

Instructions for TIDAL

Introduction

The aim is for this digital tool to facilitate trajectories work and remove barriers to implementing longitudinal research to researchers without specialist statistical backgrounds. It helps guide trajectory modelling and capture clinically meaningful features from mental health trajectories for specific individuals and/or specific groups of people.

Installation and usage

Locally

Please install the R package and launch the Shiny app locally if you want to upload sensitive data. If using R Studio it's recommended to restart your R session before installing.

```
# install.packages("remotes")
remotes::install_github("TIDAL-modelling/TIDAL")
# Note if prompted to update packages you can select option 3/None.
# Updating all packages (option 1) might take a while to run.
library("TIDAL")
# Launch the R Shiny app
launchTIDAL()
# To get documentation for launchTIDAL()
?launchTIDAL
```

Online

<https://tidal.shinyapps.io/tidalapp/>

To use this tool online please do not upload any sensitive data. Only use the synthetic datasets, described below.

Synthetic datasets

A synthetic dataset is available called “emot_reg_emot_simulated.csv” this is also embedded within the app. Details about this synthetic dataset can be found on GitHub in the /data subfolder here.

Interacting with the app

Overview page

When you launch the app the first page of the app looks like this:

The screenshot shows a web browser window displaying the TIDAL app. The title bar reads: '-/Library/Caches/org.R-project.R/R/renv/library/TIDAL-ab1dc934/R-4.1/x86_64-apple-darwin17.0/TIDAL/TIDALapp - Shiny'. Below the title bar, the URL is http://127.0.0.1:6639. The browser has tabs for 'Open in Browser' and a 'Repubish' button.

The main content area has a blue header bar with the TIDAL logo and navigation links: TIDAL, Overview, Data Preparation, Data Exploration, Interaction Variable, and Individual Trajectories. The 'Overview' tab is selected.

Below the header, there are theme settings: Default Theme (radio button selected), Dark Mode, High Contrast, Large Font, and High Contrast & Large Font.

The TIDAL logo is displayed, consisting of the word 'TIDAL' in white on a blue wave-like background, with the subtitle 'Tool to Implement Developmental Analyses of Longitudinal data' below it.

Tool to Implement Developmental Analyses of Longitudinal Data

The aim is for this digital tool to facilitate trajectories work and remove barriers to implementing longitudinal research to researchers without specialist statistical backgrounds. The following pages guide trajectory modelling and capture clinically meaningful features from mental health trajectories for specific individuals and/or specific groups of people.

These features will include:

- How mental health is changing over specific periods of time.
- When mental health is improving or worsening at the fastest rate (points of acceleration).
- How variable mental health responses are over time within individuals (stability).

Please only use synthetic data if using the application online. Details of this data is available on the [TIDAL GitHub repository](#).

To use this tool please read the "Instructions" tab on each page to guide you through the process. In brief the main aims of each page:

Data Preparation

This allows the user to upload a wide format of their longitudinal dataset. Select which columns measure time and the phenotype they want to model trajectories on. Converts the dataframe to long format. Allows the user to download the long format dataset.

Data Exploration

This is the first stage of the trajectory modelling. Here the user either uploads a long format dataset or uses the dataset formatted on the previous page (Data Preparation). They specify the columns related to the variables to include in the model. There is a choice of model type and the user can see which model type looks like it best fits their data to explore further.

Interaction Variable

Explore the effect of a categorical or continuous variable on the trajectories.

Individual Trajectories

View trajectories for specific individuals. Choose from a random sample, specific individuals of interest, individuals within a specific variable, eg. a random sample of females only.

 Funded by The Wellcome Trust and Social Finance, Grant Ref: 226686/Z/22/Z.

This package is provided solely for educational and informational purposes. Users understand and agree that any data uploaded and utilised with this package is done at their own risk. Users are solely responsible for the accuracy, legality, and ethical considerations of the data they upload. Additionally, users are responsible for the interpretation of results obtained through the use of this package. The creators and maintainers of this package shall not be held liable for any consequences arising from the use, interpretation, or implications of the package or the data uploaded.

Please read through this all this information before preceding with the following pages.

Data Preparation page

~/Library/Caches/org.R-project.R/renv/library/TIDAL-ab1dc934/R-4.1/x86_64-apple-darwin17.0/TIDAL/TIDALapp - Shiny
[Open in Browser](#)

[TIDAL](#) Overview Data Preparation Data Exploration Interaction Variable Individual Trajectories [Republish](#)

Select data source:
 Upload data
 Use demo synthetic data

Select column for participant ID:

Select columns for age at each time point:

Select columns for the variable to model trajectories on at each time point eg. depression scores:

Name of new column for age:

Name of new column for time point:

Name of new column for variable to model trajectories on:

Impute missing age [?](#)

Instructions Output

Convert longitudinal data from wide format to long format

Please only use synthetic data if using the application online. Details of this data is available on the [TIDAL GitHub repository](#).

In order to model trajectories R requires the data frame to be in "long" format. It's likely that the data is initially inputted as a "wide" format. This page allows you to upload wide formatted data and converts it to long. Similar to the image displayed below.

Wide

Participant ID	Age (time point 1)	Age (time point 2)	Age (time point 3)	Depression Score (time point 1)	Depression Score (time point 2)	Depression Score (time point 3)
A						
B						
C						

↓

Long

Participant ID	Time Point	Age	Depression Score
A	1		
A	2		
B	1		
B	2		
C	1		
C	2		
C	3		

Steps:

- Upload a wide format comma separated *.csv or tab delimited *txt or *tsv file of your dataset. It is recommended your longitudinal dataset has at least 4 time points. This must be less than 30 MB, column names must not have any spaces in them and missing data must be coded as "NA". Click on the "Output" tab and proceed with the following steps.
- Select which columns correspond to age and the variable you want to model, eg. depression, at each time point. Make sure that you select these in the correct chronological order and have the same corresponding time points for the variable you want to model and age.
- Default names for the new columns are "age", "time_point" and "score". You can change these in the text boxes provided if you wish, but make sure they are unique and also are not names of columns that already exist in your dataset.
- If you have missing data for age there is an option to impute the mean from each time point for this variable. There is a tick box you can check to do this.
- Now you can see a preview of the newly formatted long dataframe ("Output" tab). You have the option to download it (in .csv format) and also use for analysis on the subsequent pages.

~/Library/Caches/org.R-project.R/renv/library/TIDAL-ab1dc934/R-4.1/x86_64-apple-darwin17.0/TIDAL/TIDALapp - Shiny
[Open in Browser](#)

[TIDAL](#) Overview Data Preparation Data Exploration Interaction Variable Individual Trajectories [Republish](#)

Select data source:
 Upload data
 Use demo synthetic data

Select column for participant ID:

Select columns for age at each time point:

Select columns for the variable to model trajectories on at each time point eg. depression scores:

Name of new column for age:

Name of new column for time point:

Name of new column for variable to model trajectories on:

Impute missing age [?](#)

[Download .csv](#)

Instructions Output

A preview of the first few columns of this long-formatted data is shown below. Please click the download button to see all columns and rows. Explore this data further on the next page "Data Exploration".

subject	time_point	age	score
2	age_t1	3.041	0
2	age_t2	5.482	2
2	age_t3	NA	NA
2	age_t4	11	0
2	age_t5	14	0
3	age_t1	3.126	2
...
17589	age_t5	NA	NA
17590	age_t1	3.107	4
17590	age_t2	5.142	2
17590	age_t3	6.989	1
17590	age_t4	10	2
17590	age_t5	14	4

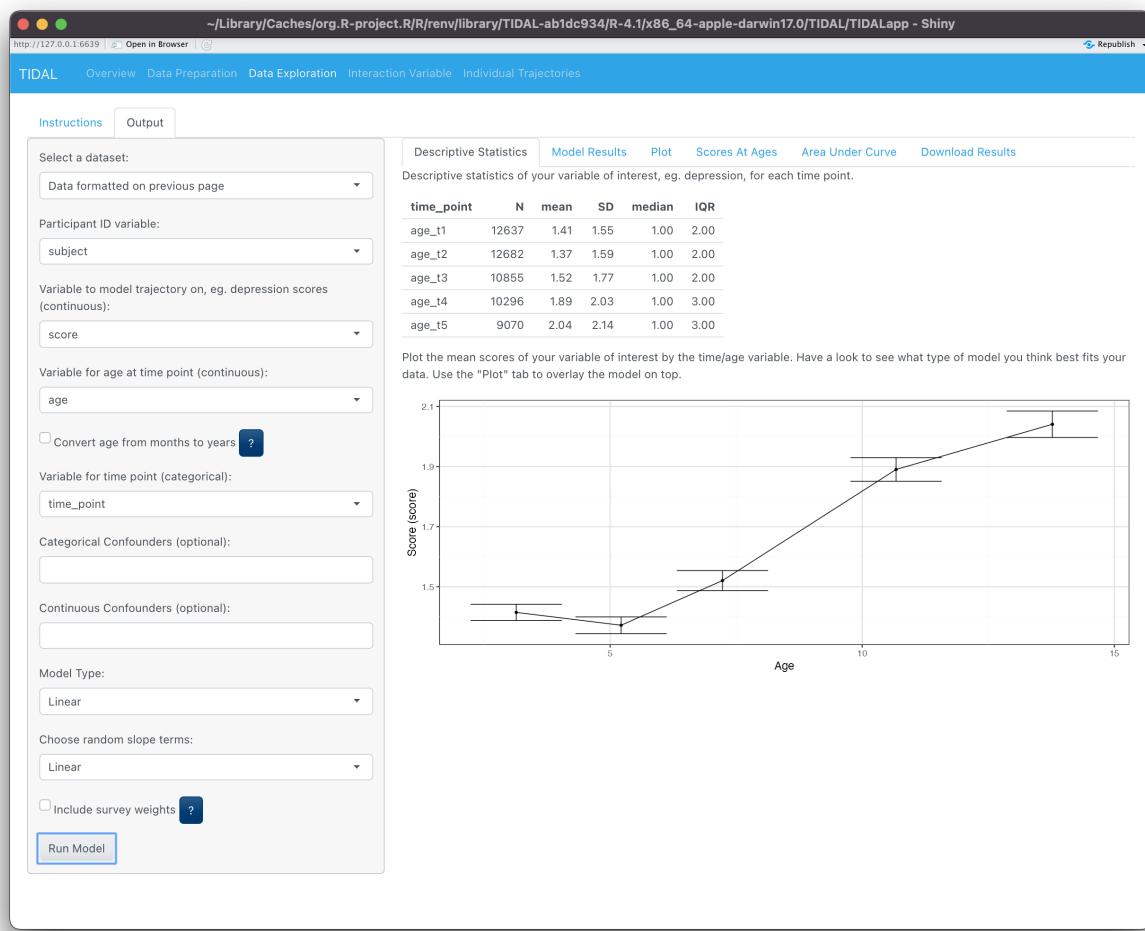
Data Exploration page

The screenshot shows the TIDAL Data Exploration page. At the top, there is a header bar with the URL <http://127.0.0.1:6639>, an "Open in Browser" button, and a "Repubish" button. Below the header is a navigation menu with links: TIDAL, Overview, Data Preparation, Data Exploration (which is the active tab), Interaction Variable, and Individual Trajectories. Under the navigation menu, there are two tabs: "Instructions" (selected) and "Output". The main content area is titled "Initial data exploration" and contains the following text:

Please only upload synthetic datasets available on the [TIDAL GitHub repository](#) if using the application online.
Either upload a long format dataframe (.csv or .tsv) or use the data frame you formatted on the previous page. If you are uploading a long format dataframe then columns must have unique names. Then select the columns you wish to use as variables in your model. Inspect the descriptive statistics of your trajectory variable at each time point. Select the model type (eg. linear or a polynomial model) and view the plot of the mean trajectory against these models. You are also able to add covariates to the model which are plotted with any categorical covariates set to zero in the plot.

The screenshot shows the TIDAL Data Exploration page after a dataset has been selected. The interface is similar to the first screenshot, with the "Data Exploration" tab active. The "Instructions" tab is selected. In the "Output" section, there is a "Select a dataset:" dropdown menu. The dropdown shows two options: "Upload a long format dataset" (highlighted with a blue border) and "Upload a long format dataset Data formatted on previous page" (highlighted with a blue background). To the right of the dropdown, there is a horizontal menu with tabs: Descriptive Statistics, Model Results, Plot, Scores At Ages, Area Under Curve, and Download Results. Below the menu, there is a descriptive text:

Descriptive statistics of your variable of interest, eg. depression, for each time point.
Plot the mean scores of your variable of interest by the time/age variable. Have a look to see what type of model you think best fits your data. Use the "Plot" tab to overlay the model on top.



~/Library/Caches/org.R-project.R/R/renv/library/TIDAL-ab1dc934/R-4.1/x86_64-apple-darwin17.0/TIDAL/TIDALapp - Shiny

<http://127.0.0.1:6639> | [Open in Browser](#) | [?](#)

[Republish](#)

TIDAL Overview Data Preparation Data Exploration Interaction Variable Individual Trajectories

Instructions Output

Select a dataset:
Data formatted on previous page

Participant ID variable:
subject

Variable to model trajectory on, eg. depression scores (continuous):
score

Variable for age at time point (continuous):
age

Convert age from months to years [?](#)

Variable for time point (categorical):
time_point

Categorical Confounders (optional):

Continuous Confounders (optional):

Model Type:
Linear

Choose random slope terms:
Linear

Include survey weights [?](#)

[Run Model](#)

Descriptive Statistics Model Results Plot Scores At Ages Area Under Curve Download Results

Model Formula: score ~ age + (1 + age | subject)

```
lmer(formula = score ~ age + (1 + age|subject),
      REML = FALSE,
      data = newModelData,
      control = lmerControl(optimizer="bobyqa",
                            optCtrl=list(maxfun=2e5)))
```

Please see more information about the "bobyqa" optimiser [here](#). The use of alternative optimisers is not currently supported. The argument `REML = FALSE` indicates the model was fitted by maximum likelihood.

Number of observations and groups
The number of observations (measurements) is 55,537 and the number of groups (people) is 12,720.

Fixed Effects

effect	term	estimate	std.error	statistic	2.5 %	97.5 %	p.z
fixed	(Intercept)	1.618	0.012	135.279	1.595	1.642	p < 0.001
fixed	age	0.066	0.002	31.950	0.062	0.070	p < 0.001

The score at the intercept is 1.62. The intercept here has been shifted to the mean age of all the assessments which is 7.58. You could interpret this as the score at the intercept of age 7.58 is 1.62.

Every unit increase in age is associated with an increase of score by 0.07.

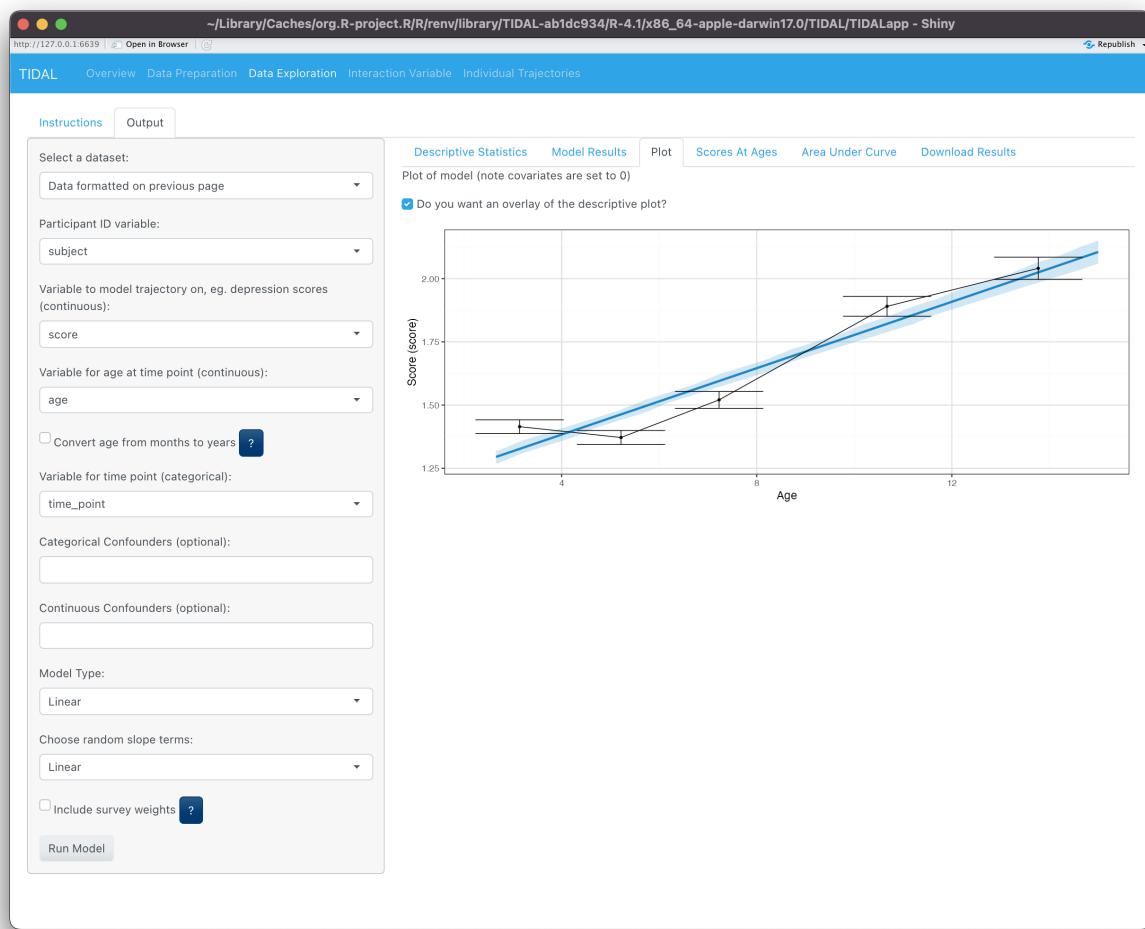
The model fit (deviance) is 208455.06, you can compare this value to other similar models to determine which model has a better fit.

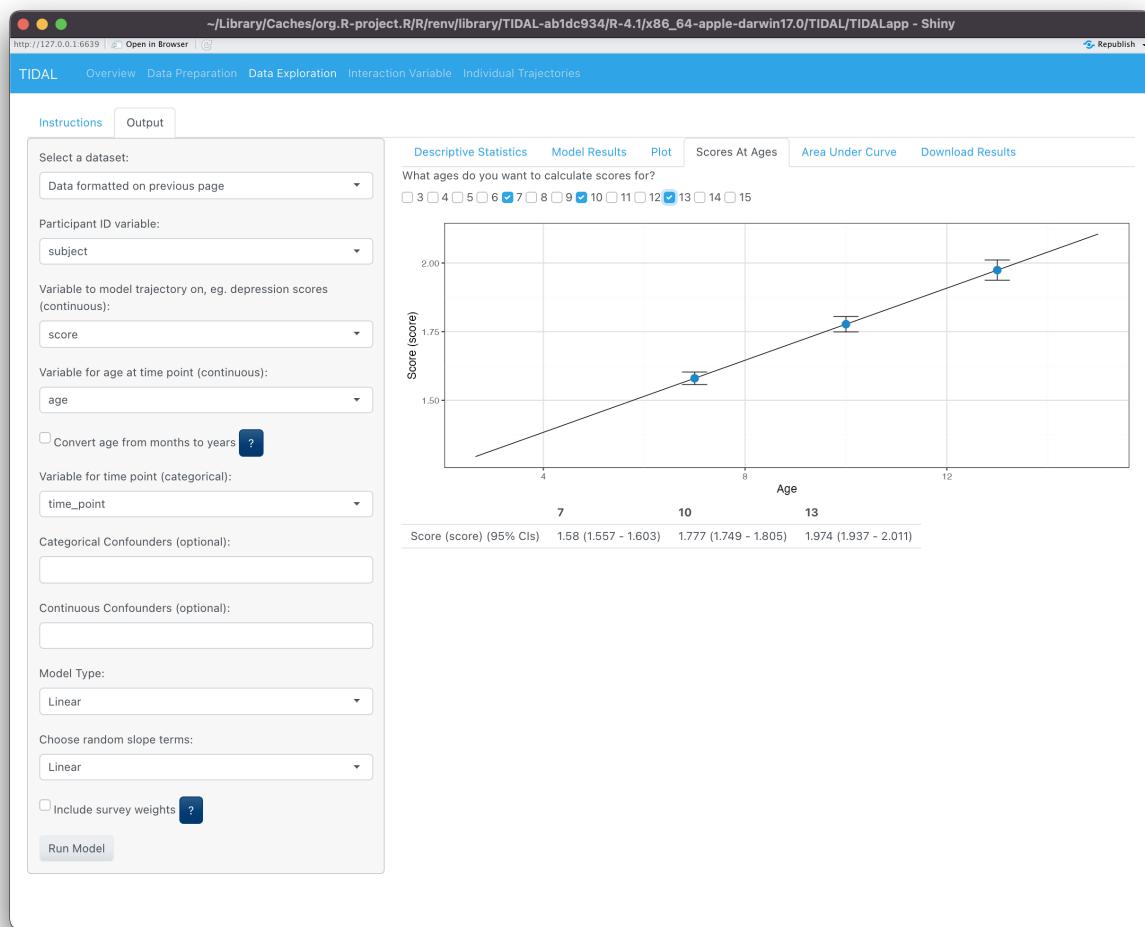
Random Effects

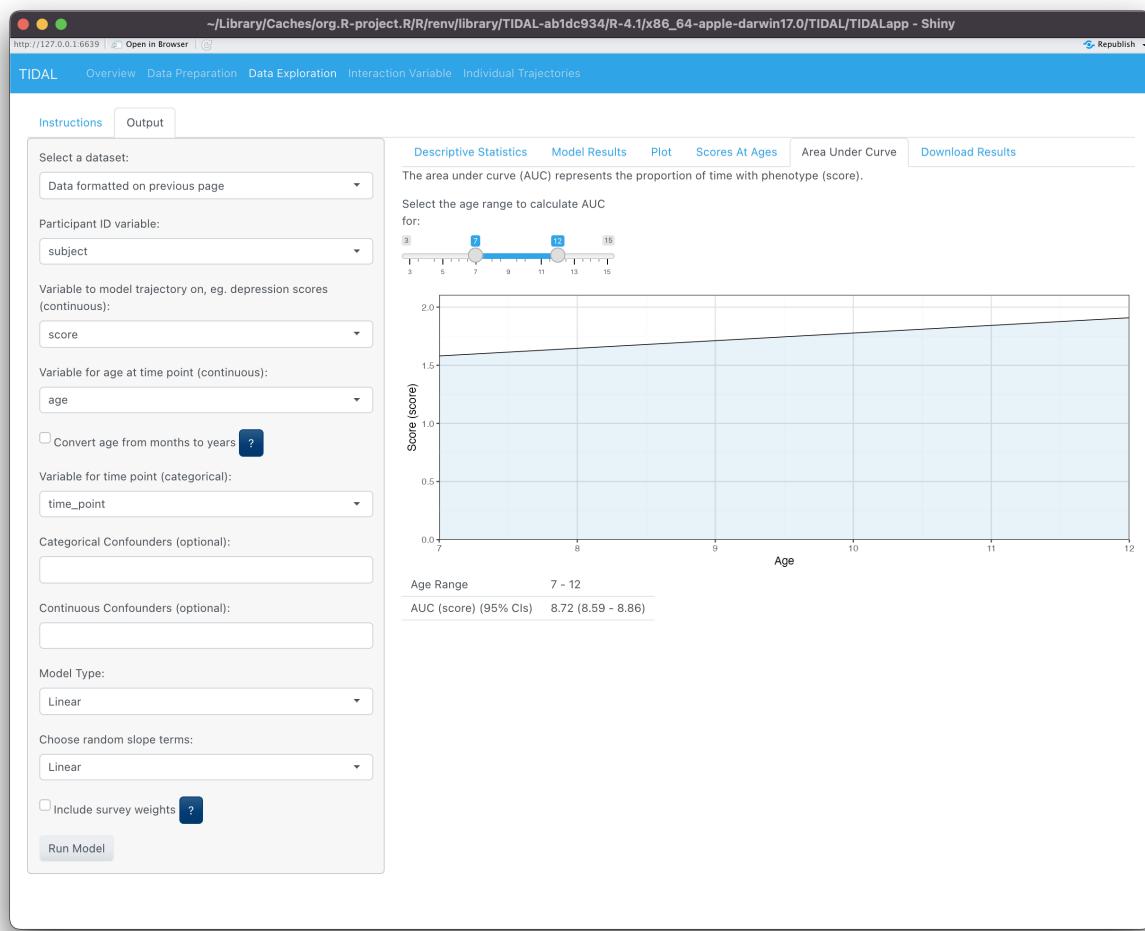
Level	Variable1	Variable2	Variance/Covariance	SD Variance/Covariance
subject	(Intercept)	NA	1.404	1.185
subject	(Intercept)	age	0.083	0.468
subject	age	NA	0.022	0.149
Residual	NA	NA	1.563	1.250

The intercept variance (how much variability there is between individuals for their intercepts) for your model is 1.404. The covariance between the intercept and age is 0.083. The age variance (how much variability there is between individuals for their age) is 0.022.

The residual variance (how much variability there is within individuals) from your model is 1.563.







~Library/Caches/org.R-project.R/R/renv/library/TIDAL-ab1dc934/R-4.1/x86_64-apple-darwin17.0/TIDAL/TIDAapp - Shiny

http://127.0.0.1:6639 | Open in Browser | Republish

TIDAL Overview Data Preparation Data Exploration Interaction Variable Individual Trajectories

Instructions Output

Select a dataset:

Data formatted on previous page

Participant ID variable:

subject

Variable to model trajectory on, eg. depression scores (continuous):

score

Variable for age at time point (continuous):

age

Convert age from months to years ?

Variable for time point (categorical):

time_point

Categorical Confounders (optional):

Continuous Confounders (optional):

Model Type:

Linear

Choose random slope terms:

Linear

Include survey weights ?

Run Model

Descriptive Statistics Model Results Plot Scores At Ages Area Under Curve Download Results

When you have run the model, please download a pdf report with the descriptive statistics, model results and plot.

Note the download button will only appear once you have clicked "Run Model" in the side panel.

Download report

The screenshot shows the TIDAapp Shiny application interface. It has a top navigation bar with tabs for Descriptive Statistics, Model Results, Plot, Scores At Ages, Area Under Curve, and Download Results. Below the navigation bar, there are several input fields and dropdown menus for specifying model parameters. The 'Instructions' tab is selected. The 'Output' tab is also present. On the right side, there is a note about downloading a PDF report after running the model. A 'Download report' button is located below the note. The main configuration area includes fields for selecting a dataset (Data formatted on previous page), Participant ID variable (subject), Variable to model trajectory on (score), Variable for age at time point (age), Variable for time point (categorical), Categorical Confounders (optional), Continuous Confounders (optional), Model Type (Linear), Choose random slope terms (Linear), and an option to Include survey weights. A 'Run Model' button is at the bottom of the configuration area.

Interaction Variable page

The screenshot shows a Shiny application window titled "TIDAL" with the URL "http://127.0.0.1:6639". The top navigation bar includes links for Overview, Data Preparation, Data Exploration, Interaction Variable (which is active), and Individual Trajectories. A "Republish" button is also present.

The main content area has two tabs: "Instructions" (selected) and "Output". Below the tabs, a section titled "Split by variable analysis" contains the following text:

Using the model made on the previous page explore some variables which may influence the trajectory. Select from a list of variables (ie. column names) of the dataset to explore the trajectory by. If you have included variables as covariates in the previous page a warning message will occur if you try and explore the trajectory further by this variable.

To the left, there is a sidebar with the following content:

Explore a categorical or continuous variable?

Categorical
 Continuous

Select the variable:

female

Be aware that it may take a while for the model to run.

Run Model

~/Library/Caches/org.R-project.R/R/renv/library/TIDAL-ab1dc934/R-4.1/x86_64-apple-darwin17.0/TIDAL/TIDALapp - Shiny

<http://127.0.0.1:6639> | [Open in Browser](#) | [Help](#)

[Republish](#)

TIDAL Overview Data Preparation Data Exploration Interaction Variable Individual Trajectories

Explore a categorical or continuous variable?

Categorical
 Continuous

Select the variable:

female

Be aware that it may take a while for the model to run.

[Run Model](#)

Instructions Output

Model Results Plot Scores At Ages Area Under Curve Download Results

Model Formula: score ~ age + (1 + age | subject) + female + age * female

Fixed Effects

effect	term	estimate	std.error	statistic	2.5 %	97.5 %	p.z
fixed	(Intercept)	1.527	0.017	90.961	1.494	1.560	p < 0.001
fixed	age	0.047	0.003	16.441	0.042	0.053	p < 0.001
fixed	female1	0.184	0.024	7.729	0.138	0.231	p < 0.001
fixed	age:female1	0.036	0.004	8.911	0.028	0.044	p < 0.001

The interaction variable you have chosen has been factorised with the lowest level "female0" being the reference or baseline category. For "female0", the score at the intercept is 1.53. The intercept here has been shifted to the mean age of all the assessments which is 7.58. You could interpret this as the score at the intercept for "female0" at 7.58 is 1.53.

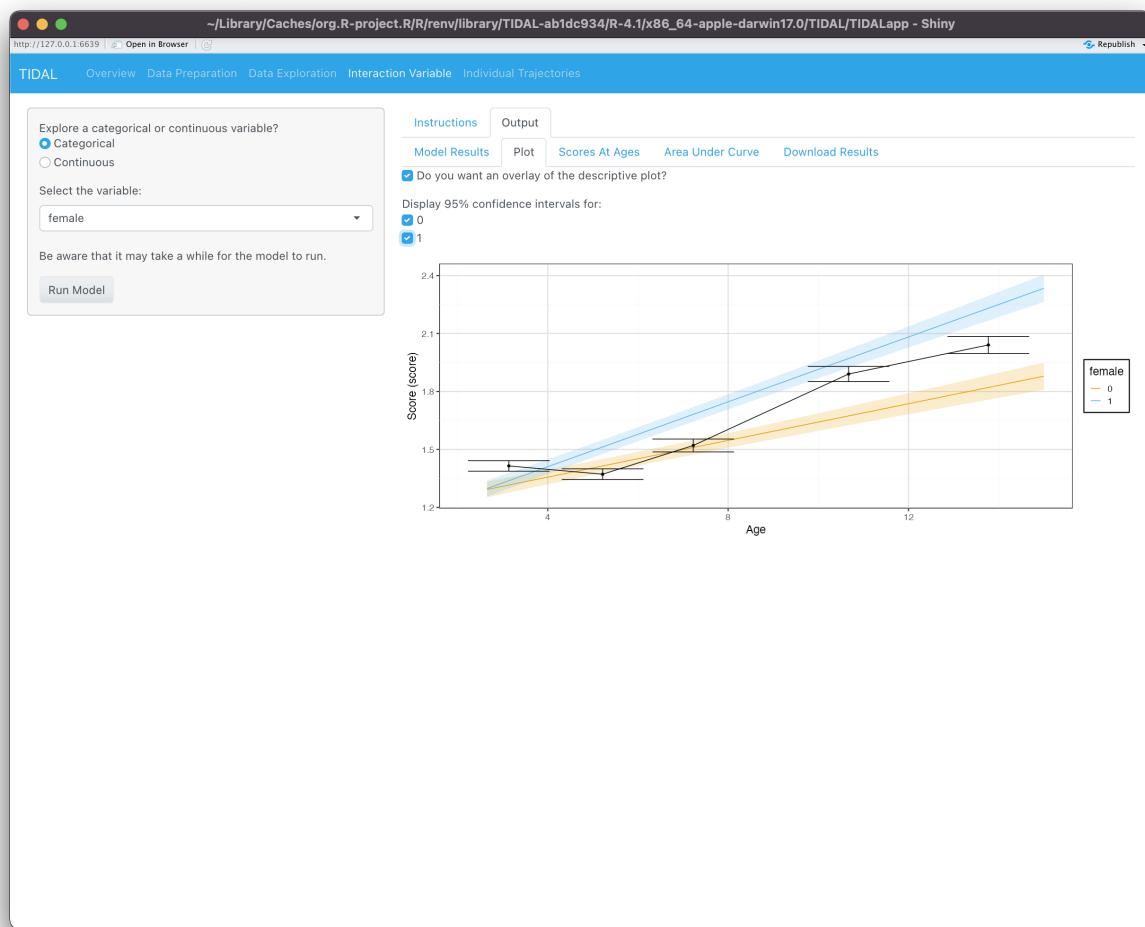
For "female0", every unit increase in age is associated with an increase of score by 0.05.

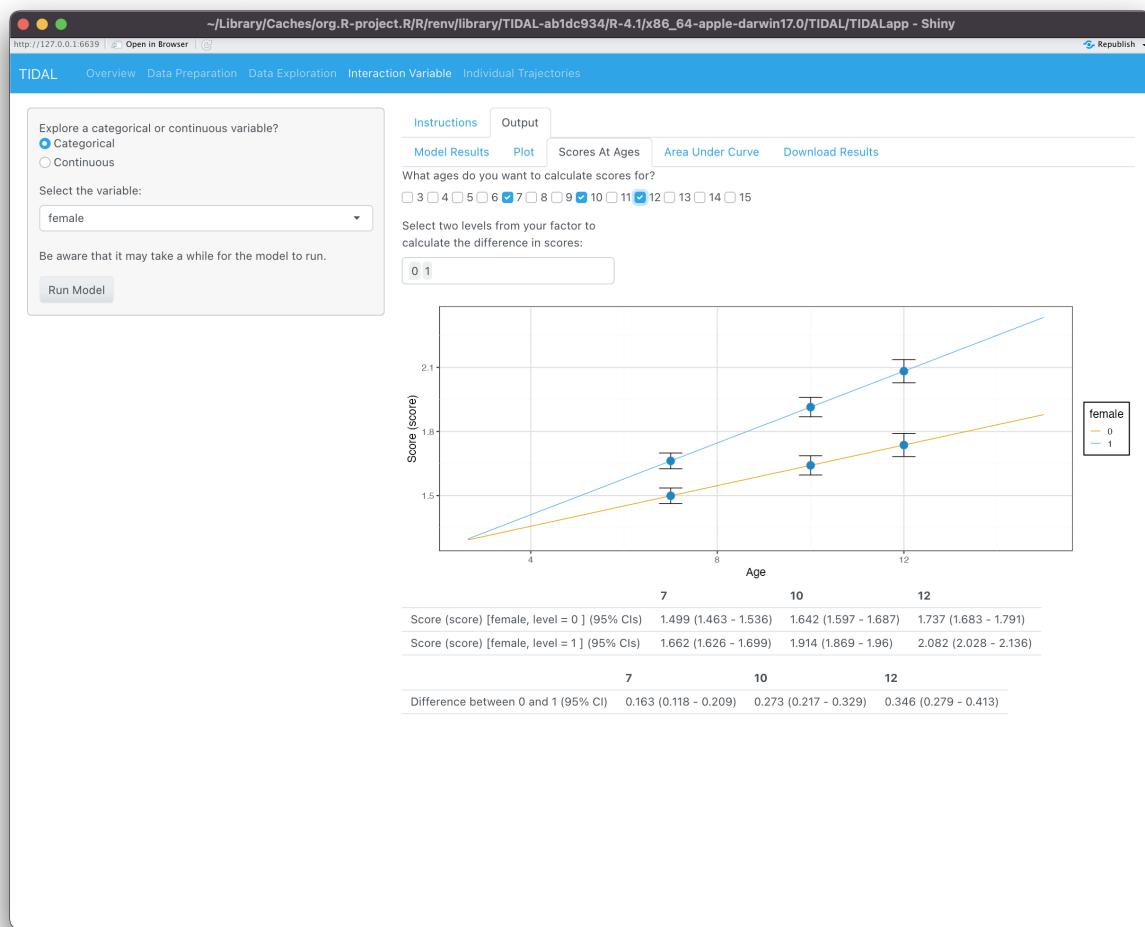
To estimate the effect of different trajectories, you can add the intercept and age estimates to the corresponding interactions and age:interactions to get group specific trajectories.

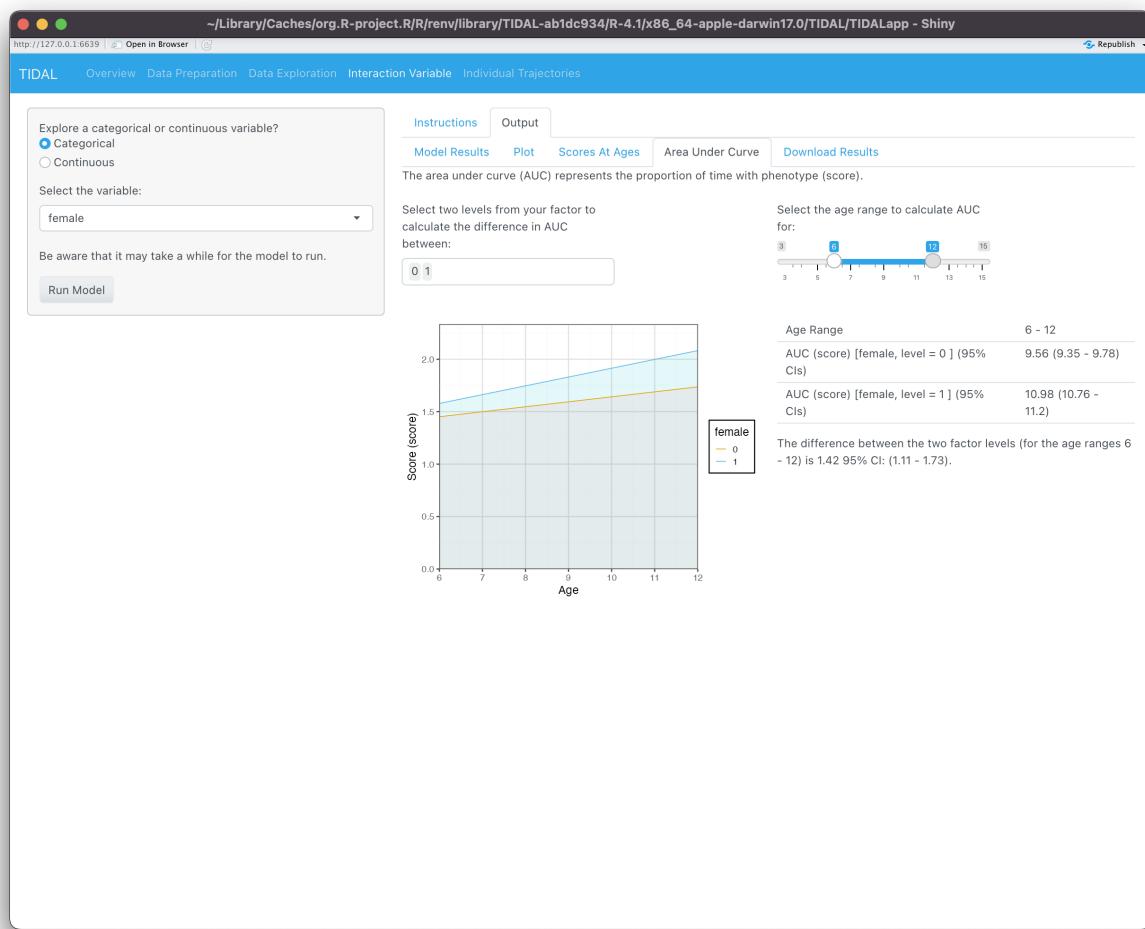
Further information on how to interpret these results can be found on the TIDAL GitHub training videos section. Please also see the "Plot" tab for visualisation of these results.

Random Effects

Level	Variable1	Variable2	Variance/Covariance	SD Variance/Covariance
subject	(Intercept)	NA	1.394	1.181
subject	(Intercept)	age	0.081	0.464
subject	age	NA	0.022	0.148
Residual	NA	NA	1.563	1.250







Individual Trajectories page

~/Library/Caches/org.R-project.R/R/renv/library/TIDAL-ab1dc934/R-4.1/x86_64-apple-darwin17.0/TIDAL/TIDALapp - Shiny
http://127.0.0.1:6639 | Open in Browser | ⌂ Republish

TIDAL Overview Data Preparation Data Exploration Interaction Variable Individual Trajectories

Instructions Analysis

Explore individual trajectories using model estimates

Using the model specified in the Data Exploration page, we can have a look at individuals trajectories.

