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PROFESSIONAL DEVELOPMENT / PROJECTS

These projects have been grouped together as per their category (**for brevity, restricted to 6-7 projects described briefly for each category**) and might not be necessarily following the overall chronological order.

A) AI-DRIVEN (MACHINE LEARNING / DATA SCIENCE) PROJECTS

Technologies: For the following data science related projects, the technologies used are Python, Scikit-learn, SciPy, NumPy, Pandas, Jupyter notebook, Matplotlib, Spacy, Tensorflow, Keras, MS-Excel, NLTK, Java, R-Programming, MYSQL, PyCharm IDE and other NLP tools.

1. Clustering public health laboratory test result data

(BC Centre for Disease Control (UBC), Canada)

Mar' 19 – Oct'19

- The developed tool performs K-means clustering of BCCDC Public Health Laboratory test result codes on selected entities, such as pathogens, test types, and disease names.
- The tool is helping **BCCDC Public Health Laboratory** in clustering the inconsistent, non-standard local codes to map and report out using standard terminologies (UMLS, SNOMED CT, LOINC) enabling the smooth transition of laboratory data towards standardization and interoperability.

2. A hybrid system for ontology-driven classification of biosamples

(BC Centre for Disease Control (UBC), Canada)

Jan' 19 – Oct'19

- This system performs an ontology-driven classification of biosamples customizable to different third party classification schemas using hybrid rule-based and learning algorithms trained on GenomeTrakr corpus using different classes provided by the given Extended Interagency Food Safety Analytics Collaboration (IFSAC+) classification schema.
- The classification by our tool is being currently incorporated by US FDA's GenomeTrakr in NCBI samples. In these NCBI samples (e.g. in sample - <https://www.ncbi.nlm.nih.gov/biosample/12609651>), the last two fields IFSAC+ classification and FoodOn ontology term in attributes section have been provided by our tool. The manuscript for this classification project is under consideration in **Plos Computational Biology journal**.

3. Clustering of food products using food-indexing features

(BC Centre for Disease Control (UBC), Canada)

Apr' 18 – Oct'18

- This project performed a k-means clustering of LanguaL-indexed US FDA's SIREN database on selected features such as food sources and processes.
- The tool has helped Hsiao Laboratory's FoodOn ontology development project (<http://foodon.org>), which is a consortium-driven project to build a comprehensive food ontology, to **cluster and structure more than 9300 food products from SIREN database**. The inaugural paper on FoodON has been published in prestigious nature publishing journal Science of Food (<https://www.nature.com/articles/s41538-018-0032-6>).

4. Harvesting food collocations using statistical and learning approaches

(BC Centre for Disease Control (UBC), Canada)

Jun' 18 – Nov'19

- Food collocations, such as “extra virgin” in “extra virgin olive oil”, comprising of bigrams (digrams) have been collected using corpora from EnteroBase, GenomeTrakr, USDA Food Data Central, Nutrient Database. Python based software implements methods ranging from raw frequency count to the sophisticated statistical association measures to learning methods for collocation identification and extraction.
- A large **dictionary resource of food collocations** has been harvested that is being used in multiple tasks related to further fine tune the data-driven analysis and analytics in food domain.

5. Prediction of prospective buyers from player data

(North Side Inc., Montreal, Canada)

Apr' 14 – Nov' 14

- The objective of the project has been to do the predictive analytic using logistic regression approach to identify the prospective buyers of Bot Colony game of North Side Inc. using the selected set of features in the large data collected from the free trial version used by players.

- The tool helped NorthSide Inc. to make a huge list of prospective buyers of the game using it further to aggressively market the game to highly probable buyers and it resulted in a huge financial benefit for the company.

6. **Word collocation finder from a large text corpora using statistical approaches**

(North Side Inc., Montreal, Canada)

Apr' 14 – Jul' 14,

- In this project, a Java based software implemented methods ranging from raw frequency count to the sophisticated statistical association measures for collocation identification and extraction from a large corpora of natural language text.
- This project helped North Side Inc. to enrich the proprietary oxford collocation dictionary with missing entries and it has been extensively used in multiple modules as part of the natural language understanding pipeline implemented in Bot Colony game.

7. **Classification of Noxiousness Levels of Pest Plants using multiple classifiers**

(University of Georgia, USA)

Aug' 10 – Oct' 10

- The objective of the project has been to do a high level of prediction for three classes of pest plants - weeds, state noxious, and federally noxious on the basis of traits data. We applied different machine learning classifiers using Weka Machine Learning software - Artificial Neural Network (ANN), A Multilayer Perceptron, A Bayes classifier, Support vector machines (SVMs), Decision tree learning. The optimal result obtained in each classification setting with Neural Network approach- Multilayer Perceptron.
- The tool helped researchers in the field of Ecology department at researches in the field of Ecology to find meaningful relations between traits of plant species and their noxiousness levels proving to be an effective step toward identifying potential invasive plant species

B) NLP RELATED PROJECTS

Most of these NLP projects have been used in the language component in NLP pipeline used for breakthrough natural language understanding technology in **Bot Colony** video game - the first application where a person can speak freely with a machine. In the projects, **technologies** used were Jena, Java, Python, NLTK, OpenNLP, SPARQL, IBM Rational Modeler as UML modeling tool, Eclipse IDE, PyCharm IDE, XML/HTML Parser/Processor, CSV Parser, other NLP tools.

8. **LexMapr: A Rule-Based Tool for Translating Short Biomedical Specimens into Ontology Terms**

(BC Centre for Disease Control (UBC), Canada)

Aug' 17 – till date

- A hybrid text mining tool LexMapr (github.com/Public-Health-Bioinformatics/LexMapr) that parses the short free-text sample metadata and maps the identified entities to terms from selected domain ontologies.
- I am the team leader of the LexMapr project and I represented Hsiao Laboratory to conduct a successful workshop at ICBO 2018 (<http://icbo2018.cgrb.oregonstate.edu/W04>) to demonstrate and test the LexMapr tool amongst the biomedical community and also presented it at ISMB/ECCB conference 2019 (https://www.iscb.org/cms_addon/conferences/ismbecb2019). LexMapr, since its inception, has progressed into a very useful tool in which many research institutions and organizations have shown keen interest in collaborating further.

9. **PP disambiguation using BNC nouns, verbs and adjectives**

(North Side Inc., Montreal, Canada)

Apr' 13 – Aug' 14

- The project used an approach of applying locally built constraints language which is generalized for different senses of a specific preposition to the sentences accumulated from British National Corpus (BNC) for the preposition under consideration. This project helped North Side Inc. to enrich the PP disambiguation module as part of the natural language understanding pipeline implemented in Bot Colony game.

10. **Domain model for nouns using WordFinder**

(North Side Inc., Montreal, Canada)

Apr' 13 – Aug' 13

- This NLP-based project modeled domains for nouns based on processing categories from WordFinder. These domains are organized in the hierarchy of 5 levels. This project helped North Side Inc. to use this domain model in many modules of the NLU pipeline implemented in Bot Colony game.

11. **Domain classification system for nouns**

(North Side Inc., Montreal, Canada)

Aug' 13 – Nov' 13

- This project of assigning domains to nouns of oxford dictionary was based on classifying nouns into domains

from WordFinder based domain model developed earlier. I developed a GUI based tool for assigning domains in batches to nouns of oxford dictionary. This tool was used by linguists for assigning domains in batches using SQL queries in constrained environment and then getting it checked manually. This domain assignment helped North Side Inc. to enrich the sense disambiguation module in NLU pipeline implemented in Bot Colony game.

12. NLP based ontology-driven quality model for nouns

(North Side Inc., Montreal, Canada)

Nov'12– Mar' 13

- This project focused on inheriting the qualities (of types Quantitative, Ordered, Narrative and Enumerated) based on manually built quality-qualities model for top genera of taxonomy of nouns into the noun taxonomy of all nouns in Oxford dictionary. The quality values of nouns have been used in different enabling modules of the natural language understanding pipeline implemented in Bot Colony game.

13. Sense disambiguation based on Roget's categories

(North Side Inc., Montreal, Canada)

Aug'12 – Nov' 12

- This novel sense disambiguation NLP project based on Roget's categories primarily built on heuristic that if the Roget's category name is present in the definitions of one/more polysemous senses of the concept under consideration then those sense/senses are chosen as the disambiguated sense/senses of that concept. This project greatly helped North Side Inc. to enrich the sense disambiguation module as part of the natural language understanding pipeline implemented in Bot Colony game.

C) ONTOLOGY RELATED PROJECTS

For the ontology related projects, the **technologies** used were Protégé, OntoFox, OWL, RDF, Jena, Java, Python, SPARQL, IBM Rational Modeler as UML modeling tool, Eclipse IDE, PyCharm IDE, XML/HTML Parser/Processor, CSV Parser, NLP tools.

14. FoodOn: a harmonized food ontology to increase global food traceability, quality control and data integration,

(BC Centre for Disease Control (UBC), Canada)

Apr' 17 – To date

- FoodOn (<http://foodon.org>) is a consortium-driven project to build a comprehensive and easily accessible global farm-to-fork ontology about food, that accurately and consistently describes foods commonly known in cultures from around the world. Much of FoodOn's vocabulary comes from transforming LanguaL, a mature and popular food indexing thesaurus, into a World Wide Web Consortium (W3C) OWL Web Ontology Language-formatted vocabulary that provides system interoperability, quality control, and software-driven intelligence. Apart from curation I clustered and organized more than 9300 food products from SIREN database.
- FoodOn define the complexity of food, diet, biochemical interactions and phenotypic health, provide the necessary instrument for linking and sharing the food roles for a wide range of analyses.

15. Genomic Epidemiology Ontology (GenEpiO)

(BC Centre for Disease Control (UBC), Canada)

Apr' 17 – To date

- The Genomic Epidemiology Ontology (<https://genepio.org/>) has been developed as a comprehensive controlled vocabulary for infectious disease surveillance and outbreak investigations.

16. Ontology Based Semantic Annotation System (OBSAS) for Protein Kinases in Cancer -PhD Thesis

(University of Georgia, USA and PU, India)

Dec' 14 – Mar' 18

- OBSAS extracts the important protein kinase and cancer information from the biomedical text and further semantically annotates them with classification, disease, and functional information using ontological knowledge. The linkages to the external sources of knowledge provided by the system for these semantic annotations further facilitate the extensive literature-navigation.

17. Semantic Feature Ontology of Nouns

(North Side Inc., Montreal, Montreal, Canada)

Apr' 11 – Mar' 17

- The project was an extensive work of building ontology of nouns using inheritance of semantic features through genera of nouns extracted from definitions of nouns in Oxford Advanced Learners Dictionary. The nouns were associated with their genera using relationships of aggregative and partitive types extracted from definitions. More than 140 categories of Semantic Feature Ontology were assigned to the entire set of nouns

using inheritance program while special cases, such as, *something, someone, pronouns etc.* treated with a special handling.

- This project helped North Side Inc. to enrich the sense disambiguation module and built a **twenty-twenty question game** component implemented in Bot Colony game.

18. ProKinO Ontology Browsing and Visualization Tool,

(University of Georgia, Athens, GA, USA)

Jul' 10 – Nov' 11

- For ProKinO, a standard web browsing tool has been also made available for protein kinase community (<http://vulcan.cs.uga.edu/prokino/>).
- Overall ProKinO project helped Kannan lab got a grant worth \$720,000 by American Cancer Society for a research project of which ProKinO was one of the key objectives.

19. Protein Kinase Ontology (ProKinO),

(University of Georgia, Athens, GA, USA)

Jun' 09 – Nov' 11

- Analyzed, designed, developed, tested, implemented and evaluated a very large and comprehensive ontology, ProKinO that serves as a useful and efficient representation of the integrated knowledge about the complex proteins, called protein kinases, which are intimately involved in the genesis and behavior of cancer cells (<http://vulcan.cs.uga.edu/prokino/about/prokino>). I led the team involved in the development of this large scale ontology, ProKinO and I was involved in all phases of ProKinO development process.
- Once the ProKinO ontology was developed, I performed several integrative analyses of ProKinO data and used ontology-based data analysis to demonstrate the generation of testable hypotheses regarding cancer mutations. The significant work for ProKinO has resulted in two publications describing integrative analysis work and ontology development framework respectively.
- With the establishment of ProKinO ontology as a rich biological knowledge resource, Kannan group collaborated with many individuals and research groups belonging to the University of Maryland, GenenTech, Monash University, Mount Sinai hospital and other departments at the University of Georgia. Since its inception, many graduate students, including a PhD student, have worked on multiple projects directly related to ProKinO or associated ontology-driven projects.