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Can Computational Thinking Predict Academic Performance?

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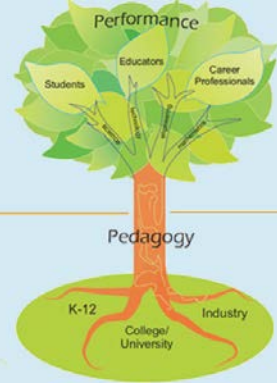*Georgia Southern University*, yalkalaani@georgiasouthern.edu

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Can Computational Thinking Predict Academic Performance?

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Outline

- Motivation

- What is Computational Thinking?

- Computational Thinking Misconceptions

- Problem Solving vs. Computational Thinking

- Proposed Hypothesis

- Study and Results

- Conclusion

Motivation

We do not acquire technical skills simply from the use of technology any more than engineering skills evolve from using automobiles or aeronautical engineering skills from flying.

Robert Tinker, Alvaro Galvis, and Andrew Zucker

The Concord Consortium

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Motivation

Not everyone should be a programmer, but everyone should be learn computational thinking.

What is Computational Thinking?

- Computational Thinking is a fundamental analytical skill that everyone can use to help solve problems, design systems, and understand human behavior.

Physical Framework → modeling → **Computational Framework**

Modeling a problem involves:

- formulating the problem,
- defining its inputs and outputs,
- dividing it into its basic components using Computational Thinking modalities.
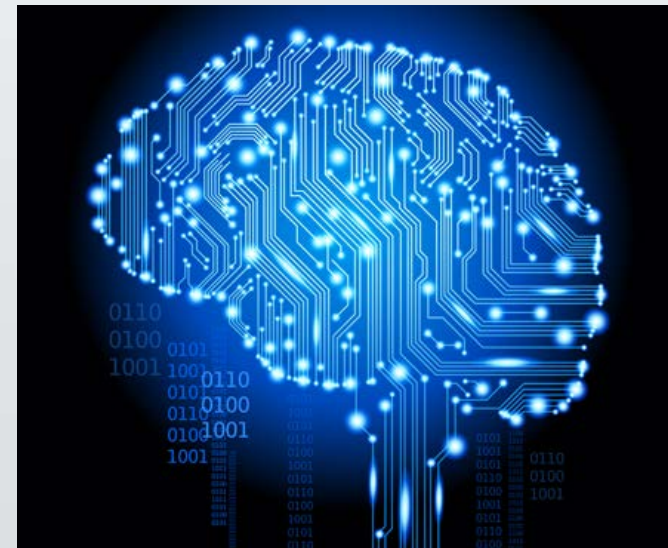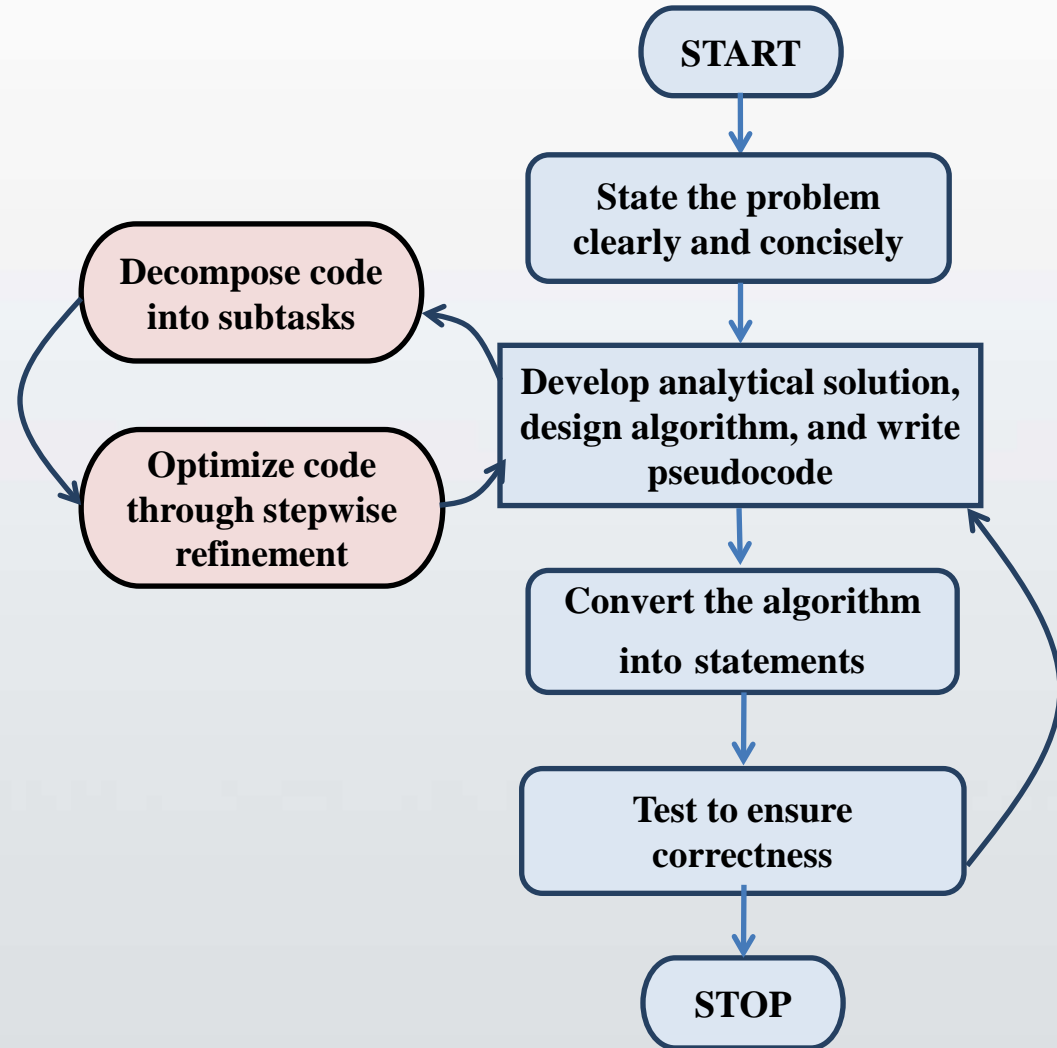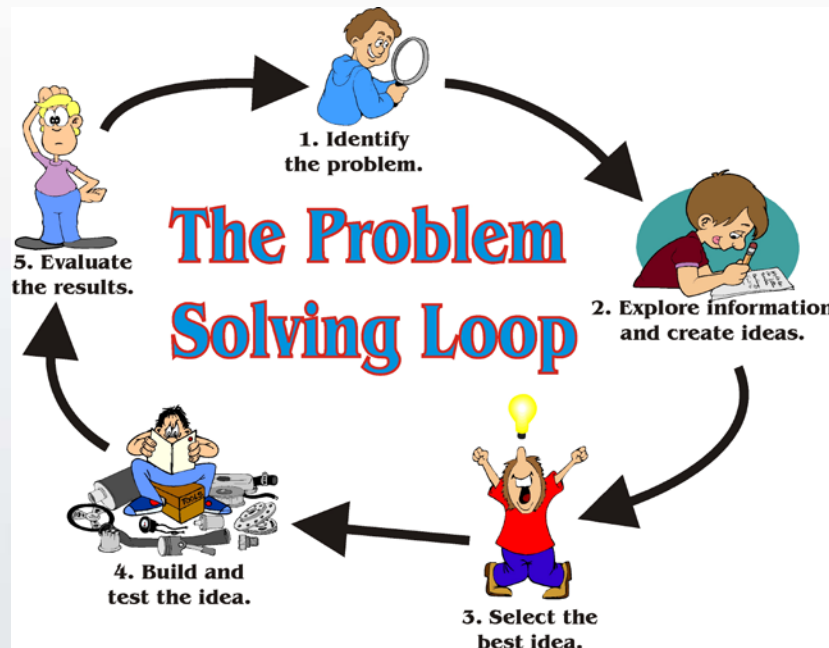
Computational Thinking Misconception

- It's not just more technical details for using software.

- It's not thinking like a computer.

- It's not programming (necessarily).

- It doesn't always require a computer.

Problem Solving vs. Computational Thinking

The Problem Solving Loop

1. Identify the problem.
2. Explore information and create ideas.
3. Select the best idea.
4. Build and test the idea.
5. Evaluate the results.

START

State the problem clearly and concisely

Decompose code into subtasks

Optimize code through stepwise refinement

Develop analytical solution, design algorithm, and write pseudocode

Convert the algorithm into statements

Test to ensure correctness

STOP

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Proposed Hypothesis

If engineering is very dependent on creative problem solving and Computational Thinking is a structured process that facilitates this, therefore, Computational Thinking is a vital skill set for engineers which can help predict the future success of engineering students.
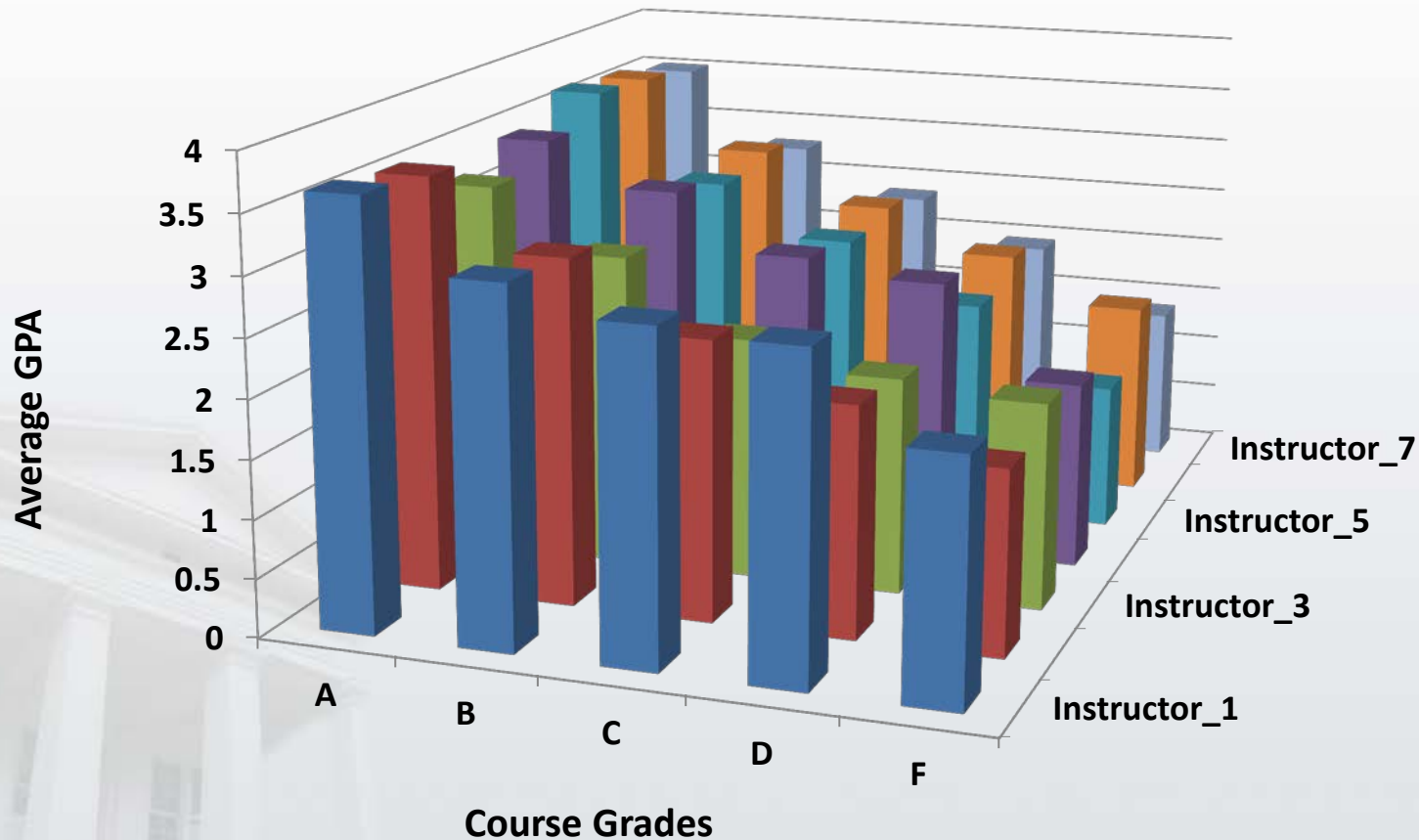
Study Details

<u>To test our hypothesis</u>,

- a quantitative analysis was conducted in over 40 different sections of this Computing for Engineers course offered between Fall 2012 and Spring 2014.

- Our sample consisted of 982 students (15% Civil, 50% Mechanical, 25% Electrical, and 10% from other Engineering disciplines)
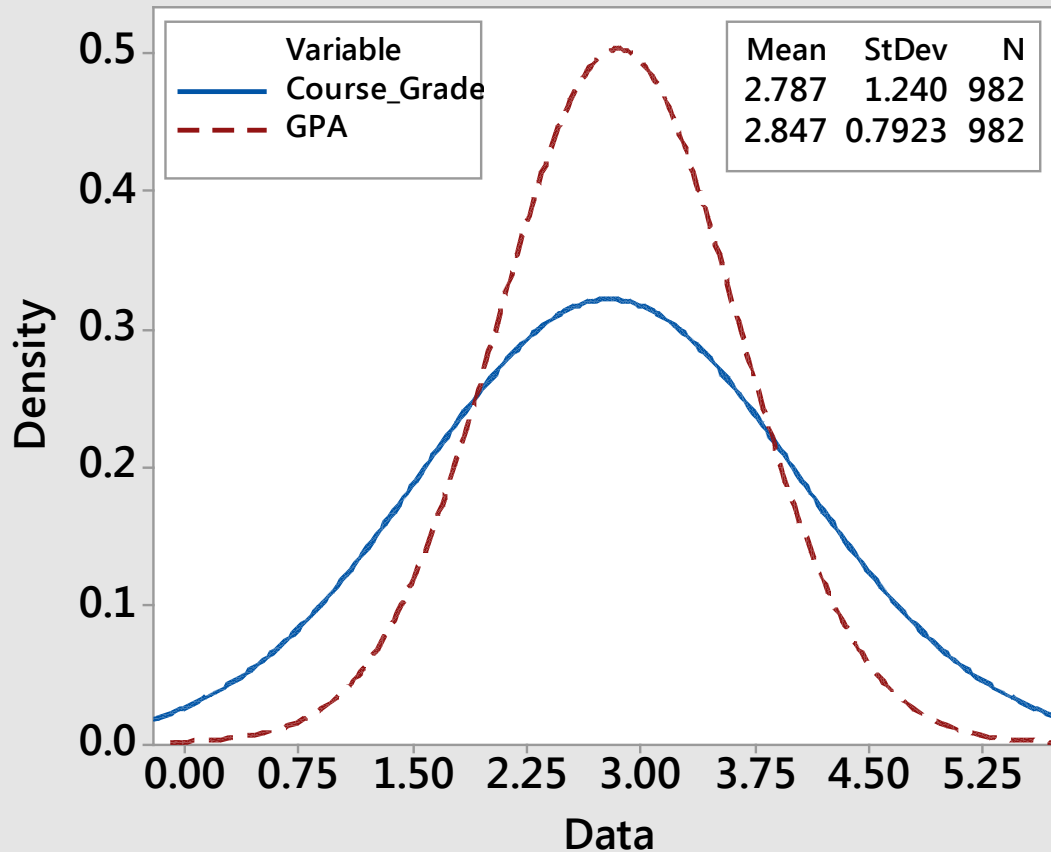
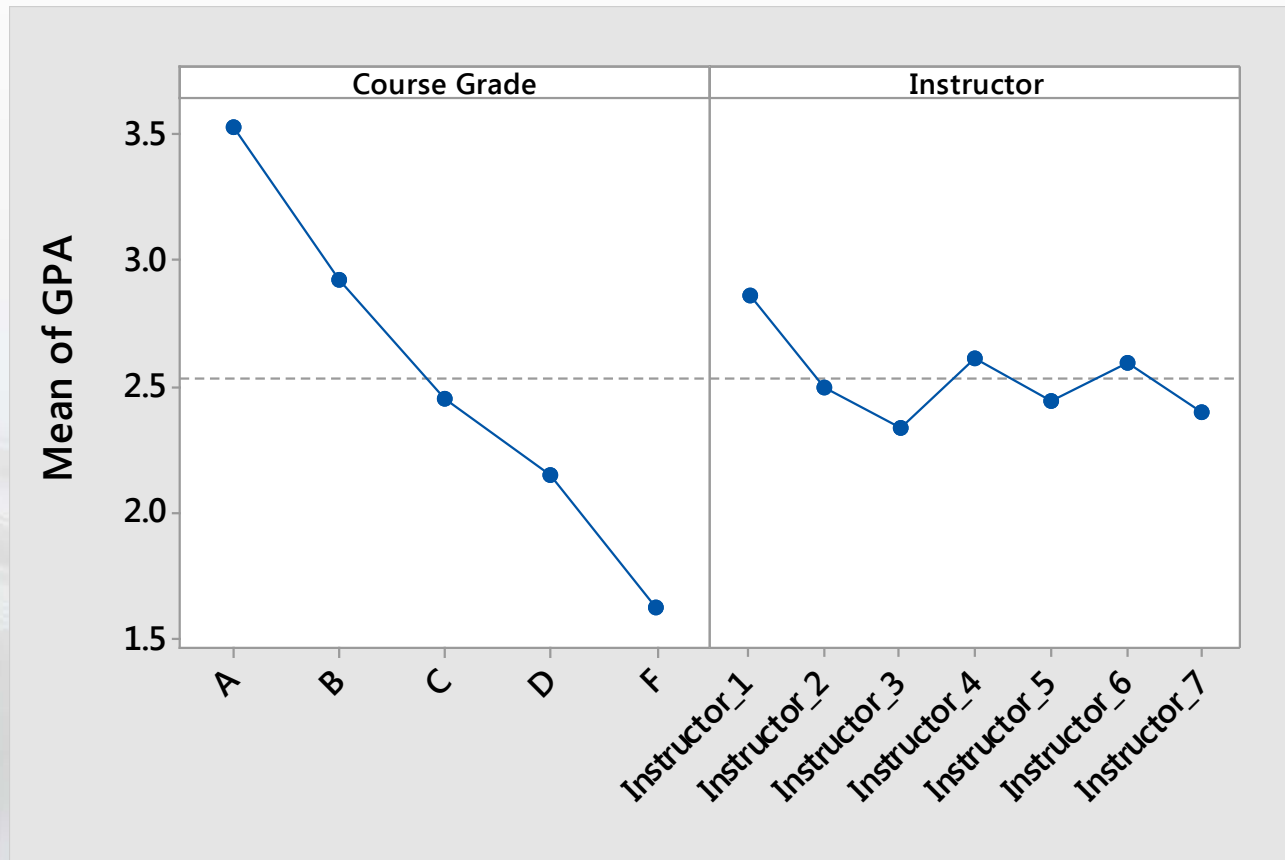# Overall GPA of Students vs. CT Grades & Instructor

Academic success of students, as represented by their average GPA, correlates with their CT performance.

Normal Fit of Data

Students' overall GPA & CT grades have the same mean.

Main Factors Effects

Statistical Analysis Results

General Linear Model: GPA versus Course Grade, Instructor

Method

Factor Information

Factor	Type	Levels	Values
Course Grade	Fixed	5	A, B, C, D, F
Instructor	Fixed	7	Instructor_1, Instructor_2, Instructor_3, Instructor_4, Instructor_5, Instructor_6, Instructor_7

Analysis of Variance

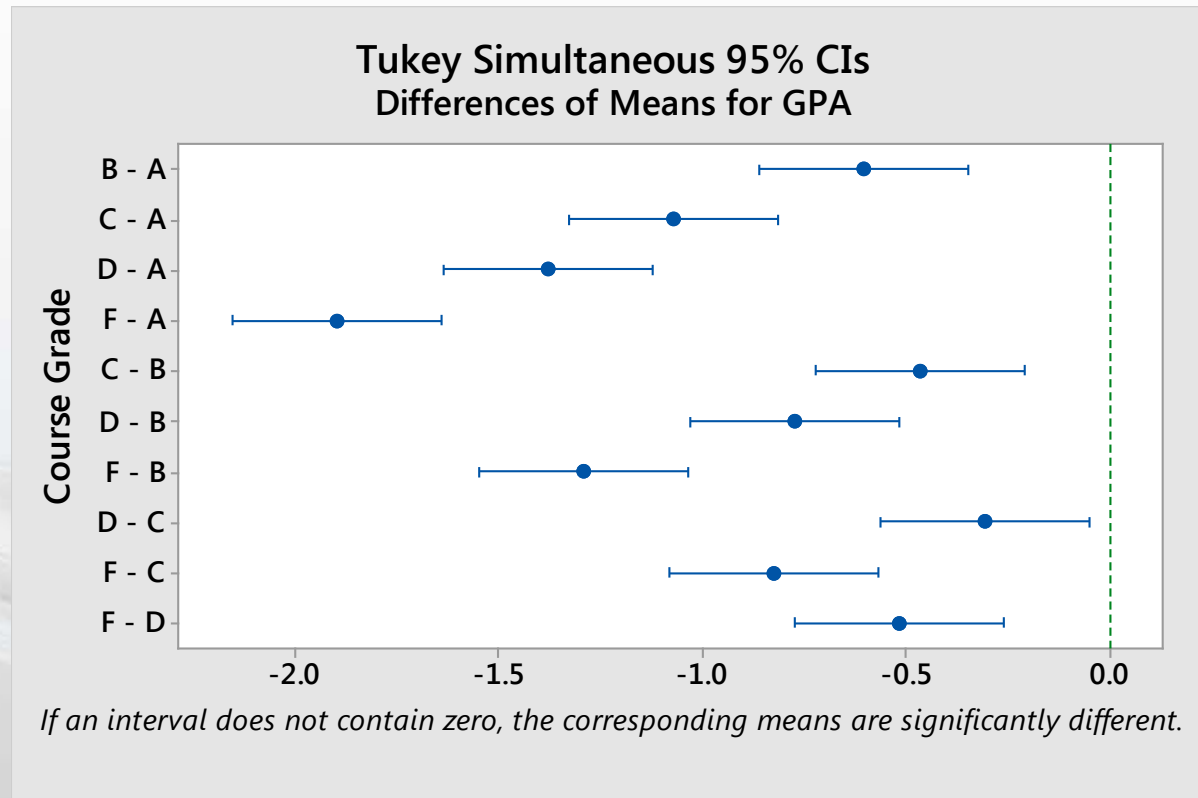| Source	DF	Adj SS	Adj MS	F-Value	P-Value
Course Grade	4	14.7863	3.69657	139.60	0.000
Instructor	6	0.8987	0.14978	5.66	0.001
Error	24	0.6355	0.02648		
Total	34	16.3205			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.162723	96.11%	94.48%	91.72%

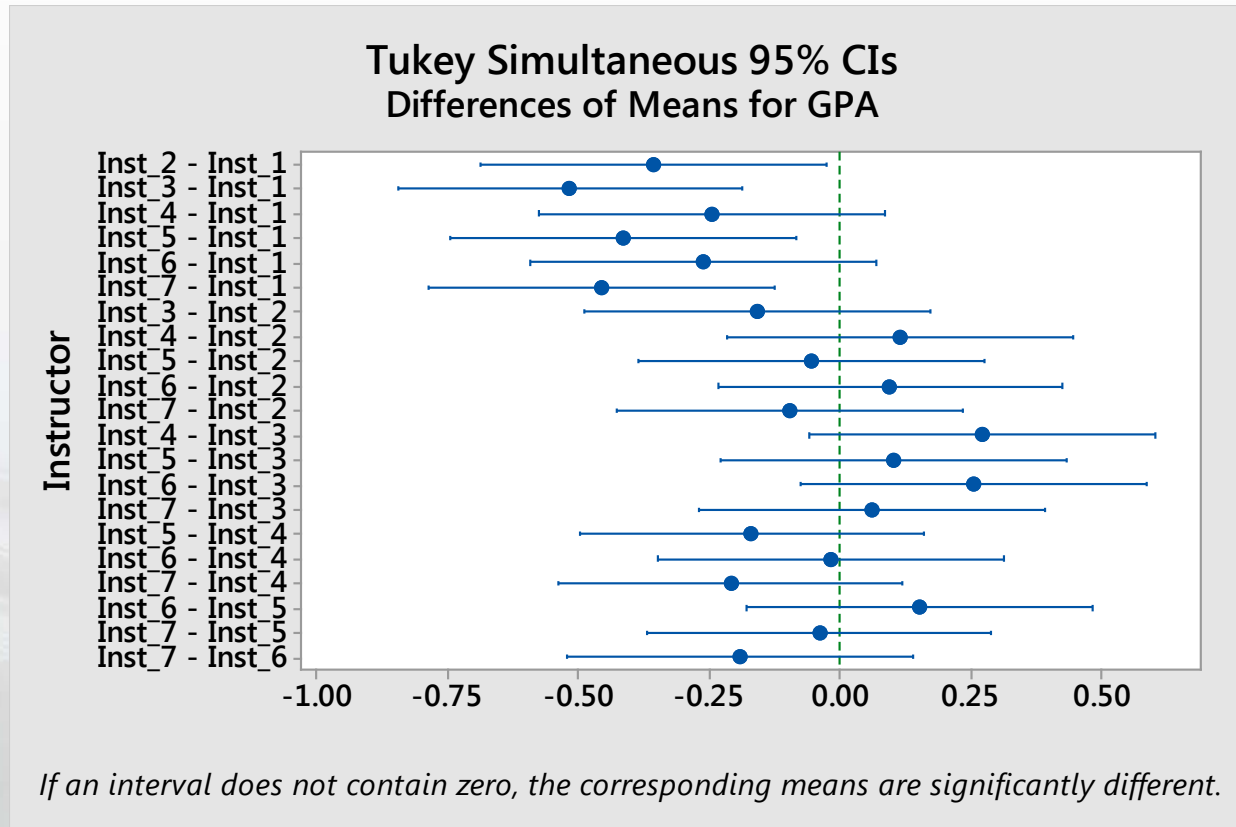We achieved statistical significance with a confidence level of **99.9%**
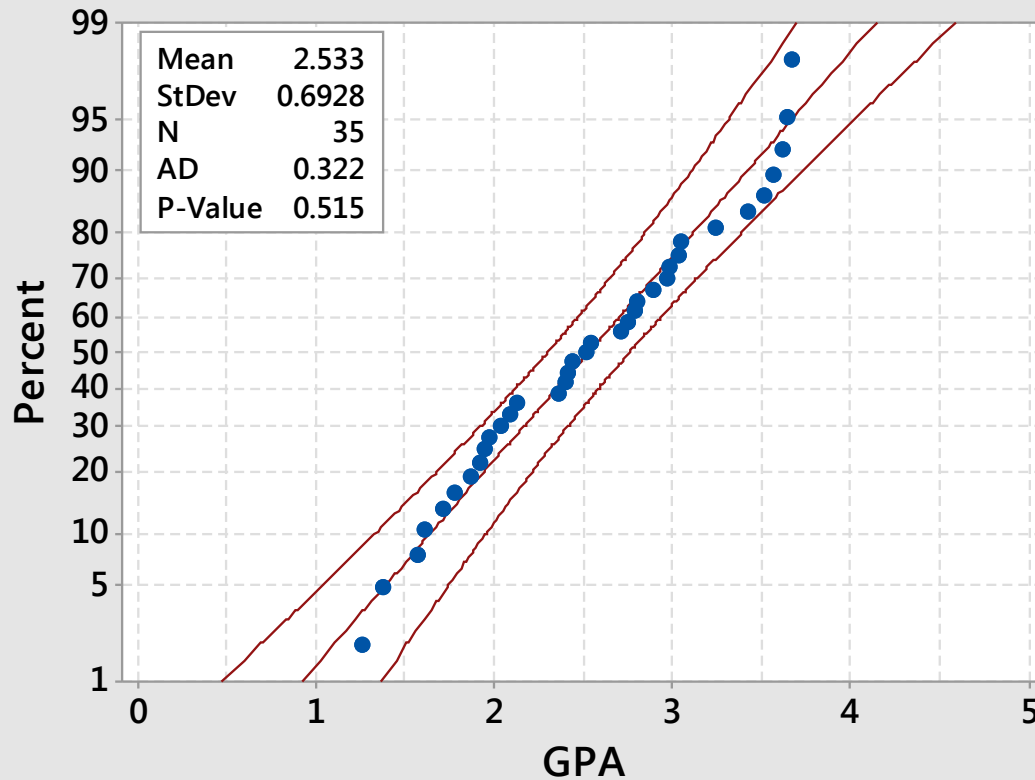
Pairwise Comparisons - Course Grades

Engineering students' academic achievement represented by their average GPA can be predicted based on their performance in this course

Pairwise Comparisons - Instructors

Tukey Simultaneous 95% CIs
Differences of Means for GPA

If an interval does not contain zero, the corresponding means are significantly different.

Data Goodness-of-Fit

Conclusion

- The notion of predicting academic performance using Computational Thinking skills was presented.

- Performance in Computational Thinking freshman courses can predict the student future academic success.

- We concluded that is statistical difference in the overall students' GPA based on their CT grades with over 99.9% confidence level.

- Finally, assessment of CT can be used as an early intervention indicator to increase the students' retention, progression, and graduation rates.

Questions?

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