Lesson Plan: Teaching Introductory Statistics (Linear Regression) using Arctic Sea Ice Data

As a **high school** or **undergraduate Mathematics** teacher, you can use this set of computer-based tools to help you in teaching introductory **statistics** and specifically **linear regression**.

This lesson plan will allow you to teach **introductory statistics** through **linear regression assignments.** The lesson plan includes **a hands-on computer-based classroom activity** to be conducted on **datasets of Arctic Ice Data (1979-2017)**. This activity includes **a set of inquiry-based questions** that will enable your students to apply their understanding of **scatter plots, regression equations, correlation coefficients, regression lines**, and **linear regression with residual (outlier) plots.**

Thus, the use of this lesson plan allows you to integrate the teaching of a climate science topic with a core topic in **Mathematics**.

Use this lesson plan to help your students find answers to:

- Use an example to describe linear regression analysis.

- Is the extent of the Arctic Sea Ice decreasing since 1979?

- Has the monthly extent of Arctic Sea Ice changed from 1979- 2017?

- Discuss the Ice Albedo Feedback and Global Warming to explain the differences in extent of Arctic Sea Ice over the past four decades.

About the Lesson Plan

Grade Level: High School, Undergraduate

Discipline: Mathematics

Topic(s) in Discipline: Scatter Plots, Correlation Coefficients, Regression Equations, Linear Regression, Residual (Outlier) Plots

Climate Topic: Climate and the Cryosphere, Climate Variability Record

Location: Global

Access: Online, Offline

Language(s): English

Approximate Time Required: 60 min

1 Contents

1. **Teaching Module (30 min)**

A teaching module to explain the basics of scatter plots, correlation coefficients, regression equations, linear regression, and linear regression with residual (outlier) plots.

This can be accessed at:

High School: https://openstax.org/books/introductory-statistics/pages/12-introduction

Undergraduate: http://www.mit.edu/~6.s085/notes/lecture3.pdf

2. **Classroom/Laboratory Activity (20 min)**

A classroom activity to apply understanding of linear regression using datasets of the extent of Arctic Sea Ice (1979-2017).

This can be accessed at:

http://sustainabilitymath.org/statistics-materials/

3. **Visualization (5 min)**

An interactive visualization of changes in the extent of Arctic Sea Ice from 1979-2020.

This can be accessed at:

https://nsidc.org/arcticseaicenews/charctic-interactive-sea-ice-graph/

4. **Suggested questions/assignments for learning evaluation**

- Use an example to describe linear regression analysis.

- Is the extent of the Arctic Sea Ice decreasing since 1979?

- Has the monthly extent of Arctic Sea Ice changed from 1979- 2017?

- Discuss the Ice Albedo Feedback and Global Warming to explain the differences in extent of Arctic Sea Ice over the past four decades.

2 Step-by-step User Guide

Here is a step-by-step guide to using this lesson plan in the classroom/laboratory. We have suggested these steps as a possible plan of action. You may customize the lesson plan according to your preferences and requirements.

1. **Topic introduction and discussion**

Use the teaching module, 'Introduction-Linear Regression and Correlation' by OpenStax™, Rice University (for High School level) or 'Chapter-3: Linear Regression' provided by Ramesh Sridharan, Massachusetts Institute of Technology (for Undergraduate level), to introduce these topics of basic statistics. Navigate to the sub-sections within the module to the basics of scatter plots, correlation coefficients, regression equations, linear regression, and linear regression with residual (outlier) plots. Use the in-built practice exercises and quizzes to evaluate your students' understanding of the topics.

These can be accessed at:

High School: https://openstax.org/books/introductory-statistics/pages/12-introduction

Undergraduate: http://www.mit.edu/~6.s085/notes/lecture3.pdf

2. Extend understanding

Use the classroom activity, 'Arctic Ice Data' from Sustainability Math by Thomas J. Pfaff, Professor of Mathematics, Ithaca College, USA, to enable your students to apply their understanding of linear regression with residual (outlier) plots using datasets from the National Snow and Ice Data Center (NSIDC). This classroom activity includes datasets of the monthly extent of Arctic Sea Ice linked from NSIDC's observations from 1979 to 2017. This data is provided in an Excel spreadsheet that you may use in your classroom to explain the mathematical functions and methods. Direct your students to download the Excel file (with dataset) and proceed with the classroom activity. Encourage your students to answer topical questions by applying their understanding of scatter plots, correlation coefficients, regression equations, and linear regression. Use the regression analyses performed to initiate a discussion on the decrease in extent of Arctic Sea Ice due to the Ice Albedo Feedback and anthropogenically forced Global Warming (links to explanatory notes given within the tool).

This can be accessed at:

http://sustainabilitymath.org/statistics-materials/

3. Discuss further

Use the visualization, 'Charctic Interactive Sea Ice Graph' from NSIDC to encourage discussion amongst your students about the changes in the extent of Arctic Sea Ice from the years 1979-2020. Discuss how these changes could be the result of changes in the Earth's climate in recent times.

This can be accessed at:

https://nsidc.org/arcticseaicenews/charctic-interactive-sea-ice-graph/

4. Questions/Assignments

Use the tools and the concepts learned so far to discuss and determine answers to the following questions:

- Use an example to describe linear regression analysis.

- Is the extent of the Arctic Sea Ice decreasing since 1979?

- Has the monthly extent of Arctic Sea Ice changed from 1979- 2017?

- Discuss the Ice Albedo Feedback and Global Warming to explain the differences in extent of Arctic Sea Ice over the past four decades.

3 Learning Outcomes

The tools in this lesson plan will enable students to:

- learn about linear regression and correlation
- understand linear regression equations and related terms such as correlation coefficients
- use linear regression analyses to describe changes in the extent of Arctic Sea Ice from monthly datasets (1979-2017)
- discuss how these changes are related to ice albedo effects and global warming

4 Credits/Copyrights

All the teaching tools in our collated list are owned by the corresponding creators/authors/organizations as listed on their websites. Please view the individual copyright and
ownership details for each tool by following the individual links provided.
We have selected and analyzed the tools that align with the overall objective of our project and have provided the corresponding links. We do not claim ownership of or responsibility/liability for any of the listed tools.

1. **Teaching Module; 'Introduction-Linear Regression and Correlation'**

Provided by OpenStax^{TM}, Rice University.

2. **Teaching Module; 'Chapter 3: Linear Regression'**

Provided by Ramesh Sridharan, MIT from 'Statistics for Research Projects'.

3. **Classroom Activity; 'Arctic Ice Data'**

Provided by Sustainability Math by Thomas J. Pfaff, Professor of Mathematics, Ithaca College, USA.

4. **Visualization; 'Charctic Interactive Sea Ice Graph'**

From National Snow and Ice Data Center (NSIDC)