MATLAB code used in Kobayashi & Matsuo, *Cell Reports* (2023)

Environment Decoding

GitHub: https://github.com/KyogoSKobayashi/Kobayashi_and_Matsuo_CellReports2023

Zenodo: https://doi.org/10.5281/zenodo.7445183

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SOFTWARE.

Generate DEMO data

1. dFF0_data: 1600 frames-by-30 cells matrix of ΔF / F0 data .
2. Session_labels: 4-by-1 string vector; "A1","A2","B1", and "B2".
3. Frame_idx: 1600-by-1 string vector; "A1","A2","B1", or "B2".

```
recording_Hz = 20;

num_of_recording_frames_of_a_session = 400; % 20/400 = 20 sec
num_of_recording_cells = 30;

dFF0_data=zeros(num_of_recording_frames_of_a_session*4,num_of_recording_cells);
Session_labels = ["A1";"A2";"B1";"B2"];
Frame_idx = [repmat(Session_labels(1),num_of_recording_frames_of_a_session,1);...
             repmat(Session_labels(2),num_of_recording_frames_of_a_session,1);...
             repmat(Session_labels(3),num_of_recording_frames_of_a_session,1);...
             repmat(Session_labels(4),num_of_recording_frames_of_a_session,1)];

[~, y0] = titanium; %1-by-49 vector

rng default % for reproducibily
y1 = [y0,0.6]; %1-by-50 vector
y2 = y1-min(y1); %1-by-50 vector, represents a calcium event
one_event_trace = y2+(0.5-rand(size(y2)))/3; %1-by-50 vector with noise
no_event_trace = (0.5-rand(size(y2)))/3; %1-by-50 vector, bakcground fluctuation

% high activity data
high_activity_data = [];
for ff = 1:(num_of_recording_frames_of_a_session/numel(y2))
    r = rand(1);
    if r > 0.3
        y = one_event_trace;
    else
        y = no_event_trace;
    end
    high_activity_data = [high_activity_data, y];
end

% low activity data
low_activity_data = [];
for ff = 1:(num_of_recording_frames_of_a_session/numel(y2))
    r = rand(1);
    if r > 0.8
        y = one_event_trace;
    else
        y = no_event_trace;
```

```
    end
    low_activity_data = [low_activity_data, y];
end

f = Frame_idx == "A1";
d = high_activity_data;
for cc = 1:num_of_recording_cells
    r = randperm(num_of_recording_frames_of_a_session,1);
    dFF0_data(f,cc) = [d(r:end),d(1:r-1)];
end

f = Frame_idx == "A2";
d = high_activity_data;
for cc = 1:num_of_recording_cells
    r = randperm(num_of_recording_frames_of_a_session,1);
    dFF0_data(f,cc) = [d(r:end),d(1:r-1)];
end

f = Frame_idx == "B1";
d = low_activity_data;
for cc = 1:num_of_recording_cells
    r = randperm(num_of_recording_frames_of_a_session,1);
    dFF0_data(f,cc) = [d(r:end),d(1:r-1)];
end

f = Frame_idx == "B2";
d = low_activity_data;
for cc = 1:num_of_recording_cells
    r = randperm(num_of_recording_frames_of_a_session,1);
    dFF0_data(f,cc) = [d(r:end),d(1:r-1)];
end
```

Prepare a Trainging Data Set and Labels

```
class_names={'EnvironmentA','EnvironmentB'};
env_label=cell(size(Frame_idx));
env_label(contains(Frame_idx,"A"))=repmat(class_names(1),...
    sum(contains(Frame_idx,"A")),1);
env_label(contains(Frame_idx,"B"))=repmat(class_names(2),...
    sum(contains(Frame_idx,"B")),1);

train_session=["B1","A1"];
train_data=[];
train_label={};
for ss=1:numel(train_session)
    train_data=[train_data;dFF0_data(Frame_idx==(train_session(ss)),:)];
    train_label=[train_label;env_label(Frame_idx==train_session(ss))];
end
```

Prepare a Test Data Set and Labels

```
test_session=["B2","A2"];
test_data=[];
test_label={};
for ss=1:numel(test_session)
    test_data=[test_data;dFF0_data(Frame_idx==(test_session(ss)),:)];
    test_label=[test_label;env_label(Frame_idx==test_session(ss))];
end
```

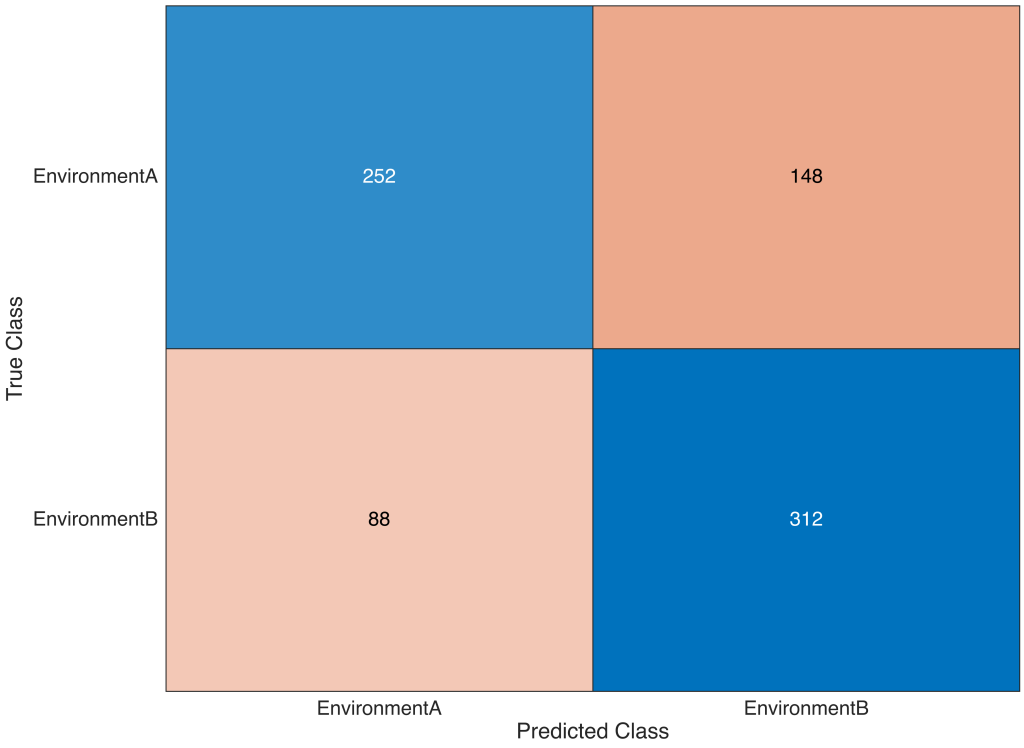
Build a Decoding Model

```
rng('default') % for reproducibility

zscored_train_data=zscore(train_data)';
[Mdl,FitInfo,HyperparameterOptimizationResults] = fitclinear(zscored_train_data,...
    train_label,'ClassNames',class_names,'ObservationsIn','columns','Solver',...
    'sparsa','OptimizeHyperparameters','auto','HyperparameterOptimizationOptions',...
    struct('AcquisitionFunctionName','expected-improvement-plus','Verbose',0,...
    'ShowPlots',false));
```

Predict the Environemnt

```
zscored_test_data=zscore(test_data);
predicted_label = predict(Mdl,zscored_test_data);
confusionchart(test_label,predicted_label)
```


252
148
88
312
EnvironmentA
EnvironmentB
True Class
EnvironmentA
EnvironmentB
Predicted Class