WATER DEMAND DATA ANALYSIS AUTOMATION: REQUIREMENTS AND SPECIFICATIONS

DEPARTMENT OF EARTH SCIENCE

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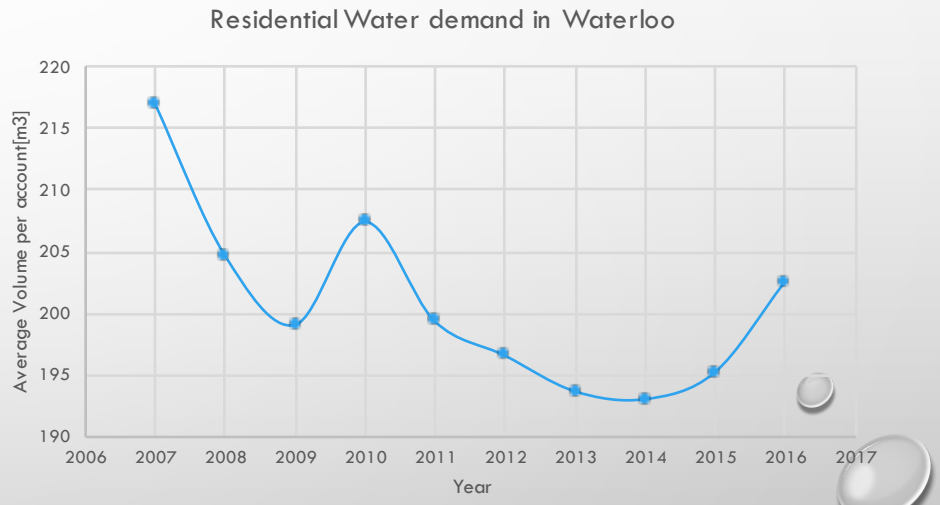
FOR CS 645

WATER DEMAND DATA ANALYSIS: BACKGROUND

- CITY OF WATERLOO FACING DECLINE OF TAP WATER SALES
- LOSS OF REVENUES
- ABLE TO FORECAST WATER DEMAND

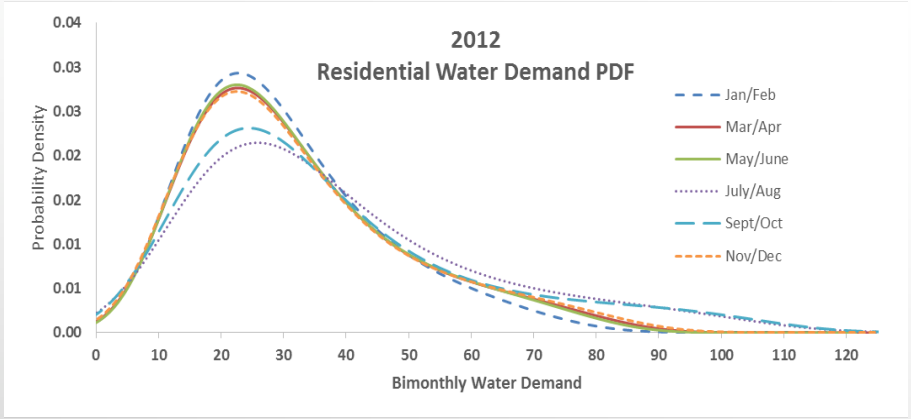


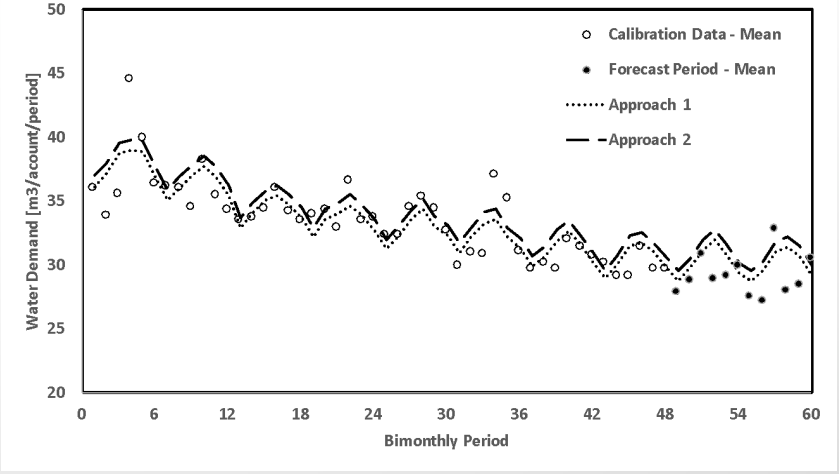
R.Enouy(2016)

METHOD

- FIT A SHIFTED, ASYMMETRIC HISTOGRAM WITH CONTINUOUS PROBABILITY DENSITY FUNCTION
  - GENERATE PDF PARAMETERS
- REGRESSION ANALYSIS
  - QUANTIFY RELATIONSHIPS BETWEEN PDF PARAMETERS, PRICE AND TEMPERATURE

METHOD

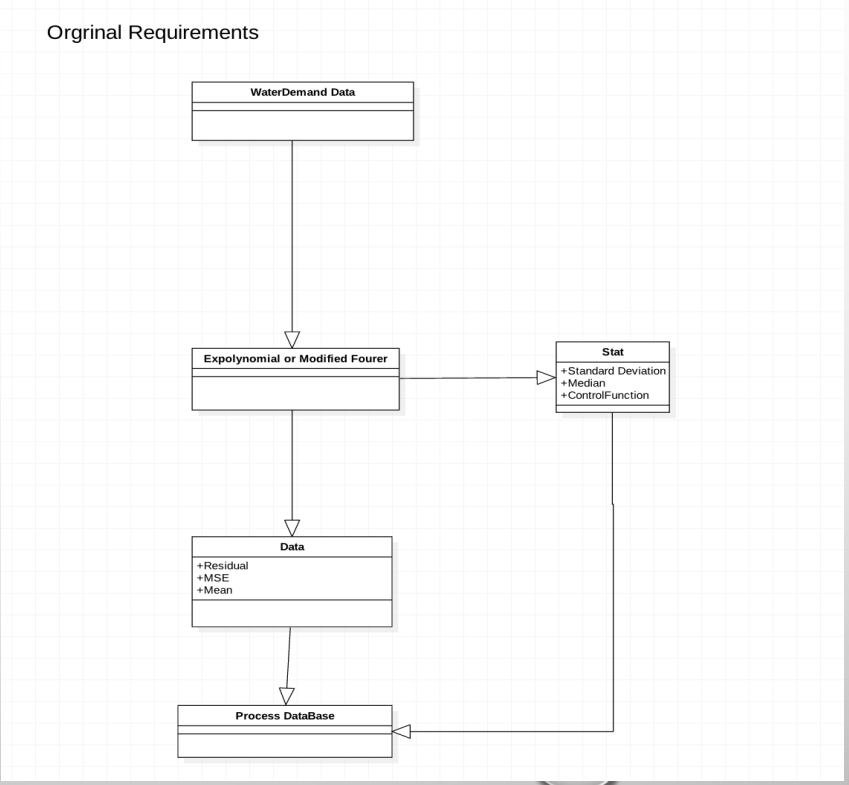




R.Enouy(2016)

CLIENT REQUIREMENTS

- Algorithm presented in paper
- Implemented in Excel sheet

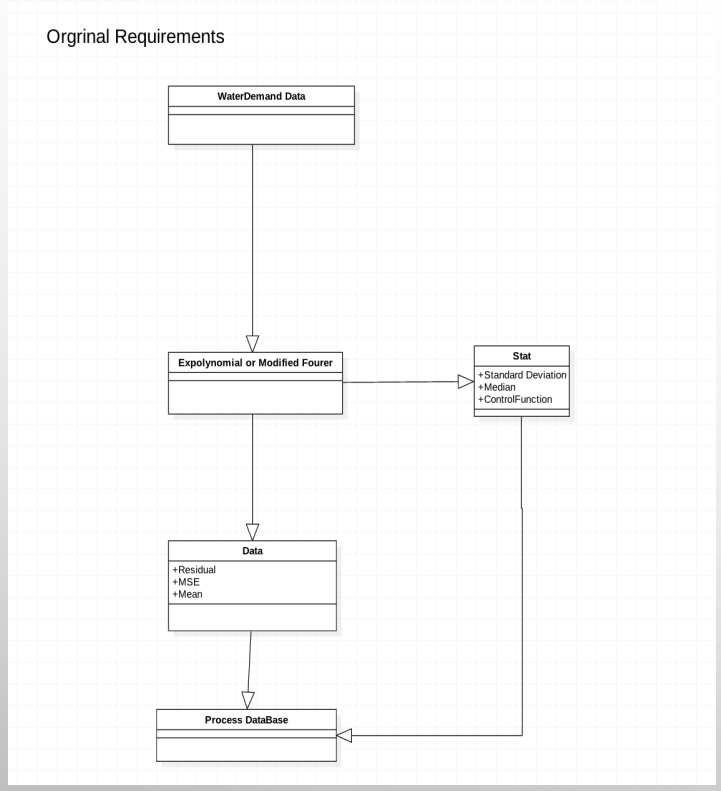


REQUIREMENTS AND SPECIFICATIONS

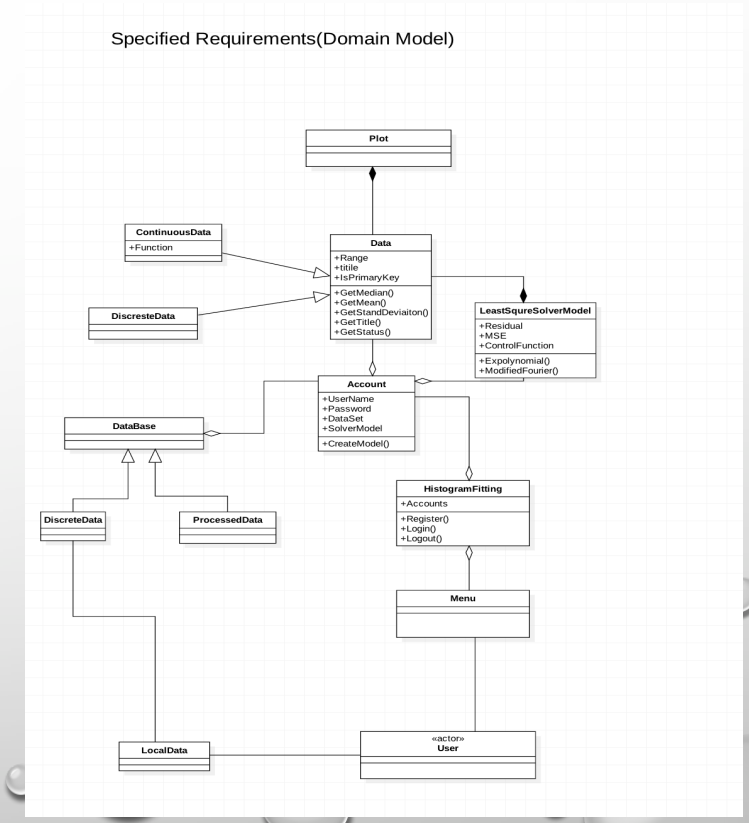
- DOMAIN MODEL
- USE CASE
- DATABASE DESIGN
- FUNCTION SPECIFICATIONS

DOMAIN MODEL

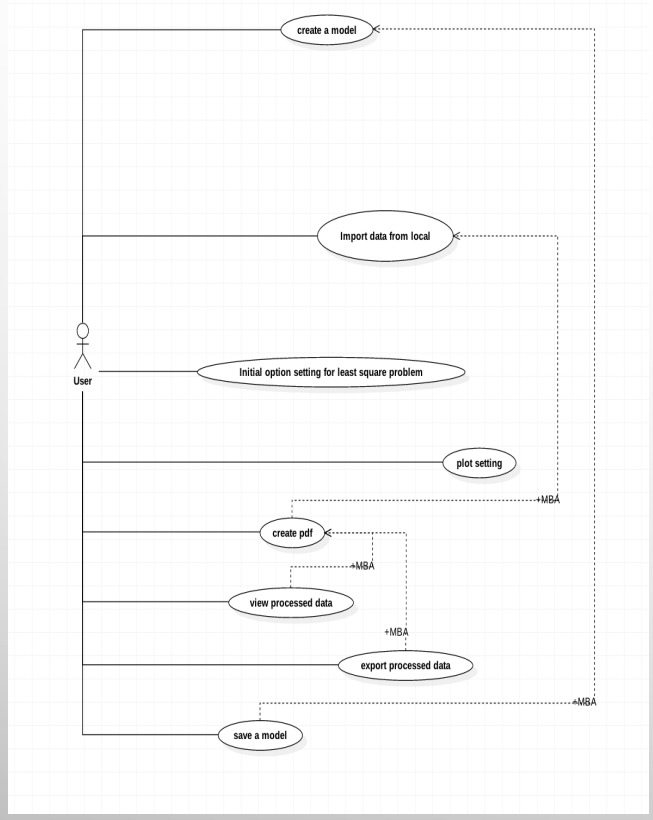
Orgrinal Requirements

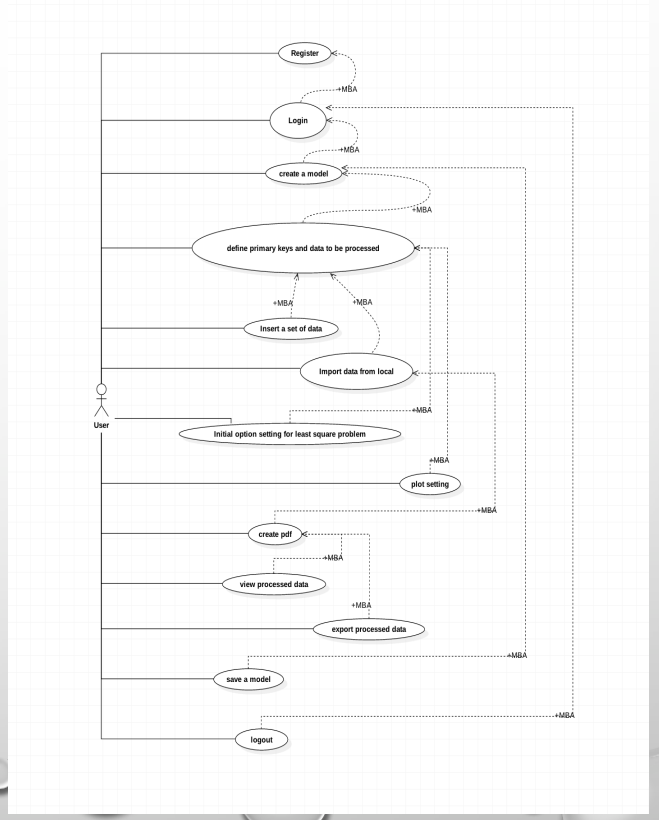


Specified Requirements(Domain Model)

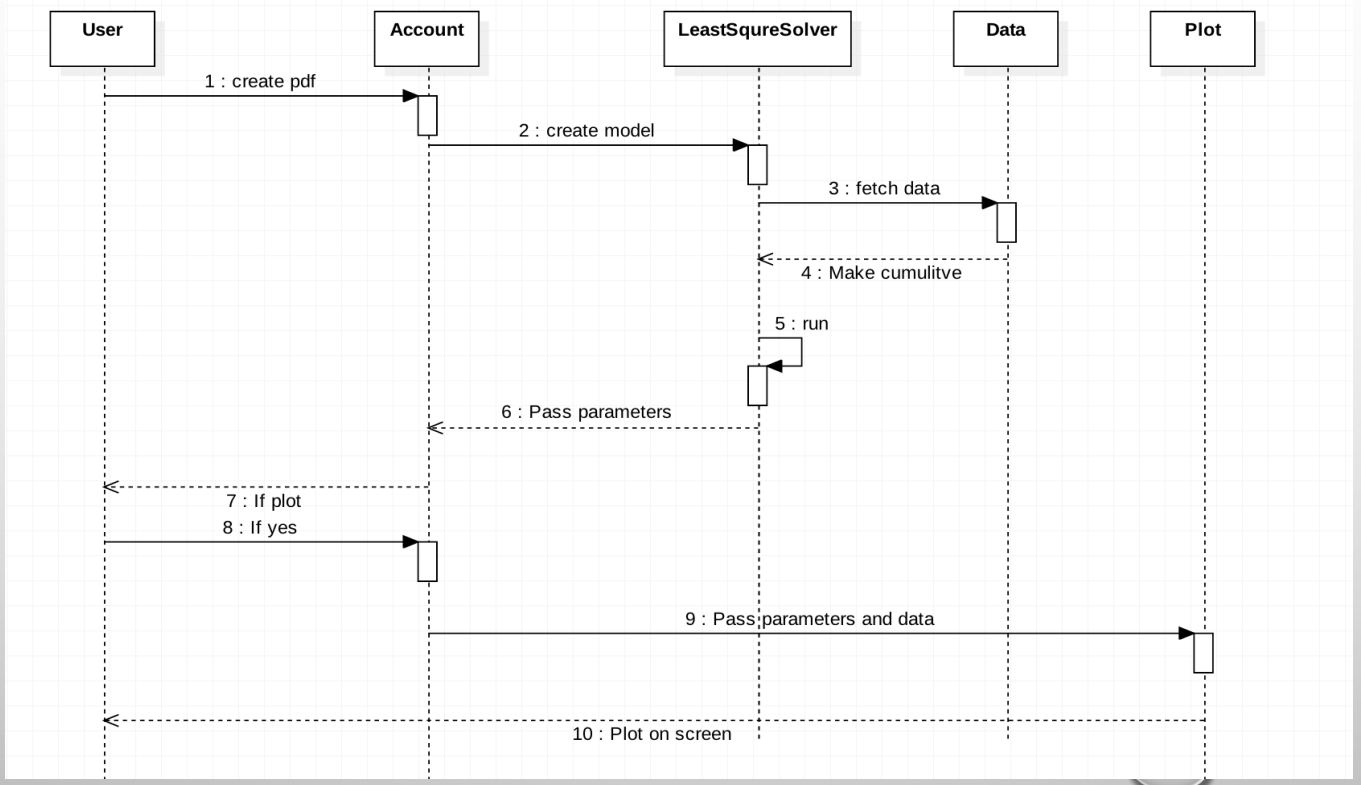


USE CASES


create a model
Import data from local
User
Initial option setting for least square problem
plot setting
+MBA
create pdf
+MBA
view processed data
+MBA
export processed data
+MBA
save a model


Register
+MBA
Login
+MBA
create a model
+MBA
define primary keys and data to be processed
+MBA
+MBA
Insert a set of data
Import data from local
+MBA
User
Initial option setting for least square problem
+MBA
plot setting
+MBA
create pdf
+MBA
view processed data
+MBA
export processed data
+MBA
save a model
+MBA
logout

FUNCTIONS SPECIFICATIONS: CREATE PDF



START FROM MATLAB

- ADVANTAGES
    1. BUILT-IN FUNCTIONS (PLOTTING, LEAST SQUARE SOLVERS)
    2. FAST WAY TO DELIVER RUNNABLE VERSIONS
- DISADVANTAGES
    1. LOW EFFICIENCY
    2. TRANSFER TO ANOTHER LANGUAGE IF EFFICIENCY FAILED TO MEET THE REQUIRED LEVEL

RESULTS BY MATLAB

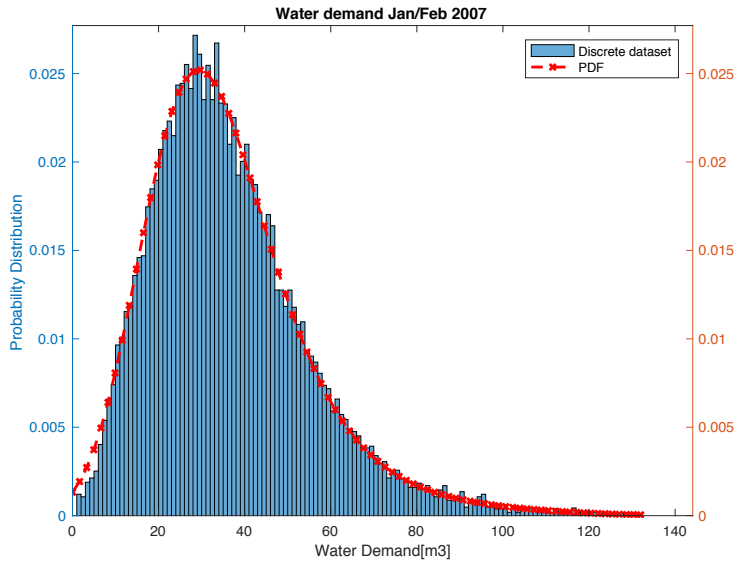
```
                                         Norm of      First-order
 Iteration  Func-count     f(x)          step          optimality
     0          6         22.7491                        38.5
     1         12         1.46905         5.6481         12.7
     2         18       0.0246356         2.47207         0.9
     3         24     0.000396985        0.615079        0.0683
     4         30     0.000134524        0.253638         0.015
     5         36     0.000101864        0.230588       0.00295
     6         42     0.000100205       0.0684746      0.000156
     7         48      0.0001002       0.00341715      2.89e-07

Local minimum found.

Optimization completed because the size of the gradient is less than
the selected value of the optimality tolerance.

<stopping criteria details>


Using polynomial series Extension by trust-region-reflective
PDF: y = (exp(-(0.797192 + 0.290841x + 1/2*tan(53.124658/180*pi)x^2 + -0.192689x^3+ 0.018420x^4)))/18.421904
MSE_ob: 0.000006
MSE_m: 0.000241
```



UNCERTAINTIES DEALING WITH NUMERICAL PROBLEMS

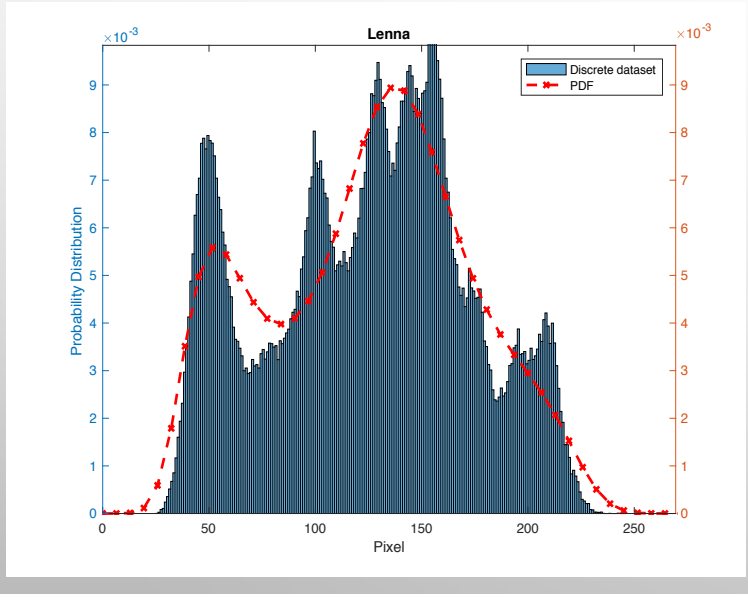
- CLIENT CAN MAKE MISTAKES
- CLIENT NOT SURE WHAT THE CORRECT RESULTS SHOULD BE LIKE
- VAGUE REQUESTS ON EFFICIENCY
- HARD TO TEST

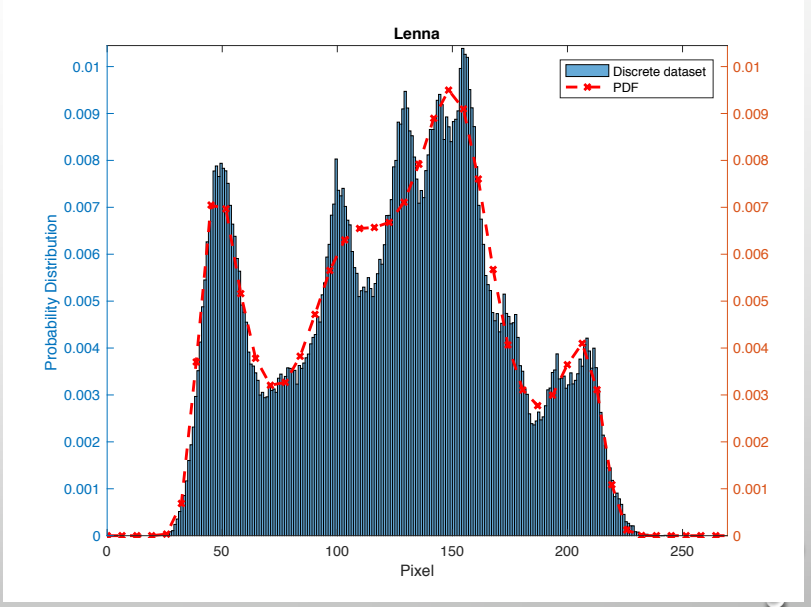
ERRORS MADE BY CLIENT

- DOCUMENT ERRORS
- IMPLEMENTATION ERRORS
- NEED MATHEMATICAL BACKGROUND TO NOTICE THOSE ERRORS
- HARD TO FIND IF IT DOESN'T AFFECT THE RESULTS OF ONE PARTICULAR CASE

UNCERTAINTY IN NUMERICAL FUNCTIONS

Which is correct?





UNCERTAINTY IN NUMERICAL FUNCTIONS

- NOT FAMILIAR WITH THE BEHAVIOR OF LEAST SQUARE SOLVER
- WRONG PATH COULD LEAD TO BETTER RESULTS
- USE MORE TEST CASES

TEST

- HARD TO GUARANTEE THE CORRECTNESS OF TEST CASES
- CLIENT AND I BOTH WRITE TEST CASES, COMPARE WITH EACH OTHER
- FREQUENT WALKTHROUGHS

POSSIBLE SOLUTIONS

- FREQUENT MEETINGS AND WALKTHROUGHS
- ABLE TO IDENTIFY CLIENT'S MISTAKES
- SPECIFY ON CONVERGENCE CRITERIA

CASE STUDIES: NUMERICAL AND SOFTWARE REQUIREMENTS FOR GENERAL NONLINEAR FINITE ELEMENT ANALYSIS

- MAN-MACHINE COMMUNICATION
- STRUCTURAL MODELING
- ANALYSIS RESTART
- ERROR RECOVERY
- COMPUTER RESOURCE UTILIZATION

Dodds Jr, R. H., Lopez, L. A., & Pecknold, D. A. (1978). *Numerical and software requirements for general nonlinear finite element analysis*. University of Illinois Engineering Experiment Station. College of Engineering. University of Illinois at Urbana-Champaign.

CONCLUSIONS

- FOCUSING ON GENERATING RESULTS FIRST
- IMPORTANCE OF WALKTHROUGH
- IDENTIFY CLIENT'S MISTAKES
- ALWAYS THINK ABOUT A LARGER SCOPE