RSM-paper

# Front Matter

**Title:**   
Developing visualization tools with R and Shiny: a case study of the new Risk of Bias visualization tool.

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# Abstract

At present there is is no open source tool to

Here I present robvis, an R package and Shiny web app that showcase how R can be used to build open source tools for R users and non-users alike. It provides two main functions to

The entire offering is open source, and has benefitted from this fact through several community suggested improvements.

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# Highlights

* No other open-source visualisation tool exists explicitly for the purpose of visualising risk of bias results
* Here we present robvis, an R package and Shiny web app for visualising risk of bias assessment results
* robvis allows users to procude publication quality graphics which confrom to the
* robvis is completely open source, as had benefitted from community suggested features.
* robvis forms part of the metaverse, a collection of R packages designed to provide an evidence synthesis workflow in R.

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# Introduction

Evidence synthesis as a field has recently experience a substantial growth in software offerings

Risk of bias assessment - assessment of the internal validity of studies included in a systematic review - forms a key part of the evidence synthesis process, particularly in the health sciences. There are several tools that are routinely used to produce risk of bias assessments, depending on the type of study under consideration. Similarly, there are two recommended formats for presenting graphically the results of the risk of bias assessments. While software does exist to create these graphs, they are exclusively commercial offerings. robvis, a package written in and for the R computing environment, seeks to solve this issue.

robvis also originated as part of the metaverse a collection of packages for R which seeks to provide an opinionated workflow for performing evidence synthesis.

Tools such as R and Shiny (an R package for building interactive web apps) have made it easier than ever to produce tools to visualize the complex data produced as part of a research synthesis project.

We will present a recently developed tool, robvis (Risk Of Bias VISualization), which allows users to rapidly produce publication quality figures to explore the risk-of-bias assessments that routinely take place as part of systematic review (Supporting Figures 1 & 2). We will present a timeline of the tool’s development, its key functionality, its advantages over commercially available software, and the main challenges we encountered in creating it.

Users can download the stable version of robvis from CRAN (<https://cran.r-project.org/package=robvis>); or contribute to the development version on GitHub (<https://github.com/mcguinlu/robvis>). Extended guidance for the tool is also available in the “Doing Meta-Analysis in R” online guide.1.

While created originally for use the major risk of bias assessment tools used in healthcare/epidemiology, a general template within the tool allows users to visualise the results produced by other domain-based risk of bias/quality appraisal tools.

Creating the figure by hand may lead to unintentional errors. IN an age where reproducibility and replicability are crucial to the confidence of

So in an effort to

In the healthcare field, the move from point-based scoring systems and checklists to domain-based assessments of the internal validity of the study has produced a range of domain-based tools.2–5 Many of these are recommneded by the Cochrane Collaboration, the

# Development

Time/ESH/Community involvement

Development of robvis began in April 2019 at the Evidence Synthesis Hackathon in April 2019, with the first completed version fo the software uploaded to CRAN in November 2019.

# Functionality

## R package

# Stable version  
install.packages(robvis)  
  
# Development version  
install.packages("devtools")  
devtools::install\_github("mcguinlu/robvis")  
  
# Load the package  
library(robvis)

### Data import

robvis expects data in a specific format, namely: 1. The first column 2. The second-to-last column 3. The final column contains the weights 4. The first row of data does not contain column headings. This can be achieved using the header = TRUE argument in the code block above

data\_rob <- read.csv("path/to/riskofbiasdata.csv",   
 header = TRUE)

### Templates and example data sets

The tool contains figure templates, created via ggplot2(6) which the uploaded data are used to customize.

Templates for three major tools

However,

While developed primarily for use with the tools routinely used in the healthcare field, robvis also contains a general template that can be used to visualise the result of any domain-based assesssment tool. This template has far more flexibility, allowing a variable number of domains a. However, we would encourage authors to not interpret this as a licence to create visualisations of

robvis contains an example dataset for each template, and for illustrative purposes, the example data for the RoB2 tool for assessing risk of bias in randomised controlled trials is presented in Table 1

### Functions

The central functions of robvis are rob\_summary(), which creates a weighted barplot showing the proportion of information at a certain level of risk of bias within each domain of the assessment tool specified, and rob\_traffic\_light(), which

A worked example using these functions is outlined below, showing the ease with which risk of bias plots can be created using robvis.

First, install and load the package:

install.packages("robvis")  
  
library(robvis)

Using the example data set (data\_rob2) presented in Table 1, the summary barplot shown in Figure 1 is created using the following code:

# Create your plot  
rob\_summary(data = data\_rob2,  
 tool = "ROB2",   
 overall = TRUE)

Similary, using the same data set, the traffic light plot shown in Figure 2 is created using:

rob\_traffic\_light(data = data\_rob2,  
 tool = "ROB2",  
 colour = "colourblind",   
 psize = 15)

### Other comments

The tool can deals with small misspellings in terms of judgements (e.g., it can recognise “*Seroius*”), and has the capacity to deal with “No Information” judgements (See Figure 1).

Both graphing functions return a ggplot object, meaning the can be easily customised further using the ggplot2 framework. For example, to add a title to the plot:

plot <- rob\_summary(data\_robDF, tool = "ROB2")  
  
plot +  
ggplot2::ggtitle("Summary Bar Plot")

## Shiny web app

Although robvis was originally designed for use in the command-line–based R programming environment, in order to make the tool available to those without knowledge of the R environment, robvis also exists as a web-app.7

The app was built using Shiny,8 a R package which makes it easy to produce interactive web-apps. The app provides a graphical user interface for the functions described above

In this case, the Shiny app provides users with a Graphical User Interface for each argument of the R functions. Users can upload their data, choose the tool they used to perform the assessments, select a colour scheme, and define other parameters depending on whether they are producing a traffic light or summary bar plot.

A singular advantage of the web-app is the ability to autosize the images for download, and to readily specify a range of download formats (PNG, JPEG, TIFF, & EPS). Images from the web appa are created at publication quality (800 dpi).

# Discussion

robvis can be incoporated into Rmarkdown document

Anyone can design

With reference to robvis, we will explore the benefits that creating visualization tools for complex data visualization can have, both to the individual researcher in terms of career progression and increased competitiveness when applying for funding, and to the field of research synthesis as a whole. We will also highlight the advantages of maintaining these visualization tools as open-source projects, with specific reference to new robvis functionality that was added as a result of community involvement (e.g. the addition of a colour-blind scheme; see Supporting Figure 2 for an example).

Overall, with reference to robvis, we will argue that if a research synthesist has created a R script to visualize complex data, the tools and resources now exist to package their code in a readily shareable format and to provide a user-friendly graphical interface for it within a very short timeframe.

robvis is already being cited in the published literature,9–11 indicating a citation benefit of designing, releasing and promoting open source tools.

In broader terms, robvis forms part of the metaverse, a collection of R packages that seek to make it easier to produce r

robvis forms one part of the metaverse, a collection of tools written using R that cover different aspects of the systematic review and meta-analysis pipelines. Key example is revtools, original published in this journal, litsearcher and metafor.

## Limitations

At present, the number of tools with a specific template included in robvis is low, Additionally, the tool does not yet allow for the production of paried forest plots, where the risk of bias judgement for each specific result included in the meta-analysis. This was initally considered to be beyond the scope of th However, this functionality is in development and will be available in the near future.

R and the collection of packages it is comprised of, currently represents an untapped source

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# Back Matter

## Acknowledgements

The following people provided valuable feedback that contributed to the development of the robvis tool: Emily Kothe, Eliza Grames, Matthew Page, Alexandra Bannach-Brown, Kyle Hamilton, Charles Gray, Vincent Cheng, Wouter van Amsterdamn, Neal Haddaway and Martin Westgate.

## Data availability statement

The code and data presented in this paper are freely available on GitHub: <https://github.com/mcguinlu/robvis>

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## Tables/Figures

Table 1: Example dataset for the ROB2 tool contained within robvis

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Study | D1 | D2 | D3 | D4 | D5 | Overall | Weight |
| Study 1 | Low | Low | Low | Low | Low | Low | 33.3333333 |
| Study 2 | Some concerns | Low | Low | Low | Low | Low | 33.3333333 |
| Study 3 | Some concerns | Low | Some concerns | Low | Low | Some concerns | 0.1428571 |
| Study 4 | Low | Low | High | Low | Some concerns | High | 9.0909091 |
| Study 5 | High | High | Low | Low | Some concerns | Low | 12.5000000 |
| Study 6 | Low | High | Some concerns | Low | Low | Some concerns | 25.0000000 |
| Study 7 | Low | Some concerns | Some concerns | High | Low | Some concerns | 200.0000000 |
| Study 8 | Low | Some concerns | Low | Low | Low | Low | 11.1111111 |
| Study 9 | Low | Low | High | Low | Low | High | 1.1111111 |

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Table 2: Description of the arguments available in the two main robvis functions

|  |  |  |  |
| --- | --- | --- | --- |
| Argument | rob\_summary() | rob\_traffic\_light() | Description |
| data | X | X | Defines the dataframe containing the summary (domain) level risk-of-bias assessments. See the text and Table 1 for the format expected by robvis |
| tool | X | X | Defines the risk of bias assessment tool used. The RoB2 (tool='ROB2'), ROBINS-I (tool='ROBINS-I'), and QUADAS-2 (tool='QUADAS-2') assessments tools are currently supported. Other tools can be visualised using the generic template (tool = 'ROB1') |
| colour | X | X | Defines the colour scheme for the plot. The default is colour = ‘cochrane’ which uses the ubiquitous Cochrane colours, while a preset option for a colour-blind friendly palette is also available (colour = 'colourblind'). Alternatively, users can specify their own colour scheme e.g. colour = c('#f442c8', '#bef441', '#000000') |
| overall | X |  | Defines whether to include an additional bar showing the distibution of overall risk of bias judgements in the summary barplot figure. Default is overall = FALSE. |
| weighted | X |  | Defines whether weights should be used to produce the summary barplot figure. Default is weighted = TRUE, in line with current Cochrane Collaboration guidance. |
| psize |  | X | Defines the size of the points in the traffic light plot. Default is psize = 20. |

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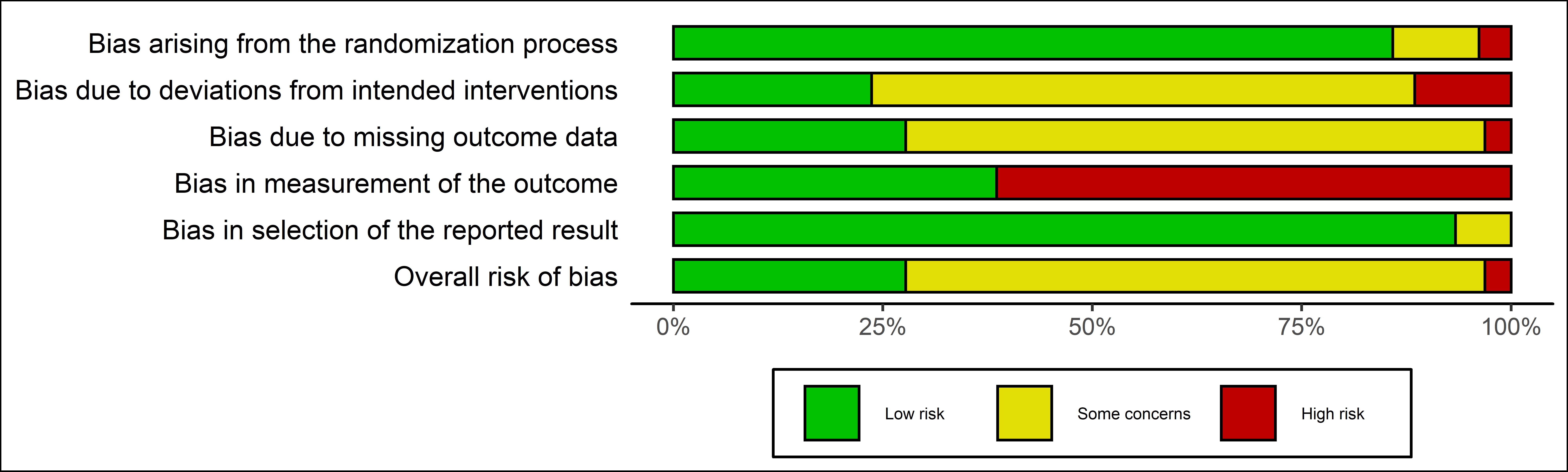


Figure 1: Example risk of bias summary plot created using robvis

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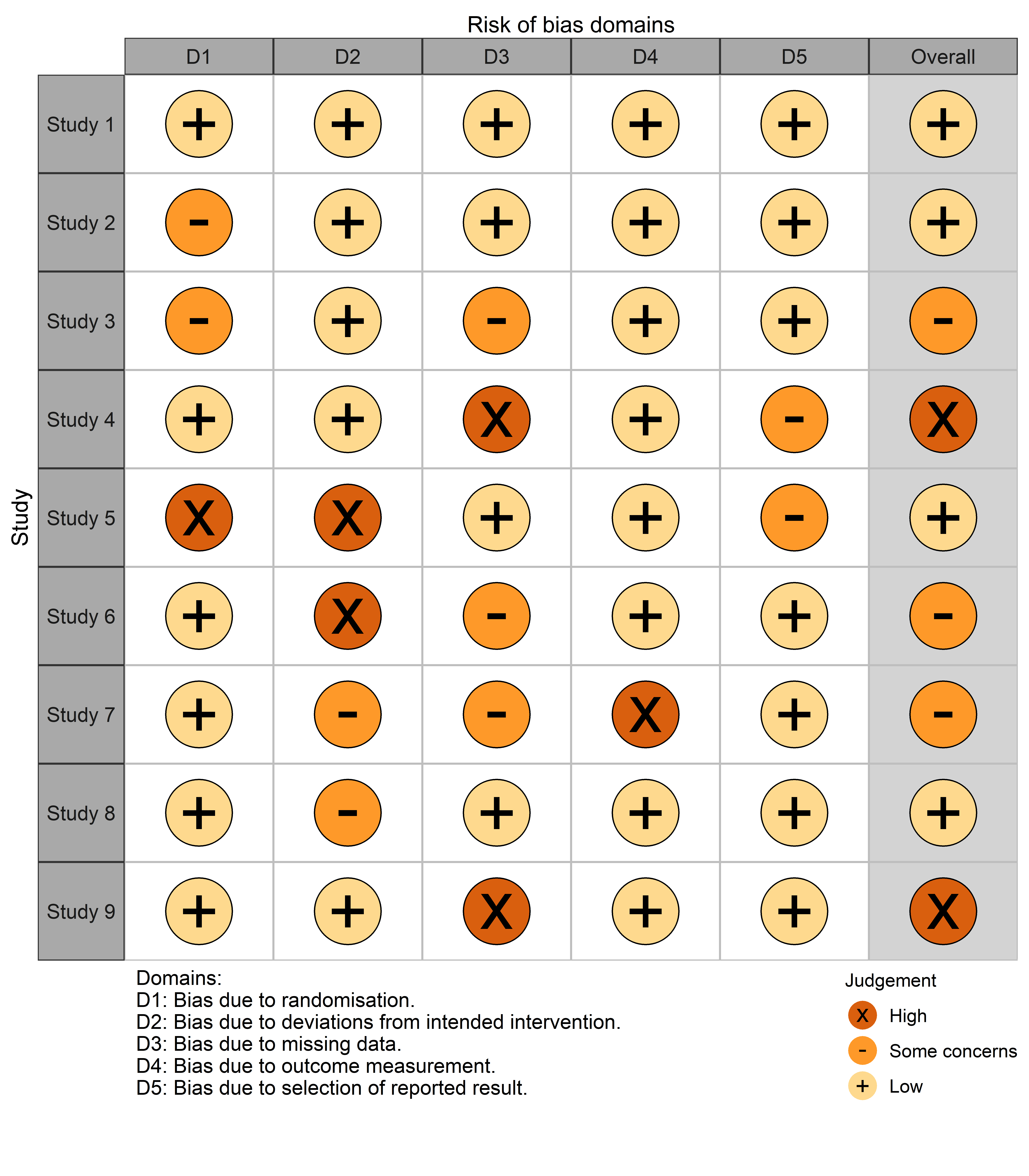


Figure 2: Example risk of bias traffic light plot created using robvis

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