

MSc. in Computing Practicum Approval Form

Section 1: Student Details

Project Title:	Exploration of Olfaction Processing using novel deep learning techniques, in-silico models, and/or statistical analytics.
Student ID:	10377593
Student name:	Denis Kealy
Student email	denis.kealy2@mail.dcu.ie
Chosen major:	Data Analytics
Supervisor	TBD
Date of Submission	TBD

Section 2: About your Practicum

Please answer all questions below. Please pay special attention to the word counts in all cases.

What is the topic of your proposed practicum? (100 words)

The topic of human olfactory processing is too large to study in its entirety for a masters practicum. I propose to either study a particular interaction within the processing chain of olfaction or, by some other means, restricting the scope of the research to an appropriate level for this type of degree.

Possible Topics:

- Clustering of Olfactory Receptor gene expression levels using ORMD
http://www.computing.dcu.ie/~mcrane/GKerrGeneCluster_CompBiolMed.pdf
<https://www.ncbi.nlm.nih.gov/pubmed/11752336?dopt=Abstract>
<https://senselab.med.yale.edu/ORDB/>
- Combining Molecule Structure, Protein Binding, Ligand binding, Neural Activity Space (many levels) & Percept of smell to learn new classifications and associations using deep learning - A Thin slice, in-silico model of human (or other) olfactory processing <https://www.igi-global.com/chapter/brain-like-processing-classification-chemical/56232>
<http://www.sciencedirect.com/science/article/pii/S096098221631288X>
- Using (XAI) Explainable AI to replicate previous successful structure-percept experiments to learn how a deep learning program classifies odorant molecules

<https://www.darpa.mil/program/explainable-artificial-intelligence> <http://science.sciencemag.org.dcu.idm.oclc.org/content/355/6327/820.full>

- Determining the functional consequences of external plexiform layer (EPL) interneuron-mediated inhibition upon olfactory processing
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3584718/>
- Analysis of Electronic Nose readings combined with matching recorded scent precepts (original idea)
- A study, and attempted reduction, of the dimensions of odor space
<https://elifesciences.org/articles/07865>
- Combining new imaging technology with existing analysis techniques
<http://onlinelibrary.wiley.com/doi/10.1002/cne.24088/full>
<https://www.osapublishing.org/abstract.cfm?uri=BRAIN-2017-BrM3B.5>
<https://link.springer.com/article/10.1007/s00429-016-1235-8>

Please provide details of the papers you have read on this topic (details of 5 papers expected).

1. 2007: Integrated olfactory receptor and microarray gene expression databases -
<https://bmcbioinformatics.biomedcentral.com/articles/10.1186/1471-2105-8-231> -
2. 2010: New Perspectives on Olfactory Processing and Human Smell -
<https://www.ncbi.nlm.nih.gov/books/NBK55977/>
3. 2016: ORDB, HORDE, ODORactor and other on-line knowledge resources of olfactory receptor-odorant interactions - <https://www.ncbi.nlm.nih.gov/pubmed/27694208>
4. 2007: Predicting olfactory receptor neuron responses from odorant structure -
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1994056>
5. 2016: Explainable Artificial Intelligence (XAI) DARPA-BAA-16-53 -
<https://www.darpa.mil/attachments/DARPA-BAA-16-53.pdf>
6. Predicting human olfactory perception from chemical features of odor molecules -
<http://science.sciencemag.org.dcu.idm.oclc.org/content/355/6327/820.full>

How does your proposal relate to existing work on this topic described in these papers? (200 words)

Papers 1 & 3 talk about OR (Olfactory Receptor) Databases and how to connect to these public repositories and how to read the data. This data could contain insights on the olfactory processing problem which could be investigated using modern data analytic techniques to identify relationships or patterns that scientist can then use to further advance the theory of

Olfaction. Paper 2 is a detailed overview of human olfactory processing which I used as a reference point when researching the entire topic. Paper 4 is a revolutionary paper in field of olfaction research which used machine learning techniques to correctly predict the human cognitive precept of an odor stimulant. This paper spawned multiple experiments in this area – such as Paper 6 as recently as February of this year. Paper 5 is a new paradigm that has been suggested for deep learning machines by which they explain the rules that they have developed to the human user. Techniques such as this could be used to help formulate or pinpoint viable theories of Olfaction.

What are the research questions that you will attempt to answer? (200 words)

Addressed in topics above. More detailed proposal will be written up once I speak with potential supervisors.

How will you explore these questions? (Please address the following points. Note that three or four sentences on each will suffice.)

- What software and programming environment will you use?

Depends upon topic chosen. Possibilities include databases listed above, SIGNA, Café, TensorFlow, Omnivore, Biological systems modelling frameworks...

- What coding/development will you do?

Possibly: implementing a deep learning program, implement an in-silico model of human/mouse/insect olfaction, develop an ambient e-nose application and integrate with accessory hardware.

- What data will be used for your investigations?

Existing Experimental Results, w/ Possibility of creating our own data

- Is this data currently available, if not, where will it come from?

- What experiments do you expect to run?

- What output do you expect to gather?

- How will the results be evaluated?