labeleR: an R package to optimize the generation of collection labels and scientific documents

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1 Abstract

`labeleR` is an R package designed to automate the creation of collection labels and documents for scientific events. It simplifies repetitive and time-consuming tasks, offering a practical alternative to manual or costly tools. With `labeleR`, users can generate a wide variety of customizable PDF documents that can also be automatically emailed.

The package provides a set of functions classified into two groups: scientific collections (e.g. labels for herbarium or insects) and scientific events organization (e.g. personal badges, abstract books and certificates of attendance and participation). Starting from a tidy dataset, users can easily customize content, incorporate QR codes, logos, images, and edit their own templates. `labeleR` transforms tedious and repetitive workflows into an efficient, reproducible process, contributing to greater scientific productivity. The package is available under an open-source license and can be freely downloaded from CRAN or the GitHub repository (https://ecologyr.github.io/labeleR/).

2 Keywords:

R, Rmarkdown, LaTeX, scientific collections, scientific events, herbaria, automation, exams

3 Cover letter

This manuscript is a first submission and authors declare no conflict of interest. The manuscript describes an R package which aims to optimize the creation of different collection labels and documents for scientific events, highly useful in any step of the scientific career. Throughout the manuscript, we discuss previous tools targeting this issue, we state the need for this package, we describe its workflow and we explain the main functions by giving visual examples. The contribution of this package to researchers' daily bases concerns both management, reducing time consuming tasks, and scientific quality, facilitating the sampling of scientific labels for any organism and including features such as the inclusion of pictures or QRs.

4 Statement of need

The management and design of scientific labels and event documents is a time-consuming task. Large-scale label generation tools for herbarium and scientific collections (used by institutions such as museums

or botanical gardens) are often paid and proprietary software (e.g. "BRAHMS" (2025) "IrisBG" (2024)). Microsoft Excel-Word integration through mailing lists is commonly used at a smaller scale, although still involving paid software with limited large database management capacity. Most free alternatives are not open-source, require installing a program with limited customization, and are often only compatible with Windows operating system (e.g. Pando, Lujano, & Cezón (2019) "pLabel" (2020)), or designed for very specific purposes (e.g. "EntomoLabels" (2022) for insects, "LichenLabler" (2025) for lichens or Zhang, Zhu, Liu, & Fischer (2016) for plant vouchers). Additionally, credentials and certificates for scientific events are either created manually one at a time, through paid online servers, or by hiring an event organization company. To our knowledge, there are no free, customizable tools for the bulk production and distribution of these documents. `labeleR` fills this gap facilitating the creation of scientific collection labels, conference badges, attendance and participation certificates, and abstract books, among others.

5 Package description

The `labeleR` package builds upon the `RMarkdown` ecosystem (Allaire et al. (2024)) to generate PDF documents from a tidy data frame in R (Figure 1). `labeleR` functions include three types of arguments: (1) R instructions, such as the data object, paths and file name of the rendered document; (2) "fixed" arguments, text that remains constant across output documents (e.g. event name or image path); (3) "variable" arguments, linked to columns in the dataframe, thus changing between documents (e.g. taxonomic names in labels or attendee names in certificates). A QR code can be included either through a fixed argument or a variable argument, without the need for external software.

Users can also edit and adapt the default `RMarkdown` templates provided by the package for their own purposes. This is useful in case pictures look too big or small, if the size of the text needs to be reduced, the default text needs to be modified, etc. It is then possible to modify these parameters inside the template.

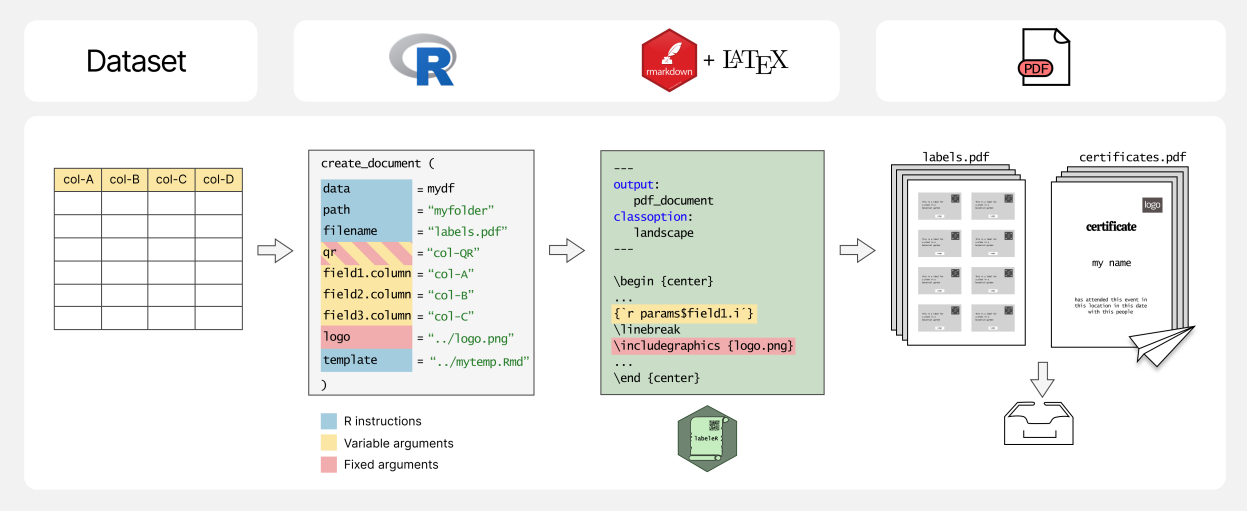

Figure 1: Figure 1. `labeleR` package workflow. Information stored in a dataset passes through an R function into a parameterized `RMarkdown` file using LaTeX syntax, and is then rendered as PDF. `labeleR` functions accept three argument types: R instructions which specify the dataset, paths to images or add custom templates (in blue); fixed arguments, such as titles or subtitles (in red), and variable arguments, linked to columns of the dataset (in yellow). Users work directly on R to introduce the parameters, while `labeleR` works in the background with markdown and latex to produce the results. Output PDF documents can be automatically emailed to participants.

6 Documents that can be generated with `labeleR`

6.1 Labels for collections

Appropriate labelling of samples is a fundamental step of the scientific process (i.e., labelling test tubes in laboratories, storing animal or plant materials or displaying collections in museums or botanical gardens). A user-friendly bulk rendering tool is vital for efficiently producing crafted, uniform labels in a reproducible manner. We present three label types: "herbarium" (most complex), "collection" (most aesthetic) and "tinylabels" (compact and simplified, for small insect collections) (Figure 2). These labels can include QR codes (e.g. links to websites, images, or identification codes) without additional tools, making it easy to quickly access and link to external information. Hereafter there is a short description of each of the functions.

6.1.1 Herbarium labels

Herbarium labels are fundamental for botanical research since they enable the correct storage and access of information for future research. The `create_herbarium_label` function include multiple variable parameters, tailored to the fields that are classically included in the labels of plant vouchers (species, family, collector, elevation, location, etc.). Note that the `family.column` content will always be capitalized, and the `taxon.column` one in italics, recommended to be used as originally defined, while the rest ca be interchangeable. The QR can include a free text (and therefore remain identical in all labels), or be a column name, which implies that the codes will be rendered with the individual information of each row. The output is a pdf file with four different labels will fit in each of the A4 pdf pages.

```
create_herbarium_label(
  data = herbarium.table,
  path = "labeleR_output",
  filename = "herbarium_labels",
  qr = "QR_code",
  title ="Magical flora of the British Isles" ,
  subtitle = "Project: Eliminating plant blindness in Hogwarts students",
  family.column = "Family",
  taxon.column = "Taxon",
  author.column = "Author",
  det.column = "det",
  date.det.column = "Det_date",
  location.column = "Location",
  area.description.column = "Area_description",
  latitude.column = "Latitude",
  longitude.column = "Longitude",
  elevation.column = "Elevation",
  field1.column = "life_form",
  field2.column = "Observations",
  field3.column = "Height",
  collector.column = "Collector",
  collection.column = "Collection_number",
  assistants.column = "Assistants",
  date.column = "Date"
)
```

6.1.2 Collection labels

Collection labels are useful for all type of public or private collections (museums, botanical gardens, living collections, etc.). The `create_collection_label` function counts with five variable parameters, which are

not recommended to be too long, along with the possibility of including a QR code (fixed or variable) and an image (logo or picture). Field 1 will be always capitalized, and Field 2 italicized. Any field can be left blank. The user may manually fix the background and text colors with HTML color codes. Eight different labels will fit in each of the A4 pdf pages.

```
create_collection_label(
  data = collection.table,
  path = "labeleR_output",
  filename = "labels",
  qr = "QR_code",
  field1.column = "field1",
  field2.column = "field2",
  field3.column = "field3",
  field4.column = "field6",
  field5.column = "field7",
  system.file("rmarkdown/pictures/Hogwarts_BnW.png", package = "labeleR"),
  bgcolor = "D0ECC1",  #White is "FFFFFF",
  textcolor = "1E3F20" #Black is "000000"
)
```

6.1.3 Tiny labels

This type of labels are a simplified and smaller version of the collection label, suited for lab tubes or insect collections. They include five variable fields, all with the same simple aesthetic, plus the possibility of including a QR code. It is recommended to write short texts for the variable arguments and the QR, as they might become difficult to read. 16 different labels will fit in each of the A4 pdf pages.

```
create_tiny_label(
  data = tiny.table,
  qr = "QR_code",
  path = "labeleR_output",
  filename = "tinylabels",
  field1.column ="field2",
  field2.column ="field1",
  field3.column ="field3",
  field4.column ="field4",
  field5.column ="field5"
)
```

6.2 Documents for scientific events

Scientific events often host a high number of participants, and require the creation of different documentation, such as abstract books, personal identification badges and certificates for attendees and participants. Bulk rendering significantly decreases the amount of time invested in the creation of these documents. Moreover, to deliver attendance and participation certificates automatically, those `labeleR` functions allow users to automatically send individual documents to email addresses stored in a column.

6.2.1 Abstract book

Abstract books are useful to compile and distribute all the information of the different contributions of a congress, seminars or reunion. The function `create_abstractbook` result in a single pdf document with

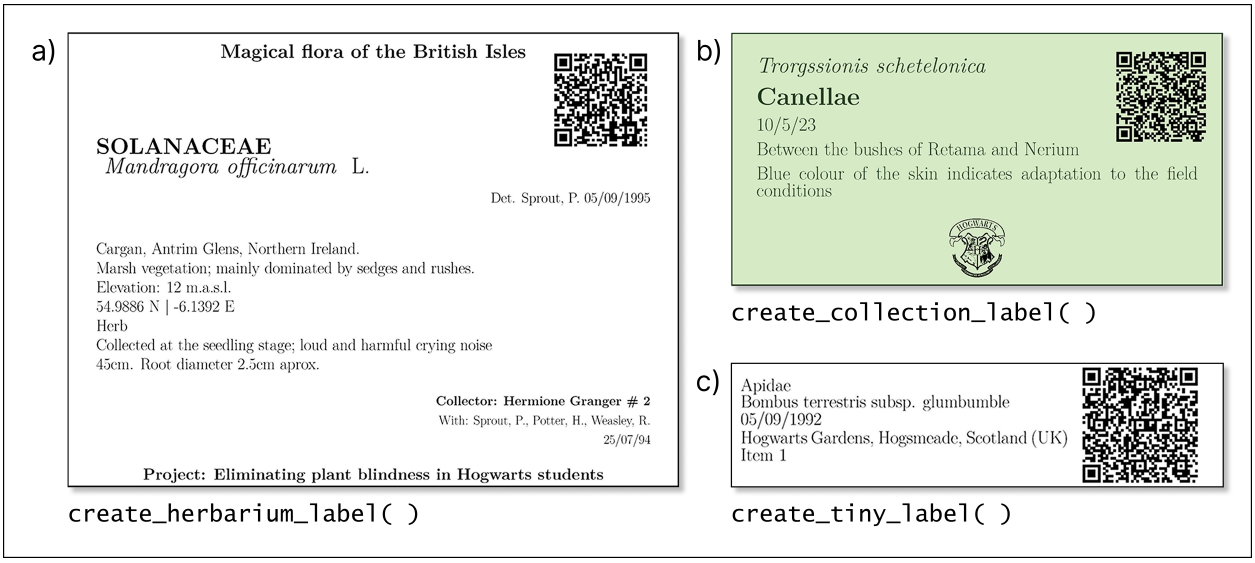

Figure 2: Figure 2. Examples of the outcomes from each label-related function in `labeleR`. a) Herbarium label: for stored plant vouchers; includes fixed fields (title, subtitle) and variable fields (e.g. taxon, date, coordinates, elevation). The family field is by default capitalized and bold, and species name italic. Size: 4 labels/page. b) Collection label: includes variable fields (first field in italics, second in bold), a customizable logo, font and background colors. Size: 8/page. c) Tinylabel: a simplified collection label with five fields. Size: 16/page. All three functions can include an optional QR code.

multiple pages, each one including one abstract. Each page will include four variable fields (title, author names, affiliations and the abstract texts). The orden of the abstracts mirrors the order of the dataframe rows. If the order of appearance needs to be changed, it is necessary to first arrange the columns in the original dataframe. The output document can include a table of contents with the titles and page numbers of all abstracts. Additionally, is possible to insert a custom front page that appearing at the beginning of the document.

```
create_abstractbook(
data=abstract.table,
path = "labeleR_output",
filename = "congress_abstractbook",
title.column = "abstract_title",
authors.column = "authors",
affiliation.column = "affiliation",
text.column = "abstract_text",
title.cex = 20,
authors.cex = 15,
affiliations.cex = 14,
text.cex = 12,
frontpage = "Congress_frontpage.pdf"
)
```

6.2.2 Badges

Badges can be used for personal accreditation in congresses, courses, meetings, etc. They have only two variable fields (name and affiliation), and can include two top logos or images. Accreditation badges include a dot line in the bottom for individual hand-edition once printed.

```
create_badge(
  data = badges.table,
  path = "labeleR_output",
  filename = "badges",
  event = "INTERNATIONAL CONFERENCE OF MUGGLEOLOGY",
  name.column = "List",
  affiliation.column = "Affiliation",
  rpic = system.file("rmarkdown/pictures/Hogwartslogo.png", package = "labeleR"),
  lpic = system.file("rmarkdown/pictures/MinMagic.png", package = "labeleR")
)
```

6.2.3 Attendance certificates

Attendance certificates are meant to certify that different attendants have been present in a specific event. Here, the only variable parameter is the name of the attendees. It allows to include a signature as an image, implying that the signer does not have to sign them individually. This certificate is available both in English and Spanish.

```
create_attendance_certificate(
  data = attendance.table,
  path = "labeleR_output",
  filename = "attendance_certificates",
  language = "English" ,
  name.column = "Names",
  type = "class",
  title = "Potions (year 1992-1993)",
  date = "23/06/1993",
  hours = "200",
  freetext = "taught by Professor S. Snape",
  signer = "A.P.W.B. Dumbledore",
  signer.role = "School Headmaster",
  rpic = system.file("rmarkdown/pictures/Hogwartslogo.png", package = "labeleR"),
  lpic = system.file("rmarkdown/pictures/Hogwartslogo.png", package = "labeleR"),
  signature.pic = system.file("rmarkdown/pictures/dumbledore.png", package = "labeleR")
)
```

6.2.4 Participation certificates

Participation certificates are used to certify that a participant has contributed in a specific event with a talk, a course, a poster, etc. They include multiple variable parameters (such as speaker, affiliation, title, etc.). This document can be rendered in English and in Spanish.

```
create_participation_certificate(
  data = participation.table,
  path = "labeleR_output",
  filename = "participation_certificates",
  language = "English",
  name.column = "Name",
  affiliation.column = "House",
  comm.type.column = "Comm.type",
  title.column = "Title",
  date.column = "Date",
```

```
  type = "online",
  event = "seminar",
  freetext = "organized by Hogwarts School of Magic and Wizardry",
  signer = "A.P.W.B. Dumbledore",
  signer.role = "School Headmaster",
  rpic = system.file("rmarkdown/pictures/Hogwartslogo.png", package = "labeleR"),
  lpic = system.file("rmarkdown/pictures/MinMagic.png", package = "labeleR"),
  signature.pic = system.file("rmarkdown/pictures/dumbledore.png", package = "labeleR")
)
```

Figure 3: Figure 3. Examples of outcomes from each event-related function in 'labeleR. a) Abstract book: creates pages with title, authors, affiliations and abstract (variable fields) and can include a table of contents and front page. b) Badges: include name, affiliation, a fixed field for the title, the option to add two images on top, and a dashed line at the bottom for additional hand-written information. c) Attendance certificate: attendee name is a variable field, while event name, signer, and date are fixed fields. d) Participation certificate: includes name, affiliation and title of the communication, and several fixed fields. Both certificate functions allow two images on top, a signature at the bottom, and offer Spanish and English templates.

7 Further applications

The `labeleR` philosophy is quite simple: creating multiple documents with a common design from a dataset containing the required information. It offers a modular structure that allows for customization and extension for new applications. For instance, the newly added `create_multichoice` function generates multichoice

tests randomizing the order of questions and possible answers from a given table (question bank). New developments will happen in the GitHub repository (https://github.com/EcologyR/labeleR) and eventually pushed to CRAN. User feedback and code contributions are welcome in the same repository to keep 'labeleR as an open and dynamic tool.

8 Figure legends

9 Data Accessibilty Statement

10 Competing Interests Statement

11 Author Contributions section

12 Acknowledgements

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