

# Interactive visualization and data exploration

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Swiss Institute of  
Bioinformatics



Friedrich Miescher Institute  
for Biomedical Research

# How can (interactive) visualization be helpful?

**Quality  
assessment**



**Hypothesis  
generation/  
exploration**



**Result  
visualization**



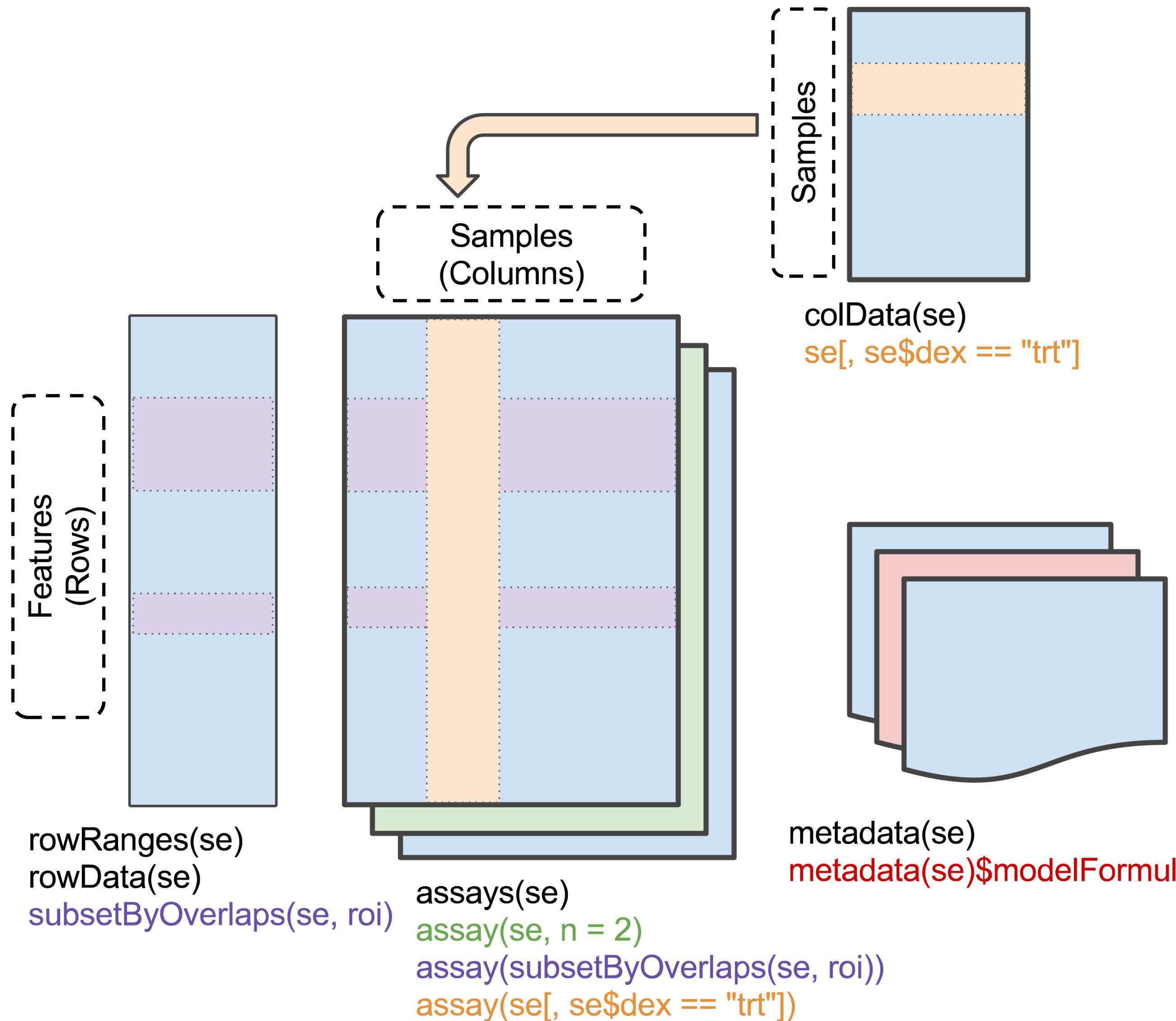
**Communication**



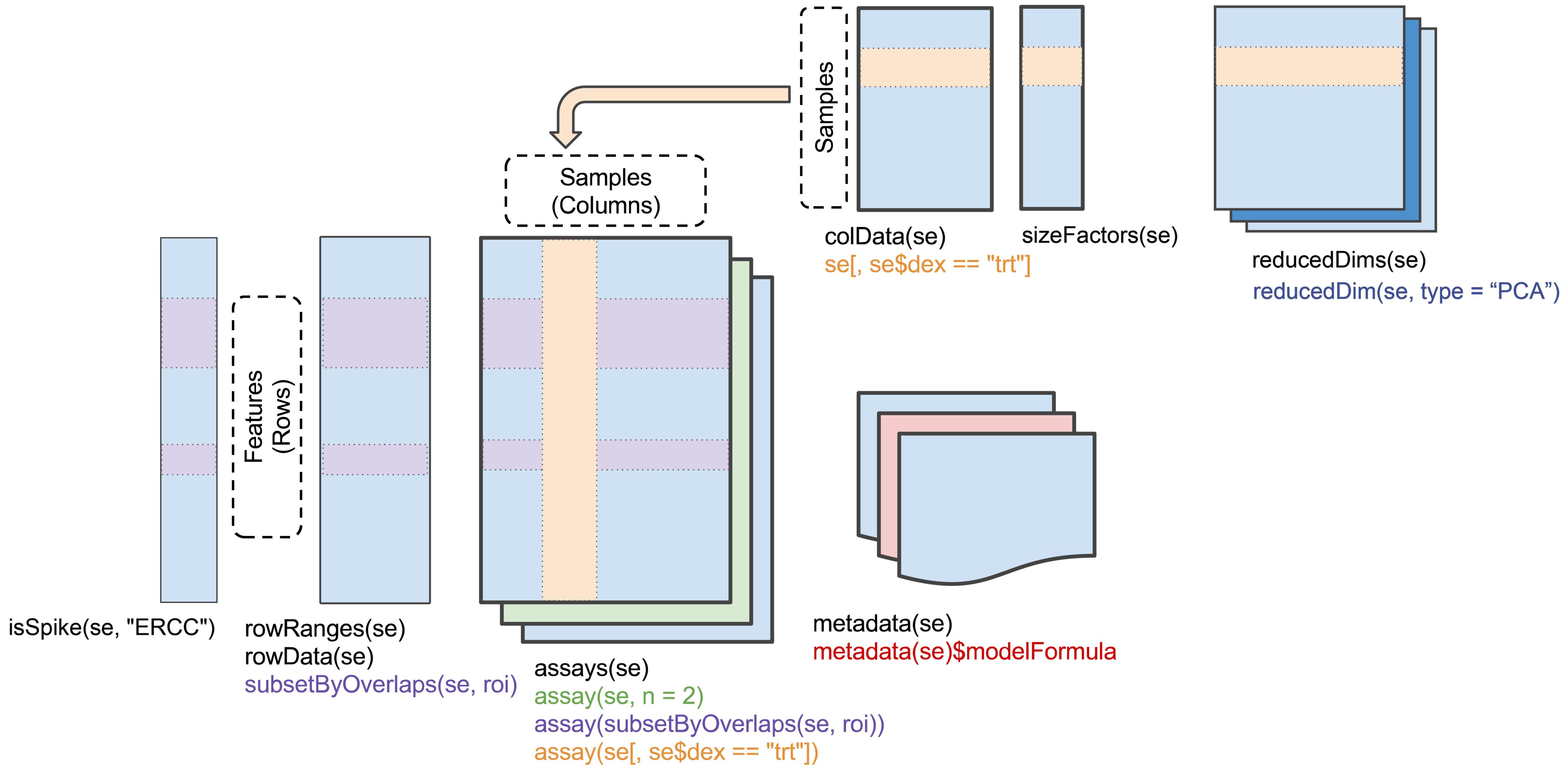
# iSEE

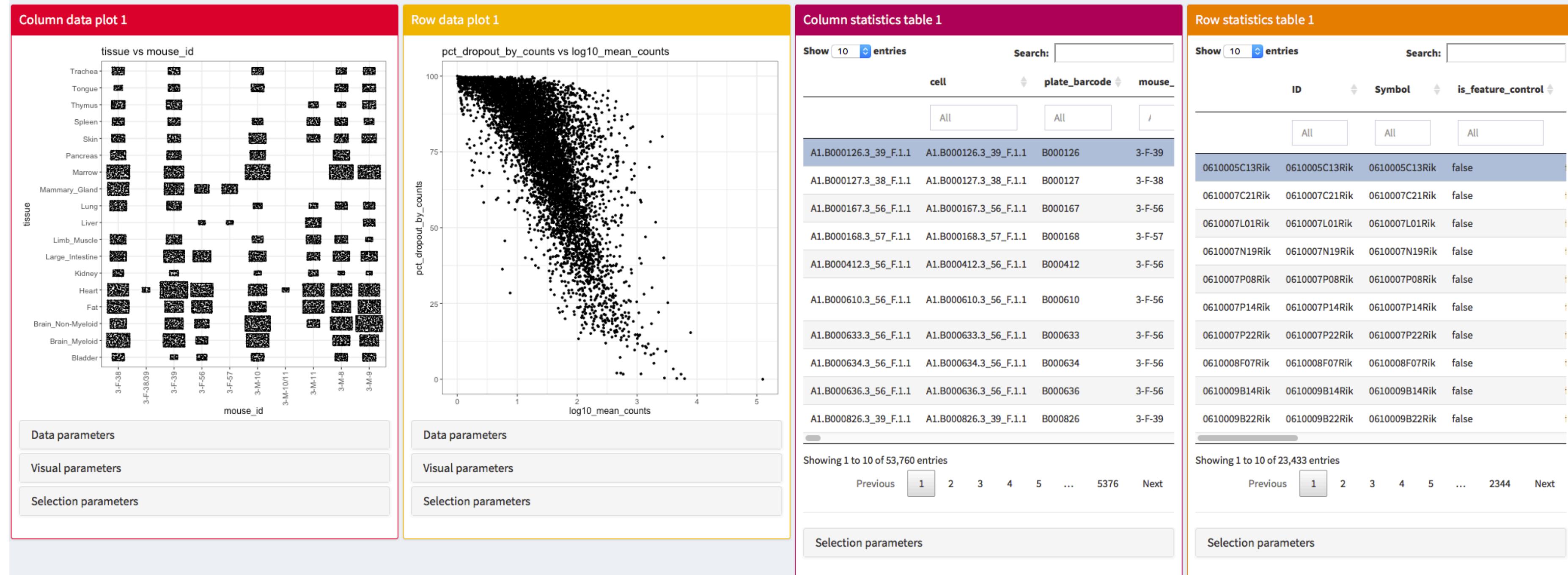
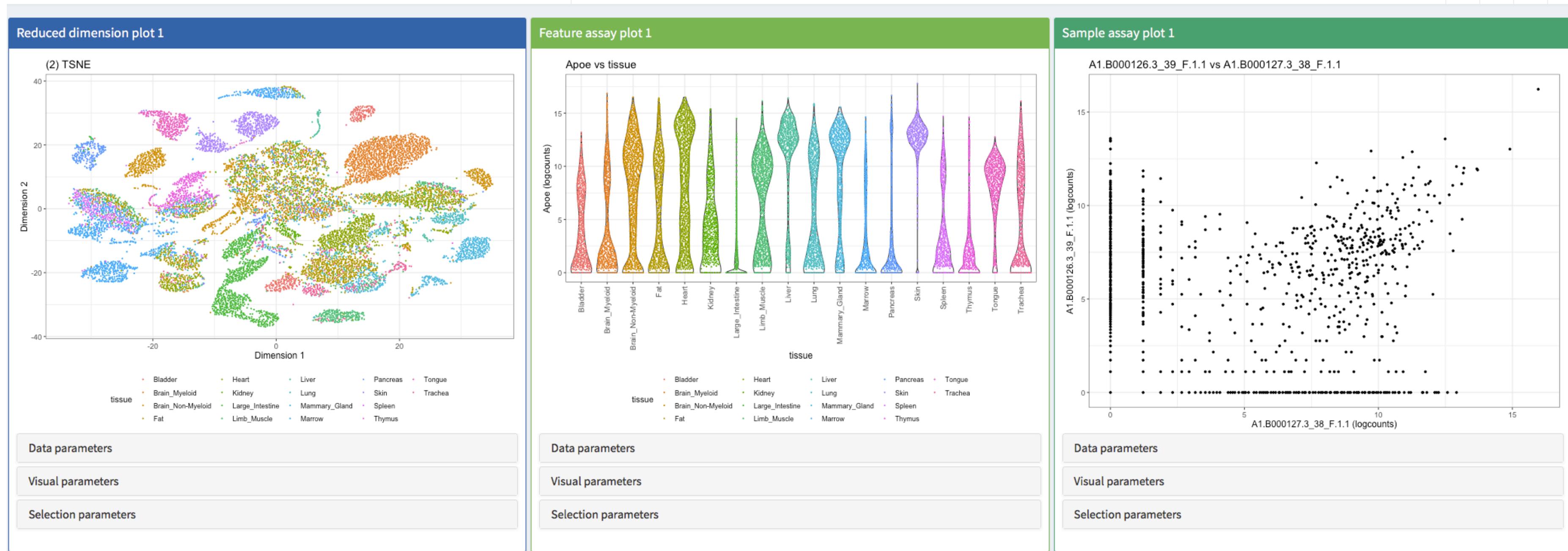
- Bioconductor package for interactive exploration of SummarizedExperiment objects (=any 'rectangular' data with row and column annotations)
- Flexible and scalable
- Reproducibility - all code to regenerate figures is provided

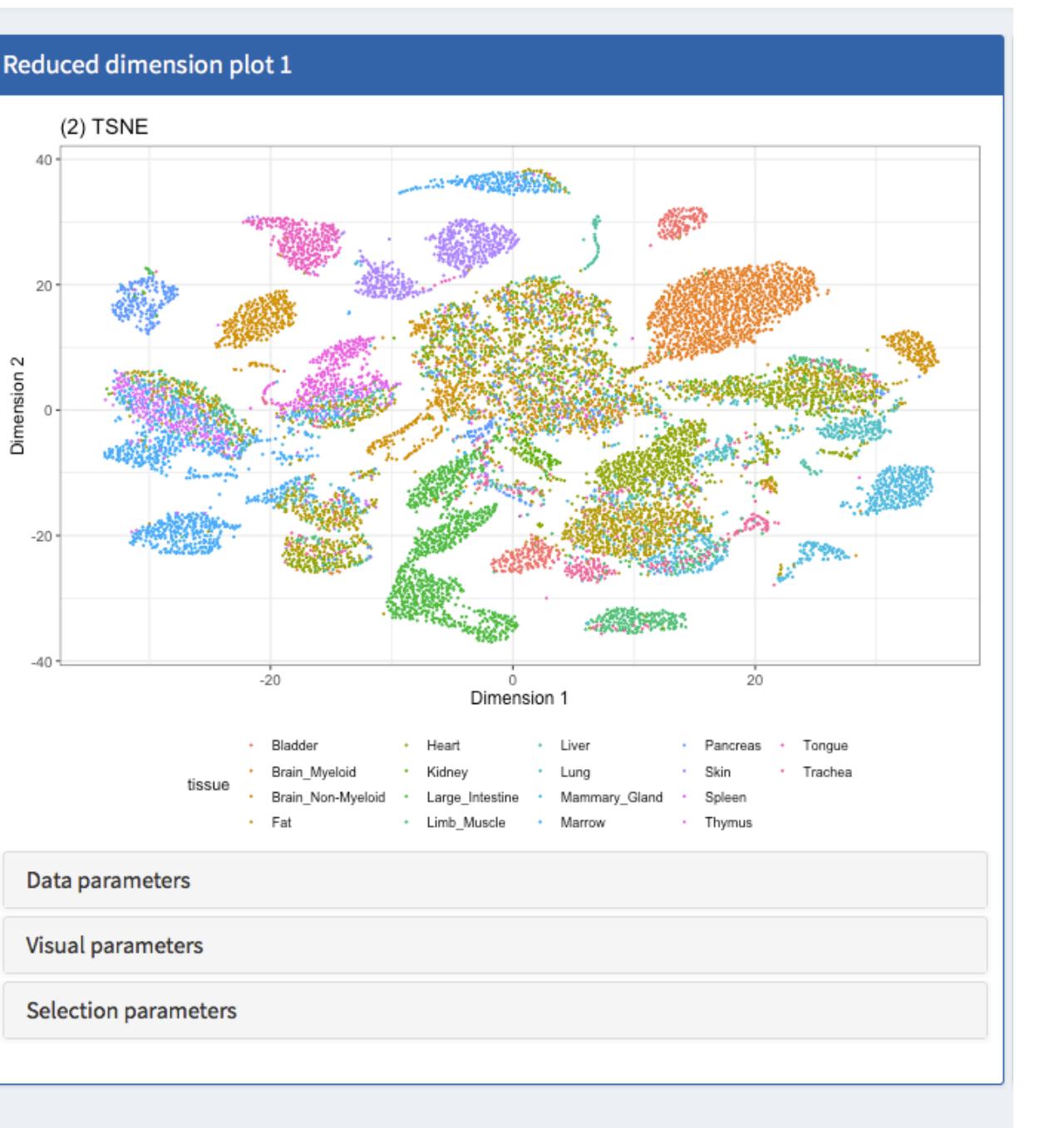
# The SummarizedExperiment class



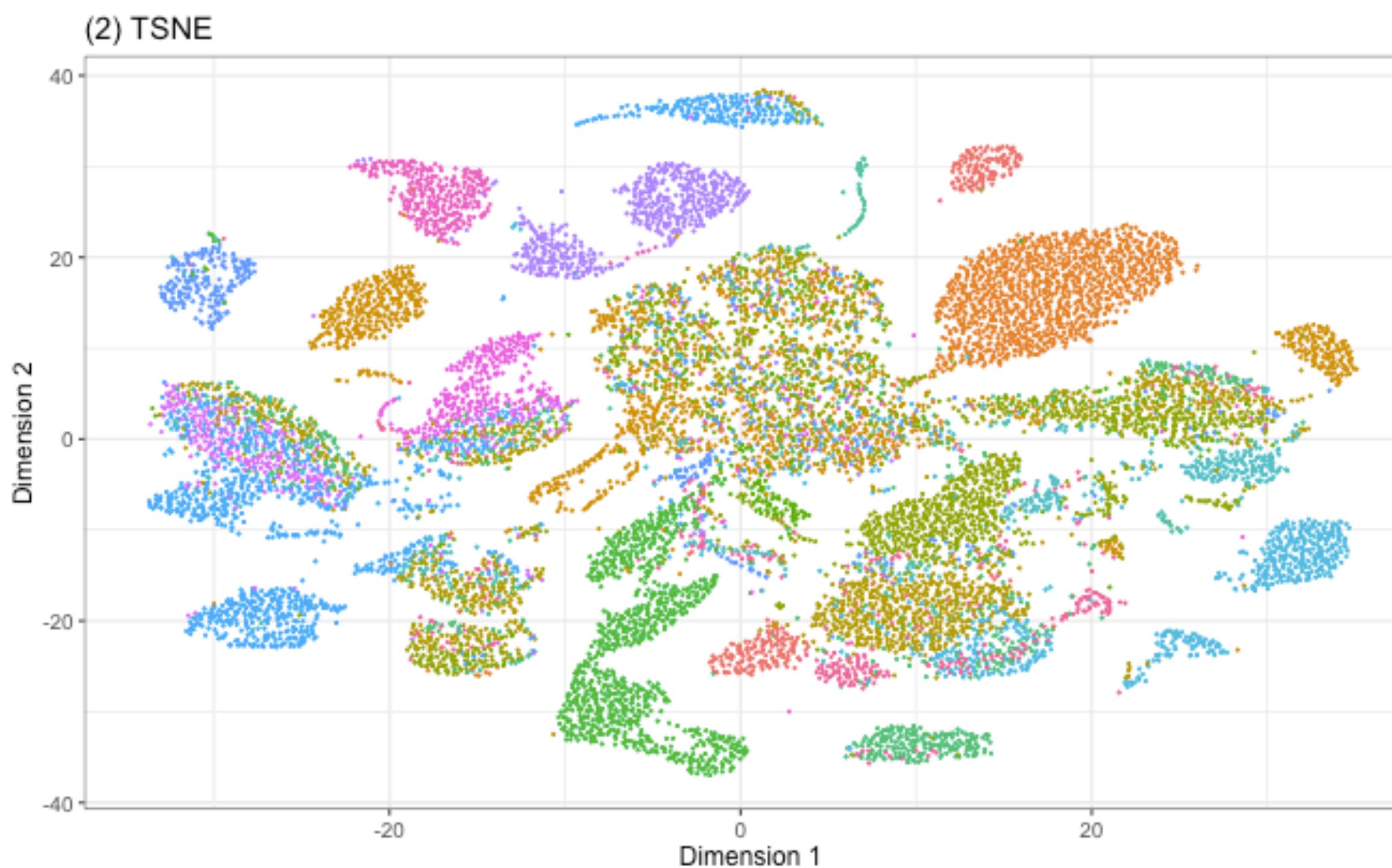
# The SingleCellExperiment class







## Reduced dimension plot 1

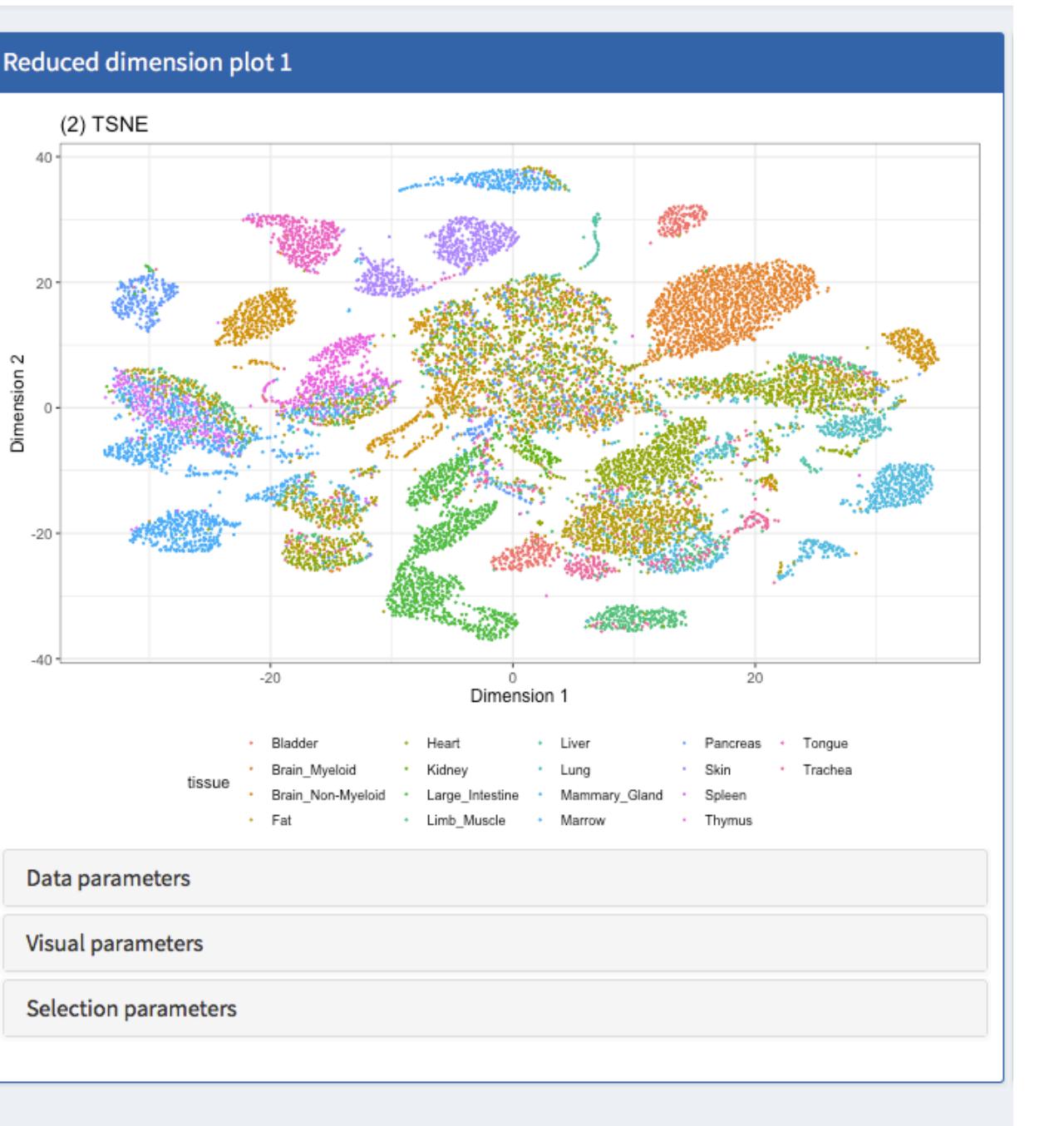


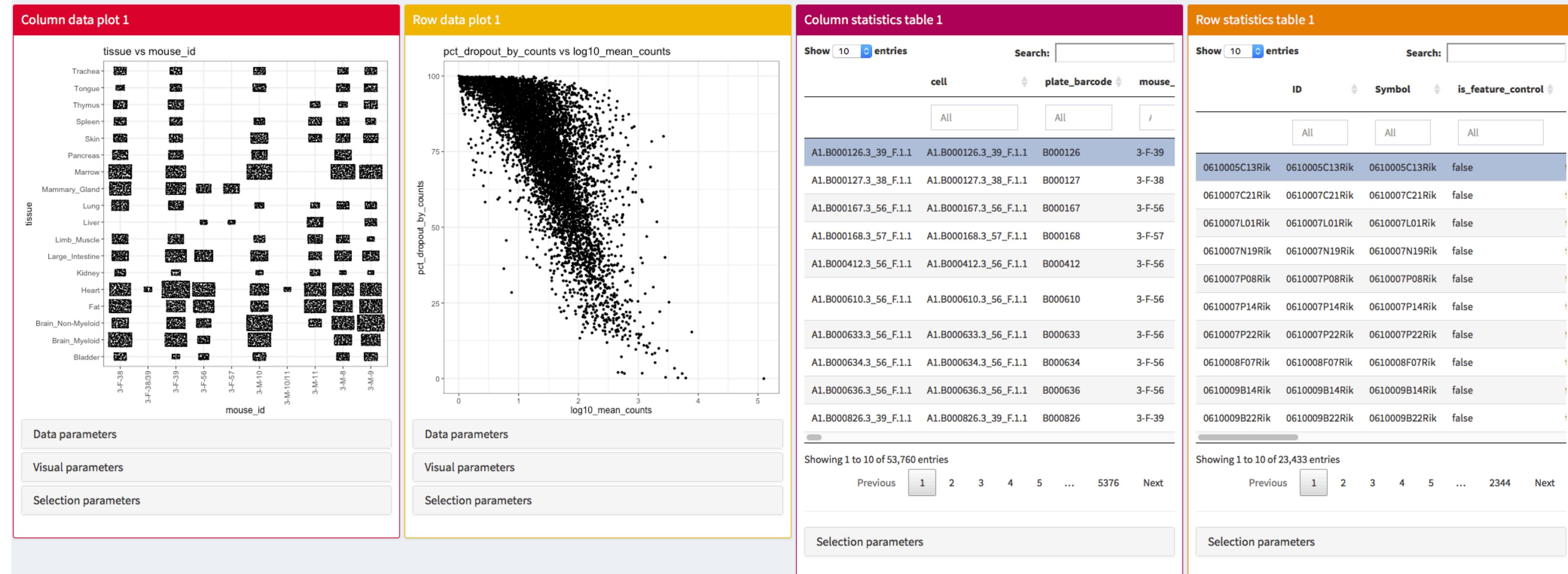
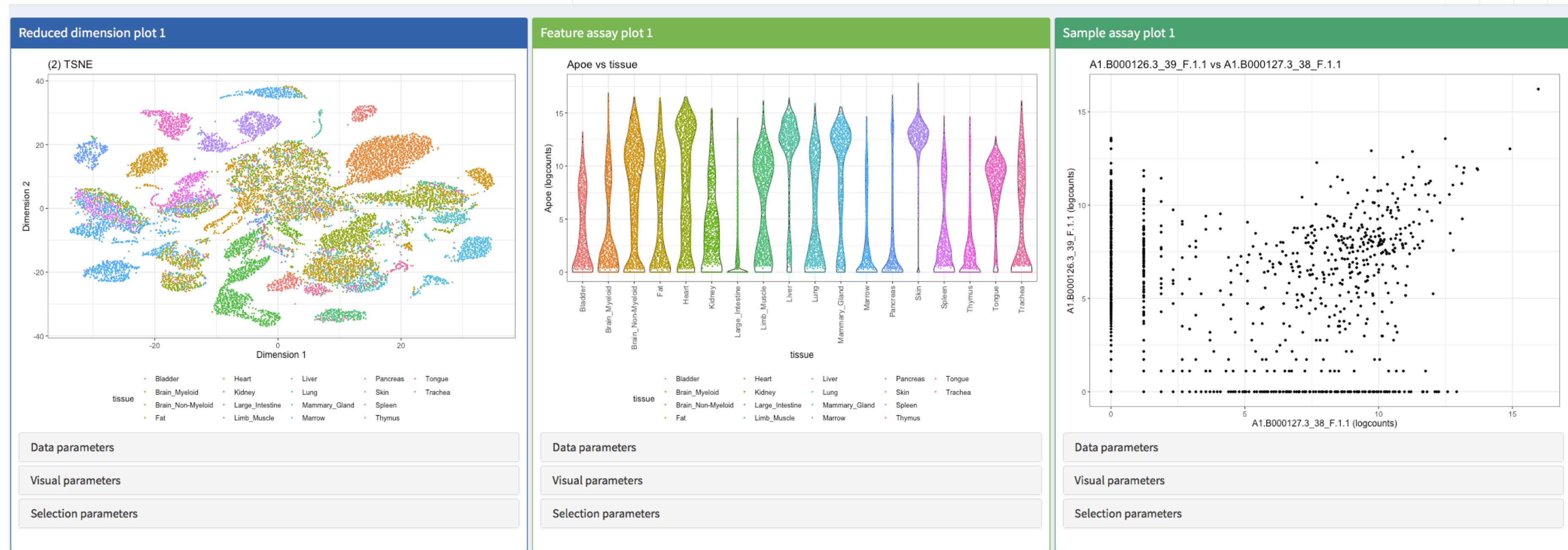
- tissue
- Bladder
  - Heart
  - Liver
  - Pancreas
  - Tongue
  - Brain\_Myeloid
  - Kidney
  - Lung
  - Skin
  - Trachea
  - Brain\_Non-Myeloid
  - Large\_Intestine
  - Mammary\_Gland
  - Spleen
  - Fat
  - Limb\_Muscle
  - Marrow
  - Thymus

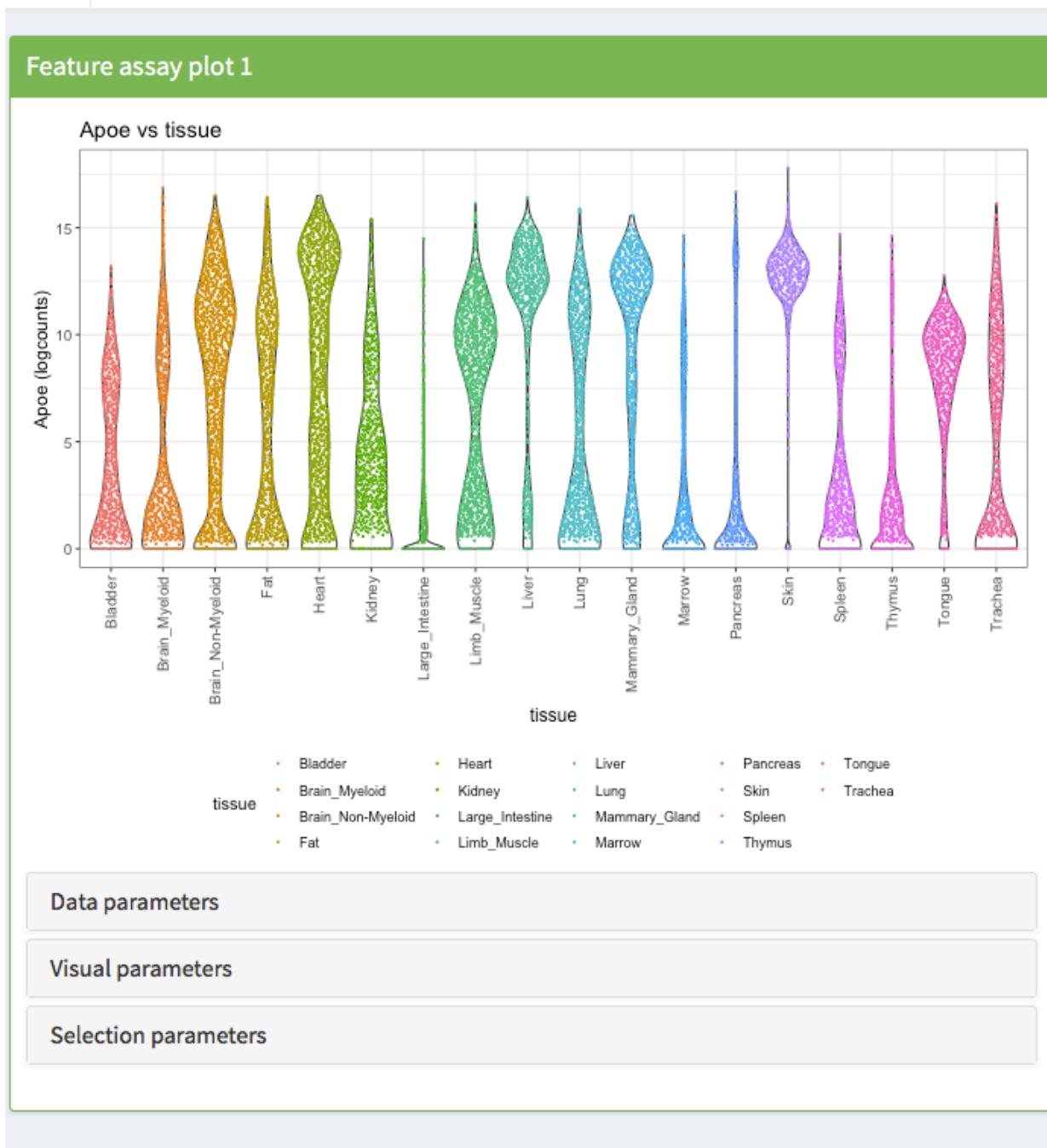
Data parameters

Visual parameters

Selection parameters

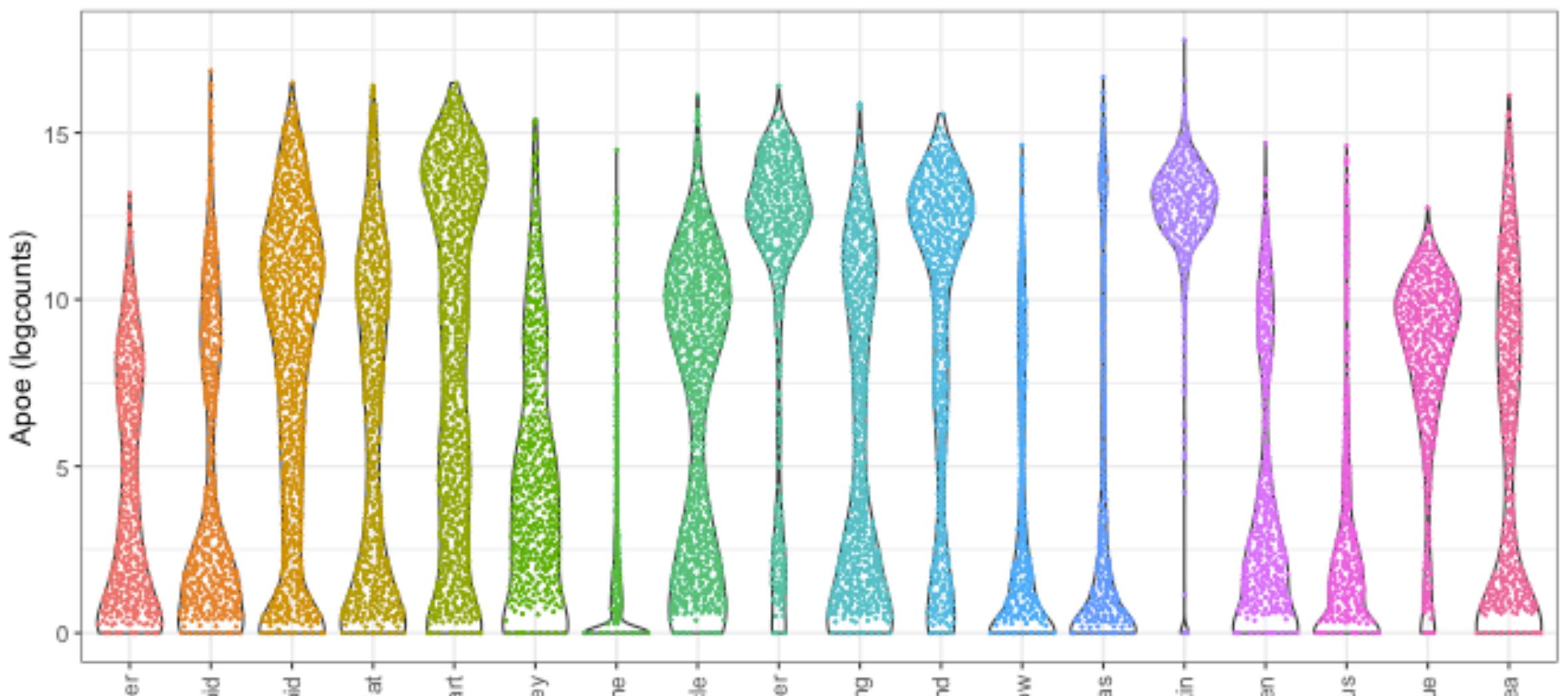






## Feature assay plot 1

Apoe vs tissue

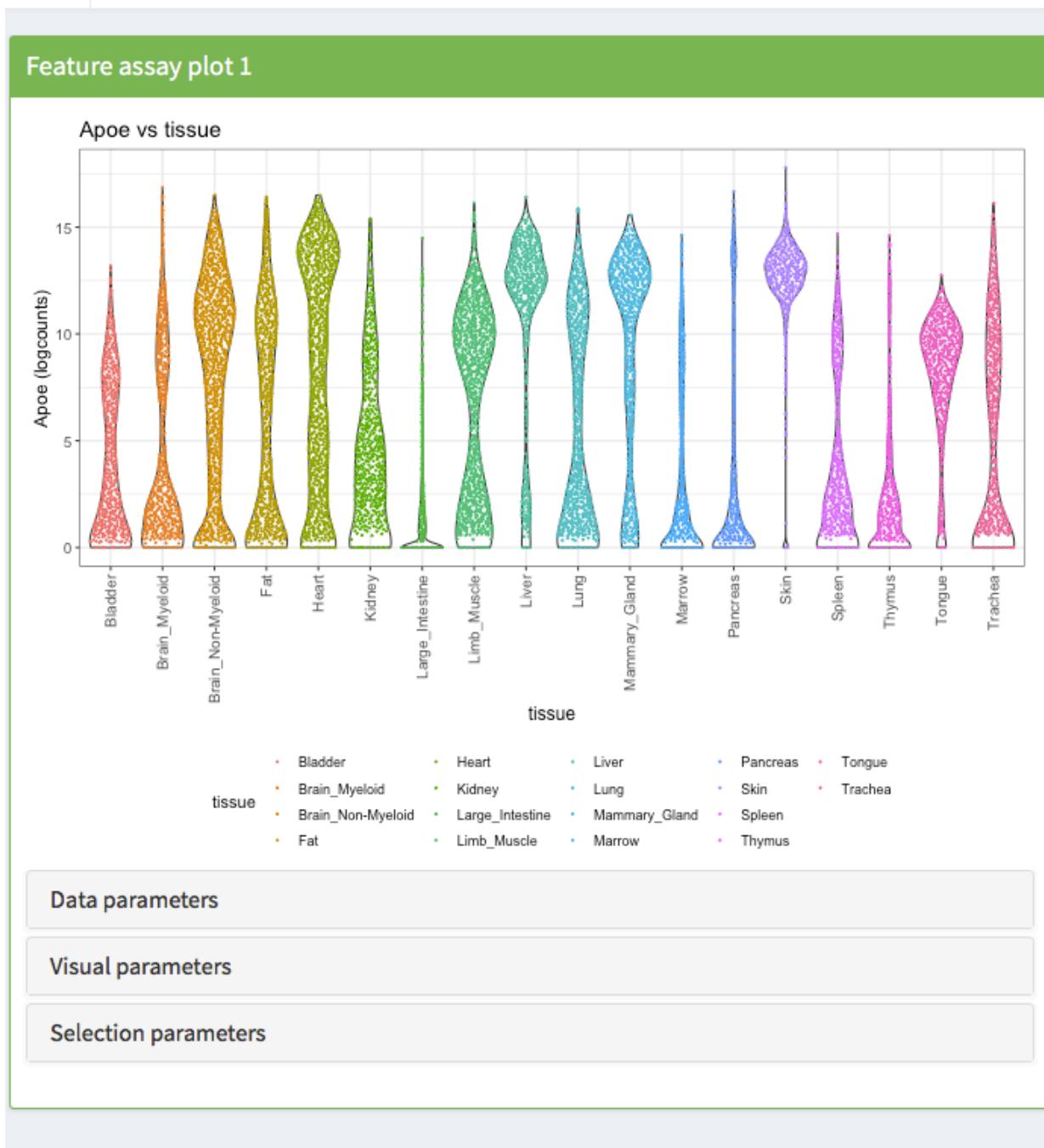


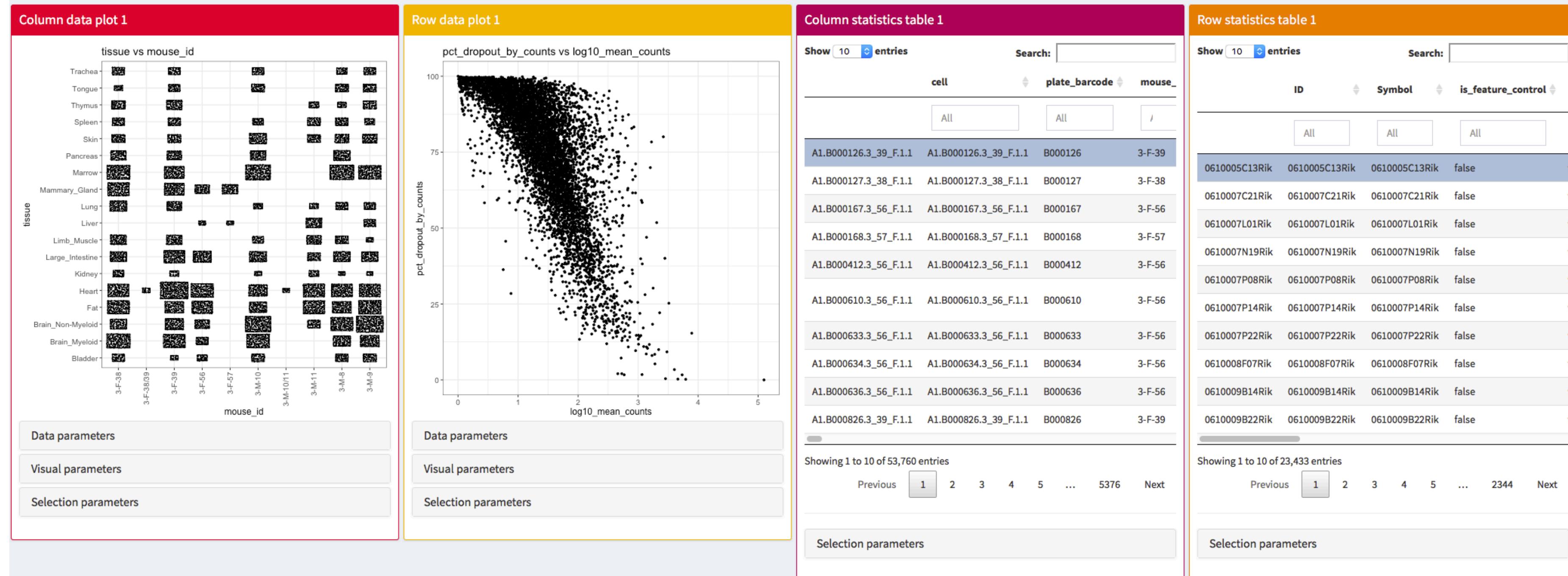
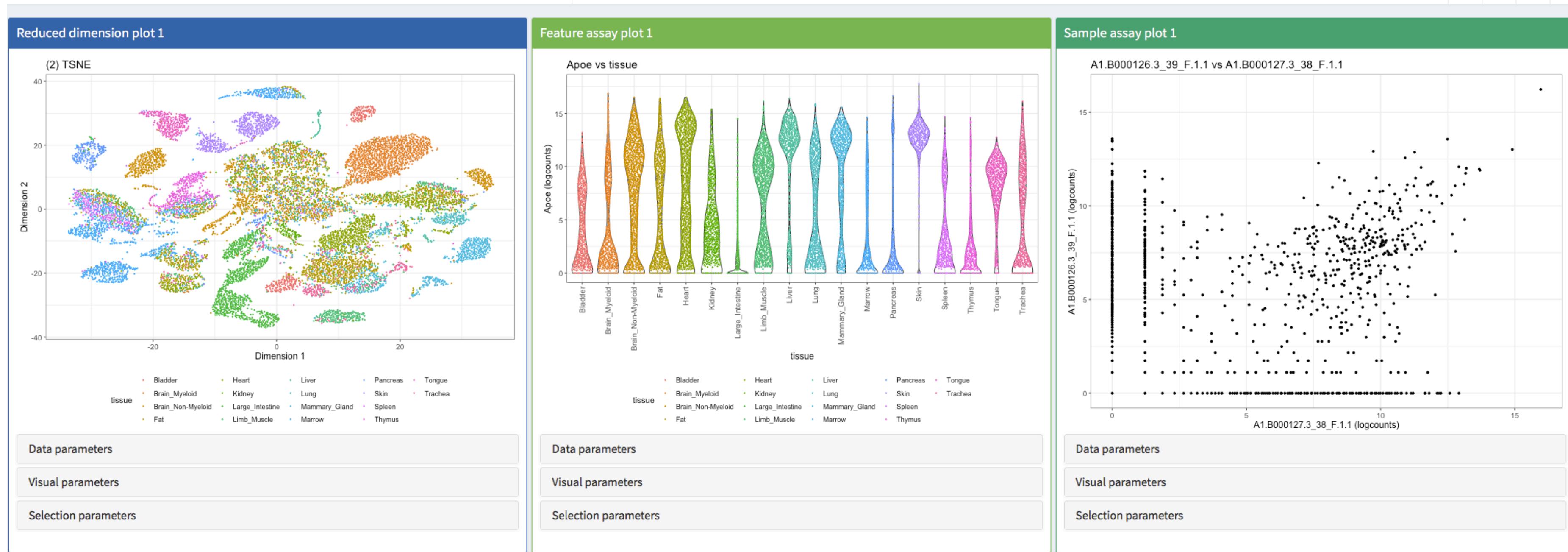
- tissue
- Bladder
  - Brain\_Myeloid
  - Brain\_Non-Myeloid
  - Fat
  - Heart
  - Kidney
  - Large\_Intestine
  - Limb\_Muscle
  - Liver
  - Lung
  - Mammary\_Gland
  - Marrow
  - Pancreas
  - Skin
  - Spleen
  - Thymus
  - Tongue
  - Trachea

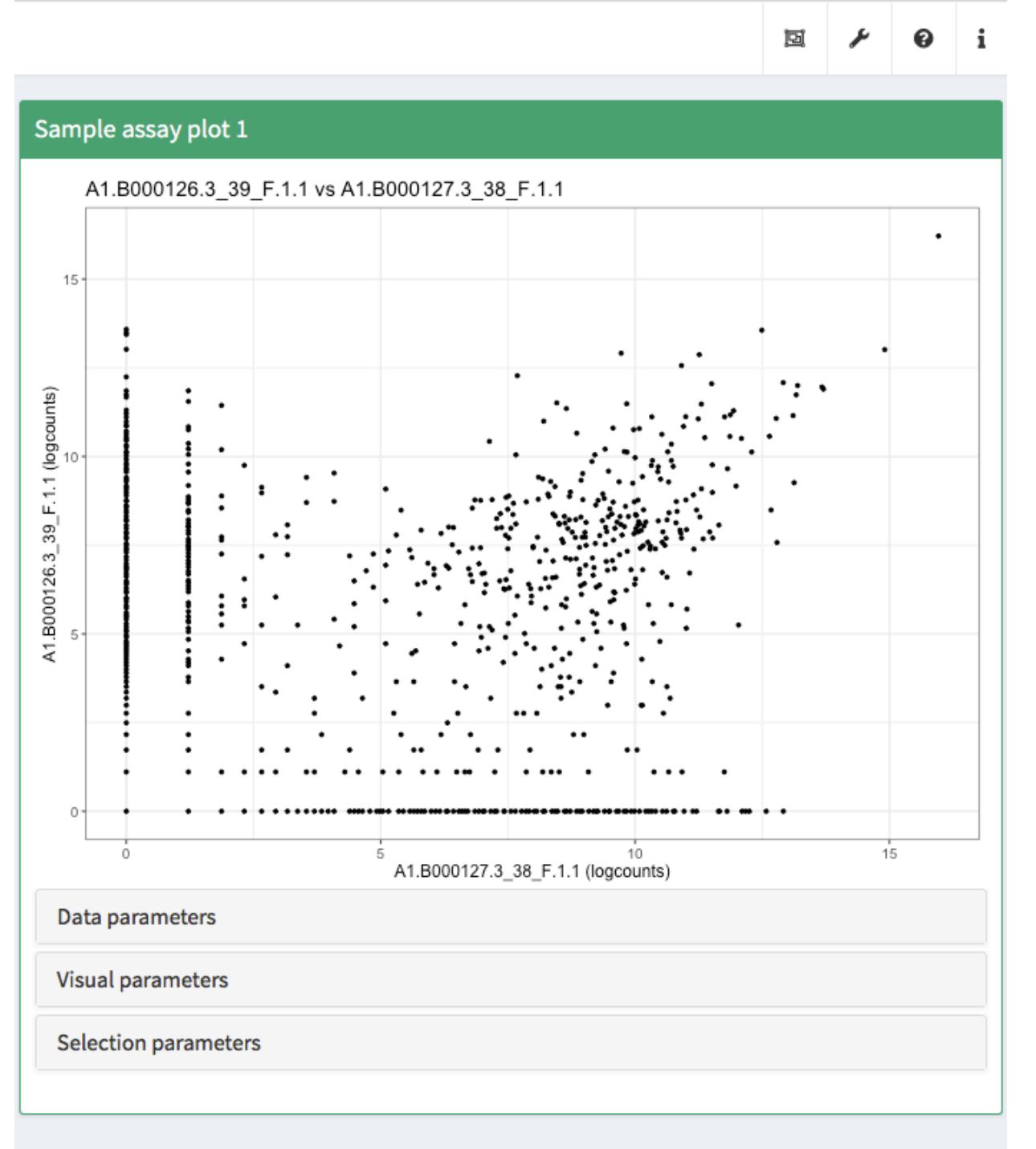
Data parameters

Visual parameters

Selection parameters

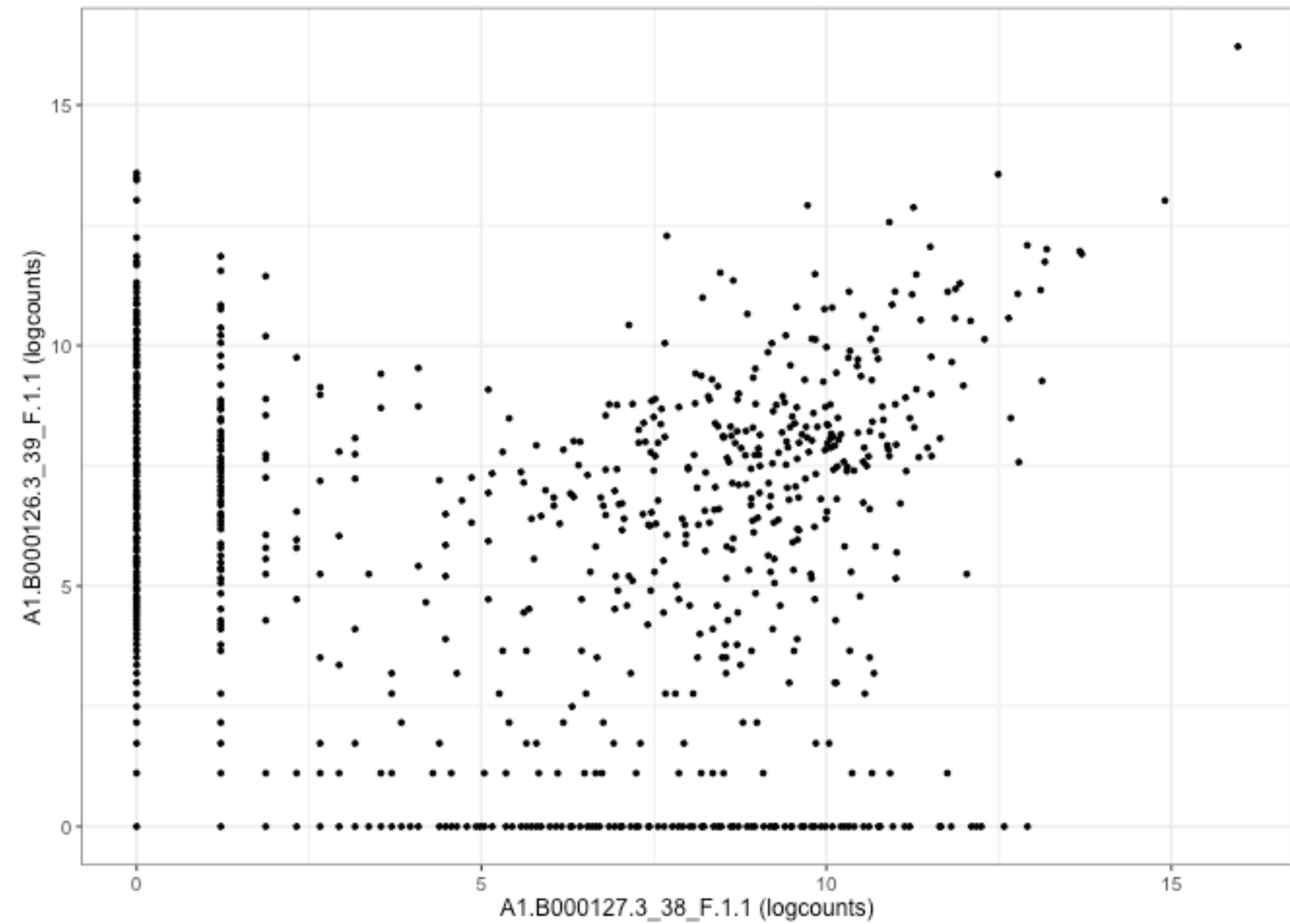






## Sample assay plot 1

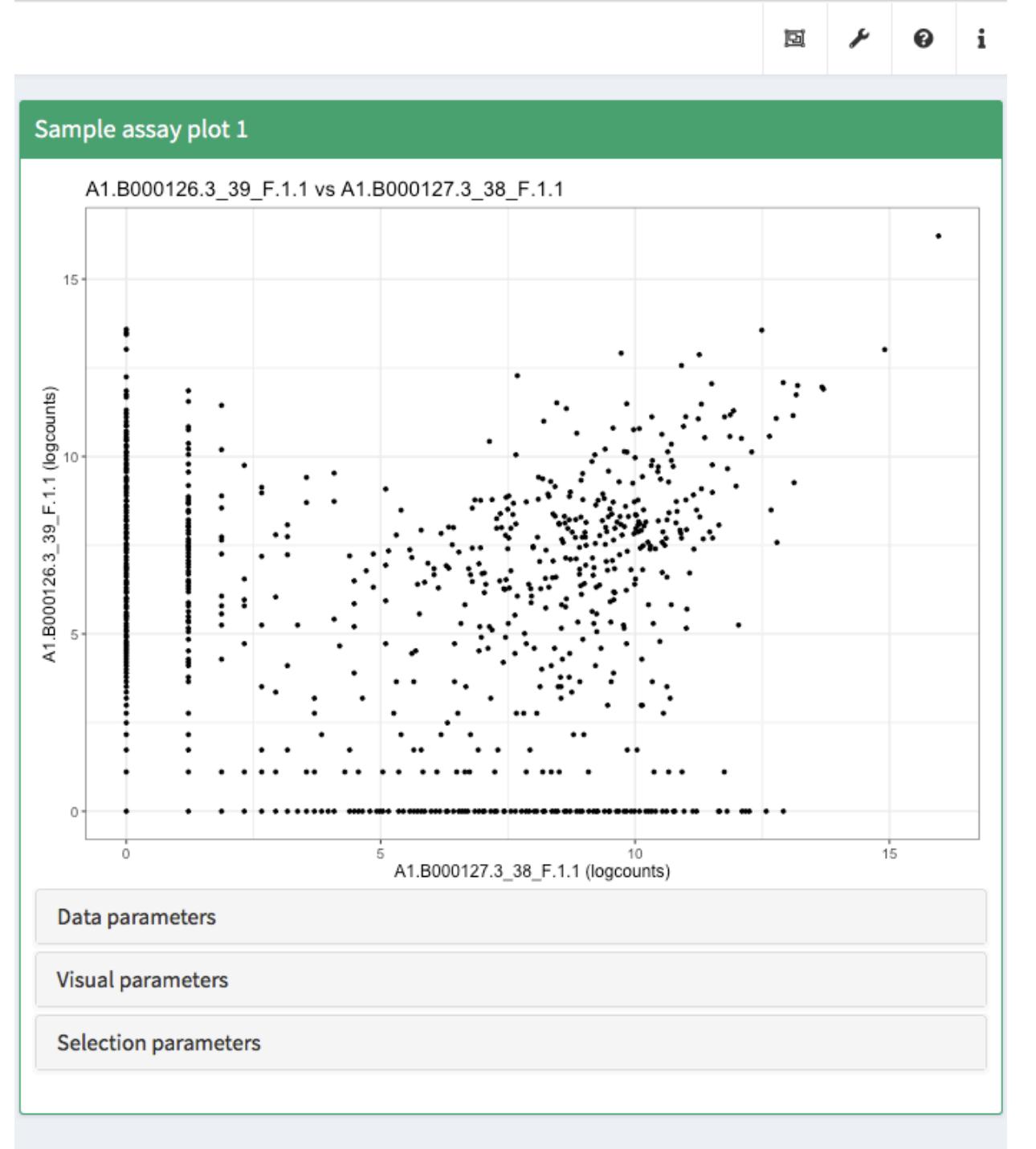
A1.B000126.3\_39\_F.1.1 vs A1.B000127.3\_38\_F.1.1

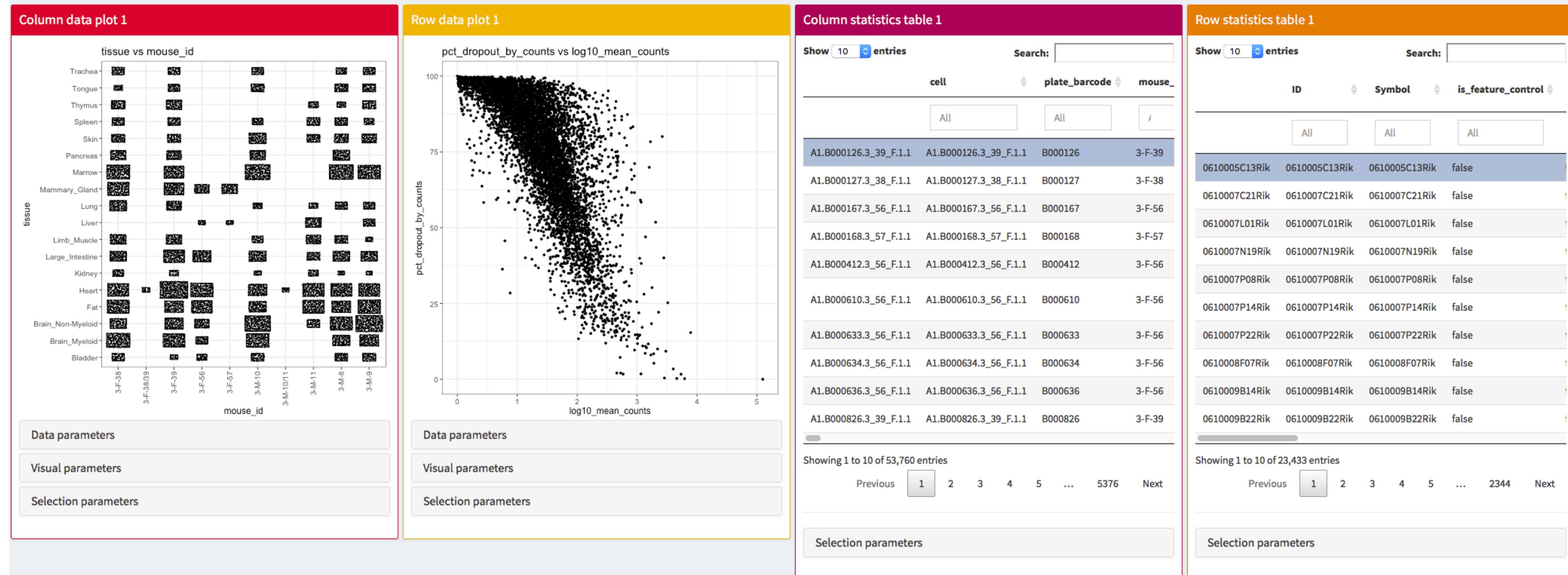
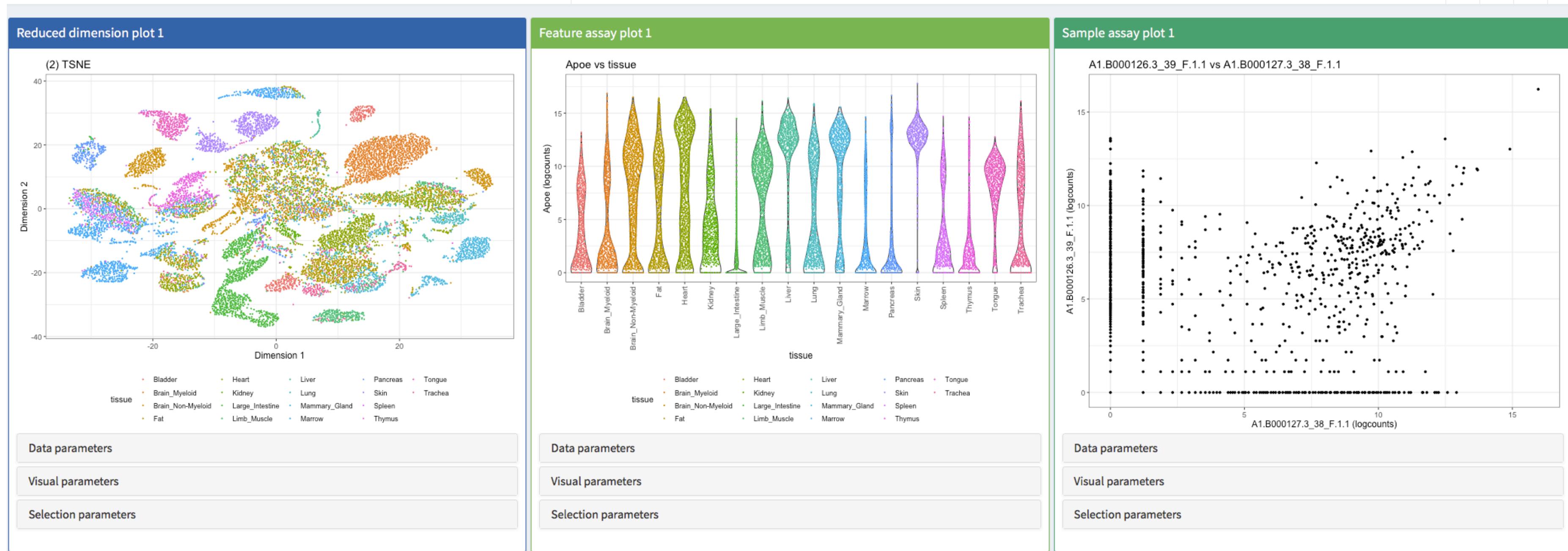


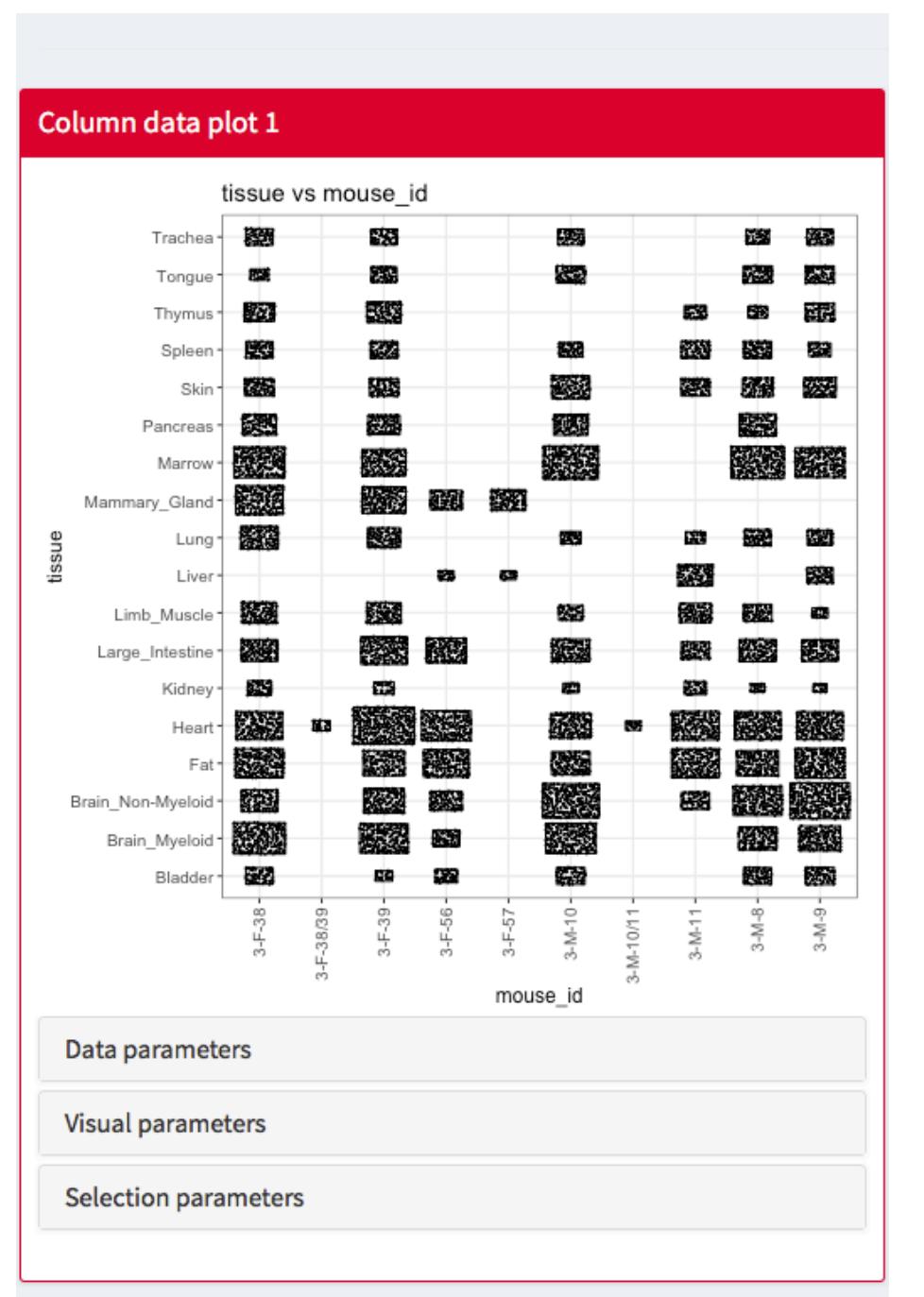
Data parameters

Visual parameters

Selection parameters

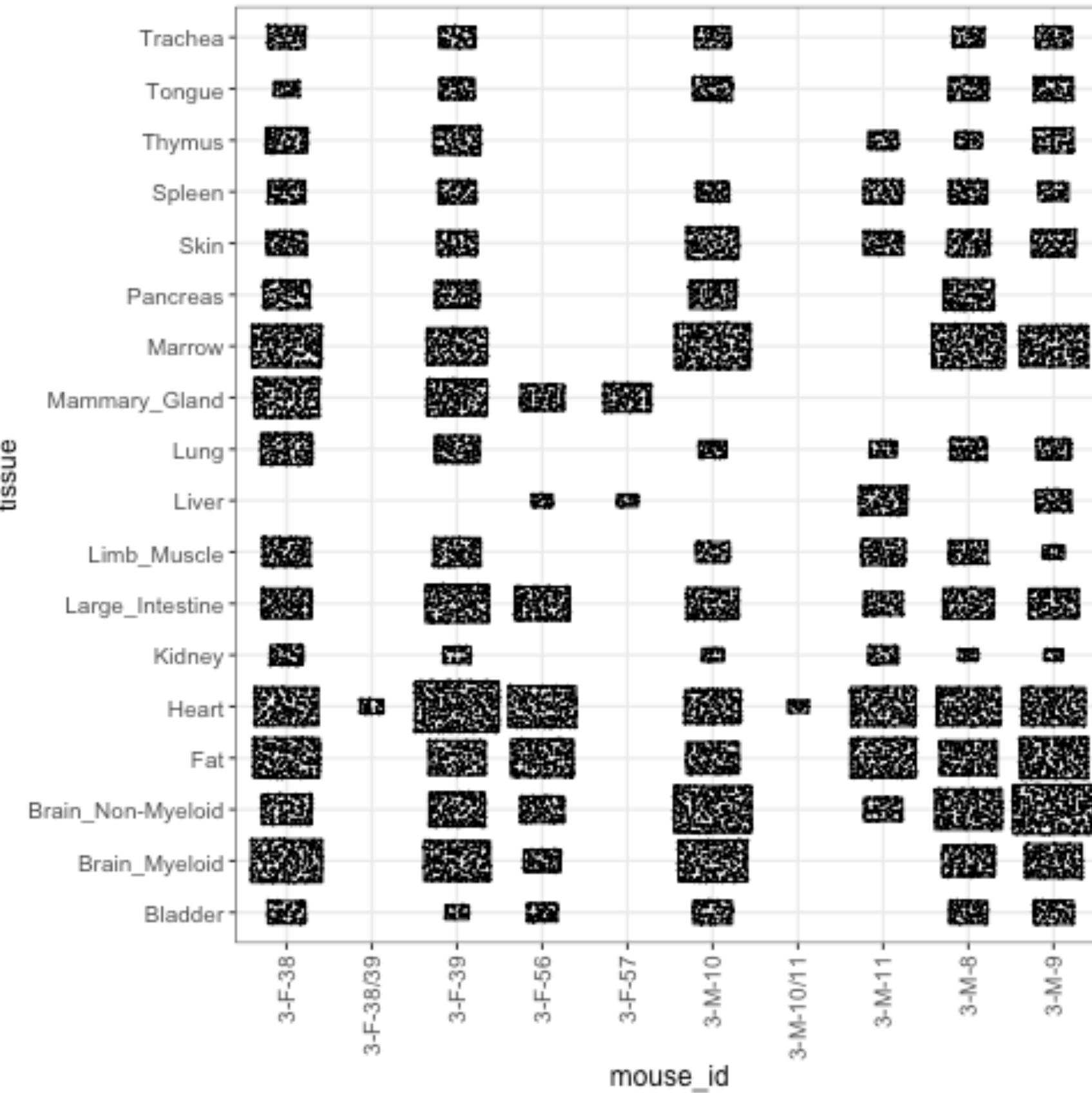






## Column data plot 1

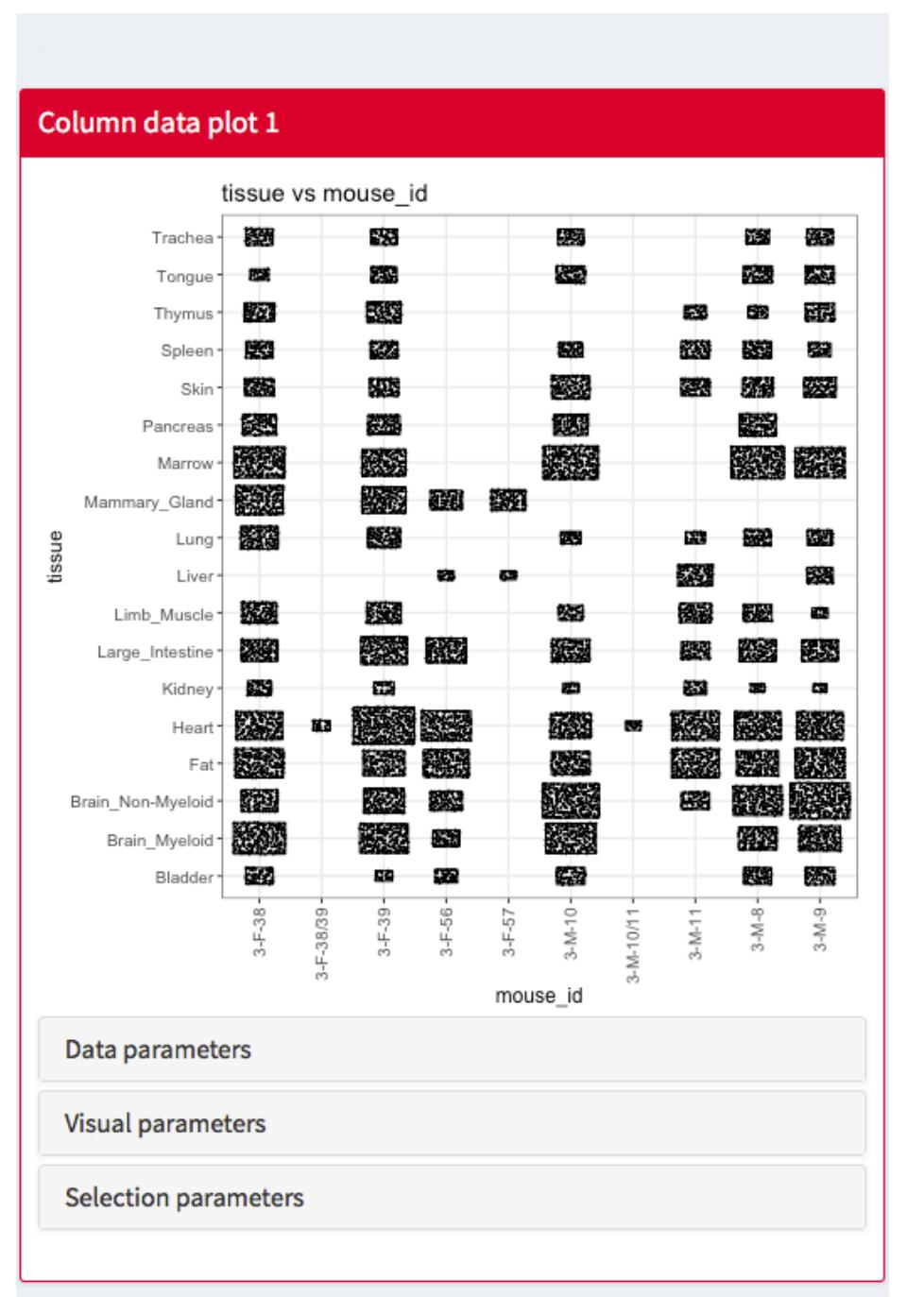
tissue vs mouse\_id

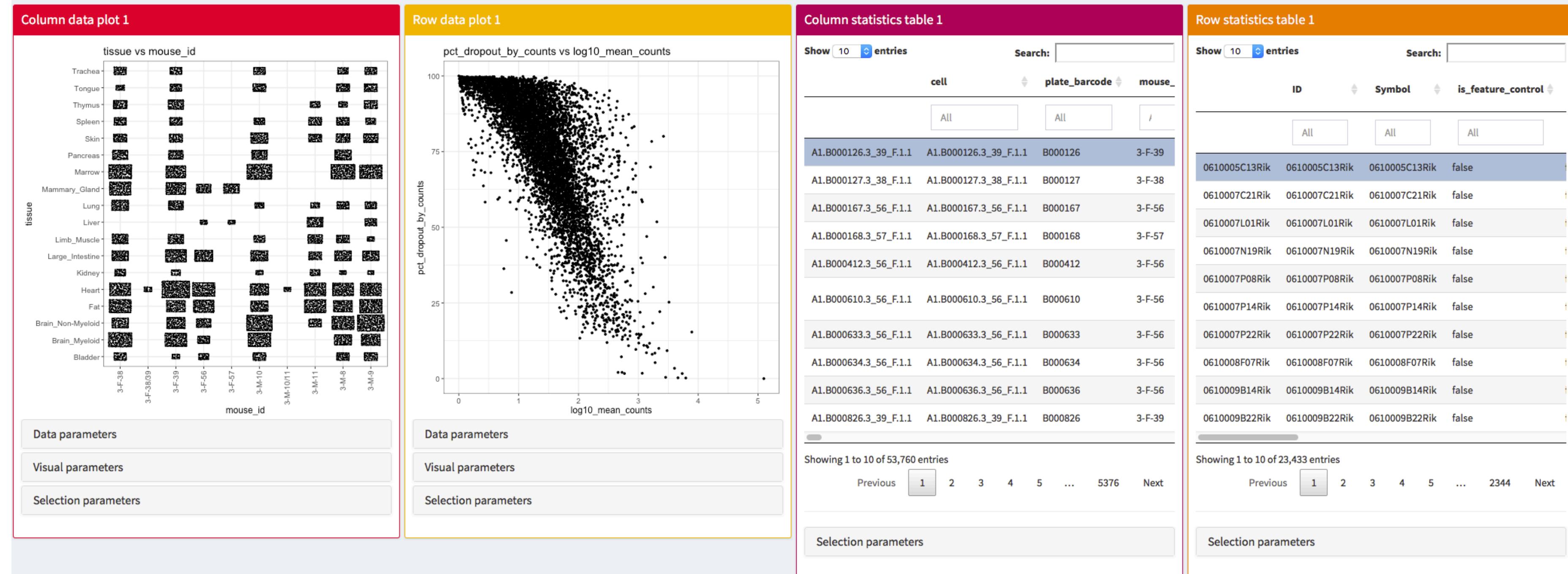
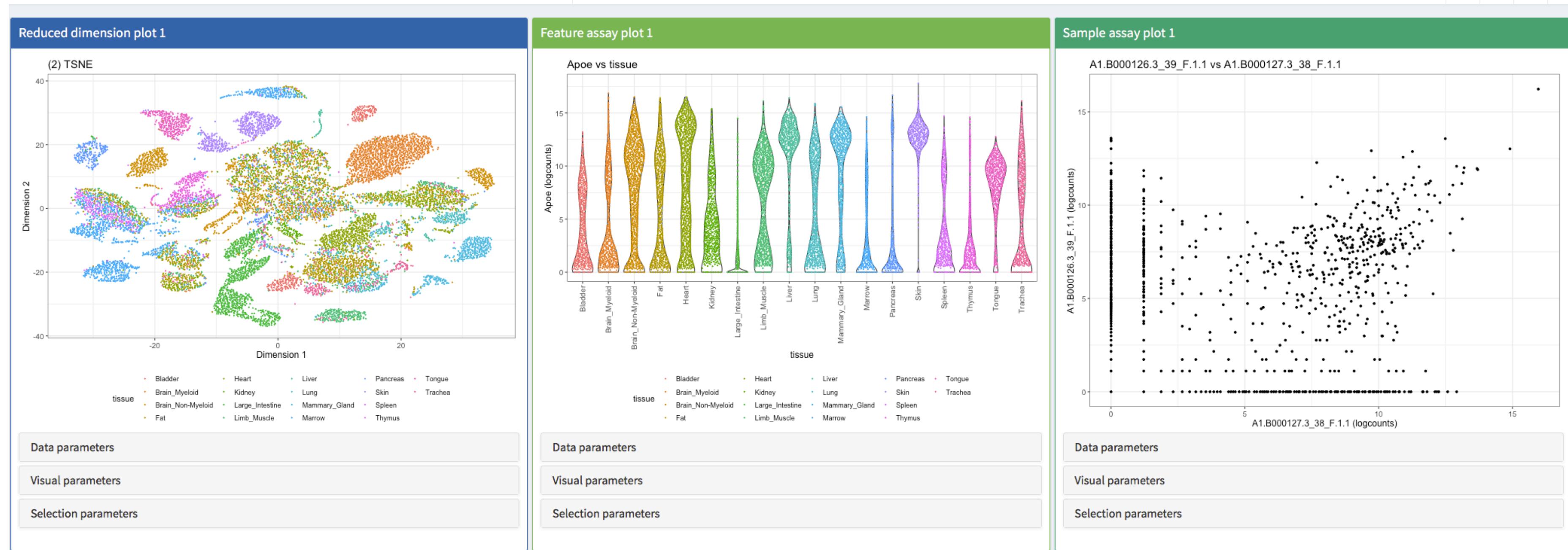


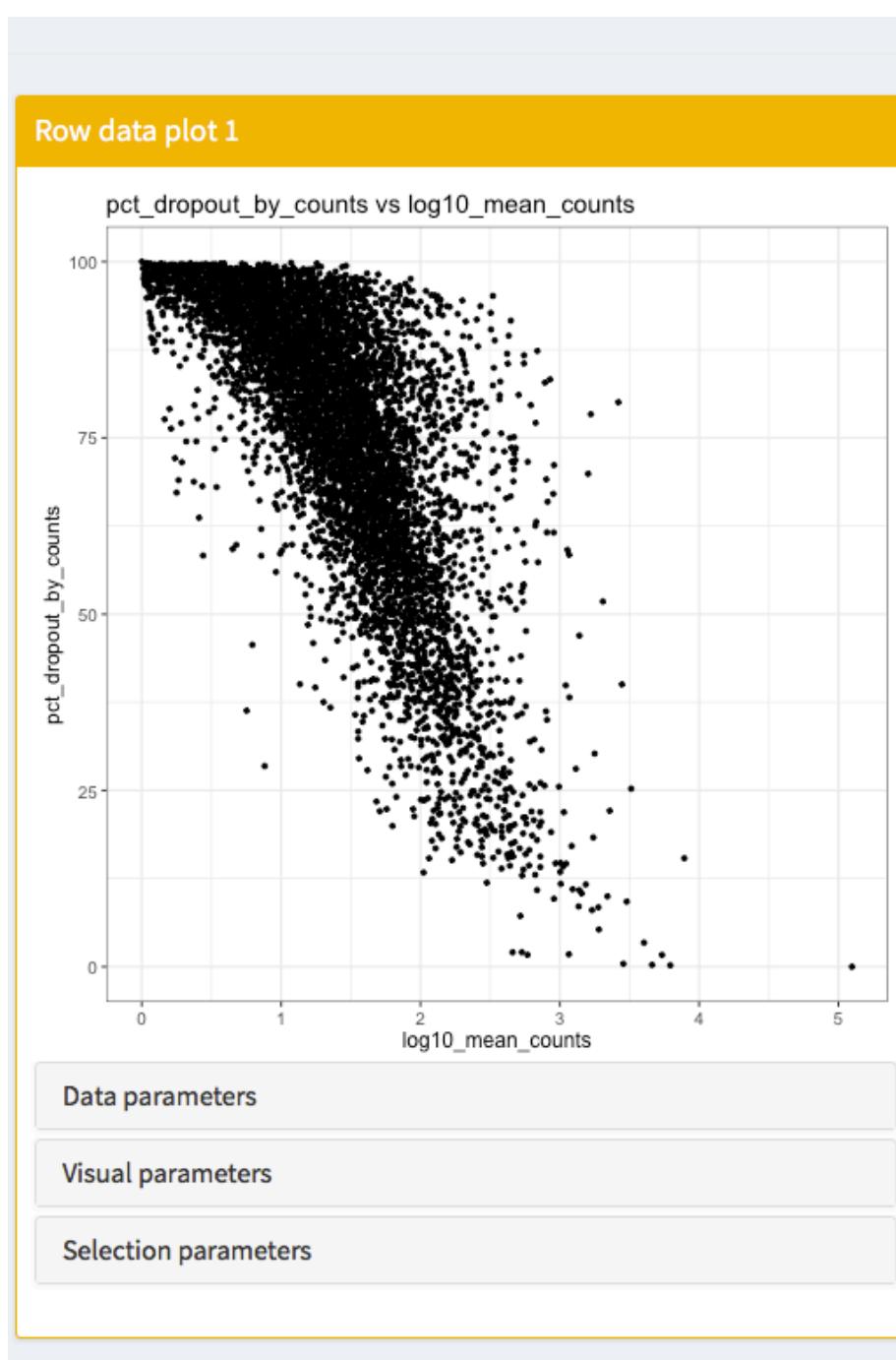
Data parameters

Visual parameters

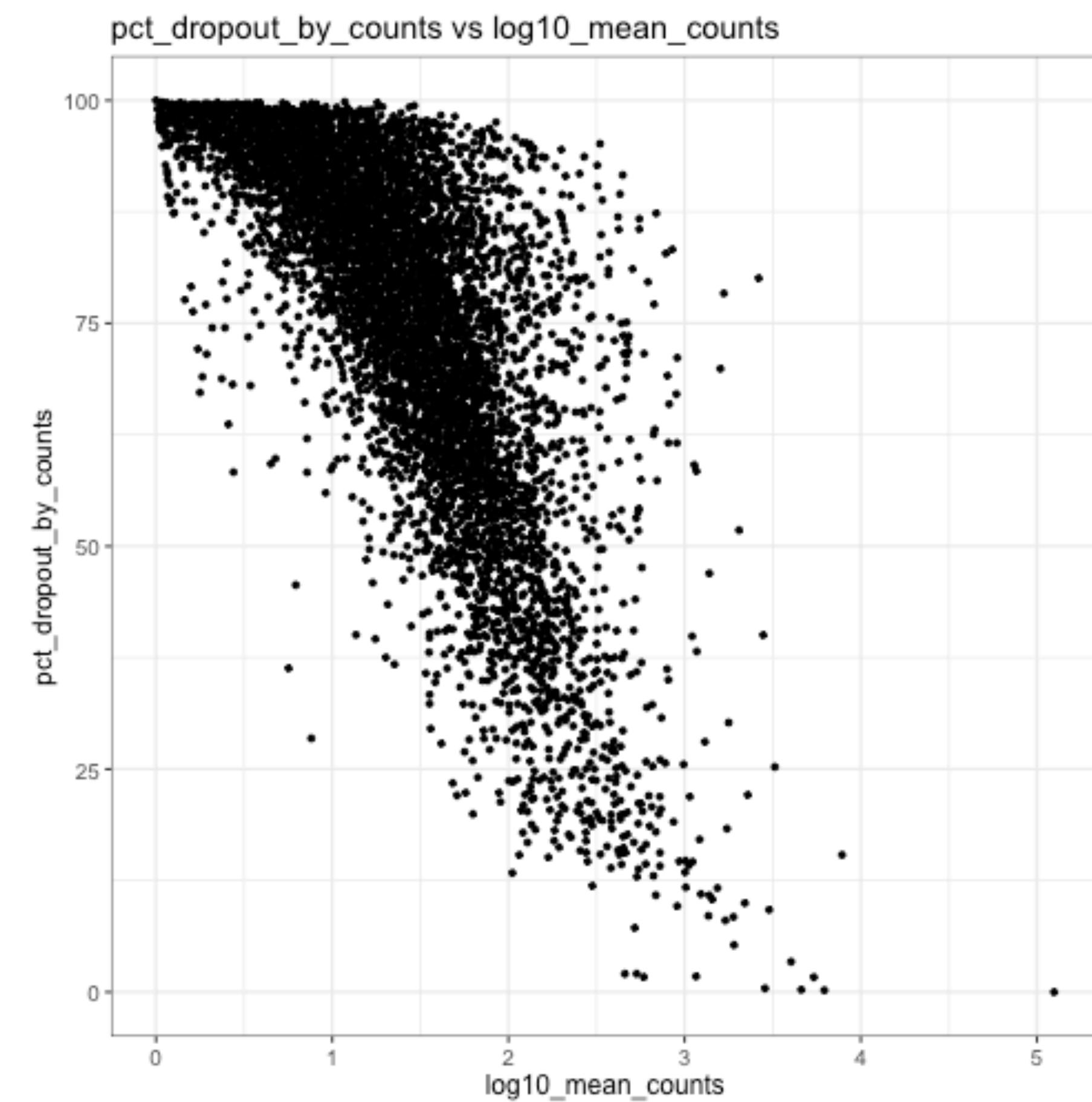
Selection parameters







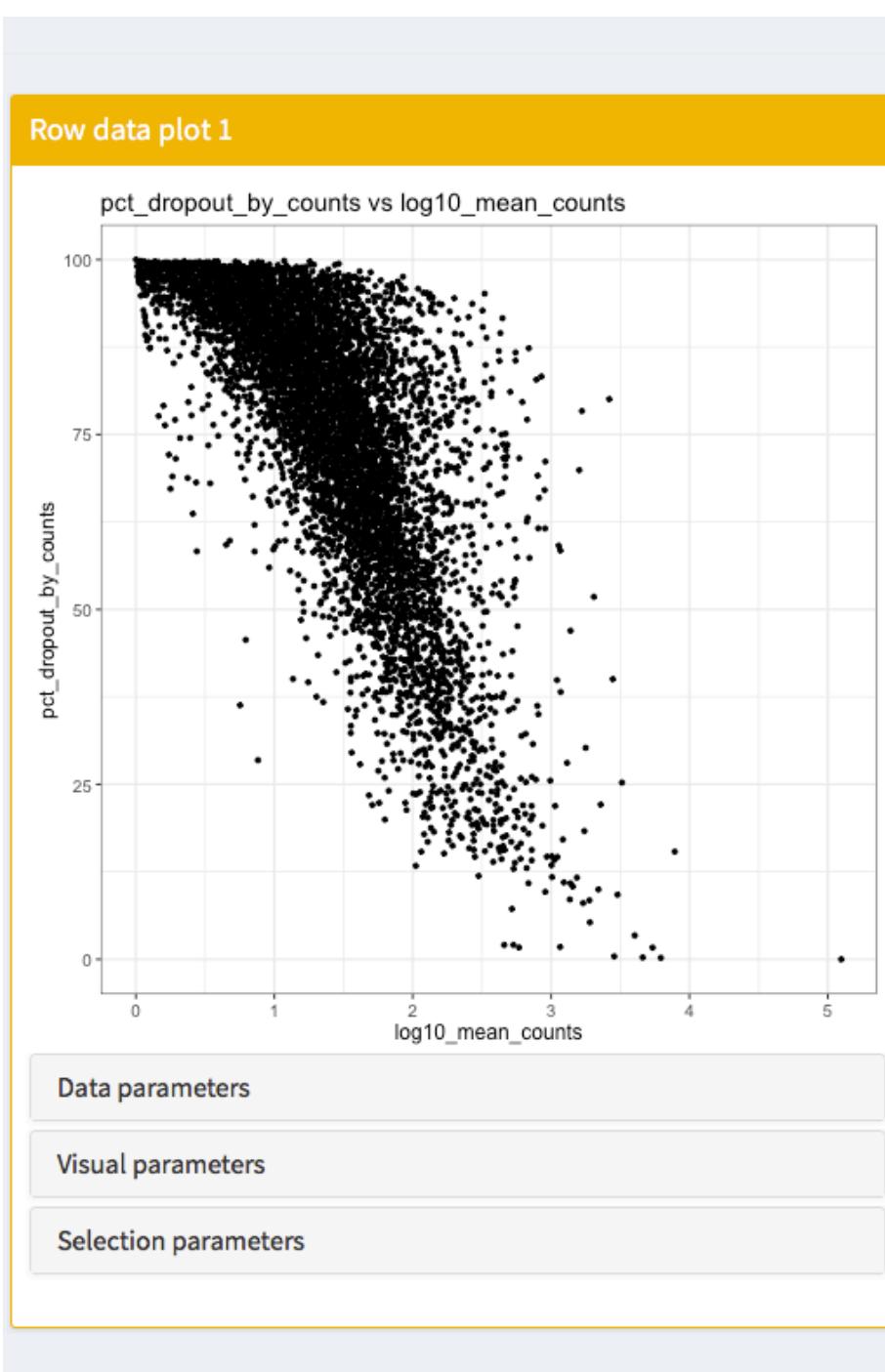
## Row data plot 1

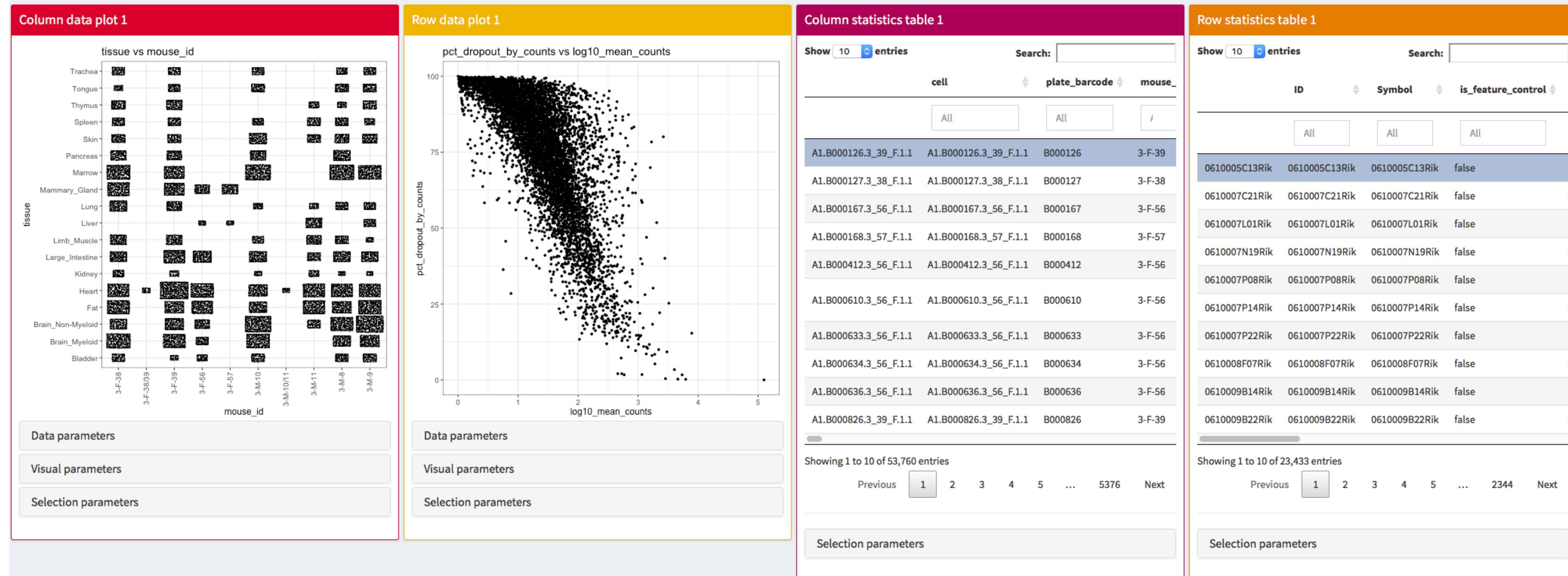
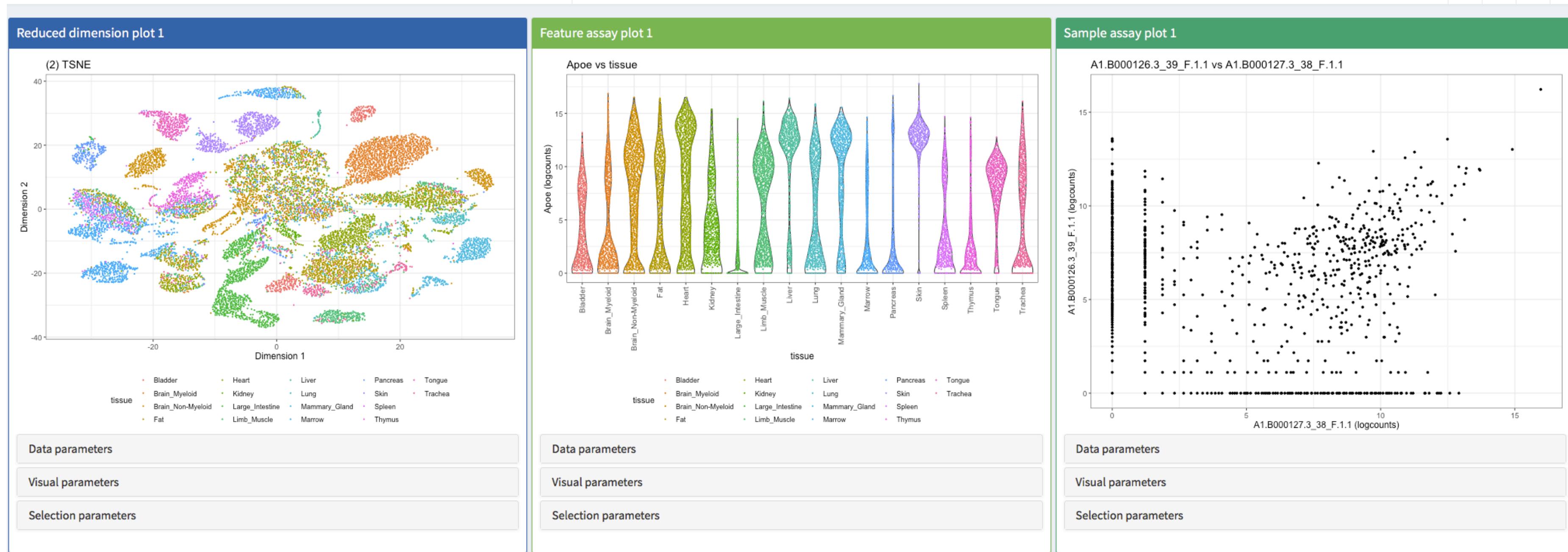


Data parameters

Visual parameters

Selection parameters





**Column statistics table 1**

Search: <input type="text"/>			
cell	plate_barcode	mouse_	
All	All	/	
A1.B000126.3_39_F.1.1	A1.B000126.3_39_F.1.1	B000126	3-F-39
A1.B000127.3_38_F.1.1	A1.B000127.3_38_F.1.1	B000127	3-F-38
A1.B000167.3_56_F.1.1	A1.B000167.3_56_F.1.1	B000167	3-F-56
A1.B000168.3_57_F.1.1	A1.B000168.3_57_F.1.1	B000168	3-F-57
A1.B000412.3_56_F.1.1	A1.B000412.3_56_F.1.1	B000412	3-F-56
A1.B000610.3_56_F.1.1	A1.B000610.3_56_F.1.1	B000610	3-F-56
A1.B000633.3_56_F.1.1	A1.B000633.3_56_F.1.1	B000633	3-F-56
A1.B000634.3_56_F.1.1	A1.B000634.3_56_F.1.1	B000634	3-F-56
A1.B000636.3_56_F.1.1	A1.B000636.3_56_F.1.1	B000636	3-F-56
A1.B000826.3_39_F.1.1	A1.B000826.3_39_F.1.1	B000826	3-F-39

Show 10 entries Search:

Showing 1 to 10 of 53,760 entries

Previous 1 2 3 4 5 ... 5376 Next

Selection parameters

**Row statistics table 1**

Search: <input type="text"/>			
ID	Symbol	is_feature_control	
All	All	All	
0610005C13Rik	0610005C13Rik	0610005C13Rik	false
0610007C21Rik	0610007C21Rik	0610007C21Rik	false
0610007L01Rik	0610007L01Rik	0610007L01Rik	false
0610007N19Rik	0610007N19Rik	0610007N19Rik	false
0610007P08Rik	0610007P08Rik	0610007P08Rik	false
0610007P14Rik	0610007P14Rik	0610007P14Rik	false
0610007P22Rik	0610007P22Rik	0610007P22Rik	false
0610008F07Rik	0610008F07Rik	0610008F07Rik	false
0610009B14Rik	0610009B14Rik	0610009B14Rik	false
0610009B22Rik	0610009B22Rik	0610009B22Rik	false

Show 10 entries Search:

Showing 1 to 10 of 23,433 entries

Previous 1 2 3 4 5 ... 2344 Next

Selection parameters

### Column statistics table 1

Show 10 entries

Search:

cell	plate_barcode	mouse_	
All	All	/	
A1.B000126.3_39_F.1.1	A1.B000126.3_39_F.1.1	B000126	3-F-39
A1.B000127.3_38_F.1.1	A1.B000127.3_38_F.1.1	B000127	3-F-38
A1.B000167.3_56_F.1.1	A1.B000167.3_56_F.1.1	B000167	3-F-56
A1.B000168.3_57_F.1.1	A1.B000168.3_57_F.1.1	B000168	3-F-57
A1.B000412.3_56_F.1.1	A1.B000412.3_56_F.1.1	B000412	3-F-56
A1.B000610.3_56_F.1.1	A1.B000610.3_56_F.1.1	B000610	3-F-56
A1.B000633.3_56_F.1.1	A1.B000633.3_56_F.1.1	B000633	3-F-56
A1.B000634.3_56_F.1.1	A1.B000634.3_56_F.1.1	B000634	3-F-56
A1.B000636.3_56_F.1.1	A1.B000636.3_56_F.1.1	B000636	3-F-56
A1.B000826.3_39_F.1.1	A1.B000826.3_39_F.1.1	B000826	3-F-39

Showing 1 to 10 of 53,760 entries

Previous

1

2

3

4

5

...

5376

Next

Selection parameters

### Row statistics table 1

Show 10 entries

Search:

ID	Symbol	is_feature_control	
All	All	All	
0610005C13Rik	0610005C13Rik	0610005C13Rik	false
0610007C21Rik	0610007C21Rik	0610007C21Rik	false
0610007L01Rik	0610007L01Rik	0610007L01Rik	false
0610007N19Rik	0610007N19Rik	0610007N19Rik	false
0610007P08Rik	0610007P08Rik	0610007P08Rik	false
0610007P14Rik	0610007P14Rik	0610007P14Rik	false
0610007P22Rik	0610007P22Rik	0610007P22Rik	false
0610008F07Rik	0610008F07Rik	0610008F07Rik	false
0610009B14Rik	0610009B14Rik	0610009B14Rik	false
0610009B22Rik	0610009B22Rik	0610009B22Rik	false

Showing 1 to 10 of 23,433 entries

Previous

1

2

3

4

5

...

2344

Next

Selection parameters

**Column statistics table 1**

Show	10	entries	Search:
cell			plate_barcode
mouse_			mouse
All	All	/	
A1.B000126.3_39_F.1.1	A1.B000126.3_39_F.1.1	B000126	3-F-39
A1.B000127.3_38_F.1.1	A1.B000127.3_38_F.1.1	B000127	3-F-38
A1.B000167.3_56_F.1.1	A1.B000167.3_56_F.1.1	B000167	3-F-56
A1.B000168.3_57_F.1.1	A1.B000168.3_57_F.1.1	B000168	3-F-57
A1.B000412.3_56_F.1.1	A1.B000412.3_56_F.1.1	B000412	3-F-56
A1.B000610.3_56_F.1.1	A1.B000610.3_56_F.1.1	B000610	3-F-56
A1.B000633.3_56_F.1.1	A1.B000633.3_56_F.1.1	B000633	3-F-56
A1.B000634.3_56_F.1.1	A1.B000634.3_56_F.1.1	B000634	3-F-56
A1.B000636.3_56_F.1.1	A1.B000636.3_56_F.1.1	B000636	3-F-56
A1.B000826.3_39_F.1.1	A1.B000826.3_39_F.1.1	B000826	3-F-39

Showing 1 to 10 of 53,760 entries

Previous 1 2 3 4 5 ... 5376 Next

Selection parameters

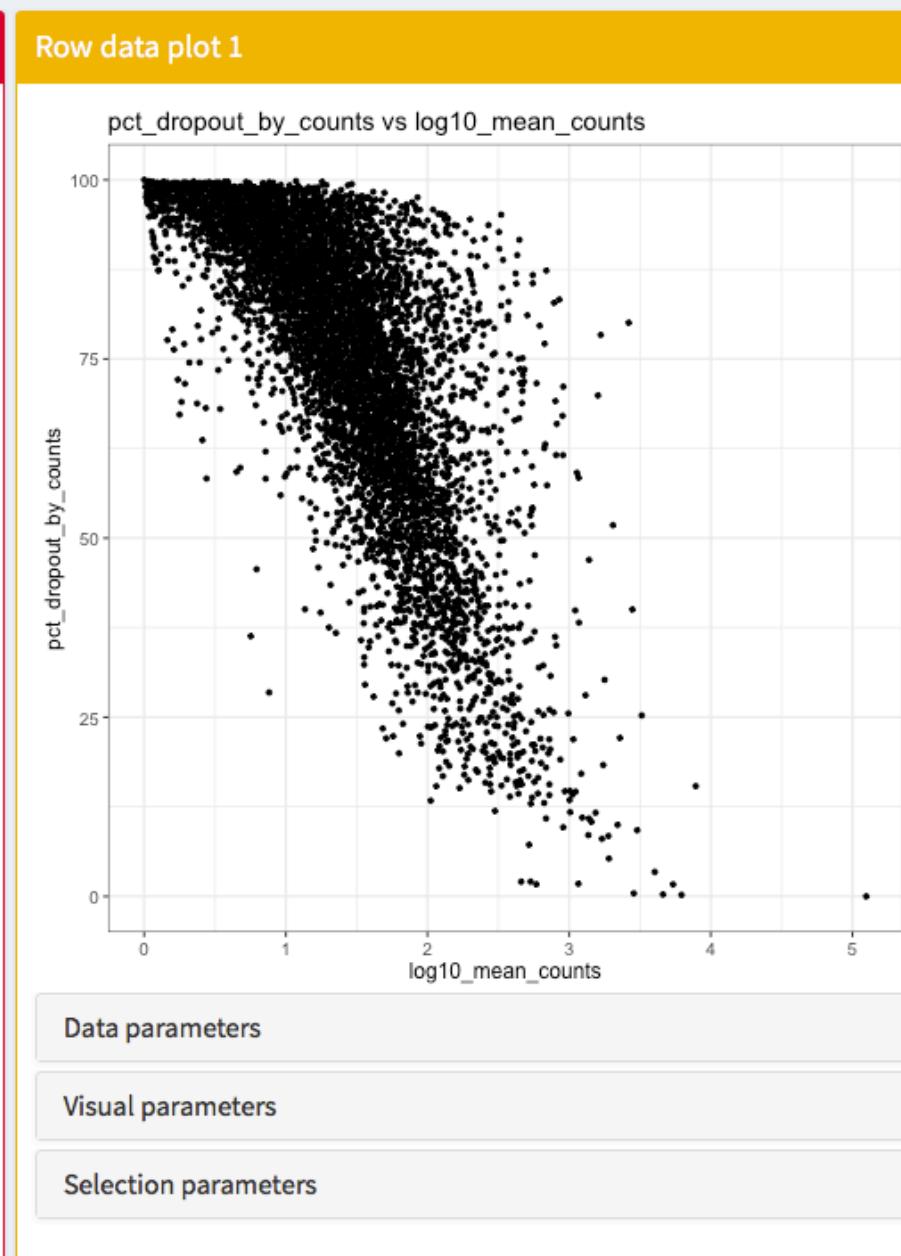
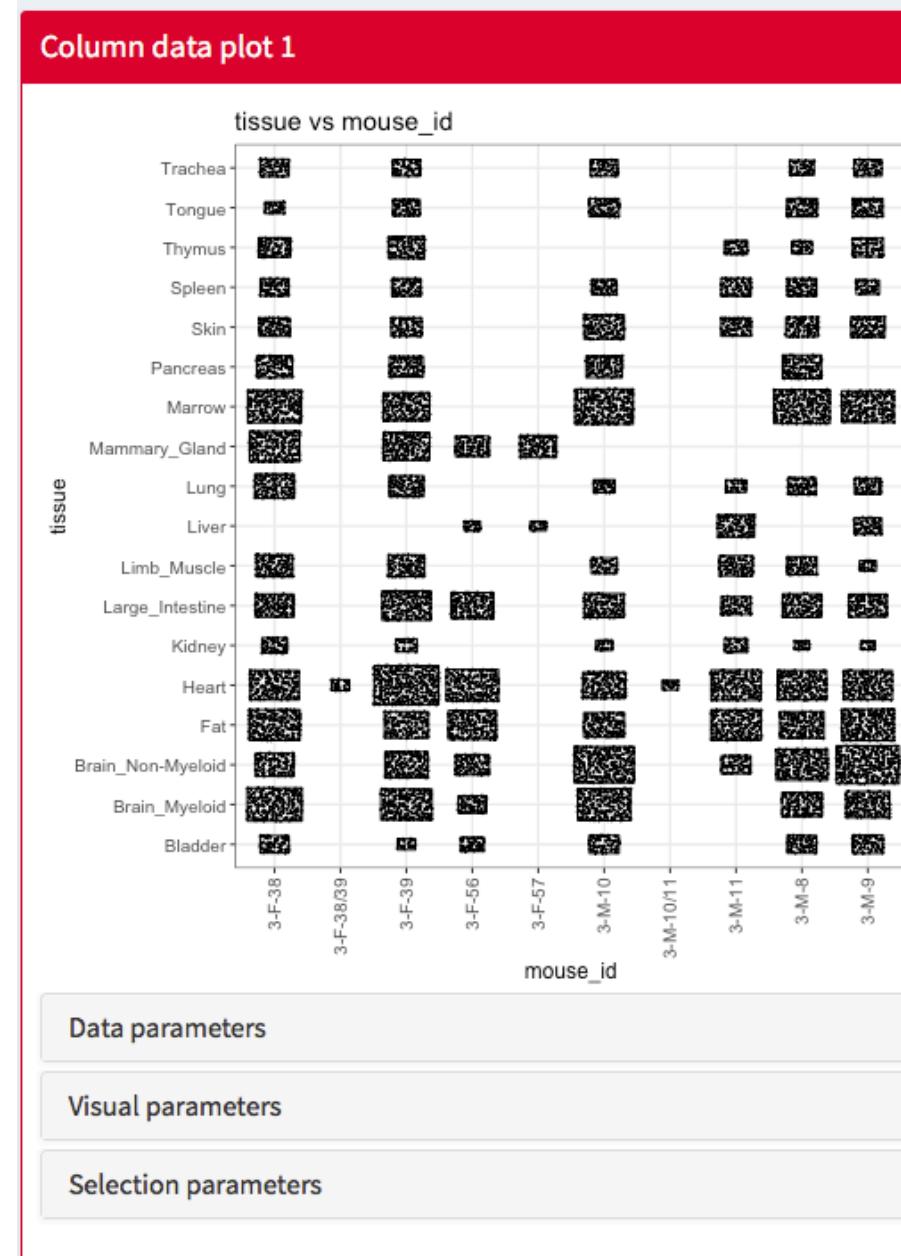
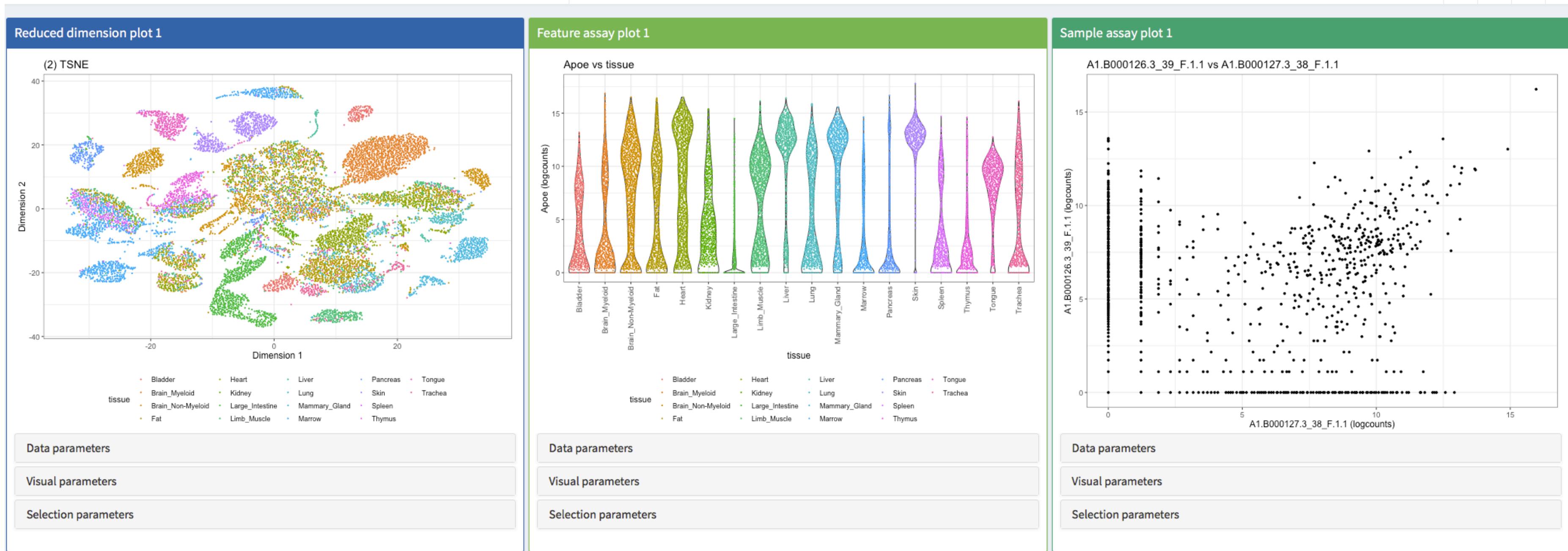
**Row statistics table 1**

Show	10	entries	Search:
ID			Symbol
			is_feature_control
All	All	All	
0610005C13Rik	0610005C13Rik	0610005C13Rik	false
0610007C21Rik	0610007C21Rik	0610007C21Rik	false
0610007L01Rik	0610007L01Rik	0610007L01Rik	false
0610007N19Rik	0610007N19Rik	0610007N19Rik	false
0610007P08Rik	0610007P08Rik	0610007P08Rik	false
0610007P14Rik	0610007P14Rik	0610007P14Rik	false
0610007P22Rik	0610007P22Rik	0610007P22Rik	false
0610008F07Rik	0610008F07Rik	0610008F07Rik	false
0610009B14Rik	0610009B14Rik	0610009B14Rik	false
0610009B22Rik	0610009B22Rik	0610009B22Rik	false

Showing 1 to 10 of 23,433 entries

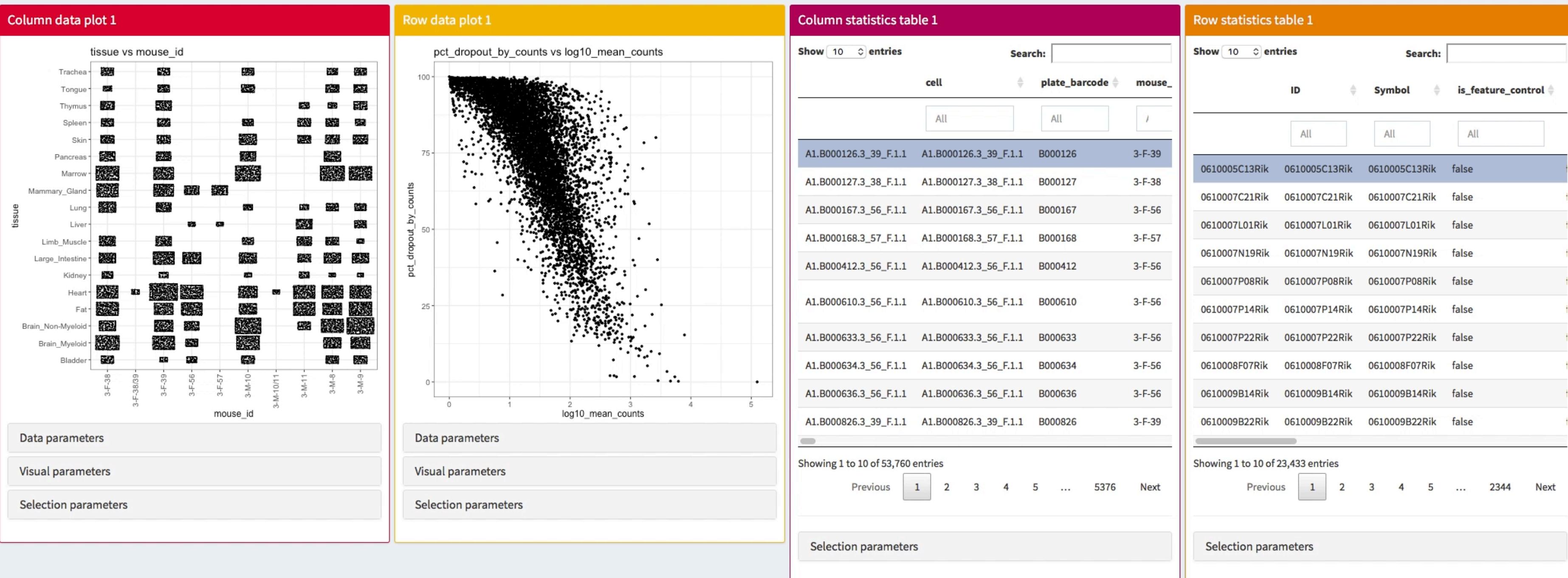
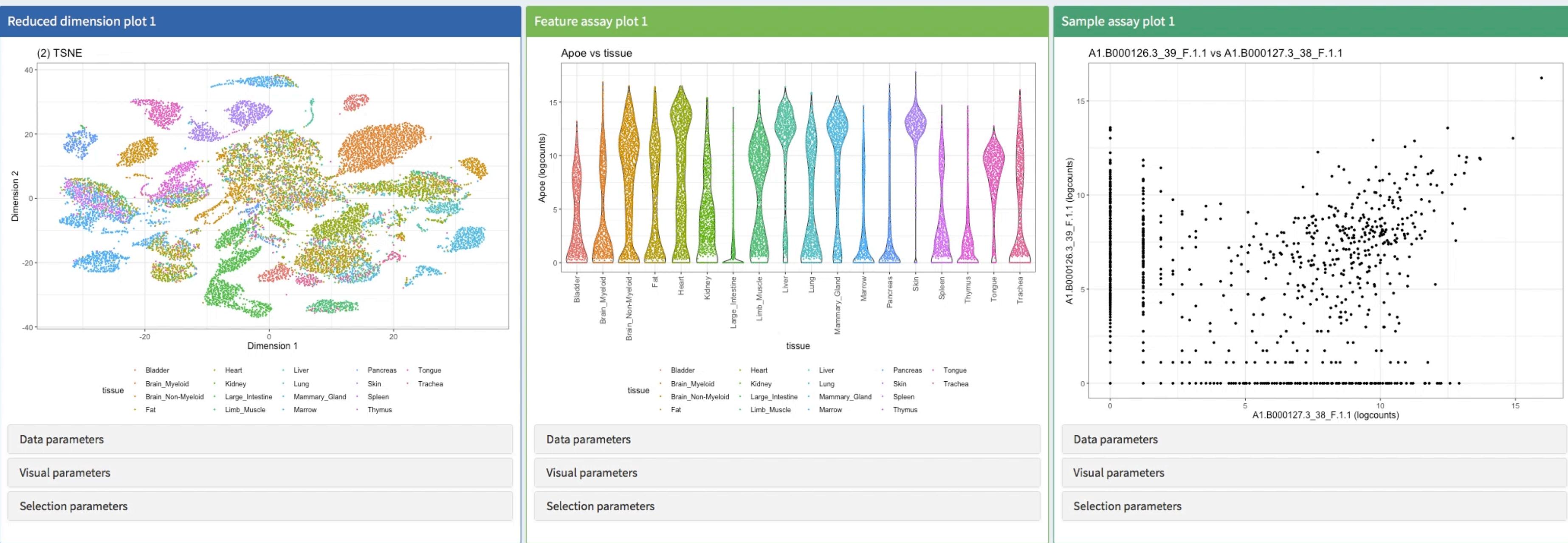
Previous 1 2 3 4 5 ... 2344 Next

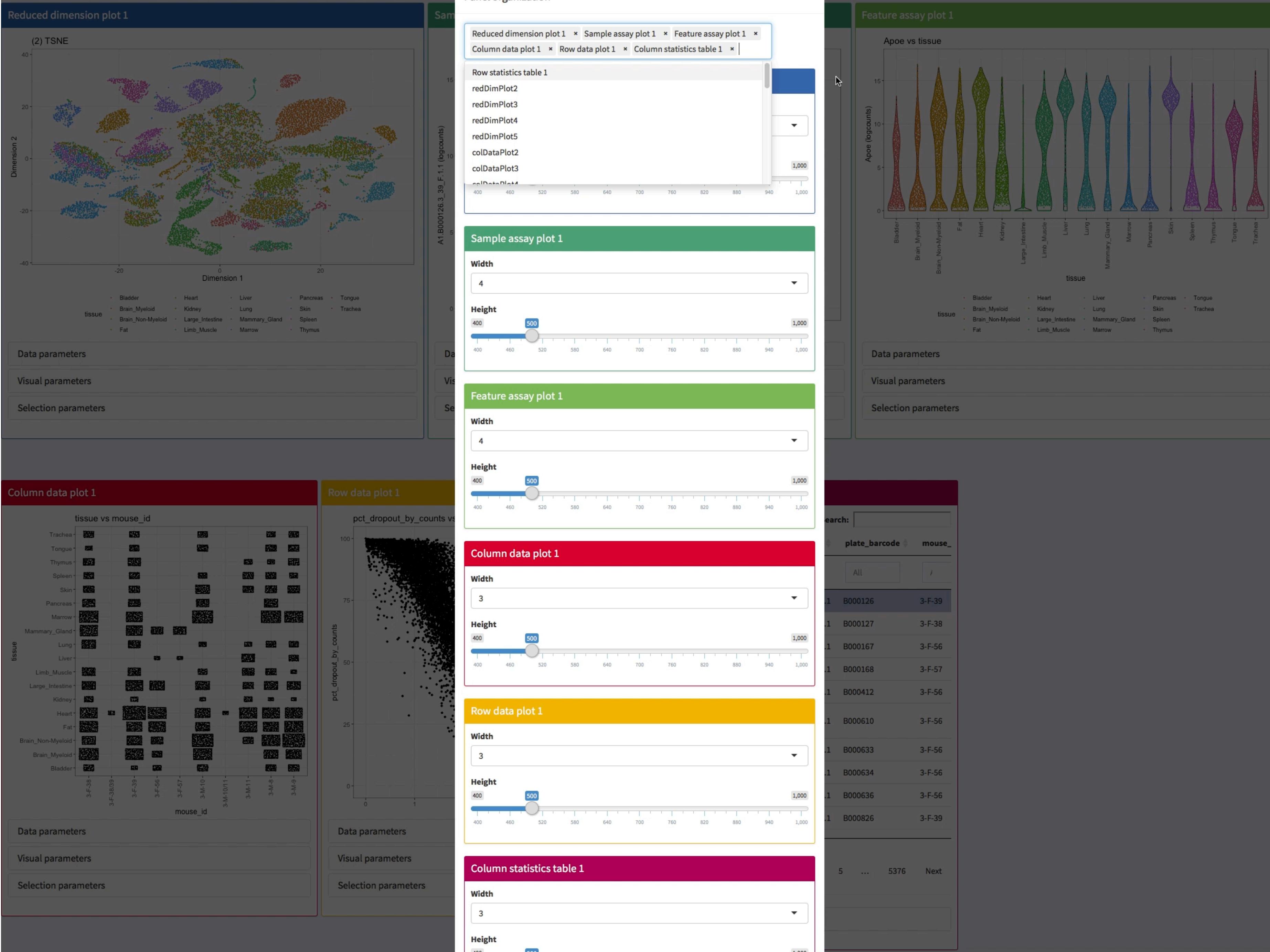
Selection parameters



Column statistics table 1			
Show	10	entries	Search:
cell	plate_barcode	mouse	
	All	All	/
A1.B000126.3_39_F.1.1	A1.B000126.3_39_F.1.1	B000126	3-F-39
A1.B000127.3_38_F.1.1	A1.B000127.3_38_F.1.1	B000127	3-F-38
A1.B000167.3_56_F.1.1	A1.B000167.3_56_F.1.1	B000167	3-F-56
A1.B000168.3_57_F.1.1	A1.B000168.3_57_F.1.1	B000168	3-F-57
A1.B000412.3_56_F.1.1	A1.B000412.3_56_F.1.1	B000412	3-F-56
A1.B000610.3_56_F.1.1	A1.B000610.3_56_F.1.1	B000610	3-F-56
A1.B000633.3_56_F.1.1	A1.B000633.3_56_F.1.1	B000633	3-F-56
A1.B000634.3_56_F.1.1	A1.B000634.3_56_F.1.1	B000634	3-F-56
A1.B000636.3_56_F.1.1	A1.B000636.3_56_F.1.1	B000636	3-F-56
A1.B000826.3_39_F.1.1	A1.B000826.3_39_F.1.1	B000826	3-F-39

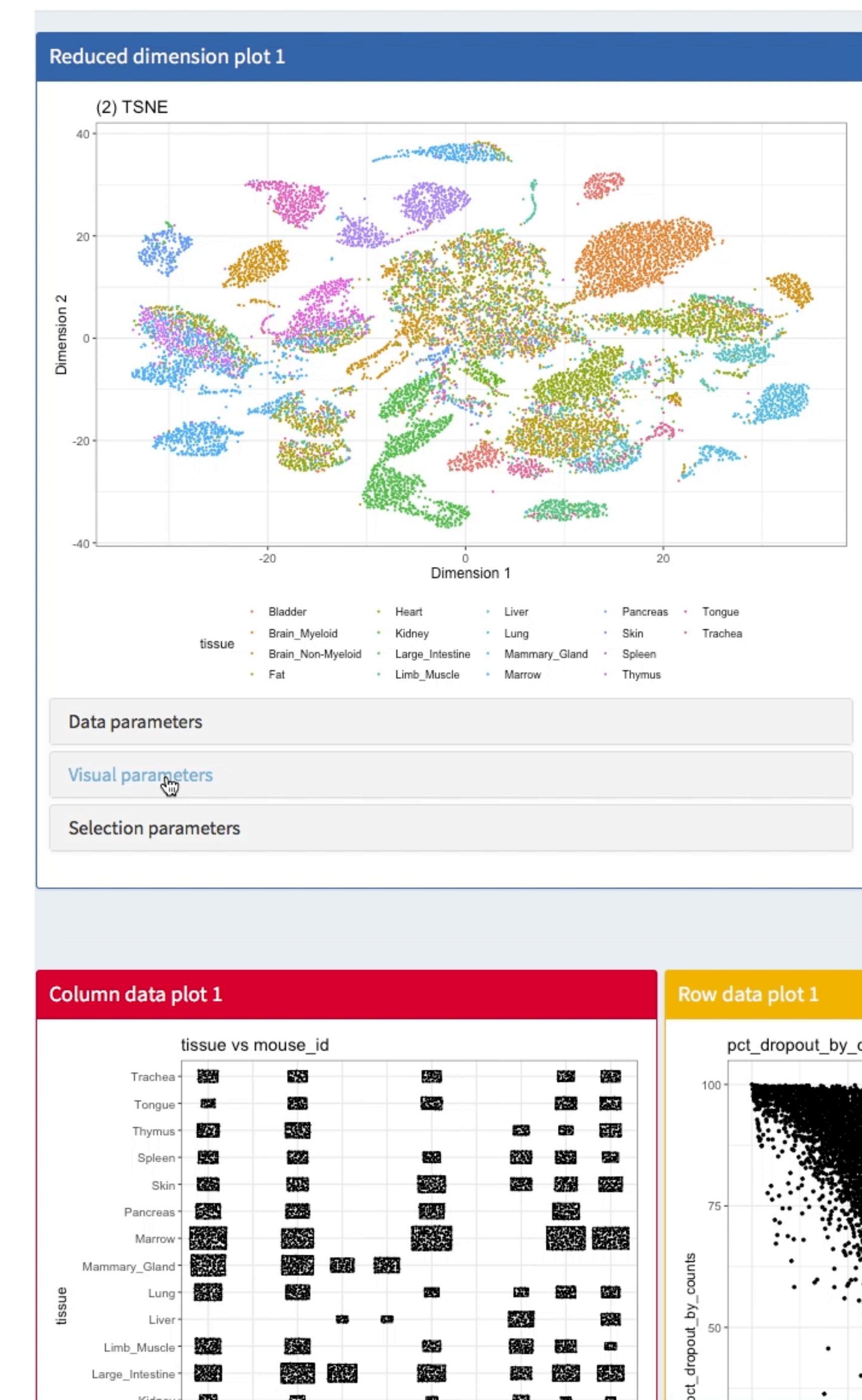
Row statistics table 1				
Show	10	entries	Search:	
ID	Symbol	is_feature_control		
All	All	All	All	All
0610005C13Rik	0610005C13Rik	0610005C13Rik	0610005C13Rik	false
0610007C21Rik	0610007C21Rik	0610007C21Rik	0610007C21Rik	false
0610007L01Rik	0610007L01Rik	0610007L01Rik	0610007L01Rik	false
0610007N19Rik	0610007N19Rik	0610007N19Rik	0610007N19Rik	false
0610007P08Rik	0610007P08Rik	0610007P08Rik	0610007P08Rik	false
0610007P14Rik	0610007P14Rik	0610007P14Rik	0610007P14Rik	false
0610007P22Rik	0610007P22Rik	0610007P22Rik	0610007P22Rik	false
0610008F07Rik	0610008F07Rik	0610008F07Rik	0610008F07Rik	false
0610009B14Rik	0610009B14Rik	0610009B14Rik	0610009B14Rik	false
0610009B22Rik	0610009B22Rik	0610009B22Rik	0610009B22Rik	false



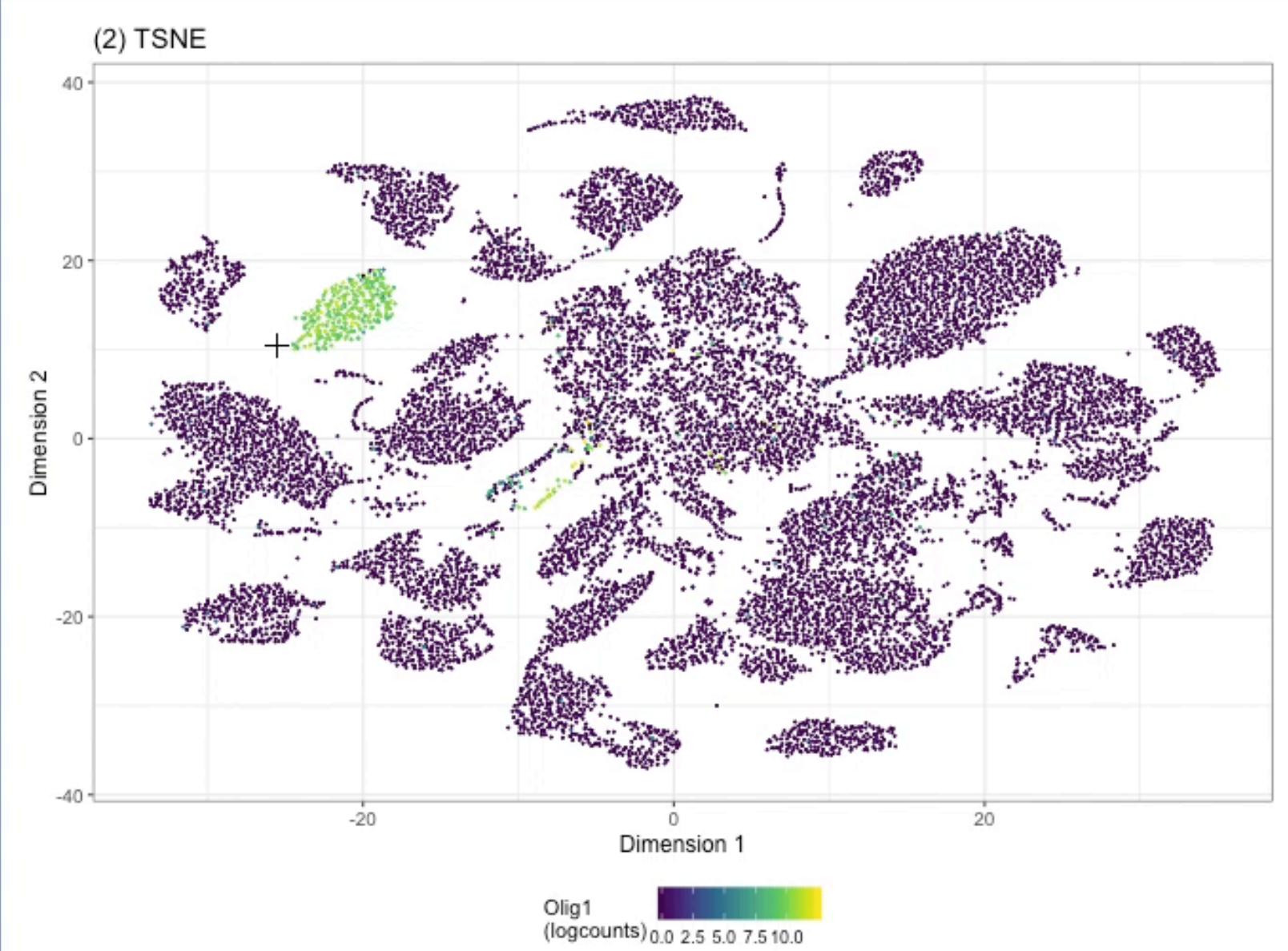


# Interactive data exploration enables hypothesis generation

- Overlay biological knowledge onto observed data
- Color cells by expression of known marker gene(s) to assign cell type labels
- Exploration of complex data is aided by multiple simultaneous viewpoints



## Reduced dimension plot 1



Data parameters

Visual parameters

Selection parameters

Receive column selection from:

---

Active  Union  Saved

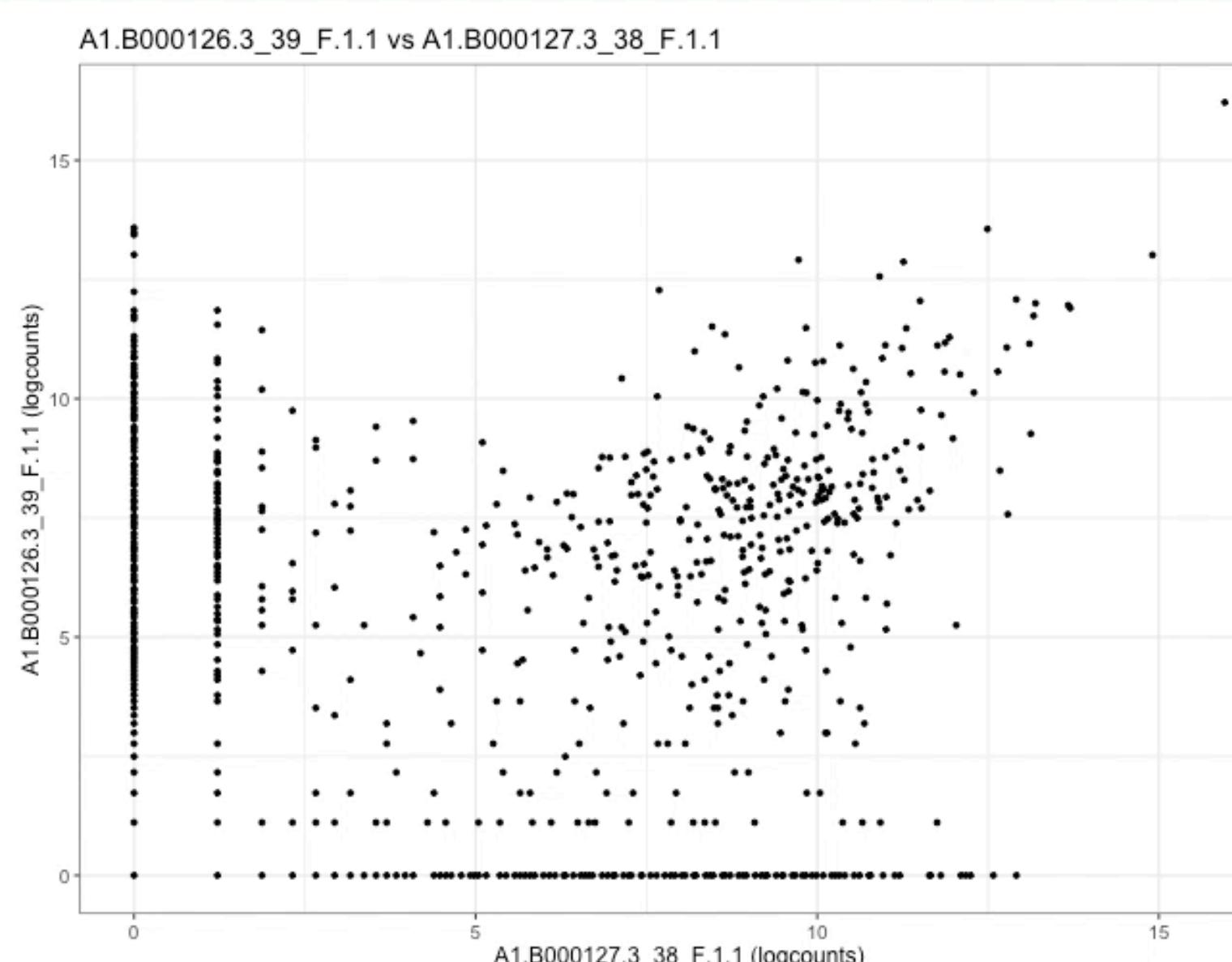
Selection effect:

 Restrict  Color  Transparent

Manage multiple selections:

No selection No history

## Sample assay plot 1

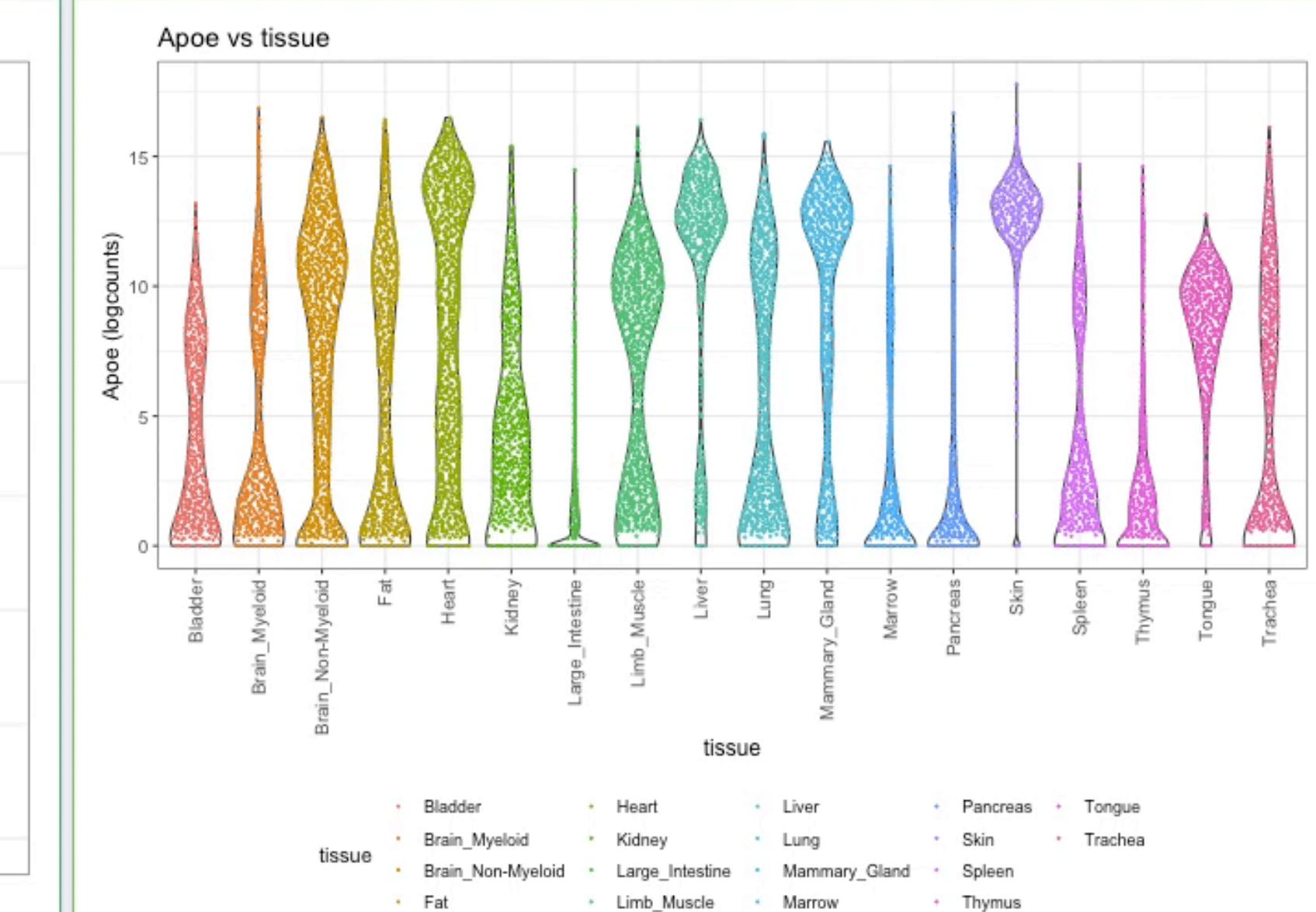


Data parameters

Visual parameters

Selection parameters

## Feature assay plot 1



Data parameters

Visual parameters

Selection parameters

Receive column selection from:

---

 Active  Union  Saved

Selection effect:

 Restrict  Color  Transparent

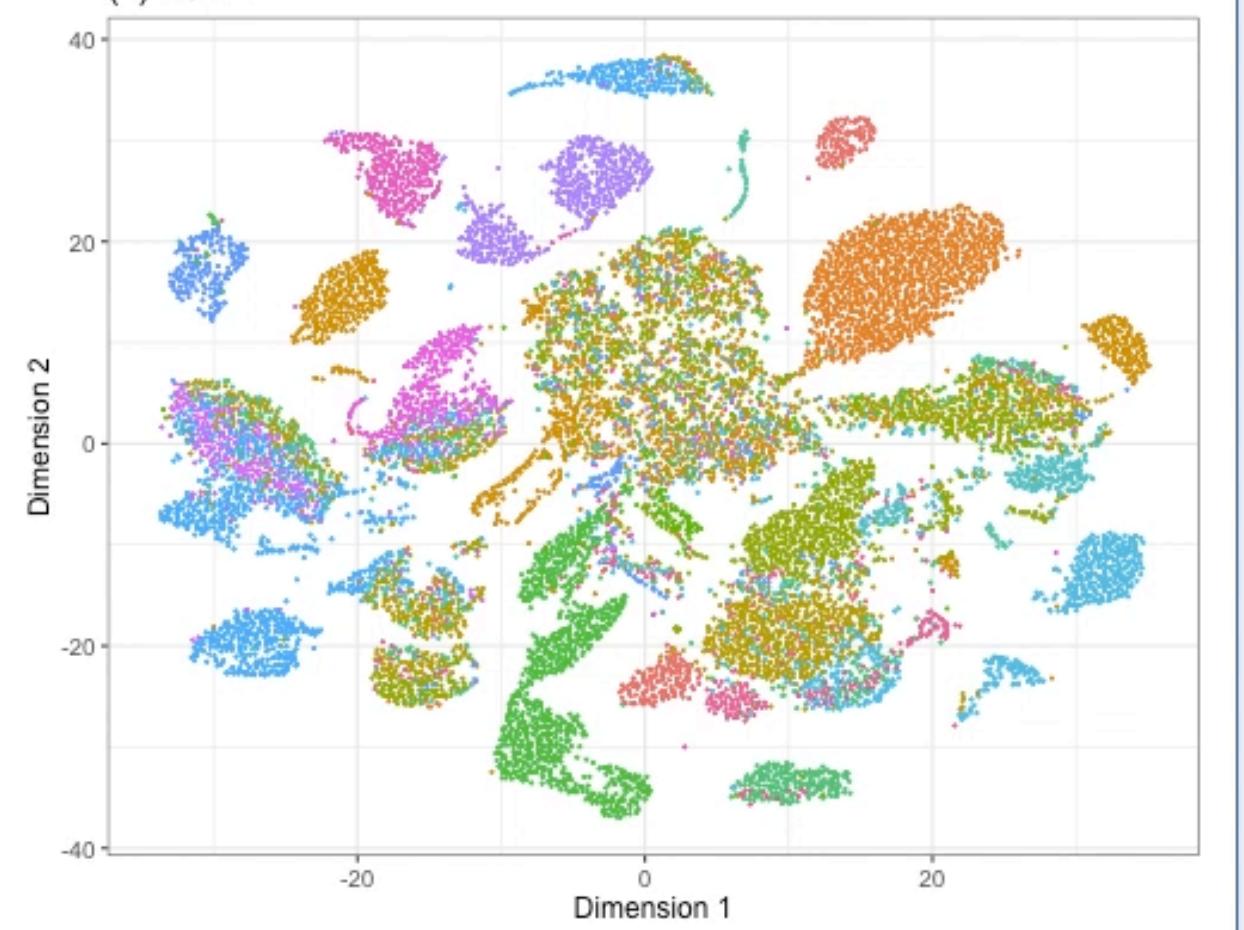
Manage multiple selections:

No selection No history

Transmitting selection to Column data plot 1

## Reduced dimension plot 1

(2) TSNE



Data parameters

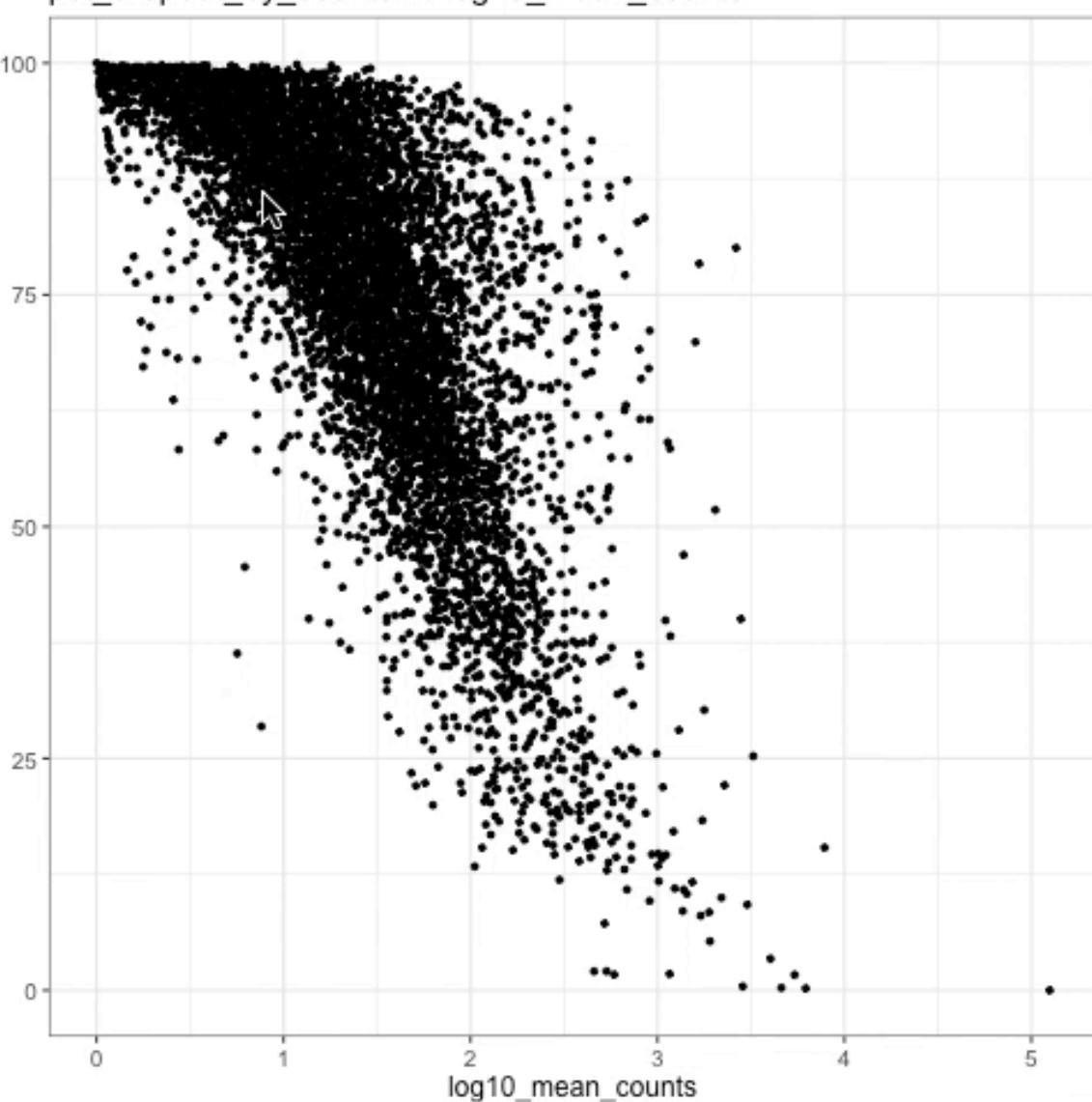
Visual parameters

Selection parameters

Transmitting selection to *Custom data plot 1*Transmitting selection to *Custom statistics table 1*

## Row data plot 1

pct\_dropout\_by\_counts vs log10\_mean\_counts



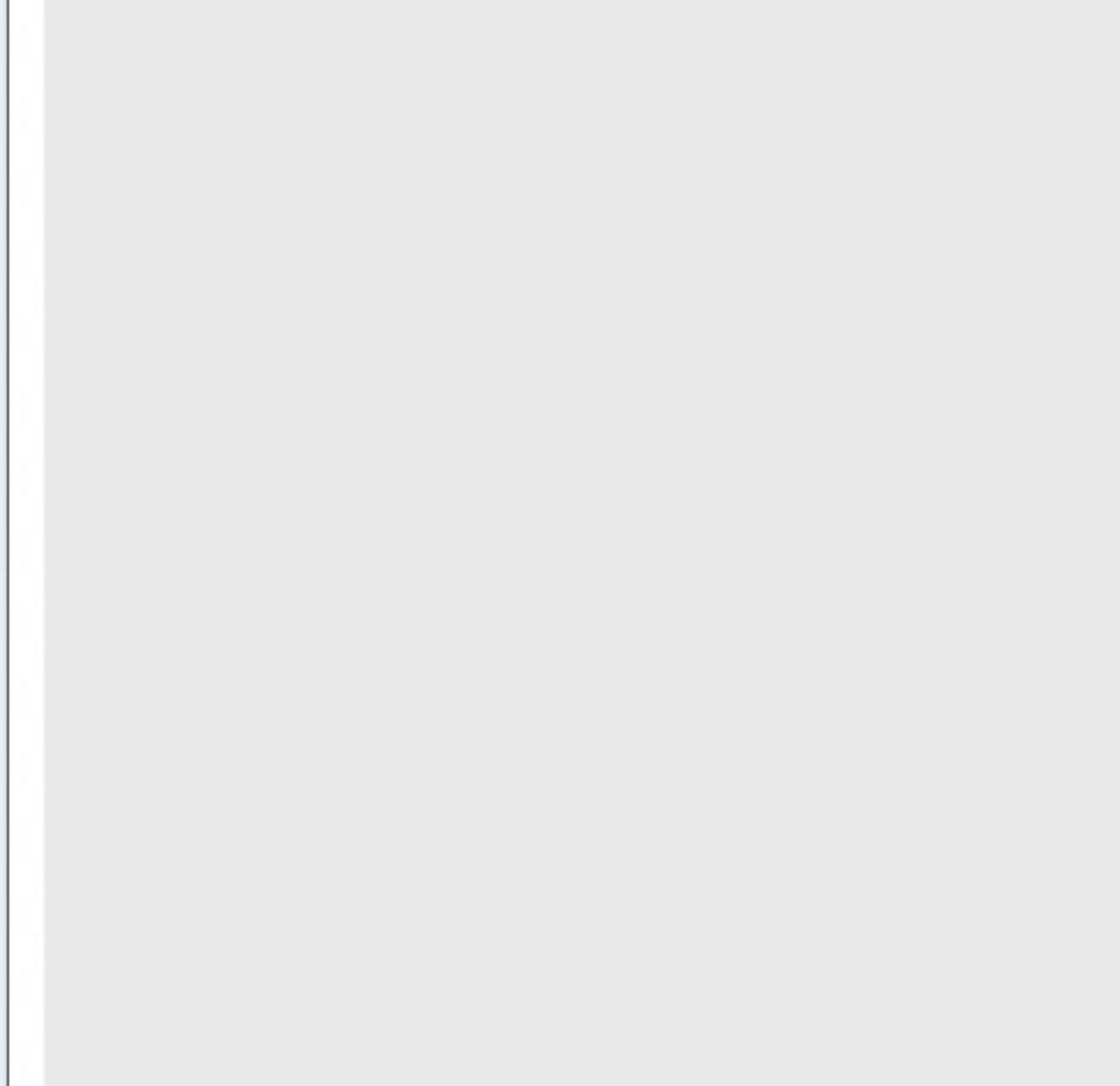
Data parameters

Visual parameters

Selection parameters

Transmitting selection to *Custom data plot 1*Transmitting selection to *Custom statistics table 1*

## Custom data plot 1

Receiving selection from *Row data plot 1*Receiving selection from *Reduced dimension plot 1*

## Custom statistics table 1

Show 10 entries

Search: 

LogFC

All

No data available in table

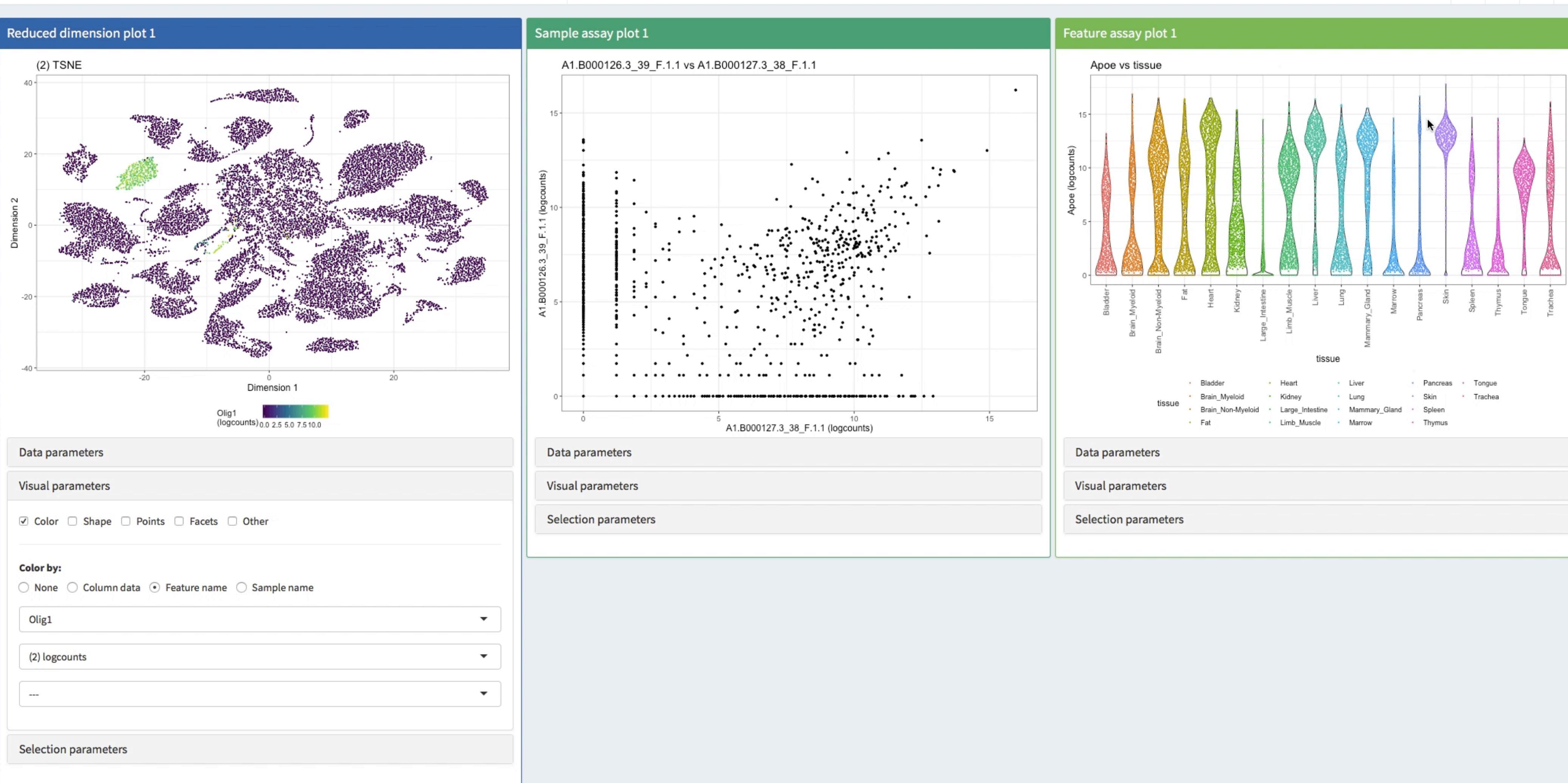
Showing 0 to 0 of 0 entries

Previous Next

Data parameters

Selection parameters

Receiving selection from *Row data plot 1*Receiving selection from *Reduced dimension plot 1*



### Column data plot 1

tissue vs mouse\_id

tissue	mouse_id
Trachea	1
Tongue	2
Thymus	3
Spleen	4
Skin	5
Pancreas	6
Marrow	7
Mammary_Gland	8
Lung	9

### Row data plot 1

pct\_dropout\_by\_counts vs log10\_mean\_counts

log10\_mean\_counts

### Column statistics table 1

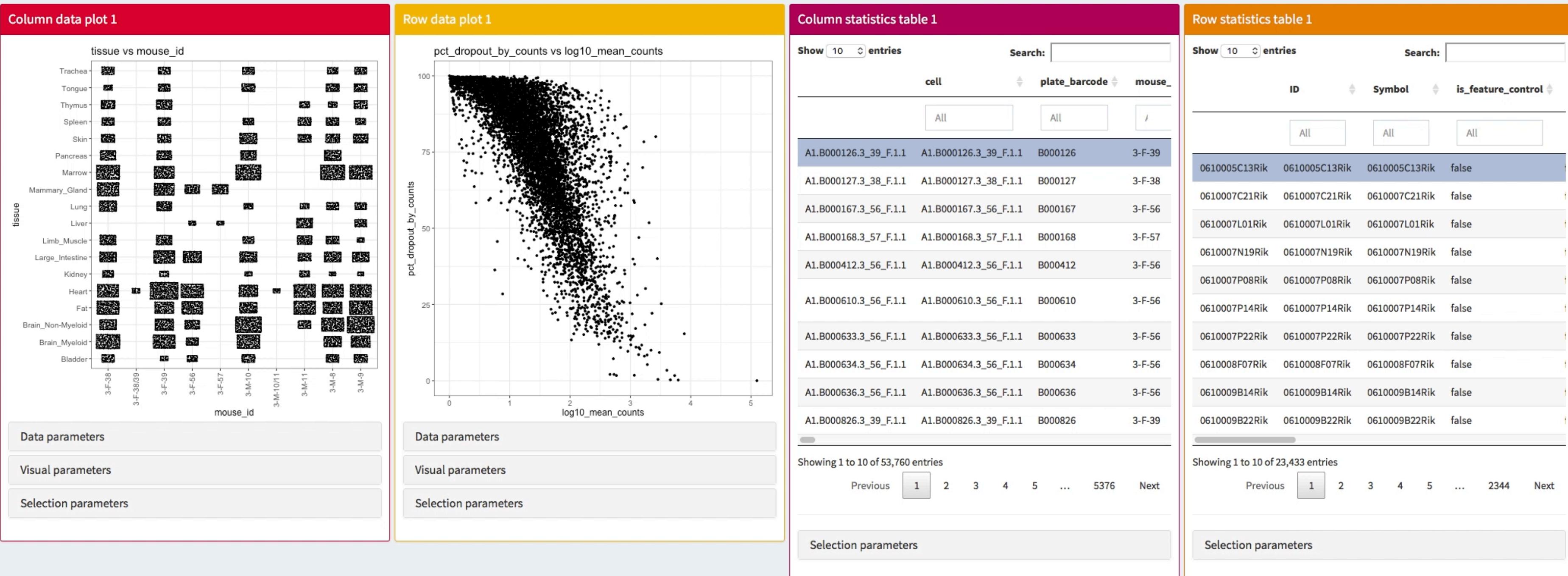
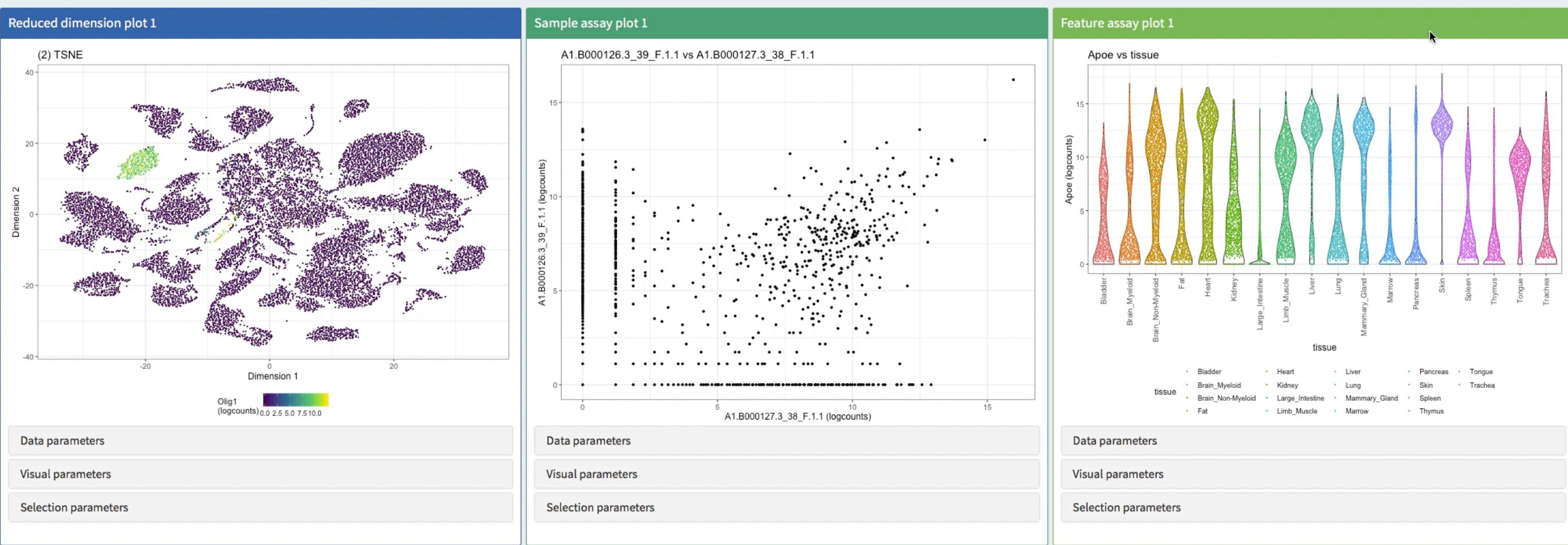
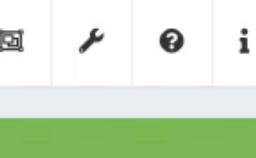
Show 10 entries Search:

cell	plate_barcode	mouse_
All	All	/
A1.B000126.3_39_F.1.1	A1.B000126.3_39_F.1.1	B000126
A1.B000127.3_38_F.1.1	A1.B000127.3_38_F.1.1	B000127
A1.B000167.3_56_F.1.1	A1.B000167.3_56_F.1.1	B000167

### Row statistics table 1

Show 10 entries Search:

ID	Symbol	is_feature_control
All	All	All
0610005C13Rik	0610005C13Rik	0610005C13Rik
0610007C21Rik	0610007C21Rik	0610007C21Rik



# Where to learn more?

- Bioconductor package: <https://bioconductor.org/packages/iSEE/>
- Development version: <https://github.com/csoneson/iSEE>
- Publication: <https://f1000research.com/articles/7-741>
- Example apps: <https://github.com/LTLA/iSEE2018>, [https://github.com/federicomarini/iSEE\\_instances](https://github.com/federicomarini/iSEE_instances), <https://marionilab.cruk.cam.ac.uk/>
- Custom panels: [https://github.com/kevinrue/iSEE\\_custom](https://github.com/kevinrue/iSEE_custom)
- Step-by-step tutorial: [http://biocworkshops2019.bioconductor.org.s3-website-us-east-1.amazonaws.com/page/iSEEWorshop2019\\_iSEE-lab/](http://biocworkshops2019.bioconductor.org.s3-website-us-east-1.amazonaws.com/page/iSEEWorshop2019_iSEE-lab/)
- List of other expression browsers: <https://github.com/federicomarini/awesome-expression-browser>