Problem Set 07: Function Discovery

New Learning Objectives under Evaluation

12.00 Perform linear regression

Learning Objective	Evidence
13.01 Estimate log10x for any x	Sketch a pair of linear and log number lines representing a range of one order of magnitude Label the tick marks on the pair of linear and log number lines Place x on the log number line Read across from the log number line to the linear line to estimate the log10x value to the nearest tens decimal place

13.02 Identify function types from graphs of bivariate data, specifically linear, power, exponential, and logarithmic	Use intercept, behavior at or near the origin, and asymptotic behavior to identify the function type
	• Linear: y = mx + b: has a y intercept and data falls approximately on a line
	• Exponential: y = b10mx: has a y intercept
	  ○ for m>0, as x increases, y increases (concave up)
	  ○ for m<0, as x increases, y decreases and asymptotically approaches y = 0
	• Power: y = bxm
	  ○ for m>0, passes through the origin, as x increases, y increases (concave up for m>1, concave down for 0<m<1)
	  ○ for m< 0, there is no intercept; as x approaches 0, y asymptotically approaches x = 0; and as x increases - y asymptotically approaches y = 0
	• Logarithmic: x = b10my: has an x intercept; as x approaches 0, y approaches negative infinity; as x increases, y increases (concave down)

13.03 Confirm function identification using a combination of linear and log transformations of the independent and dependent data variables	Identify the independent and dependent data variables that need transformation (or log scaling) to linearize the data Identify the function type that correspond to the transformations (or log scaling) needed to linearize the data
13.04 Create plots with linear and/or log axis scales (by-hand)	Plots of data using different axis scales to show relationships useful for function discovery • Linear scale: linear scale on x-axis, linear scale on y-axis • Log-linear scale: log scale on x-axis, linear scale on y-axis

Problem Set 07: Function Discovery

New Learning Objectives under Evaluation

	• Linear-log scale: linear scale on x-axis, log scale on y-axis • Log-log scale: log scale on x-axis, log scale on y-axis Data points are plotted correctly on any given graph Function discovery plots display original independent and dependent data (i.e., non-linearized data) whose relationship is being examined Each plot has x- and y-axis labels that reference the data in the plot and do not reference the type of scale used
13.05 Create plots with linear and/or log axis scales (Excel)	Plots of data using different axis scales to show relationships useful for function discovery • Linear scale: linear scale on x-axis, linear scale on y-axis • Log-linear scale: log scale on x-axis, linear scale on y-axis • Linear-log scale: linear scale on x-axis, log scale on y-axis • Log-log scale: log scale on x-axis, log scale on y-axis Function discovery plots display original independent and dependent data (i.e., non-linearized data) whose relationship is being examined Each plot has x- and y-axis labels that reference the data in the plot and do not reference the type of scale used Show the minor gridlines on log scaled axes Manage the horizontal axis crosses option so that the x-axis tick labels are at the bottom of the plot Manage the decimal places shown on the x and y axis tick marks
13.06 Create plots with linear and/or log axis scales (MATLAB)	Plots of data with different axis scales to show relationships useful for function discovery are generated using the correct syntax for plotting on different scales • Linear scale plot: plot command used for linear scale on x-axis, linear scale on y-axis • Log-linear scale plot: semilogx command used for log scale on x-axis, linear scale on y-axis • Linear-log scale plot: semilogy command used for linear scale on x-axis, log scale on y-axis • Log-log scale plot: loglog command used for log scale on x-axis, log scale on y-axis Function discovery plots display original independent and dependent data (i.e., non-linearized data) whose relationship is being examined Each plot has x- and y-axis labels that reference the data in the plot and do not reference the type of scale used

Problem Set 07: Function Discovery

New Learning Objectives under Evaluation

13.07 Linearize and plot data appropriately	Linearize the independent variable data correctly based on the diagnosed function type • Linear: no change to data • Logarithmic: log of independent data • Exponential: no change to independent data • Power: log of independent data Linearize the dependent variable data correctly based on the diagnosed function type • Linear: no change to data • Logarithmic: no change to dependent data • Exponential: log of dependent data • Power: log of dependent data Axes labels (description and units) are correct based on the plotted data
13.08 Linearize a power, exponential, and logarithmic functions	Take the log of both sides of the general form and arrange the terms in the linear form of the equation: Y = MX + B • Linear: y = mx + b - the linear and general forms are the same • Exponential: $y = b10^{mx}$ becomes log(y) = mx + log(b) • Power: $y = bx^{m}$ becomes log(y) = mlog(x) + log(b) • Logarithmic: $x = b10^{my}$ becomes y = (1/m)log(x) – (1/m)log(b)
13.09 Determine the linear and general forms of the equations for linear, power, exponential, and logarithmic functions	Identify slope (M) and intercept (B) coefficients for the best-fit linear model of the linearized data • Linear: use x and y data • Exponential: use x and log(y) transformed data • Power: use log(x) and log(y) transformed data • Logarithmic: use log(x) and y transformed data Place M and B correctly within the linear form of the equation Correctly determine the general form constant m from the linear form slope M • Linear: M = m • Exponential: M = m • Power: M = m • Logarithmic: M = 1/m Correctly determine the general form constant b from the linear form intercept B • Linear: B = b

Problem Set 07: Function Discovery

New Learning Objectives under Evaluation

	• Exponential: B = log(b) • Power: B = log(b) • Logarithmic: B = 1/m*log(b) Replace (m) correctly within the general form of the equation • Linear: y = mx +b • Exponential: $y = b10^{mx}$ • Power: $y = bx^{m}$ • Logarithmic: $x = b10^{my}$ Replace (b) correctly within the general form of the equation • Linear: y = mx +b • Exponential: $y = b10^{mx}$ • Power: $y = bx^{m}$ • Logarithmic: $x = b10^{my}$
13.11 Use the function to make predictions only when appropriate	Independent variable values within the range of the original data set (domain of the function model) can be used to make predictions Independent variable values outside the range of the original data set (domain of the function model) must be acknowledged or justified when making predictions Predicted numerical values must be consistent with the equation used to make the prediction Presentation of numerical predictions with appropriate units Management of the decimal places of numerical predictions