Learn-Design-Implement (LDI) Project Structure and Suggestions

Contents

ELEN90097 LDI project aims to achieve the objectives and ILOs listed in the manual. We need to balance these against your “individualised learning.” Therefore, we impose a specific structure to ELEN90097 LDI projects while giving you as much freedom as possible. We will provide you an “example” project along with many resources and options so that you make most of ELEN90097 LDI project in your own way.

Project Structure Requirements

Each project should have the following structure and satisfy the requirements listed below.

LDI Project Part I – System Modelling, Simulation, and Identification

1. Choose a system model described in terms of ODEs (or PDEs).
2. Solve the system ODEs directly using Python solvers and cross-check your results with other software (simulators, MATLAB, etc).
3. Store the data obtained from the model in a database.
4. Assume that you don’t know one or more system parameters. Use the data you have stored (add noise to make it interesting) and system identification methods like least squares to estimate parameters. Cross-check your results against actual values. Investigate the effect of noise or missing data.

LDI Project Part II – Databases, statistical analysis, and use of logic

1. Download a dataset (ideally relevant to the system in Part I or follow suggestions).
2. Store the data in a (SQL) database using multiple tables.
3. Query the database to obtain subsets of the data using logic.
4. Analyse the data using classical statistical methods.

Project Options

For Part I

There is a rich variety of choices when it comes to system models based on your background, course, and interests:

- Electrical, electronic systems
- Electro-mechanical, mechanical systems
- Industrial, manufacturing, and civil engineering systems
- Chemical or biomedical systems
- Hybrid or event-based versions of any of those above.

For Part II

There are multiple enrichment options:

- Exploration of rule engines and rule-based expert systems in an engineering context and their connections to logic.
- Exploration of logic programming.
- PLC system programming and checking using logic.

Self-proposed Projects

Self-proposed projects are allowed only if they are explicitly approved by the lecturer (not the demonstrator). As you can expect, the lecturer will try to make sure that your creative project somehow incorporates the aspects listed in the requirements because the idea is for you to get hands-on experience with those. Please keep this in mind when proposing projects.

PhD Students

Formally enrolled PhD students can (maybe should) align the LDI project with their research topics as much as possible. All PhD students must talk to the lecturer about the LDI project before starting.

Links to Potential Resources

- These are only some of the resources I could find. You may find others that are even better!
- Please let me know (a) if a link does not work anymore and (b) if you find other good resources so that we can update this part.

For Part I

- Pole-cart, quadrotor
  https://colab.research.google.com/github/lvjonok/mujoco-sysid/blob/master/examples/mujoco_sysid_demo.ipynb

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- Mainly chemical/bio stuff (maybe not relevant but as info)
  https://webpages.ciencias.ulisboa.pt/~aeferreira/stimator/
- A few interesting systems (but not engineering-focused) here
  https://allendowney.github.io/ModSimPy/
- Interesting system models at
  https://python-control.readthedocs.io/en/0.10.0/examples.html#jupyter-notebooks
- This could be a good resource
  https://github.com/murrayrm/fbs2e-python
- ODEs
  https://math.libretexts.org/Bookshelves/Calculus/Calculus_(OpenStax)/08%3A_Introduction_to_Differential_Equations/8.05%3A_First-order_Linear_Equations
- This could be interesting, e.g. design of an analogue filter in MATLAB and then converting the transfer function to state space
  https://au.mathworks.com/help/signal/ug/iir-filter-design.html
  https://au.mathworks.com/help/signal/ref/tf2ss.html

For Part II

There are many options for datasets, for example

- Robot health data
  https://catalog.data.gov/dataset/degradation-measurement-of-robot-arm-position-accuracy-be76e
- Radiofrequency
  https://catalog.data.gov/dataset/radio-frequency-measurements-for-selected-manufacturing-and-industrial-environments-0efb0
- Tons of signal-processing sets
  https://www.kaggle.com/datasets?tags=13203-Signal+Processing

Data Analysis Resources

- Chapters 3 and 4 of this one
  https://jakevdp.github.io/PythonDataScienceHandbook/
- This is a good book, too
  https://greenteapress.com/thinkstats2/html/thinkstats2008.html
- This is one of the best resources on this topic
  https://openintro-ims.netlify.app/exploratory-data-analysis