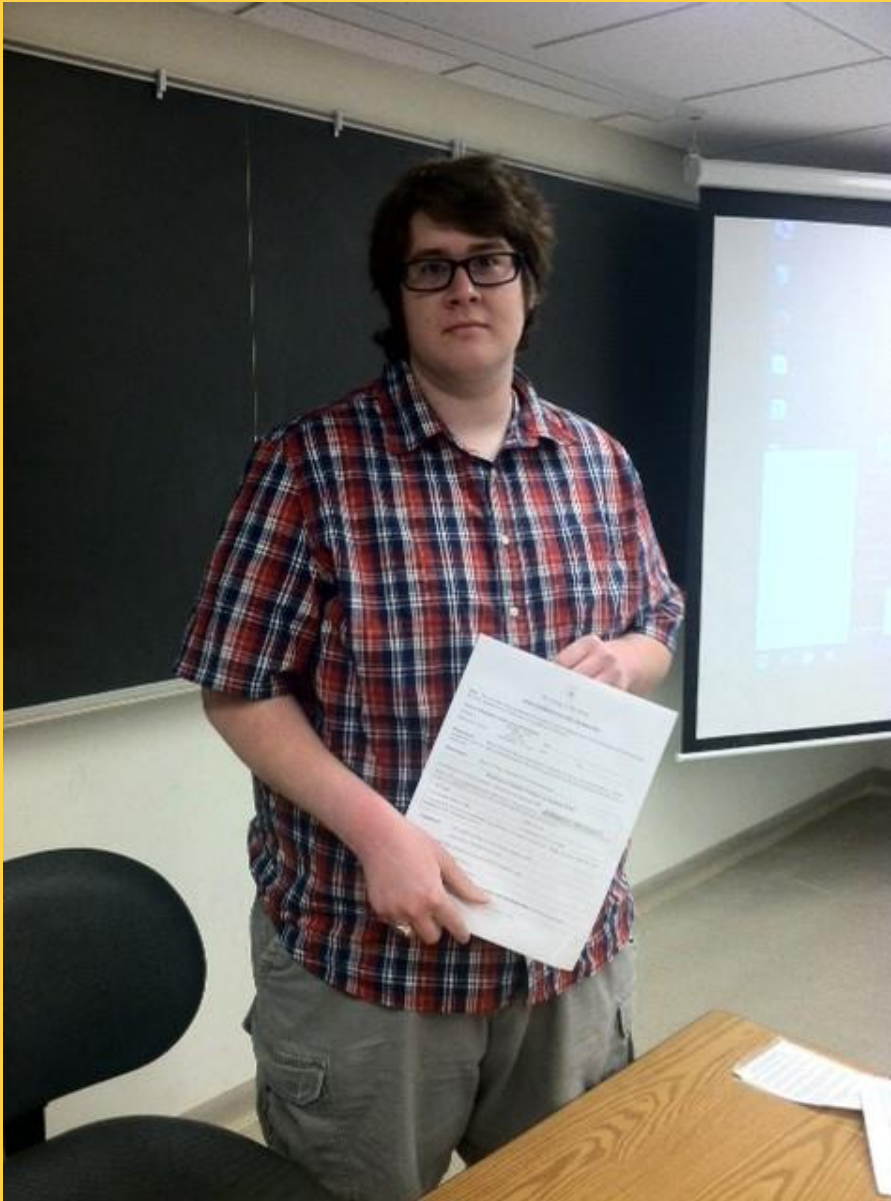
"I've never wanted to poke my eyeballs out as much as I wanted to in Abstract Algebra. I've never stared at something for so long and it still didn't make sense."-Amanda Nicol











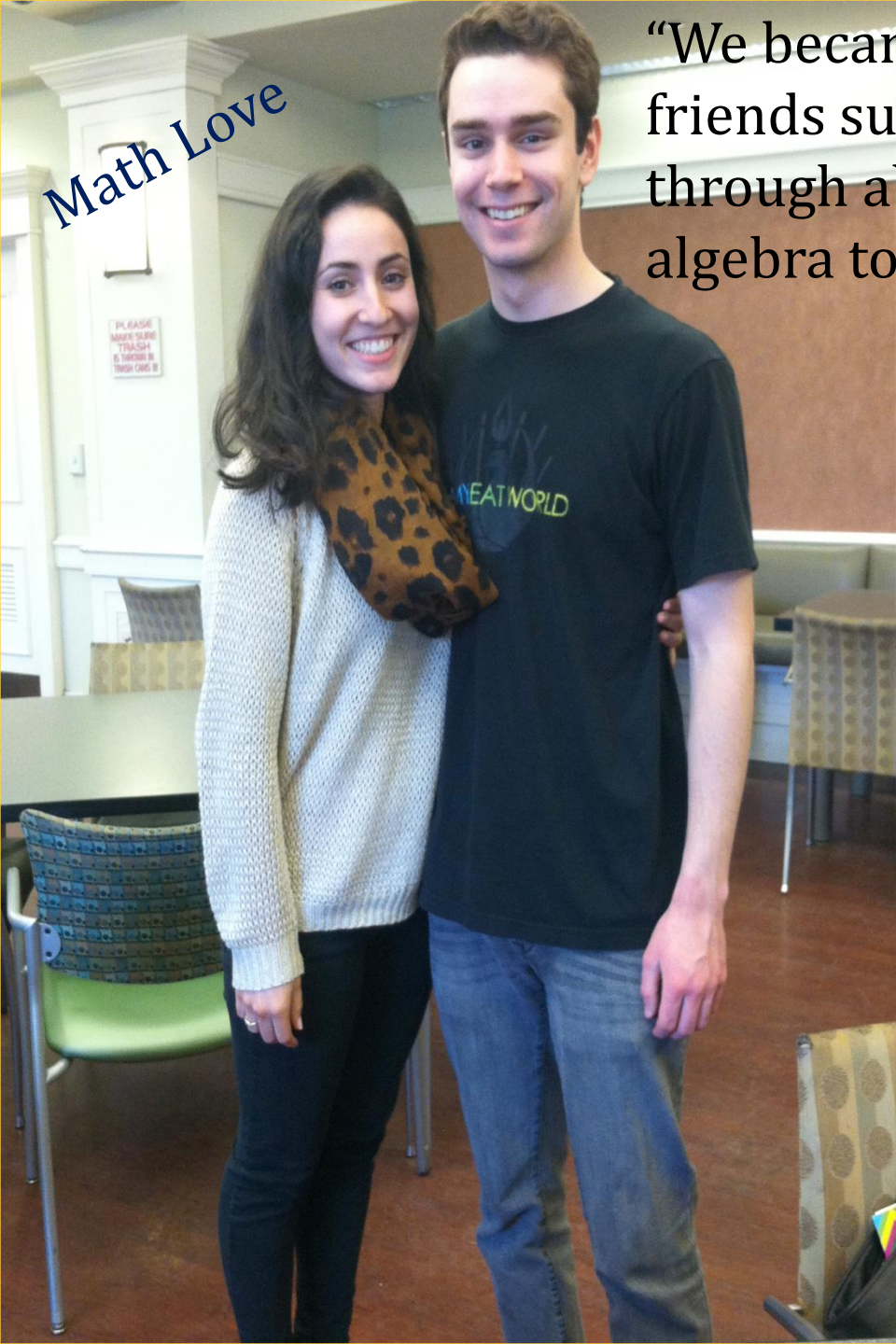
“The My Teacher is  
a Butt-Head form.”  
– Dr. Clifford



Math Love

“We became great friends suffering through abstract algebra together.”

Math Hate





# Relations Among Moduli Spaces of Triangles

Michael McLoughlin  
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## Introduction

Moduli spaces are geometric representations of sets of mathematical objects. Here I consider a collection of moduli spaces of Euclidean triangles and consider their relationships to one another and to the triangles they intend to represent. In so doing, I arrive at a better understanding of the structure of the various moduli spaces of triangles and their value in representing Euclidean triangles.

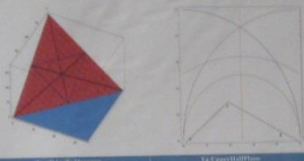
## Moduli Spaces

- A moduli space requires:
  - Objects to represent
  - Parameters to sort these objects
  - A notion of equivalence among the objects

## Moduli Spaces of Triangles



## Are these spaces equivalent?



To ask whether two moduli spaces are equivalent is to ask whether or not these spaces represent their objects with the same fidelity.

- Are these apparently different representations capturing the set of Euclidean triangles in a comparable and unbiased way?

## Investigations:

- Given a triangle, what are the chances that it is obtuse? - Calculation 1
- What is the average product of interior angles for Euclidean triangles? - Calculation 2

Space	Calculation 1	Proposition
T3	$\frac{\int_{\mathcal{P}_3} \mathbb{1}_{\text{obtuse}}(a, b, c) da db dc}{\int_{\mathcal{P}_3} da db dc}$	$\approx 0.8333 \pm \epsilon$
T4	$\frac{\int_{\mathcal{P}_4} \mathbb{1}_{\text{obtuse}}(x, y) dx dy}{\int_{\mathcal{P}_4} dx dy}$	$\approx 0.8333 \pm \epsilon$

Space	Calculation 2	Proposition
T3	$\frac{\int_{\mathcal{P}_3} \alpha \beta \gamma da db dc}{\int_{\mathcal{P}_3} da db dc}$	$\approx 0.0489 \pm \epsilon$
T4	$\frac{\int_{\mathcal{P}_4} \alpha \beta \gamma dx dy}{\int_{\mathcal{P}_4} dx dy}$	$\approx 0.0489 \pm \epsilon$

\*The function  $\mathbb{1}_S$  is 1 when the parameters of our space (T3 or T4) produce the angle in space S represented by the triangles indicated on T3 or T4.

## Corrections

- Calculations on T3 and T4 are interesting, but they are inconsistent with those results for T2 and T5.
- The reason for this is that the angle measure spaces T3 and T4 are not equivalent to T2 and T5.
- To correct this problem the Jacobian,  $J$ , is used to balance the coordinate change between spaces and rectify the naive calculation from before.

Space	Calculation 1	Proposition
T3	$\frac{\int_{\mathcal{P}_3} \mathbb{1}_{\text{obtuse}}(a, b, c) da db dc}{\int_{\mathcal{P}_3} da db dc}$	$\approx 0.8333 \pm \epsilon$
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T3	$\frac{\int_{\mathcal{P}_3} \alpha \beta \gamma da db dc}{\int_{\mathcal{P}_3} da db dc}$	$\approx 0.0489 \pm \epsilon$
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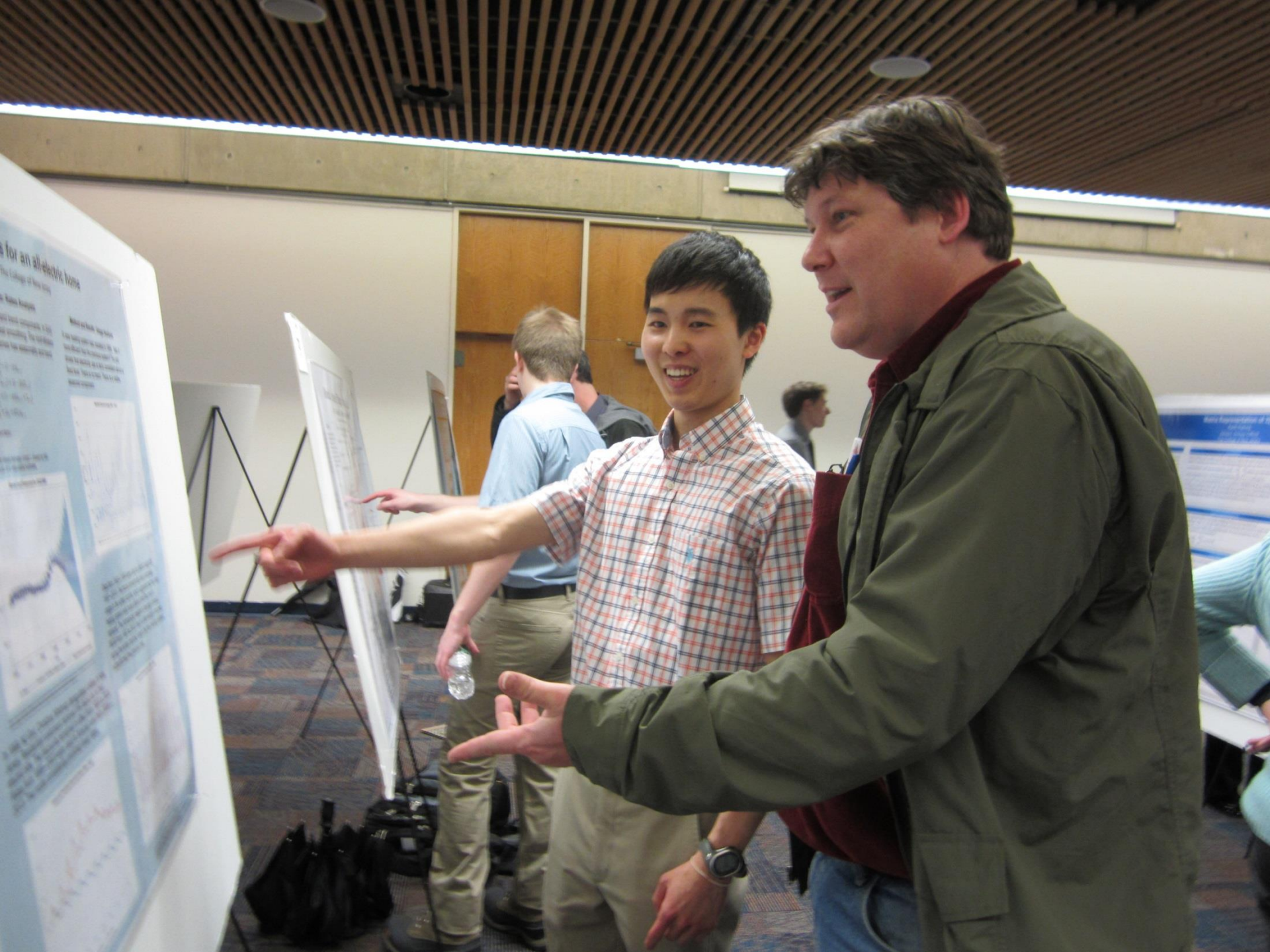
\* Where the ellipsis notes the formula from before augmented with the appropriate Jacobian correction

## Discussion/Conclusion

It is observed that not all moduli spaces represent their objects equivalently. Despite this, it has been shown that moduli spaces of like dimension may be transformed into one another with the appropriate Jacobian to recover calculations. It remains to be shown on these moduli spaces the properties of Euclidean quantities manifest in the

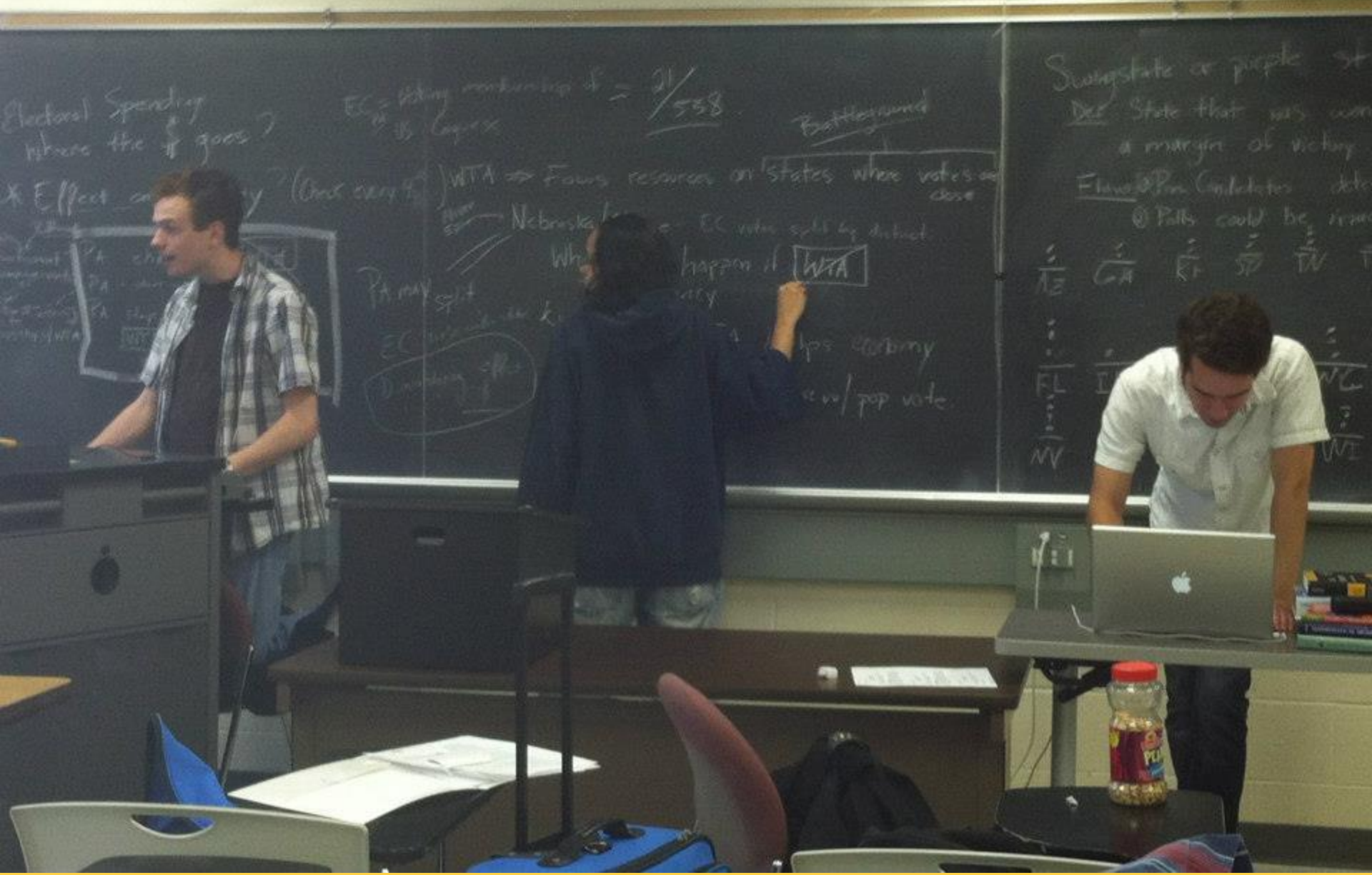


“I love this department so much, I let Beth bake cookies while I wore an apron.” – Ryan Manheimer





“We slept in that classroom.  
#GoodTimes” –Ryan Manheimer









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TCNJ

# Strategizing the Adjusted Winner Procedure in a Conflict

Christopher Falk  
Dr. Andrew Clifford

**Abstract**  
 In a two-player game, players can be expected to intelligently choosing a procedure to solve a conflict. In cases involving 2 players, the Adjusted Winner Procedure (AW) is a good choice. There can be any number of goods to be divided, and the goods can be assigned to 3 steps: Allocation & point assignments, Equitability adjustment, and Transfer stage. AW always produces an allocation that is envy-free, efficient, and honest.

**Example**  
 Consider the following goods: G is mixed and contains both a primary HQ, appointment of CEO, and immunity to employee layoffs.

Company	Tech Co
Primary location	20
Chairman	25
CEO	10
Immunity to EE layoffs	30
Totals	15
	100

**2. Transfer stage**  
 So far, Sancorp won 49 points, Tech Co won 35. Transfer the tied goods to Tech Co. Tech Co becomes the Temporary Winner. Analogously, Sancorp becomes the Temporary Loser.

**Analysis by Point Ratios**

- Definition - Tech Co's Point Ratio for a good is Tech Co's valuation of the good divided by Sancorp's valuation.
- If Tech Co's point ratio for a good is  $X$ , we say, "Tech Co values the good  $X$ -times more than Sancorp."
- Transfer goods to Sancorp in ascending order of Tech Co's point ratios (lowest PR's  $\rightarrow$  highest PR's)

	Sancorp	Tech Co
Company name	40	
Primary location		25
Chairman		10
CEO		30
Immunity to EE layoffs	15	
Totals	55	65

**3. ★ Equitability adjustment ★**

- This step is crucial. The equitability adjustment is unique to the AW procedure, and guarantees equitability with absolute certainty.
- Equitability means that each player values their allocation exactly equal to the other.
- This is often difficult to achieve with fair division schemes.

**Solving for  $p$**

- Definition -  $p$  is the percentage of the CEO good Sancorp needs to receive to achieve an equitable allocation.

$$55 + 30p = 35 + 30(1-p)$$

$$\rightarrow p = 1/6$$

	Sancorp	Tech Co
Company name	40	
Primary location		25
Chairman		10
CEO	30(1/6) = 5	30(1 - 1/6) = 25
Immunity to EE layoffs	15	
Totals	40	40

**Other**

1. Most
- Highly
- Strong
- your
- Allocation
- Effective

**2. Honesty**

- The optimal

Consider the

Company	Tech Co
Primary location	20
Chairman	25
CEO	10
Immunity to EE layoffs	30
Totals	15
	100

**3. Equitability**

Co. name	Tech Co
Location	5
Chairman	5
CEO	40
EE layoffs	10
Totals	100

$80 + 10p = 60 + 30(1-p)$   
 $\rightarrow p = .143$   
 Sancorp receives  
 Tech Co receives

**Conclusion**

1. AW always produces an equitable allocation.
2. Honesty allows truth.

In the last example, this is important.

# Relay For Life





6E

### ABSTRACT

This paper presents a project studying quadratic integer rings  $\mathbb{Z}[\sqrt{d}]$ ,  $\mathbb{Z}[\frac{1+\sqrt{d}}{2}]$  ( $d \in \mathbb{Z}$ ) by viewing them as subsets of the reals in order to get a more visual understanding of them. By doing this, we can prove that they are dense in the real line, and then use this method of proof to show integral multiples of the units of the ring  $\mathbb{Z}[\frac{1+\sqrt{d}}{2}]$  are dense in the real line as well.

### $\mathbb{Z}[\sqrt{d}]$ IS DENSE IN $\mathbb{R}$

When we look at quadratic integer rings as a subset of the reals, we can use the density argument to show that  $\mathbb{Z}[\sqrt{d}]$  is dense in  $\mathbb{R}$ .

*Sketch of proof:*

- 1) Show that the elements  $n\sqrt{d}$ , where  $n$  is an integer, are dense in the reals. For any  $x$  in the reals, for any  $\epsilon > 0$ , we can choose  $n$  large enough so that  $n\sqrt{d}$  is within  $\epsilon$  of  $x$ .
- 2) When we consider integral multiples of the units  $u$  of the ring, we can see that they are also dense in the reals. For any  $x$  in the reals, for any  $\epsilon > 0$ , we can choose  $n$  large enough so that  $nu$  is within  $\epsilon$  of  $x$ .

Therefore, the integral multiples of the units of the ring are dense in the reals.



They didn't  
break their  
egg!

# Does $SL_2(\mathbb{R})$ Look Like?

Ryan Manheimer  
The College of New Jersey

Point on the Interior of the Solid Torus is a Matrix



Figure 5: Theta Specifies a Disk

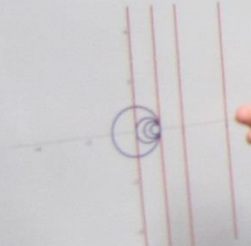


Figure 6: Tau Specifies a Circle

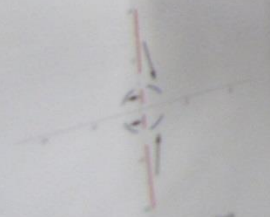


Figure 7: Sigma Specifies a Point on a Circle

How does  $K$  act on the interior of the solid torus?

Let  $K_\theta = \begin{pmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{pmatrix} \in K$   
 $K_\theta \cdot A_{\tau, \sigma} = A_{\tau, \sigma}$

Interpretation  
 •  $K_\theta$  rotates the torus by  $\theta$  radians counterclockwise.

How does  $J$  act on the interior of the solid torus?

Let  $A_\tau = \begin{pmatrix} 1 & \tau \\ 0 & 1 \end{pmatrix} \in A$   
 $A_\tau \cdot A_{\tau', \sigma} = A_{\tau + \tau', \sigma}$

Interpretation  
 •  $A_\tau$  contracts/repels the blue circles interior to the disk  $D$ .

$A_\tau \cdot A_{\tau', \sigma} = A_{\tau + \tau', \sigma}$  since  $\sqrt{\tau^2 + \tau'^2} > \sqrt{\tau^2 + \tau'^2 + \sigma^2}$

Observations  
 •  $\arcsin \left( \frac{\sigma}{\sqrt{\tau^2 + \tau'^2 + \sigma^2}} \right)$  only depends on  $\sigma$   
 •  $A_\tau$  preserves disk structure

How does  $N$  act on the interior of the solid torus?

Let  $N_\tau = \begin{pmatrix} 1 & \tau \\ 0 & 1 \end{pmatrix} \in N$   
 $N_\tau \cdot A_{\tau', \sigma} = A_{\tau + \tau', \sigma}$

Observations  
 •  $\arcsin \left( \frac{\sigma}{\sqrt{\tau^2 + \tau'^2 + \sigma^2}} \right)$  only depends on  $\sigma$   
 •  $N_\tau$  preserves disk structure

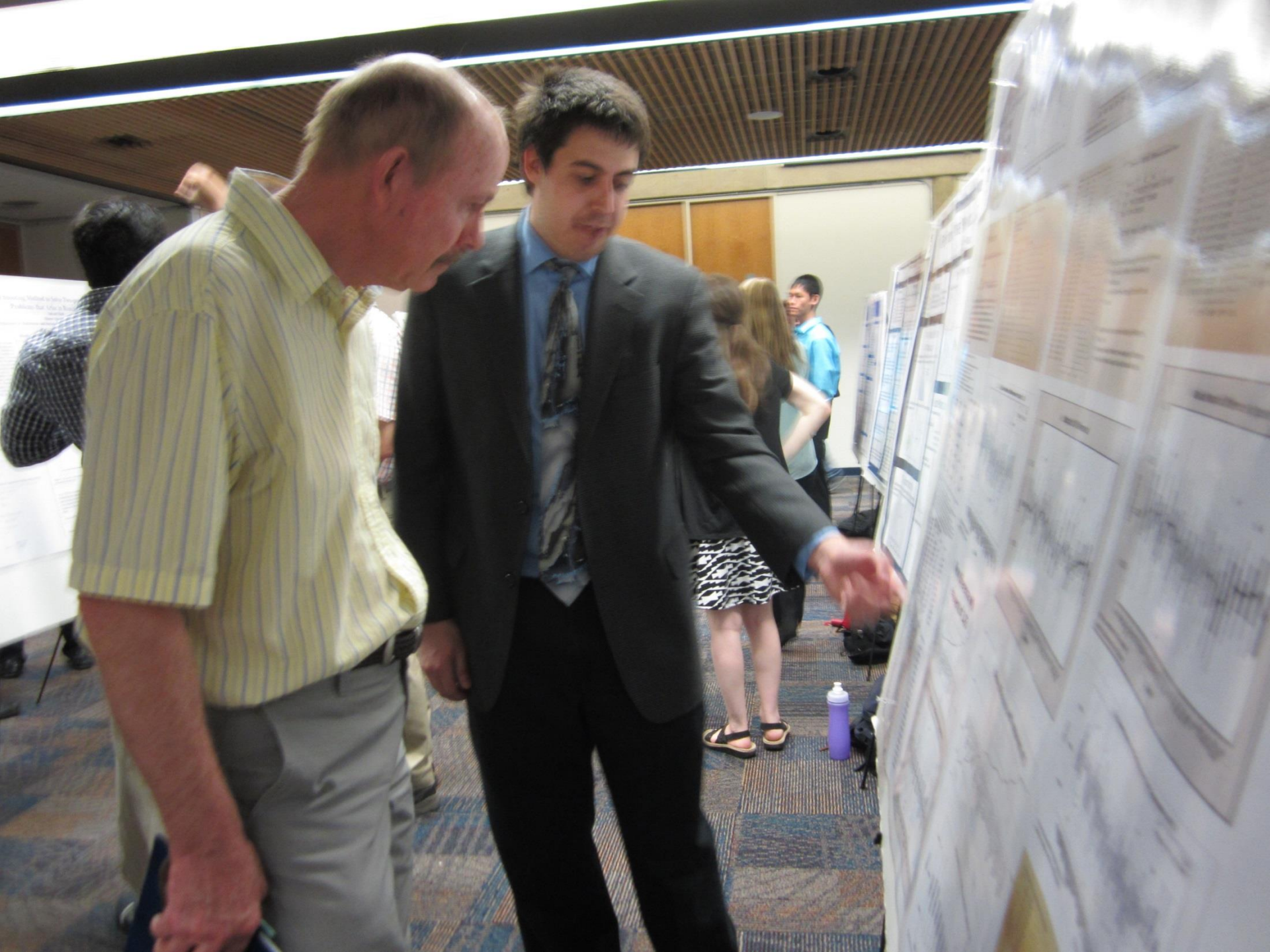
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 [2] John Stillwell. Introduction to Topology: Free and Fixed Point Sets. John Wiley, Hoboken, NJ, 2002.  
 [3] John A. Stillwell. Introduction to Topology: Free and Fixed Point Sets. John Wiley, Hoboken, NJ, 2002.  
 [4] John A. Stillwell. Introduction to Topology: Free and Fixed Point Sets. John Wiley, Hoboken, NJ, 2002.  
 [5] David H. Cohen. Algebraic Topology and Representation Theory. Springer, Berlin, 2004.

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“GSUMC: We do math  
as a recreational sport.”  
–Ryan Manheimer





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Abstract

The US Dollar Exchange Rate  
Technical

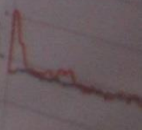
Faculty of Mathematics & Statistics  
Results



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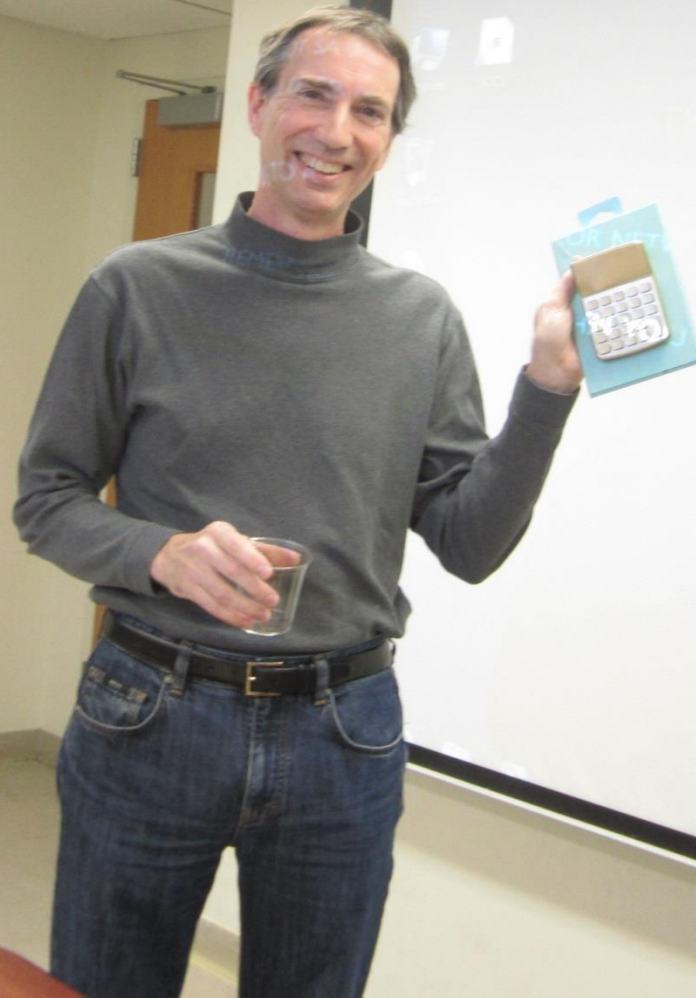
USD/EUR Actual Exch







# The Golden Calculator



# Study of Portfolio Risk Management Using Alternative Allocation

Alissa Migliore & Faculty Advisor: Dr. Edward Conjura  
The Department of Mathematics & Statistics, The College Of New Jersey, Ewing NJ 08618

## Abstract

The data used in this project was provided by Dr. Conjura. The data consists of 4 different equity portfolios entitled "K", "S", "T", & "V". The data begins in 1991 and ends in 2012, and contains closed & daily equity values, in which we will be using the daily equity values. The VBA program receives the data input from the user, as well as user inputs for RSI Length, RSI High & Low Parameters, and the Kelly Length. The program then creates a statistics sheet that includes the calculated RSI values, Kelly values, and then the adjusted equity values for when to cut and add to the investor's position size. The first threshold level and return back down, the investor's position is cut to 50%, and returns back to 100% once the overshoot level has been crossed below and then crossed above, in the Kelly adjusted equity stream. If the Kelly value < 0.5, then position size = 50%. If the adjusted equity stream, the weight used is the average of the RSI weight and Kelly weight, each respectively calculated in the other 3 equity streams.

## Methods

The data used in this project was provided by Dr. Conjura. The data consists of 4 different equity portfolios entitled "K", "S", "T", & "V". The data begins in 1991 and ends in 2012, and contains closed & daily equity values, in which we will be using the daily equity values. The VBA program receives the data input from the user, as well as user inputs for RSI Length, RSI High & Low Parameters, and the Kelly Length. The program then creates a statistics sheet that includes the calculated RSI values, Kelly values, and then the adjusted equity values for when to cut and add to the investor's position size. The first threshold level and return back down, the investor's position is cut to 50%, and returns back to 100% once the overshoot level has been crossed below and then crossed above, in the Kelly adjusted equity stream. If the Kelly value < 0.5, then position size = 50%. If the adjusted equity stream, the weight used is the average of the RSI weight and Kelly weight, each respectively calculated in the other 3 equity streams.

Kelly Length  
 RSI High Parameter  
 RSI Low Parameter  
 Kelly Length

## Introduction

The Relative Strength Index (RSI) is a widely popular momentum indicator that is used to analyze price movements of an investment. It is calculated on a 14-day time frame, but can also be calculated on other time frames. The RSI is used to identify when an investment is trading in a strong or weak position. The RSI is calculated as a simple moving average of the RSI, which is used to calculate the average gain/loss for the investment. The RSI is not a true length dependent indicator, but rather a relative strength indicator, and RSI and RSI are used to identify when an investment is trading in a strong or weak position.

"A" Relative Strength Index and Kelly Percentages



## Results

To analyze the newly created equity streams, the data was analyzed by Dr. Conjura. It returns an annual analysis, including a Profitability Index and Sharpe Ratio. To an investor, the slightly more important result is the Sharpe Ratio, which explains the largest decline that can be expected in relation to the Sharpe Ratio to increase in size. There were 6 different strategies combining different RSI parameters together and separately changed. Combined adjusted equity stream using both RSI & Kelly inputs turned out to be the optimal trading strategy. It was formulated using the average weight of the two methods and therefore did not improve overall performance, but fell between the two methods. The results of the 6 different strategies used on the original 4 portfolios is shown below. The largest ratios are highlighted.

Original A	Profits/Decline	Sharpe Ratio
RSI 20-70/30	5.5409	0.1724
RSI 20-65/35	8.2139	0.2169
RSI 14-70/30	6.7948	0.2155
RSI 14-65/35	8.3807	0.2215
Kelly 60	6.9122	0.1808
Kelly 40	5.5736	0.1688
	5.29	0.1504

Original S	Profits/Decline
RSI 20-70/30	3.1
RSI 20-65/35	3.1
RSI 14-70/30	3.1
RSI 14-65/35	3.1
Kelly 60	3.1
Kelly 40	3.1

Profits/Decline	Sharpe Ratio
1.7225	0.0748
1.6335	0.0788
1.8176	0.0877
1.3960	0.0624
1.0364	0.0624
1.6124	0.0624

Original T	Profits/Decline
RSI 20-70/30	3.1
RSI 20-65/35	3.1
RSI 14-70/30	3.1
RSI 14-65/35	3.1
Kelly 60	3.1
Kelly 40	3.1





**CONGRATULATIONS!**