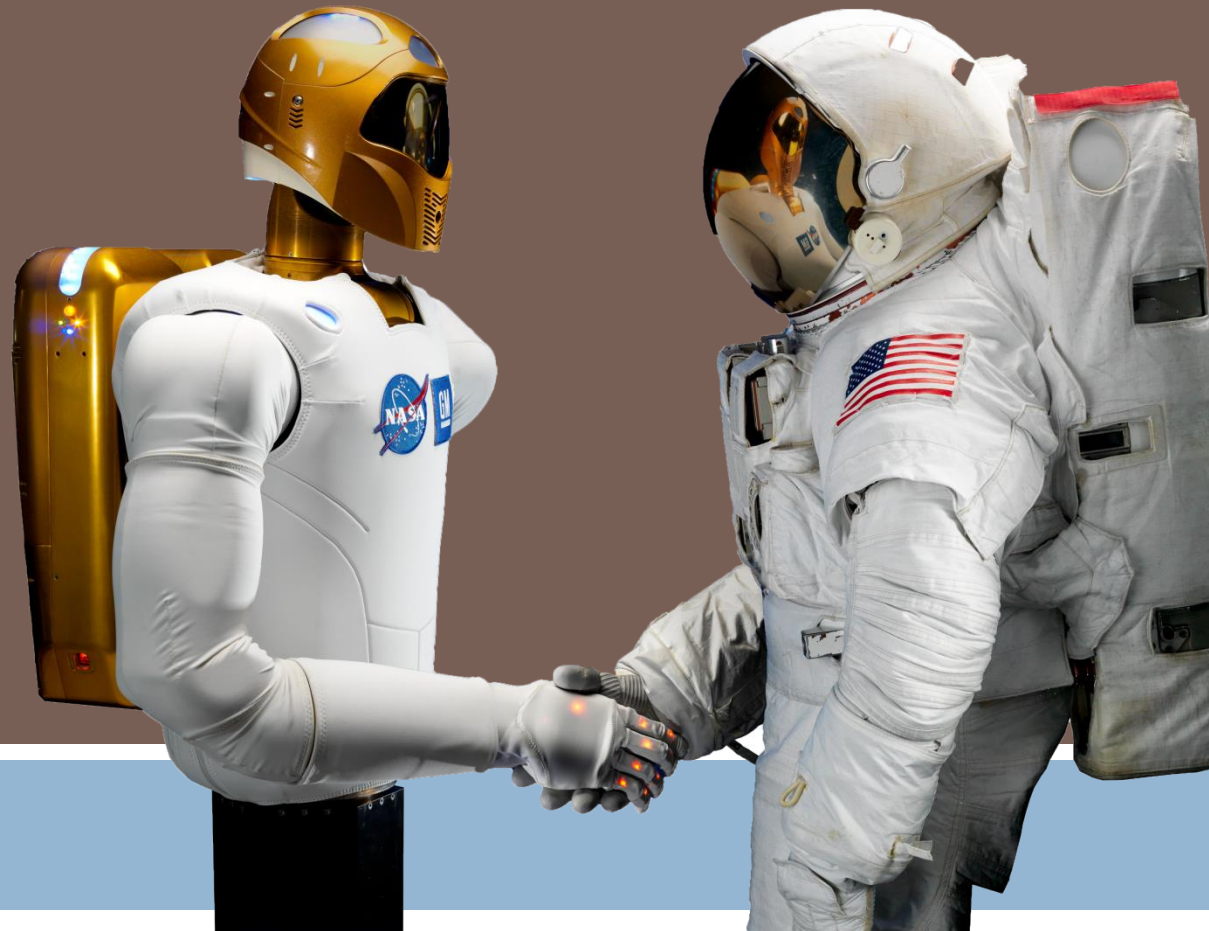


A Robotic Hand with a Gentle Touch!

Understand the Challenge



Outline

- Curve fitting
- Electrical engineering fundamentals
- Curve modeling equations
- Curve modeling graphs
- Regression and correlation
- Curve fitting with linear models
- Finding best fit line using summation
- Finding best fit line using calculator
- Rise to the challenge

Curve Fitting

- The process of constructing a curve model, or mathematical function, that has the best fit to a series of data points.
- Studying these models gives us a better understanding of the behavior and relationships among variables.
- Curve models are an effective and efficient method to simulate solutions to real-world problems.
- Curve modeling plays an important role in the electrical engineering field.

Electrical Engineering Fundamentals

- Current (I)

A flow of electrical charge

$$\underline{I = V/R}$$

[Show Ohm's law simulation](#)

- Resistor (R)

A passive two-terminal electronic component that implements electrical resistance as a circuit element

- Voltage (V)

The electric potential energy difference between 2 points.

- Ground \perp

A reference point in an electrical circuit from which other voltages are measured

Curve Modeling Equations

Ohm's law: The current through a conductor between 2 points is directly proportional to the potential difference across the 2 points.

$$I = V/R$$

Newton's second law of motion: The acceleration of a body is directly proportional to, and in the same direction as, the net force acting on the body, and inversely proportional to its mass.

$$F = ma$$

Amdahl's law: The maximum expected improvement to an overall system when only part of the system is improved.

$$S_{overall} = \frac{1}{(1 - F_{enhanced}) + \frac{F_{enhanced}}{S_{enhanced}}}$$

Curve Fitting Graphs

Ohm's law

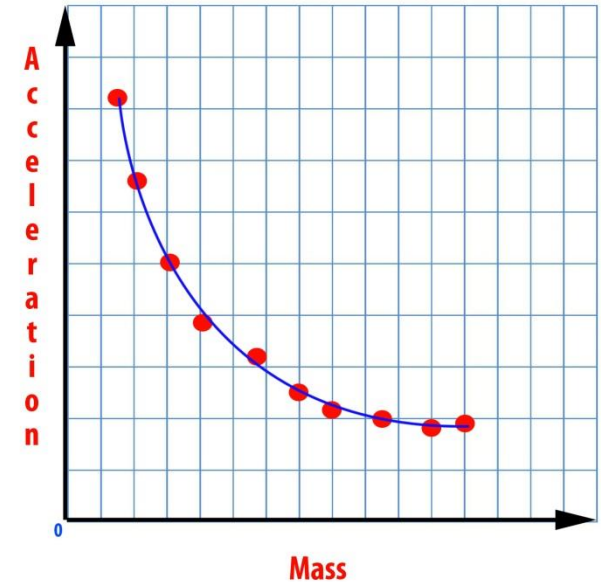
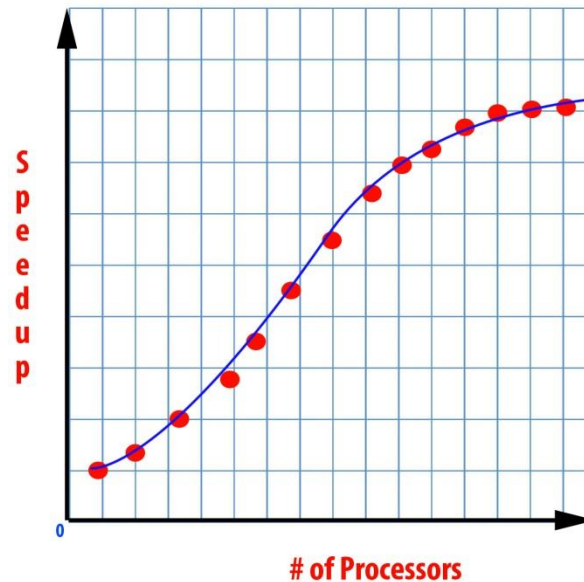
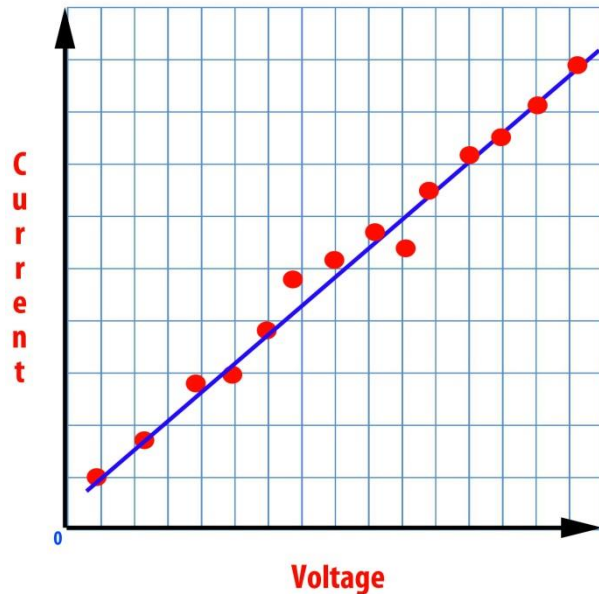
$$I = \frac{V}{R}$$

Amdahl's law

$$S_{overall} = \frac{1}{(1 - F_{enhanced}) + \frac{F_{enhanced}}{S_{enhanced}}}$$

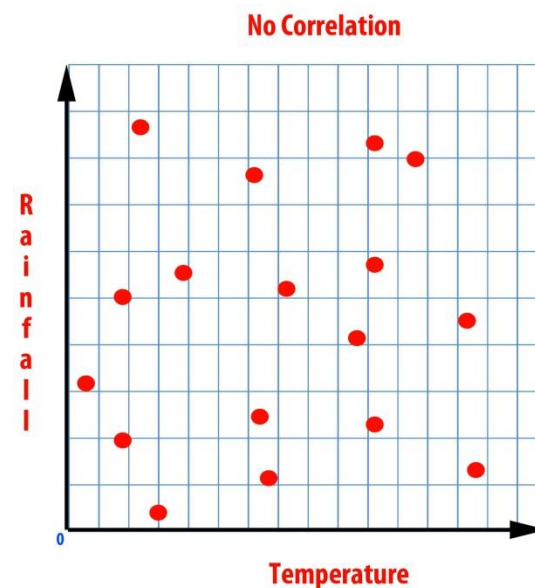
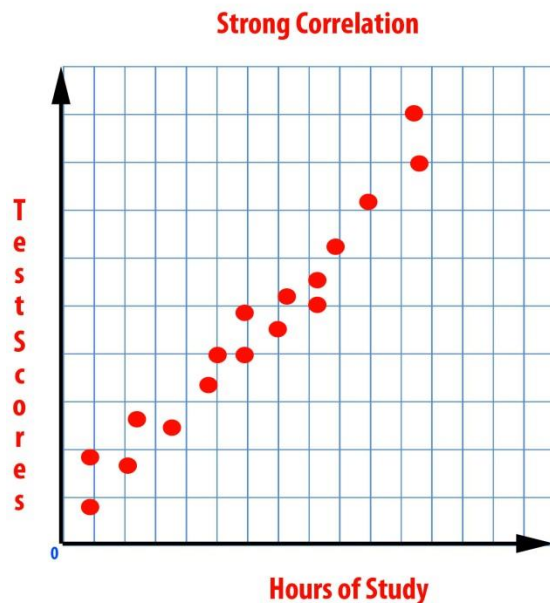
Newton's second law

$$F = ma$$



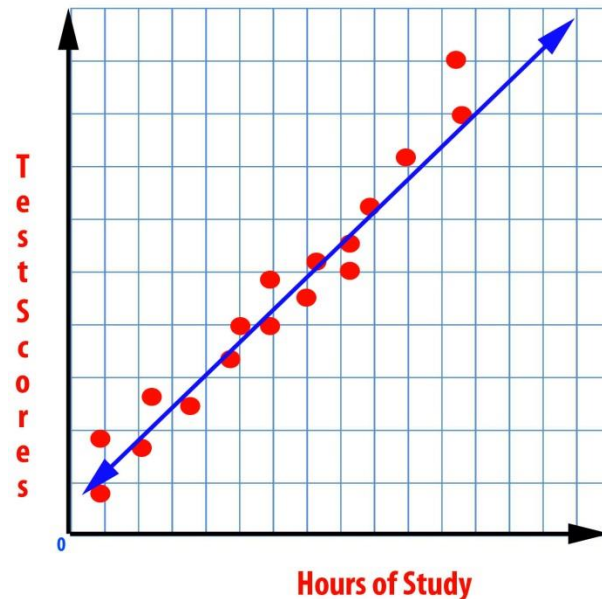
Regression and Correlation

- **Regression** is the study of the relationship between variables.
- **Correlation** is the strength and direction of the linear relationship between the 2 variables.



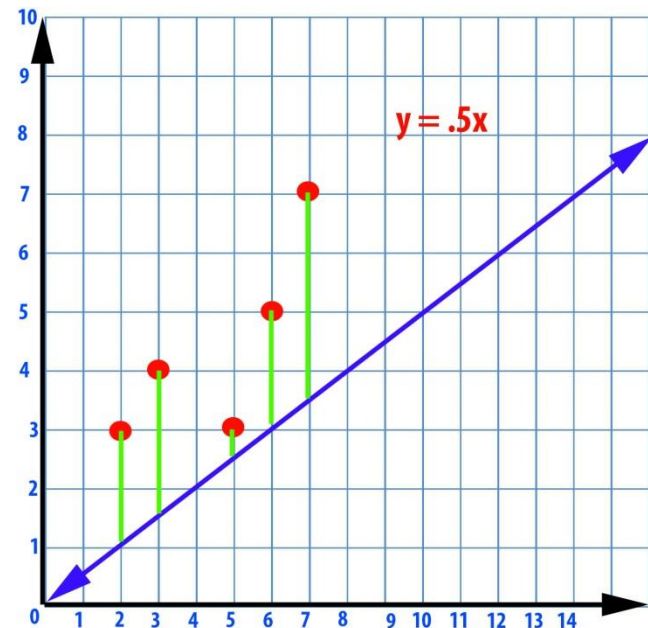
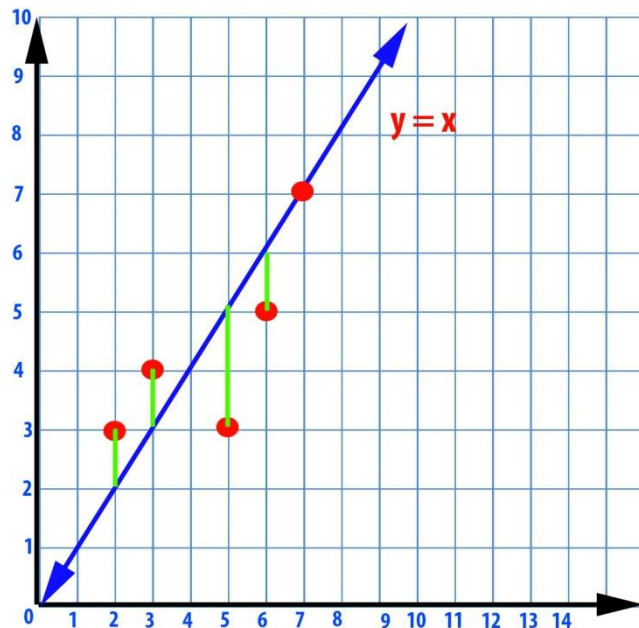
Curve Fitting with Linear Models

- A **line of best fit** is the line that comes closest to all data samples in a regression study.
- A **residual** is the signed vertical distance between a data point and a line of fit.



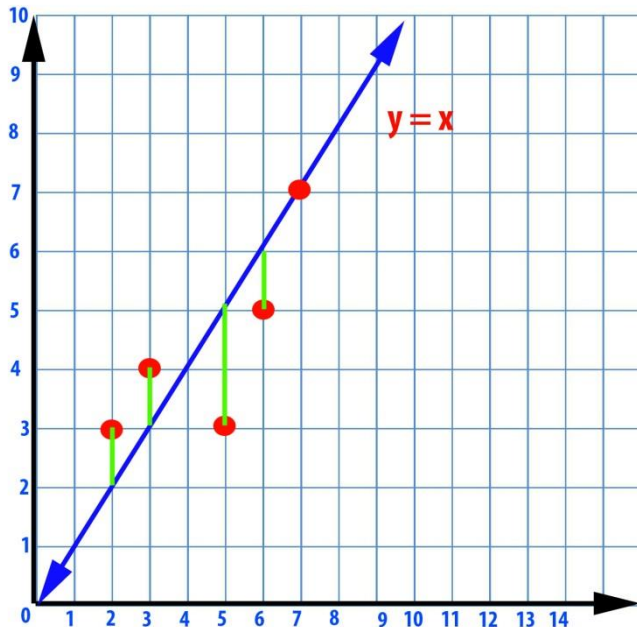
Finding Best Fit Line Using Summation

- You can find the best fit line by finding the sum of the squares of the residuals.
- The sum with a value closest to 1 is the best fit line.

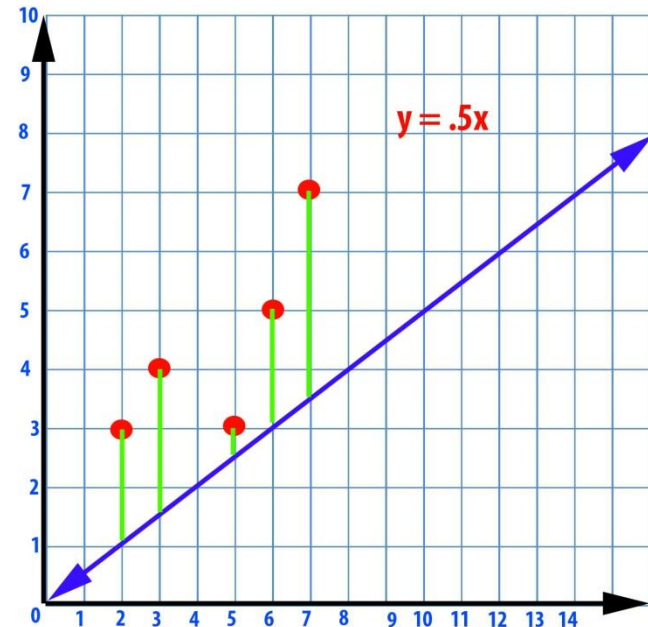


Finding Best Fit Line Using Summation

The sum with a value closest to 1 is the best



$$R = 1^2 + 1^2 + 2^2 + 1^2 + 0^2 = 7$$



$$R = 2^2 + 2.5^2 + .5^2 + 2^2 + 3.5^2 = 26.75$$

Finding Best Fit Line Using Calculator

Using a TI-8X graphing calculator:

- Press STAT and select EDIT.
- Enter data into L1 and L2 using arrows.
- Press STAT again and choose CALC.
- Choose LinReg($ax+b$) and press ENTER twice.



Understand the Challenge

Welcome to Johnson Space Center, young NASA/GM engineers. It is with great privilege that I reveal to you our latest project—**Robo-Glove**!

- Our latest prototype is functional, but not calibrated correctly. Our Robo-Glove used on **Robonaut 2** keeps CRUSHING people's hands when shaking them.
- To improve our design, we would like you to add the revolutionary FlexiForce sensors on our Robo-Glove X2. Your task is to develop a working prototype of our glove, calibrate it using weights, and test it using an egg within three days!! If time allows, test it by shaking people's hands.

Oh, one more thing, our senior electrical engineers do not want to replicate the calibration or testing. So please provide them with:

- A scatterplot graph using resistance vs. force, conductance vs. force, and voltage vs. force (lbs)
- And, for the last two graphs, create a best fit line on the graph and a best fit equation.



References

Robots shaking hands (image)

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