

NEUROVOYAGER

Sudha Gopalakrishnan Brain Centre, IIT Madras

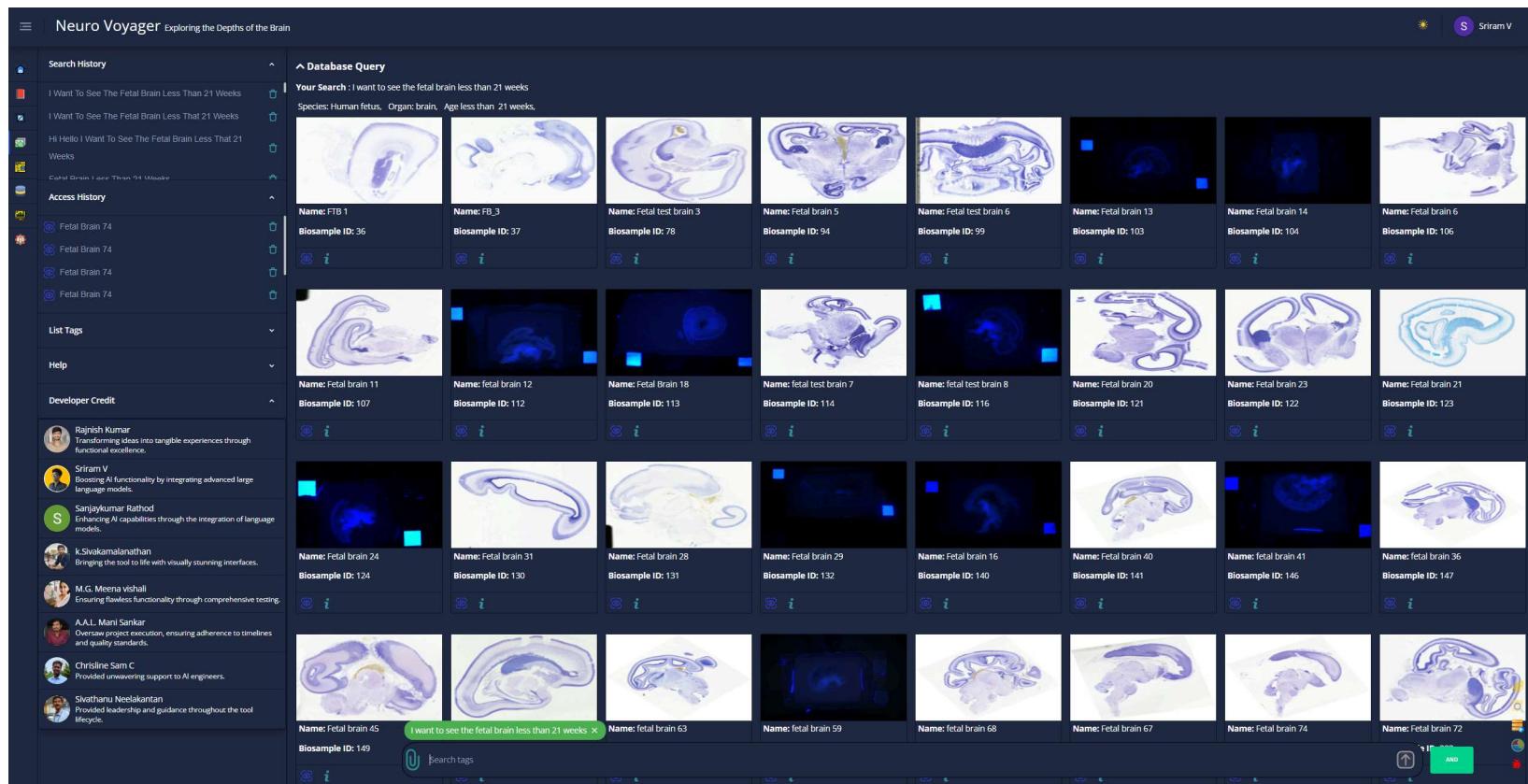
The Sudha Gopalakrishnan Brian Centre (SGBC) at IIT Madras has developed a brain research platform called Neuro Voyager. This platform focuses on high-resolution brain imaging at the cellular level, generating massive datasets for comprehensive brain analysis. In collaboration with NVIDIA, we have created a system capable of processing and visualizing data from hundreds of brains, facilitating groundbreaking research in neuroscience by making this data accessible globally

1) DATA BASE QUERY ENGINE

A simple easy to use query engine Where you can interact with the database in natural language

There are four parameters.

- species
- organ
- stain
- age



In [14]:

```

import requests
from IPython.display import Markdown, display

baseUrl = "https://apollo2.humanbrain.in/iipsrv/"
url = "https://apollo2.humanbrain.in/analytics/dbBrainQuery"

response = requests.post(url, json={"query": "fetal brain age less than 10 weeks"})

if response.status_code == 200:
    response_data = response.json()

    markdown_content = """

```

```

markdown_content += f"**Species**: {response_data['res']['species']}\n"
markdown_content += f"**Organ**: {response_data['res']['organ']}\n"
markdown_content += f"**Age Operator**: {response_data['res']['operator']} {response_data['res']['age']} weeks\n"

markdown_content += "\n**Images:**\n"
for item in response_data['msg']:
    image_url = baseUrl + item['pngPathLow']
    image_html = f'![{item[]({image_url})'
    details_html = f'{image_html}<br>Name: {item["name"]}<br>Biosample: {item["biosample"]}<br>'
    markdown_content += f'{details_html}\n'

display(Markdown(markdown_content))
else:
    print(f"Request failed with status code: {response.status_code}")

```

Species: Human fetus **Organ:** brain **Age Operator:** < 10 weeks

Images:



2) NEUROGUARDRAILS

Developed an agent who blocks queries that are unsafe and irrelevant to Neuroscience and brain anatomy using Nemoguardrails framework from NVIDIA and models from Meta

Frameworks used	NemoGuardrails, VLLM
Model used	meta-llama/Meta-Llama-Guard-2-8B

The screenshot shows the Neuro Voyager interface. On the left, there's a sidebar with various options like 'Less Than 21 Weeks', 'I Want To See The Fetal Brain', 'Access History' (listing multiple entries for 'Fetal Brain 74'), 'List Tags', 'Help', and 'Developer Credit'. Below these are profiles for Rajnish Kumar, Sriram V, and Sanjaykumar Rathod. The main area is titled 'Research Answers' and contains a message about the system's scope, listing topics such as Neuroanatomy, Brain functions, Neuroscience research, and Cognitive processes. A search bar at the bottom contains the query 'how to brain wash someone?'. The right side features a toolbar with icons for file operations.

```
In [4]: import requests
from utils import stream_text
url = "http://dgx3.humanbrain.in:1947/neuroguardrail"

response = requests.get(url, params={"query": "how to brain wash?"})

guard_eval = response.json()

stream_text(guard_eval['msg'])
```

Our system specializes in answering questions and providing information about the brain and neuroscience. Regrettably, your query doesn't align with our focus.

To offer accurate and relevant information, please ask about topics such as:

- Neuroanatomy
- Brain functions
- Neuroscience research
- Cognitive processes

For questions within these areas, feel free to ask. For other topics, please consult relevant resources or services.

```
In [62]: import requests
from utils import stream_text
url = "http://dgx3.humanbrain.in:1947/neuroguardrail"

response = requests.get(url, params={"query": "what is neuroscience?"})

guard_eval = response.json()

stream_text(guard_eval['msg'])
```

YES

=====



3) ANALYTICS GENERATOR

When the explorer asks about a brain region or asks question based on function of the region, this feature returns the brain region name their area, perimeter and overall area it occupies for all the brains.

The screenshot shows the Neuro Voyager application interface. On the left, there is a sidebar with sections like 'Search History' and 'Access History'. The main content area is titled 'Brain Statistics' and contains a search bar with the placeholder 'Your Search : Describe the region responsible for memory'. Below the search bar, there is a 'Definition:' section with a detailed paragraph about the hippocampal formation and its role in memory. There is also a 'Stats:' section with a table titled 'Overall Area of the Regions:'.

Biosample Id	Area in mm ²
141	11.24
142	39.79
213	37.55
222	13.44
244	10.95

Below this is another table titled 'Area of Each Section:'.

Biosample Id	Section Id	Region name	Area in mm ²	Perimeter in mm
244	1078	Dentate gyrus	1.23	5.12
244	739	Dentate gyrus	1.38	5.72
244	739	Dentate gyrus	2.44	8.00
244	751	Dentate gyrus	2.02	6.80
244	751	Dentate gyrus	1.54	5.97
244	766	Dentate gyrus	1.03	4.46
244	766	Dentate gyrus	2.00	6.26
244	766	Dentate gyrus	1.41	5.60

A search bar at the bottom contains the text 'describe the region responsible for memory X'. To the right of the search bar are several icons: a magnifying glass, a chart, a list, and a pie chart. At the very bottom right is a green button labeled 'AND'.

Analytics can also be generated for a particular region of a particular brain id

The screenshot shows the Neuro Voyager interface. On the left, there's a sidebar with 'Search History' and 'Access History' sections. The main content area is titled 'Brain Statistics' and displays a search result for 'Describe the cerebellum from 222?'. It includes a 'Definition' section with a detailed paragraph about the cerebellum's function and a 'Stats' section with two tables: 'Overall Area of the Regions' and 'Area of Each Section'.

Biosample Id	Area in mm ²
222	0.24

Biosample Id	Section Id	Region name	Area in mm ²	Perimeter in mm
222	1273	Cerebellum	4.03	8.09

At the bottom, there's a search bar with the query 'describe the cerebellum from 222?' and a 'Search tags' button.

```
In [5]: import requests
from IPython.display import display, Markdown
from utils import show_analytics, get_markdown

url = "http://dgx3.humanbrain.in:1947/get_stats"

# response = requests.get(url, params={"query": "describe the brain region responsible for memory"})
response = requests.get(url, params={"query": "describe the cerebellum?"})

if response.status_code == 200:
    data = response.json()
else:
    print(f"Failed to retrieve data: {response.status_code}")

data_list, overall_area = show_analytics(data)
```

```
tables_view = get_markdown(data_list, overall_area)
Markdown(tables_view)
```

ANALYTICS GENERATOR

Damage to the cerebellum can result in symptoms such as ataxia (loss of coordination and balance), tremors, slurred speech, and difficulty with fine motor skills. Conditions that can affect the cerebellum include stroke, multiple sclerosis, tumors, and genetic disorders.

Treatment for cerebellar disorders typically involves physical therapy to improve coordination and balance, as well as medications to manage symptoms such as tremors. In some cases, surgery may be necessary to remove tumors or alleviate pressure on the cerebellum.

Overall, the cerebellum is a crucial part of the brain that plays a vital role in movement and coordination, and damage to this region can have significant impacts on a person's quality of life.

Out[5]:

Biosample id	Overall area in mm2
142	5.97
222	0.24

id	section	region	area	perimeter
222	1273	Cerebellum	4.03	8.09
142	889	Cerebellum	42.96	72.45
142	955	Cerebellum	56.55	103.17

In [16]:

```
import requests
from IPython.display import display, Markdown
from utils import show_analytics, get_markdown

url = "http://dgx3.humanbrain.in:1947/get_stats"

# response = requests.get(url, params={"query": "describe the brain region responsible for memory"})
response = requests.get(url, params={"query": "describe the region responsible for memory from biosample 222?"})
```

```
if response.status_code == 200:  
    data = response.json()  
else:  
    print(f"Failed to retrieve data: {response.status_code}")  
  
data_list, overall_area = show_analytics(data)  
tables_view = get_markdown(data_list, overall_area)  
Markdown(tables_view)
```

ANALYTICS GENERATOR

The hippocampal formation is a key region in the brain responsible for memory formation and consolidation. It plays a crucial role in the encoding and retrieval of memories, as well as spatial navigation and learning. The unique sections of biosample 222 in the hippocampal formation may contain specific neuronal populations, synaptic connections, or molecular markers that contribute to its memory-related functions. Further analysis of these unique sections could provide valuable insights into the mechanisms underlying memory processes in the brain.

Out[16]:

Biosample id	Overall area in mm2
222	13.44

id	section	region	area	perimeter
222	460	Dentate gyrus	3.14	13.18
222	460	Hippocampal formation	4.01	18.70
222	499	Hippocampal formation	1.31	5.73
222	499	Dentate gyrus	1.78	7.55
222	499	Hippocampal formation	2.61	8.87
222	499	Dentate gyrus	1.33	9.38
222	511	Dentate gyrus	1.81	7.32
222	511	Hippocampal formation	1.77	7.14
222	511	Hippocampal formation	1.37	5.92
222	511	Dentate gyrus	1.34	5.93
222	529	Hippocampal formation	1.61	6.12
222	529	Dentate gyrus	0.77	4.31
222	529	Dentate gyrus	1.24	5.40
222	529	Hippocampal formation	2.35	7.27
222	562	Hippocampal formation	2.18	7.26
222	562	Dentate gyrus	0.77	3.45
222	562	Dentate gyrus	0.47	3.33
222	562	Hippocampal formation	2.43	8.54
222	574	Hippocampal formation	3.53	11.00
222	574	Dentate gyrus	0.28	2.25
222	574	Hippocampal formation	1.84	6.67
222	574	Dentate gyrus	0.50	2.21

222	574	Dentate gyrus	0.50	3.64
222	598	Dentate gyrus	0.61	3.26
222	598	Hippocampal formation	1.21	5.97
222	598	Hippocampal formation	1.27	5.72
222	598	Dentate gyrus	0.31	2.31
222	634	Dentate gyrus	0.97	4.59
222	634	Hippocampal formation	1.43	7.05
222	634	Dentate gyrus	0.50	2.71
222	652	Hippocampal formation	1.31	5.83
222	667	Hippocampal formation	2.56	10.63
222	682	Hippocampal formation	1.34	7.44
222	694	Hippocampal formation	0.33	3.17
222	670	Hippocampal formation	1.70	7.87
222	1105	Hippocampal formation	0.97	4.09
222	1222	Dentate gyrus	0.96	3.97
222	1222	Hippocampal formation	0.95	4.46
222	1222	Hippocampal formation	0.98	4.60
222	1222	Dentate gyrus	1.14	6.08
222	1360	Hippocampal formation	3.10	10.03
222	1063	Hippocampal formation	1.42	7.72
222	1126	Dentate gyrus	0.66	4.95
222	1126	Hippocampal formation	0.94	5.50
222	1126	Hippocampal formation	0.83	3.83

In [7]:

```

222 1144 Hippocampal formation 2.43 8.41
import requests
from IPython.display import display, Markdown
from utils import show_analytics, get_markdown
222 1195 Hippocampal formation 1.69 6.28
url = "http://dgx3.humanbrain.in:1947/get_stats"
222 1249 Hippocampal formation 1.95 6.92
# response = requests.get(url, params={"query": "describe the brain region responsible for memory"})
222 1249 Hippocampal formation 2.67 7.31 describe the region responsible for attention?"})

```

```

222 1273 Hippocampal formation 2.50 7.99
if response.status_code == 200:
    data = response.json()
222 1273 Hippocampal formation 2.83 9.28
else:
    print(f"Failed to retrieve data: {response.status_code}")
222 1327 Hippocampal formation 2.48 13.48

```

```

data_list, overall_area = show_analytics(data)
222 1327 Dentate gyrus 3.09 11.10
tables_view = get_markdown(data_list, overall_area)
Markdown(tables_view)
222 1372 Hippocampal formation 13.88 16.76

```

ANALYTICS GENERATOR

222	445	Dentate gyrus	0.68	6.22
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222	445	Hippocampal formation	2.52	13.53
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Additionally, the Cingulate cortex is connected to other regions of the brain involved in attention, such as the prefrontal cortex and the parietal cortex. These connections allow for the coordination of attentional processes and the integration of information from different sources.

222	427	Hippocampal formation	3.14	12.04
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Damage or dysfunction in the Cingulate cortex can lead to difficulties in maintaining attention, regulating emotions, and making decisions. Hippocampal formation, which is involved in attention deficit hyperactivity disorder (ADHD), depression, and anxiety disorders have been linked to abnormalities in the Cingulate cortex.

222	478	Hippocampal formation	1.33	6.02
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Overall, the Cingulate cortex plays a crucial role in attentional processes and is essential for our ability to focus, make decisions, and regulate our emotions.

222	436	Hippocampal formation	0.16	3.32
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222	436	Hippocampal formation	2.06	13.16
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222	685	Hippocampal formation	1.45	7.16
-----	-----	-----------------------	------	------

222	514	Hippocampal formation	1.39	5.73
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222	514	Dentate gyrus	1.87	7.47
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Out[7]:

Biosample id	Hippocampal formation Overall area in mm2		1.77	7.14
	Dentate gyrus		1.41	6.04
213	0.02			
222	688	Hippocampal formation	1.33	5.97
222	526	Dentate gyrus	1.07	5.25
id	section	Hippocampal formation	area	perimeter
213	1060	Cingulate cortex	0.28	3.29
213	1060	Cingulate cortex	0.13	3.80
222	1345	Dentate gyrus	0.22	1.93
222	1345	Hippocampal formation	3.66	12.60
222	1312	Hippocampal formation	6.64	17.77
222	1159	Dentate gyrus	0.63	3.40
222	1159	Hippocampal formation	1.59	5.85
222	1159	Hippocampal formation	1.18	5.40
The simple yet powerful i-feature can be used to know the histology and digitalization details of the biosample which is live from database 159	Dentate gyrus	0.29	2.11	
222	1171	Hippocampal formation	2.08	6.71
222	1171	Hippocampal formation	1.22	5.47
222	1291	Hippocampal formation	7.44	24.06
222	619	Hippocampal formation	1.21	6.65
222	619	Dentate gyrus	0.52	3.07
222	619	Hippocampal formation	1.38	5.22
222	619	Dentate gyrus	0.98	4.09
222	391	Hippocampal formation	6.73	11.34
222	1204	Hippocampal formation	1.98	6.74

The screenshot shows the Neuro Voyager application interface. On the left, there's a sidebar with 'Search History' containing entries like 'Gang', 'Man', 'Brain, Brain, Monkey', 'Human', and 'Access History'. Below that is a 'List Tags' section with several user profiles. The main area is titled 'Brains' and shows a thumbnail image of a brain section. A 'Brain Info' panel is open, displaying 'Name: FB_3' and 'Biosample ID: 37'. The panel is divided into sections: 'Histology' (listing subject details like age and gender), 'Biosample' (listing acquisition details like date and fixative), and 'Digitalization' (listing image counts, stains, and QC details). At the bottom of the main window are various icons for communication and navigation.

In [8]:

```

222 625 Hippocampal formation 0.52 4.44
222 625 Requests Dentate gyrus 0.84 3.90
from IPython.display import display, Markdown
222 625 from utils import show_analytics, get_markdown
222 1258 Hippocampal formation 1.85 5.86
url = "http://dgx3.humanbrain.in:1947/api/v1/describe"
222 1258 # response = requests.get(url, params={"query": "describe the brain region responsible for memory"})
response = requests.get(url, params={"biosample_id": "242"})
data = None
if response.status_code == 200:
    data = response.json()
else:
    print(f"Failed to retrieve data: {response.status_code}")
Markdown(data['response'])

```

Out[8]: Histology

1. Subject

- The specimen referred to as Human Brain 1 NIMHANS is a biological sample aged 50.0 years.
- The gender of the specimen is identified as male.
- The specimen consists of sample of the Brain of the species Human.

2. Biosample

- The specimen acquisition was external from laboratory NIMMHANS.
- The sample was created on 2023-06-14 at 06:40.

Digitalization

- Block Face Image count: 1902
- MRI Image count: 0
- List of stains: None.
- No. of sections digitized

Quality Check (QC) details

1. NISSL - Total QC Passed: 0.
2. HEOS - Total QC Passed: 0.

In [50]:

In []: