Solving Data Analysis Problems – A Guided Thought Process

Example - Data Imputation

- Readings from five sensors (X_1, X_2, X_3, X_4, X_5) are made available to you (for 100 different tests, check the file, *GTPvar.csv*). The readings are not arranged according to any order.
- There are some records, though, where there are a few missing readings that are marked *NA*.
- Your supervisor has asked you if there are any ideas that can be employed to rationally fill the missing values. Can you develop a data analytic approach to answer this question ?

Example - Data Imputation

- STEP 1: Problem Definition
  - Fill in missing data records
- STEP 2: Problem Characterization
  - Given part of the information, fill the missing information
  - Relate missing information with known information
  - Function approximation problem
  - $x_{unknown} = f(x_{known})$

Example - Data Imputation

- STEP 3: Solution Conceptualization
  - Need complete data set for identifying the function
    - Collect records without missing data
  - Assumption: All variables are independent of each other
    ⇒ no relation exists between the variables
  - For each variable, fill the missing data with the most likely value
- Step 3a: Verify assumption
  - Assumption not satisfied
- STEP 3: Solution Conceptualization
  - Assumption: Variables are inter-related
  - Step 3a: Assumption cannot be verified a priori

Example - Data Imputation

- STEP 4: Method Identification
  - Identify relationships using null space
  - Fill in missing values using the notion of pseudo-inverse
- STEP 5: Actualization
  - Implement in R programming language
- STEP 6 : Assess assumptions
  - Use it in intended application to check performance ?
- Solution realized (OR)
- STEP 3: .....
- STEP 4: …..
- STEP 5: ….
- STEP 6: ….

Data science for Engineers

Example - Data Imputation

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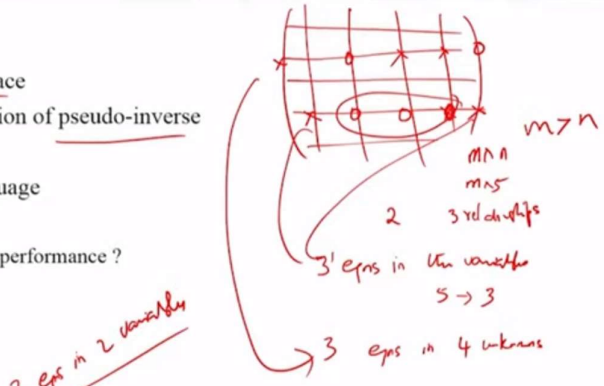

Conceptual Framework for Solving Data Analysis Problems

- START: Problem Arrival – Whole lot of words. Diffuse problem statement
- STEP 1: Problem Definition – Convert the loose words in to one problem statement (as precise as possible)
- STEP 2: Problem Characterization
  - Define high-level problems and sub-problems that need to be solved maintaining a high-level granularity
  - Develop a dependence diagram
  - Identify the problems and sub-problems as either function approximation or classification problems

Conceptual Framework for Solving Data Analysis Problems

- STEP 3: Solution Conceptualization – Visualization of the solution process through two conceptual devices
  - List assumptions (3a – Assumptions that can be verified a priori)
  - Flowchart
  - Pictures
- STEP 4: Method Identification – Map the elements of the flowchart and pictures into mathematical modules
  - Identify mathematical constructs/algorithms for the elements in the flowchart/picture
  - Identify lacunae – Data scientist to conceptualize method development
  - Develop the solution method map
- STEP 5: Actualization
  - Realize the solution method map in a software environment of choice
- STEP 6 : Assess assumptions and go through steps 3 to 6 if necessary

Conceptual Framework for Solving Data Analysis Problems