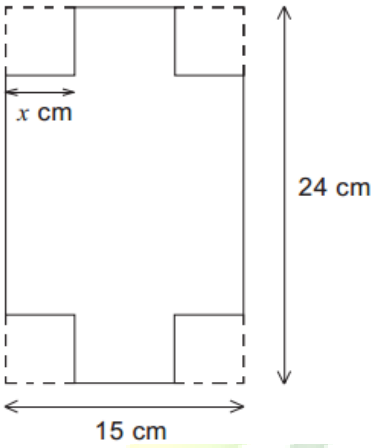
Practical Data Science
(Optimization)

Write R Scripts or use R to perform any mathematical operations while solving the following problems.

Problem 1: Design maximum volume open rectangular box

The diagram below shows a 24cm by 15cm sheet of cupboard from which a square of side x cm has been removed from each corner. The cardboard is then folded to form an open rectangular box of depth x cm and volume of v cm3. Find the value of x for which volume is maximum.



Problem 2: Find the least amount of fencing

A rectangular paddock is having an area of 50 m^2. One side of the rectangle is straight wall as shown below and the remaining three sides are to be made from wire fencing. What is the least amount of fencing required?

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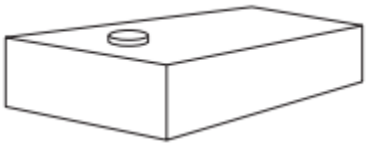
Problem 3: Design of optimal sized petrol tank

An emergency petrol tank is designed to carry 1 gallon of petrol(4546 cm^3). Its shape can be considered to be cuboid as shown below. The base of the cuboid is a rectangle with the length double the width. Find the dimensions of tank that minimizes the surface area required.



Problem 4: Univariate Polynomial Regression

In class we derived a gradient descent learning algorithm for univariate linear regression model where we assumed $y = b + mx + €$ and $€ \sim N(0, \sigma^2)$. In this question, you will do the same for the following model $y = w0 + w1\ x + w2\ x^2 + €$ where $€ \sim N(0, \sigma^2)$ where your learning algorithm will estimate the parameters w0, w1 and w2. Do the following changes to the batch stochastic gradient descent algorithm discussed in class :

a) Find the objective error function for polynomial regression learning. Modify the error function to reflect it.
b) Compute the gradients for the objective function and modify the stochastic_gradient function to reflect these gradients.
c) Modify the update rule for three parameters available inside stochastic_gradient_function.
d) Load the data from file regression1.tsv available in datasets branch of algorithmica github repository and plot the data to check whether data is more conducive for linear regression or polynomial regression learning.
e) Find the optimal learning parameters w0, w1 and w2 for the loaded dataset and also compute the corresponding error.
f) Compare the results of univariate linear & polynomial regression learning. What are your findings?
g) Repeat e and f for dataset regression2.tsv.