

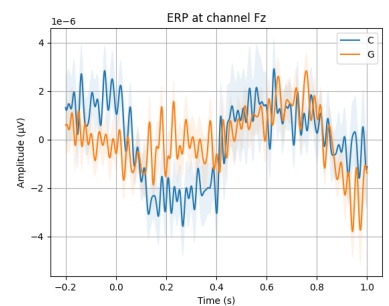
Dagnosis Quests

At [Dagnosis](#), we are working with dogs + AI to develop breath-based cancer screening tests. Our product is simple: people breathe into a mask for 10m, ship it to our lab, and our K9AI system provides a risk assessment based on volatile organic compounds (VOCs).

Tech Roadmap

DogOS

We are looking to do what no one has done before — quantitatively decipher the dog's sense of smell in real time. To do this, we will use data from non-invasive brain computer interfaces, wearable sensors, and video cameras to create a [4EML](#) 'DogOS' model of canine olfaction. DogOS serves as an interpretative core, enabling real time monitoring and decision making based on a dog's interactions with SniffSpace.



SniffSpace

We are building an “olfactory console” for biomedical detection dogs modded with an automated breath sample management system. It will integrate sensors, IOs, and automations to facilitate efficient and accurate movement and analysis of breath samples for disease screening. The aim of SniffSpace is to significantly enhance the throughput and reliability of canine assisted biomedical diagnostics, streamlining the process from sample presentation to data collection and analysis. More [details](#).



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Guidelines

Before diving into the challenges, here's a brief prompt for your response, if you choose to accept it:

Choose any one quest that resonates with you the most, though you're welcome to tackle more if you're compelled. Your response can take the form of a concise 1-2 page document, including a proposed framework, schematics, code snippets, or any other format that best conveys your ideas. Remember, **there are no fixed answers or strict requirements**; we encourage creativity and personal insight. While your submission can extend beyond two pages or its equivalent in schematics/code, it's not a necessity. Feel free to only devote a few hours on this, or longer.

4 Q Google Form - Quest Log - <https://forms.gle/UM5yBHbeJsBWmJ8AA>

Building an Olfactory Console for Dogs

Class : Mechatronic

Skill-set : Expertise in CAD, robotics, sensor integration, microcontroller programming, automation technologies

Quests :

Precision Pawds for Breath Samples

Develop an automated mechanism for the precise opening and closing of sample containers. These containers, which store masks imbued with Volatile Organic Compounds (VOCs) from cancer and control samples, must be seamlessly integrated into the SniffSpace rack. The system should ensure that the lids are automatically open once the dog approaches the container and doing that while minimizing the opening time to maintain the integrity of the samples throughout the process. In your solution, think about scalability and cost effectiveness.

Breath Sample Management System

Develop an automated mechanism for the precise opening and closing of sample containers, integrated into the SniffSpace rack. This system should ensure seamless transfer of VOC-imbued breath samples from the freezer to the correct SniffSpace battery with minimal human intervention, maintaining sample integrity throughout. Implement a conveyor belt system with barcode or RFID scanners for sample identification, directing each sample to the correct SniffSpace battery using robotic arms or diverter mechanisms. A central control system will coordinate the freezer retrieval, sorting, and placement, with real-time monitoring to

ensure accuracy. The system will use modular, cost-effective components to allow scalability, ensuring efficient handling and preservation of the samples.

Bridging Dog and Machine

Class : Data Weaver

Proficient in full-stack development, database management, data integration, real-time system monitoring, embedded system programming, and IoT technologies

Data Architect

Schemes high-level designs of robust and scalable backend architecture that supports the complex data flows and operational demands of both SniffSpace and DogOS. This architecture would facilitate real-time data processing as well as actuation, seamless integration of diverse data sources such as EEG and video, and ensure reliability and scalability.

Extendable Multimodal Database Architecture:

Propose a high-level database schema that encompasses:

- EHR Database: Already present, with demographic details corresponding to positive and control samples, marked by QR codes.
- SniffSpace Log: Every trial run, including sample sets, dog indications by button press, sensor data (time-stamps of sniffing events by IR sensors), and camera data.
- DogOS Data: Canine mental, behavioral, and performance data for training of ML models, incorporating elements such as EEG readings and video data.

Data Operator

Proficient in data management libraries like Pandas and Numpy, DataOps, MLOps, IoT Automation, DevOps and deployment, Testing/ Debugging, Networking Protocols.

Quests :

Seamless Data Integration Pipeline for DogOS

In DogOS, data needs to be integrated from multiple streams like EEG, Vision, Motion etc. It's essential there is a seamless and systematic pipeline for acquisition, management, and visualization of this data. Example [data](#).

DogOS Data Integrator :

Propose a high-level design for the Data Integrator pipeline :

- **Data Acquisition :** Time synchronous acquisition of data from multiple streams, over multiple sessions for each dog. Save this data in an organized directory structure, easy to pull for further analysis.
- **Visualization :** Data needs to be visualized for qualitative understanding to build novel pipelines. A seamless and automated visualization pipeline that pulls the required data and helps with quick and easy visualization of certain features. For example, pull an EEG data file from a particular experimental paradigm - for a particular dog - from a particular session - visualize the time - frequency plots, PSD plots, Channel correlation plots etc for specific sniffing events based on IR data. Likewise for other streams.
- **Data and ML Ops :** Version control to track changes in data, code and models to ensure reproducibility and collaboration. Monitoring and Logging of model performances, Scalability of ML workflows.

Deciphering the Canine Mind

Class: DoG WhispEEr

Skill-set: Proficiency in EEG data analysis, signal processing, machine learning, experimental design, and an understanding of neuroscientific principles.

Quests:

Theoretical Approach to ML Classification of Moving Canine EEG Data

Develop a framework that outlines the experimental design for collecting EEG data from biomedical detection dogs at SniffSpace. This could include signal processing pipelines that

account for the unique challenges of analyzing data from moving subjects and a machine learning model architecture suited for deciphering complex canine EEG patterns.

Analysis of 2023 Olfaction EEG Pilot Data

- a) Paw at the provided EEG dataset, from a 2023 Olfaction EEG pilot conducted by Akash with researchers from the [Family Dog Project](#). It contains EEG data from a dog exposed to green tea and black tea odors. Try to extract meaningful features, and train a machine learning model to distinguish between the neural signatures associated with each scent.
- b) EEG Experimental Critique: Offer constructive peer review on the Olfaction Pilot Script with the Family Dog Project. Suggest an alternative paradigm for building still canine olfactory ML models and provide an experimental work-flow for the same.

Data Folder -

<https://drive.google.com/drive/folders/1vTqO7lcPofgl6HxQiPYbeQWjHnyBMBIQ?usp=sharing>

Class : BCI Engineer/Designer

Skill-set : Systems design - mechanical and product design, embedded and wearable electronics with biopotential hardware experience a big plus, sensor and firmware design

Quests:

A Wireless and Custom Canine EEG Brain-Computer Interface

Choose any one of the following -

- a) Use the headscans in this [folder](#) to create an accurate head mesh that can be used to design custom helmets for dogs. You may use any software but worth considering how the organic curves and contours necessary may benefit from Blender/Nomad Sculpt type platforms versus CAD ones like Fusion or SolidWorks.
- b) Design a custom EEG dry electrode that can be used to measure high quality signals from the furry scalp of a dog. Give a high-level overview of how this electrode could be manufactured.

- i) Alternatively, perform a detailed review on current SOTA electrodes and propose the best electrode design for a canine BCI helmet and how much this would 8ch system would cost.
- c) Write down a mini-review and exploratory thinking on how canine EEG would require changes in commonly used biopotential firmware for humans - like bandpass filters, gain etc
- d) Write down a brief on the systems engineering required to deploy a functional canine BCI helmet for operational use by airport dogs.

More Quests

Propose a 1-2 page essay, framework, schematics, image, or preliminary code for any of the following challenges :

1. An element of design branding/aesthetic for what you see as Dagnosis' persona - either a simple mock-up logo, a mini-story, anything that conveys a sense of how you envision Dagnosis' brand identity
2. Machine learning vision models for analyzing canine behavior and whole-body movements, aiming to decode the subtleties of their actions in relation to detection accuracy. This could use a package such as DeepLabCut or any other package/model.
3. Computational techniques for identifying and quantifying canine facial expressions during sniffing events, to gain insights into their cognitive and emotional states. See the work of <https://www.tech4animals.org/> for some references as well as [Towards a 4E Model of Canine Olfaction](#) (e.g nostril movement)
4. Computational models and pipelines that make use of already-present accelerometer and gyroscope data in the EEG device.
5. Designing a deep learning model architecture that binds the pros of multiple pre existing architectures tailored for using multi modal data streams choosing the parts of existing models and creating a sort of ensemble to leverage the complementary nature of these data streams to create insights.
6. A wearable, non-invasive ECG tracking system tailored for dogs, ensuring their comfort while providing reliable heart rate and respiration monitoring throughout trials. This can utilize off-the-shelf components. Useful reference is work such as Yasin Cotour's with AniML.
7. A real-time dashboard that integrates and visualizes comprehensive data from DogOS and SniffSpace, enabling immediate access to trial outcomes and canine performance metrics.

8. A stakeholder engagement strategy for the launch of a large prospective cancer screening study in India (post PoC validation)
9. A grant strategy memo on the various state, national, and international grants applicable to Dognosis
10. Propose your own quest that would be aligned with the Dognosis Roadmap