



## BrAPI and High-Dimensional Phenotypes

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# High-Dimensional Phenotypes

## Single Dimension Phenotype

(e.g., fresh root yield)



Sample 1

Sample 2

Sample 3

Sample 4

Sample 5

⋮

⋮


# High-Dimensional Phenotypes

## Single Dimension Phenotype

(e.g., fresh root yield)



Sample 1

Sample 2

Sample 3

Sample 4

Sample 5

⋮

⋮


## High-Dimensional Phenotype

1 2 3 4 ...

Sample 1

Sample 2

Sample 3

Sample 4

Sample 5

⋮

⋮

⋮

⋮

⋮

...

...

...

...

...

...


# High-Dimensional Phenotypes

## Transcriptomics



Illumina

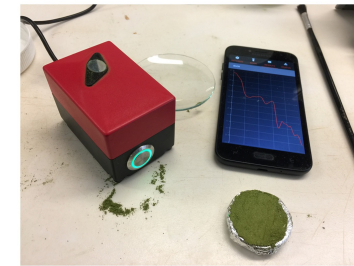
	Gene 1	Gene 2	Gene 3	Gene 4	
Sample 1					...
Sample 2					...
Sample 3					...
Sample 4					...
Sample 5					...
⋮	⋮	⋮	⋮	⋮	⋮

## Metabolomics



	Compound 1	Compound 2	Compound 3	Compound 4	
Sample 1					...
Sample 2					...
Sample 3					...
Sample 4					...
Sample 5					...
⋮	⋮	⋮	⋮	⋮	⋮

## NIRS



Prananto et al., 2021

	$\lambda 1$	$\lambda 2$	$\lambda 3$	$\lambda 4$	
Sample 1					...
Sample 2					...
Sample 3					...
Sample 4					...
Sample 5					...
⋮	⋮	⋮	⋮	⋮	⋮

# High-Dimensional Phenotypes

## Transcriptomics



Illumina

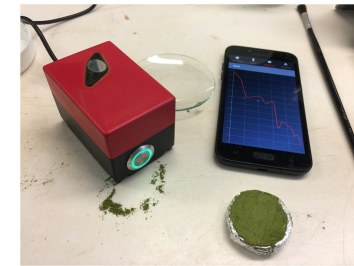
	Gene 1	Gene 2	Gene 3	Gene 4	
Sample 1					...
Sample 2					...
Sample 3					...
Sample 4					...
Sample 5					...
⋮	⋮	⋮	⋮	⋮	⋮

## Metabolomics



	Compound 1	Compound 2	Compound 3	Compound 4	
Sample 1					...
Sample 2					...
Sample 3					...
Sample 4					...
Sample 5					...
⋮	⋮	⋮	⋮	⋮	⋮

## NIRS



Prananto et al., 2021

	$\lambda 1$	$\lambda 2$	$\lambda 3$	$\lambda 4$	
Sample 1					...
Sample 2					...
Sample 3					...
Sample 4					...
Sample 5					...
⋮	⋮	⋮	⋮	⋮	⋮

# High-Dimensional Phenotypes

## Transcriptomics



Illumina

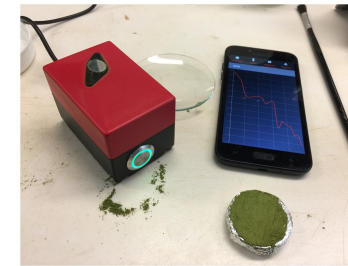
	Gene 1	Gene 2	Gene 3	Gene 4	
Sample 1					...
Sample 2					...
Sample 3					...
Sample 4					...
Sample 5					...
⋮	⋮	⋮	⋮	⋮	⋮

## Metabolomics



	Compound 1	Compound 2	Compound 3	Compound 4	
Sample 1					...
Sample 2					...
Sample 3					...
Sample 4					...
Sample 5					...
⋮	⋮	⋮	⋮	⋮	⋮

## NIRS



Prananto et al., 2021

	$\lambda 1$	$\lambda 2$	$\lambda 3$	$\lambda 4$	
Sample 1					...
Sample 2					...
Sample 3					...
Sample 4					...
Sample 5					...
⋮	⋮	⋮	⋮	⋮	⋮

# High-Dimensional Phenotypes

## Transcriptomics



Illumina

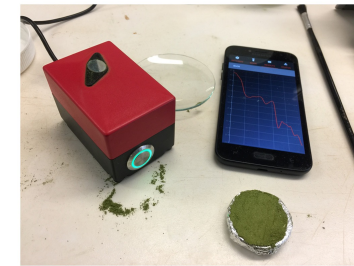
	Gene 1	Gene 2	Gene 3	Gene 4	
Sample 1					...
Sample 2					...
Sample 3					...
Sample 4					...
Sample 5					...
⋮	⋮	⋮	⋮	⋮	⋮

## Metabolomics



	Compound 1	Compound 2	Compound 3	Compound 4	
Sample 1					...
Sample 2					...
Sample 3					...
Sample 4					...
Sample 5					...
⋮	⋮	⋮	⋮	⋮	⋮

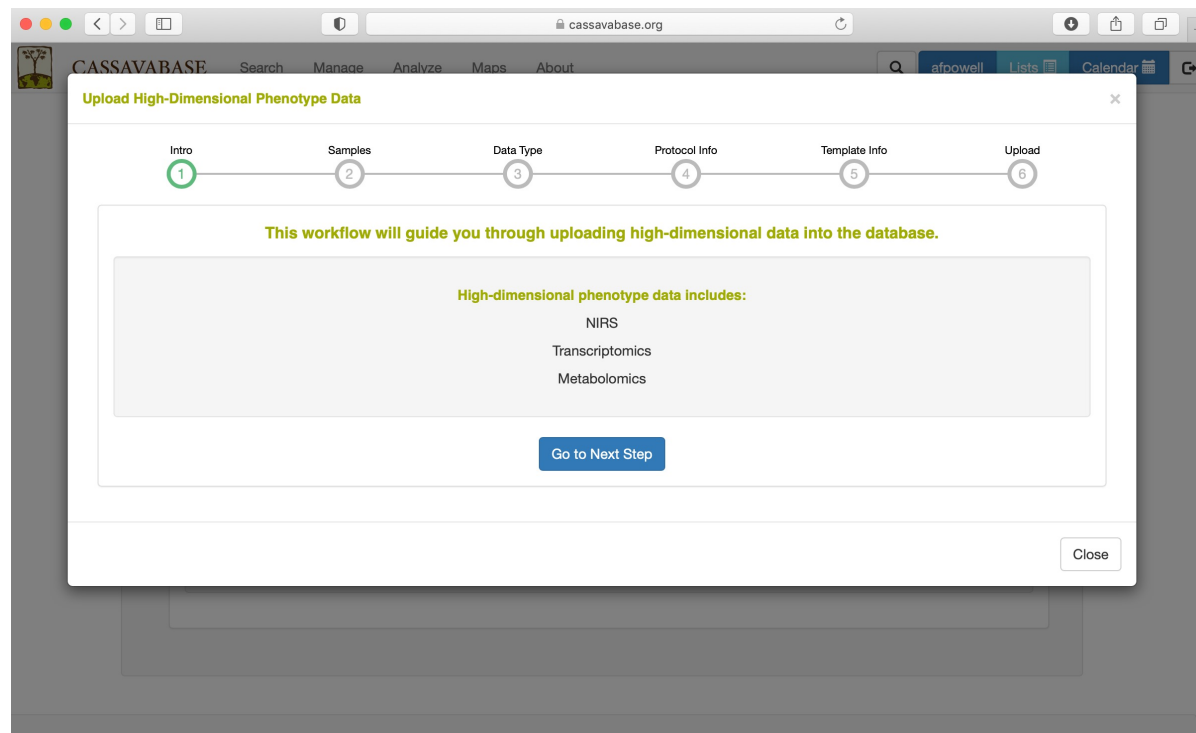
## NIRS



Prananto et al., 2021

	$\lambda 1$	$\lambda 2$	$\lambda 3$	$\lambda 4$	
Sample 1					...
Sample 2					...
Sample 3					...
Sample 4					...
Sample 5					...
⋮	⋮	⋮	⋮	⋮	⋮

# High-Dimensional Phenotypes: Breedbase Upload and Storage





## High-Dimensional Phenotypes: BrAPI Calls

<b>Protocol Metadata</b>	GET <a href="https://test-server.brapi.org/brapi/v2/nirs/id">https://test-server.brapi.org/brapi/v2/nirs/id</a>
	GET <a href="https://test-server.brapi.org/brapi/v2/transcriptomics/id">https://test-server.brapi.org/brapi/v2/transcriptomics/id</a>
	GET <a href="https://test-server.brapi.org/brapi/v2/metabolomics/id">https://test-server.brapi.org/brapi/v2/metabolomics/id</a>
<b>Data Matrices</b>	GET <a href="https://test-server.brapi.org/brapi/v2/nirs/id/matrix">https://test-server.brapi.org/brapi/v2/nirs/id/matrix</a>
	GET <a href="https://test-server.brapi.org/brapi/v2/transcriptomics/id/matrix">https://test-server.brapi.org/brapi/v2/transcriptomics/id/matrix</a>
	GET <a href="https://test-server.brapi.org/brapi/v2/metabolomics/id/matrix">https://test-server.brapi.org/brapi/v2/metabolomics/id/matrix</a>
	GET <a href="https://test-server.brapi.org/brapi/v2/nirs">https://test-server.brapi.org/brapi/v2/nirs</a>
	GET <a href="https://test-server.brapi.org/brapi/v2/nirs?observationunitDbId=abcxyz">https://test-server.brapi.org/brapi/v2/nirs?observationunitDbId=abcxyz</a>
	GET <a href="https://test-server.brapi.org/brapi/v2/nirs/id/matrix?studyDbId=123">https://test-server.brapi.org/brapi/v2/nirs/id/matrix?studyDbId=123</a>

# High-Dimensional Phenotypes: BrAPI Calls

## Data Matrix

For each 'row':

- Observation Unit DbID
- Observation Unit Name
- Tissue Type
- Data Values
- ...

# High-Dimensional Phenotypes: BrAPI Calls

## Transcriptomics

### Protocol Metadata

- Header Column Names
- Header Column Details
  - Gene ID
  - Chromosome
  - Start
  - End
  - Gene Description
- Genome Version
- Annotation Version
- Expression Unit

## NIRS

### Protocol Metadata

- Header Column Names
- Device Type

### Data Matrix

For each 'row':

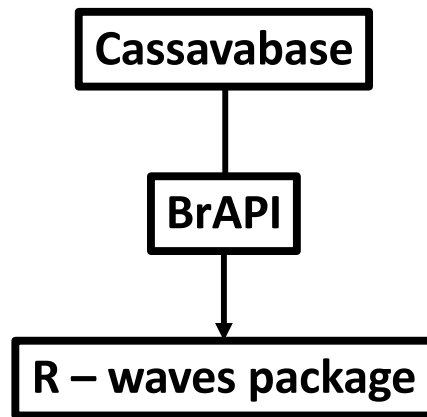
- Observation Unit DbID
- Observation Unit Name
- Tissue Type
- Data Values
- ...

## Metabolomics

### Protocol Metadata

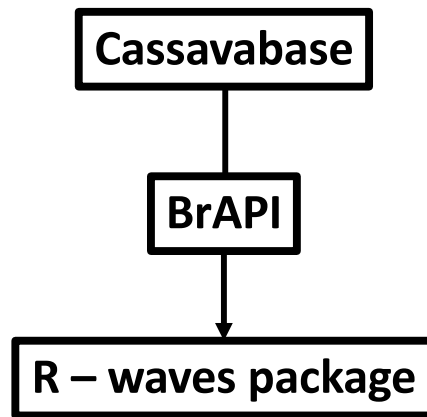
- Header Column Names
- Header Column Details
  - InChI Key
  - Compound Name
- Equipment Type
- Equipment Description
- Data Processing Description
- Phenotype Type
- Phenotype Units

## High-Dimensional Phenotypes: Usage Example



```
afp43@debian:~/projects/Brapi_R_nirs_test19$
```

# High-Dimensional Phenotypes: Usage Example



```
R version 4.1.3 (2022-03-10) -- "One Push-Up"  
Copyright (C) 2022 The R Foundation for Statistical Computing  
Platform: x86_64-apple-darwin17.0 (64-bit)
```

```
R is free software and comes with ABSOLUTELY NO WARRANTY.  
You are welcome to redistribute it under certain conditions.  
Type 'license()' or 'licence()' for distribution details.
```

```
Natural language support but running in an English locale
```

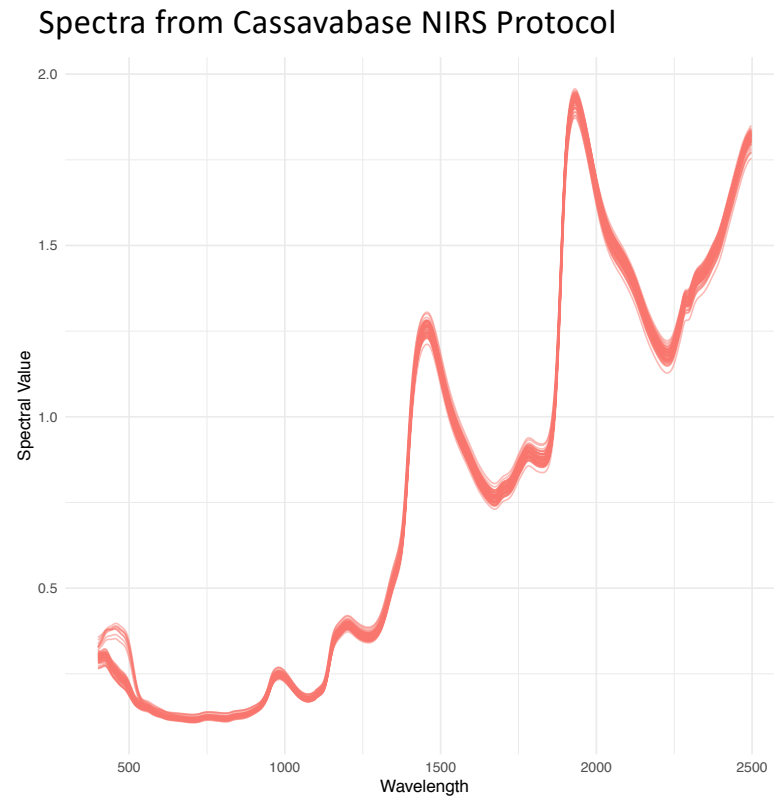
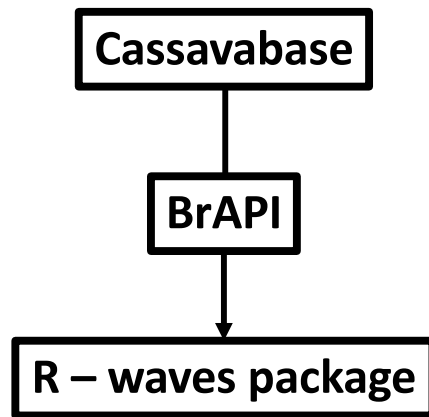
```
R is a collaborative project with many contributors.  
Type 'contributors()' for more information and  
'citation()' on how to cite R or R packages in publications.
```

```
Type 'demo()' for some demos, 'help()' for on-line help, or  
'help.start()' for an HTML browser interface to help.  
Type 'q()' to quit R.
```

```
[Workspace loaded from ~/Documents/BTI/High Dimensional Nirs Brapi/Nirs_brapi/.RData]
```

```
> |
```

## High-Dimensional Phenotypes: Usage Example



## High-Dimensional Phenotypes: Ongoing Work

- Finalize and test transcriptomics calls
- Implement metabolomics calls
- Additional documentation and usage examples
- Other types of High-Dimensional Phenotypes?
  - Ground Penetrating Radar
  - Hue-Saturation-Value (HSV)
- Ensure compatibility with BrAPI-R package, etc.

# High-Dimensional Phenotypes: New Concept Preview

<https://brapinewconceptpreview.docs.apiary.io/>

<https://github.com/plantbreeding/BrAPI/tree/brapi-new-concept-preview/Specification/New-Concept-Preview/High-Dimensional-Phenotypes>

<https://app.swaggerhub.com/apis-docs/PlantBreedingAPI/BrAPI-New-Concept-Preview>

The screenshot shows the GitHub repository page for `plantbreeding/BrAPI`. The repository is public and has 54 issues, 27 forks, and 40 stars. The current branch is `brapi-new-conc...`, which is 27 commits ahead and 1 commit behind `brapi-V2.0`. The directory structure is as follows:

File/Folder	Description	Last Commit
NIRS	new concept setup	2 months ago
ObservationVector/Schemas	new concepts setup	2 months ago
GroupDescription.md	new concepts setup	2 months ago
README.md	new concept setup	2 months ago

The `README.md` file is selected, showing the following content:

## Group High-Dimensional Phenotypes

High-Dimensional Phenotypes description

Get - /nirs [GET /brapi/v2/nirs/{nirsProtocolDbId}{?observationUnitDbId}{?externalReferenceID}{?externalReferenceSource}{?page}{?pageSize}]

Get a filtered list of NIRS Protocols