

ggpedigree: Visualizing Pedigrees with ‘ggplot2’ and ‘plotly’

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Summary

Pedigree diagrams underpin research and practice across genetics, animal breeding, genealogy, forensics, and counseling. They help medical geneticists trace the inheritance of Mendelian diseases and identify at-risk relatives; enable dairy breeders to plan matings that improve milk yield; support genealogists in reconstructing ancestry; assist forensic scientists in establishing familial connections in criminal investigations; and facilitate family therapists and counselors in understanding their clients’ relationships (McGoldrick, Gerson, & Petry, 2020). Early R tools such as kinship2 (Sinnwell, Therneau, & Schaid, 2014) plot simple nuclear families effectively, but they do not scale to today’s pedigrees that can exceed 1,000s of individuals. As datasets have grown, researchers now work with increasingly complex family structures, including large-scale plant breeding pedigrees (Shaw, Graham, Kennedy, Milne, & Marshall, 2014), web-based pedigree management systems (Ranaweera, Makalic, Hopper, & Bickerstaffe, 2018), interactive pedigree editors (Carver et al., 2018), and behavior genetic studies of extended family structures (Garrison et al., 2023; M. Hunter, Garrison, Burt, & Rodgers, 2021). Such complexity exposes the limitations of existing tools, which often struggle to handle large datasets and complex relationships. ggpedigree addresses this need by combining a vectorised layout algorithm, ggplot2 output, and optional plotly interactivity.

Statement of need

Pedigree visualization has traditionally relied on specialized proprietary software (e.g., Progeny, GenoPro, Pedigree Viewer) or R packages like kinship2 (Sinnwell et al., 2014), pedtools (Magnus Dehli Vigeland, 2021a), pedtricks (J. Martin, Wolak, Johnston, & Morrissey, 2025). While these tools are functional for many use cases, their limitations become pronounced when working with complex, modern pedigree datasets or when more detailed customization is required. Most existing R packages focus on base graphics or simple ggplot2 implementations.

First, base R graphics lack the modular design and extensibility needed for generating publication-quality pedigree figures. For example, kinship2 (Sinnwell et al., 2014) uses base graphics and loop-based layout functions that do not scale well. pedtricks (J. Martin et al., 2025), by contrast, returns ggplot2-based plots and is designed for large, multigenerational animal pedigrees, but offers minimal support for annotation layering, per-individual theming, or integration with phenotypic and model-based data

Second, most existing R-based tools offer no interactivity. Static graphics are often sufficient for publication, but interactivity improves exploration and communication during model development or data cleaning. A notable exception is pedtools (Magnus Dehli Vigeland, 2021b), which offers a sister shiny app, QuickPed (Magnus D. Vigeland, 2022). While the R ecosystem includes libraries like plotly that support interactive plotting, these features have yet to be integrated into pedigree functions.

Third, current solutions are often poorly integrated with tidyverse workflows and do not expose the full theming and layering capabilities familiar to users of ggplot2 (Hadley Wickham, 2016). In animal-focused workflows, rapid rendering often takes precedence over aesthetic flexibility, which can hinder interpretability in human-focused research.

Recent advances in behavior genetics and genetic epidemiology (Garrison et al., 2023; Lyu, Hunter, Good, Carroll, & Garrison, 2025; McArdle & McDonald, 1984) have introduced new visualization demands, particularly for extended families and highly interconnected pedigrees. Modern pedigree datasets can include hundreds or thousands of individuals across multiple generations, with overlapping relationships, consanguinity, remarriages, and twin sets that strain existing layout algorithms. Additionally, researchers increasingly need to overlay phenotypic information, genetic relatedness values, and model outputs onto pedigree plots to support interpretation and communication of their findings.

Several R packages attempt to address these challenges with built-in pedigree plotting functions. kinship2 (Sinnwell et al., 2014) remains widely used but produces static base graphics and relies on non-vectorized recursive layout functions that do not scale well to large families. A partial ggplot2 implementation exists but is incomplete, non-vectorized, and not actively maintained. pedtricks, a revival of pedantics (Morrissey, 2018), provides a ggplot2-based implementation for large animal pedigrees but lacks extensibility and interactivity. The geneHapR (Zhang, Jia, & Diao, 2023) package focuses on haplotype visualization rather than general pedigree structure. The pedgene package (Daniel & Sinnwell, 2024) offers some plotting functions but is primarily designed for association testing rather than visualization. The pedigreejs package (Carver et al., 2018) provides an interactive pedigree editor but does not integrate with R or ggplot2, limiting its utility for R users.

None of these packages offers the combination of modern ggplot2 integration, interactive capabilities, and extensibility that ggpedigree provides. ggpedigree addresses these limitations by providing a comprehensive visualization framework built on modern R graphics infrastructure. It leverages the extensive customization capabilities of ggplot2 while adding specialized functionality for pedigree-specific visualization challenges.

Software Architecture

ggpedigree is built on a modular architecture that separates data processing, layout calculation, and visualization layers. The core workflow involves: (1) data standardization and family structure analysis using BGmisc functions, (2) coordinate calculation using algorithms adapted from kinship2, (3) relationship connection mapping, and (4) layer-based plot construction using ggplot2 geometry functions. This design allows users to customize any aspect of the visualization while maintaining computational efficiency for large pedigrees. The package integrates tightly with the broader R ecosystem, particularly the tidyverse (H. Wickham et al., 2019) and BGmisc (Garrison, S. M., Hunter, M. D., Lyu, X., Trattner, J. D., & Burt, S. A., 2024). All functions return standard R objects (ggplot or plotly) that can be further customized using familiar syntax, ensuring accessibility for users already comfortable with modern R data science workflows.

Features

We briefly describe the main features of the ggpedigree package below. A more detailed description of the package's features and usage is available in the package vignettes, which include examples of how to create static and interactive pedigree plots, customize aesthetics, and visualize relatedness matrices. Additional example data include squirrel data from the Kluane Red Squirrel Project (McFarlane et al., 2014, 2015) and Targaryen family data from the Song of Ice and Fire universe (G. R. Martin, 1997; G. R. R. Martin, 2018; G. R. R. Martin, Jr, & Antonsson, 2014). These datasets demonstrate the package's capabilities for both empirical and fictional pedigrees.

90 Core Functions

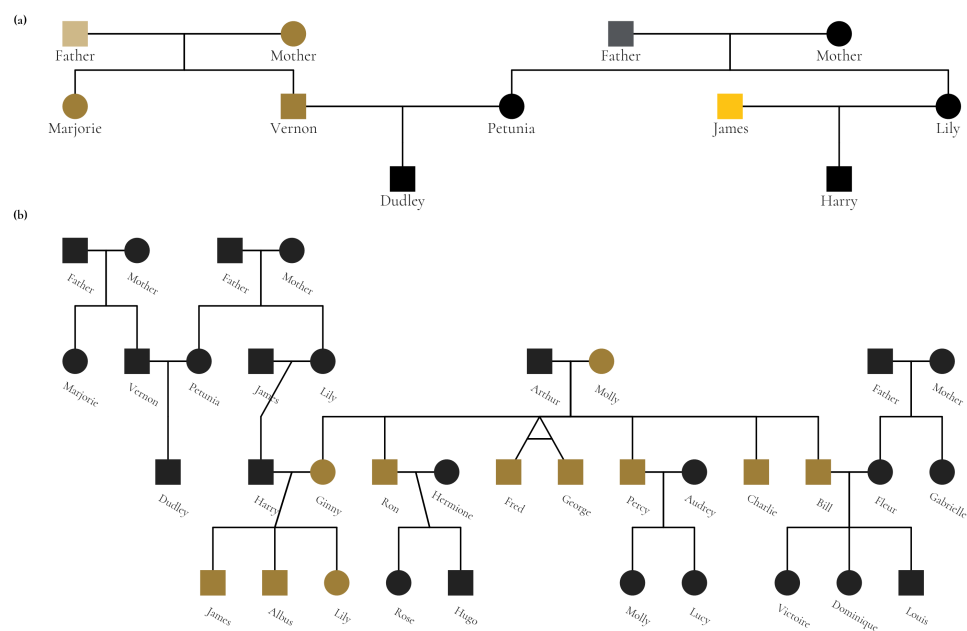
- 91 ▪ Data Standardization and Family Structure Analysis: `ggPedigree()` integrates with
92 BGmisc functions like `ped2fam()` to organize individuals by family, `recodeSex()` to
93 standardize sex coding, and `checkParentIDs()` to validate pedigree structures. The
94 function handles complex scenarios including consanguineous relationships and individuals
95 appearing in multiple pedigree positions.
- 96 ▪ Coordinate Calculation: `calculateCoordinates()` computes optimal positioning for
97 individuals using algorithms adapted from `kinship2::align.pedigree`, with enhance-
98 ments for large multi-generational pedigrees and complex family structures. The function
99 returns coordinate grids that optimize spacing and minimize visual overlap. These steps
100 are vectorized as much as possible to ensure computational efficiency, especially for large
101 pedigrees.
- 102 ▪ Relationship Connection Mapping: `calculateConnections()` generates connection paths
103 between family members, mapping parent-child, sibling, spousal, and twin relationships.
104 The function determines midpoints for line intersections and handles overlapping con-
105 nections with specialized curved segments. These calculations are optimized for large
106 datasets by using vectorized operations rather than the loop-based approaches used in
107 `kinship2`.
- 108 ▪ Layer-based Plot Construction: `ggPedigree()` constructs plots using `ggplot2` geome-
109 try functions, returning standard `ggplot2` objects that integrate with existing R work-
110 flows. `ggPedigreeInteractive()` extends plots into interactive `plotly` widgets with hover
111 tooltips and dynamic exploration capabilities. A comprehensive config system allows
112 customization of over 100 aesthetic and layout parameters.
- 113 ▪ Focal Individual Highlighting: Advanced functionality to highlight specific individuals and
114 their relatives based on additive genetic, mitochondrial, or other relationship matrices.

115 Specific Visualization Functions

- 116 ▪ Pedigree Plotting: `ggPedigree()` creates static pedigree plots using `ggplot2`, supporting
117 complex family structures, multiple generations, and customizable aesthetics. It can
118 handle large pedigrees with thousands of individuals while maintaining clarity and
119 readability.
- 120 ▪ Interactive Pedigree Visualization: `ggPedigreeInteractive()` generates interactive pedi-
121 gree plots using `plotly`, allowing users to explore large pedigrees dynamically. Users can
122 configure tooltip content to display individual IDs, names, phenotypic information, and
123 other relevant data. It supports tooltips, zooming, and panning for detailed exploration
124 of family structures.
- 125 ▪ Relatedness Matrix Heatmaps: `ggRelatednessMatrix()` creates customizable heatmap
126 visualizations for genetic relatedness matrices with support for hierarchical clustering,
127 interactive exploration, and seamless integration with BGmisc relatedness calculations.
- 128 ▪ Phenotype-Relatedness Analysis: `ggPhenotypeByDegree()` produces specialized plots
129 for visualizing phenotypic correlations as a function of genetic relatedness, including
130 confidence intervals and statistical summaries for quantitative genetic analysis.

131 Illustrative Example of `ggPedigree`

132 Here, we illustrate some of the features by reproducing the figure from (M. D. Hunter et
133 al., 2025) but restyled to conform to the Wake Forest Style Guidelines. As you can see,
134 the `ggpedigree` package allows for complex family structures to be visualized in a clear and
135 aesthetically pleasing manner.



We have combined two figures using patchwork (Pedersen, 2025) to show the pedigree of the Potter family from the Harry Potter series. The first plot (a) highlights the individual mtDNA lines in the Dursley and Evans families, while the second plot (b) shows the entire family structure with mitochondrial relationships highlighted in a gradient color scale. Features such as focal individual highlighting, custom color scales, text labels, and fonts are easily implemented. The package supports both static and interactive plots, allowing users to explore large pedigrees dynamically.

The plot includes individuals' names, relationships, and phenotypic information, all while maintaining clarity even with overlapping relationships. Although pleasing, this level of customization is not required, as default settings produce clear and informative pedigree plots.

Collectively, these tools provide a valuable resource for behavior geneticists and others who work with extended family data. They were developed as part of a grant and have been used in several ongoing projects, presentations (Garrison, 2024; M. D. Hunter, Garrison, Lyu, Good, & Burt, 2024), and forthcoming papers (Burt et al., 2025; M. D. Hunter et al., 2025; Lyu et al., 2025).

Availability

The ggpedigree package is open-source and available on both GitHub at <https://github.com/R-Computing-Lab/ggpedigree> and the Comprehensive R Archive Network (CRAN) at <https://cran.r-project.org/package=ggpedigree>. It is licensed under the GNU General Public License.

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238 Appendix

239 Source code for the figures above is available in the vignettes/articles/_paper.Rmd file.
240 The code below reproduces the figure using the ggpedigree package.

```
library(ggpedigree) # ggPedigree lives here
library(BGmisc) # helper utilities & example data
library(tidyverse) # for data manipulation and plotting
library(showtext)
library(sysfonts)
library(patchwork) # for combining plots

# Load the potter pedigree data
data("potter")
# Removing Last names
df_potter <- potter %>%
  mutate(
```

```

name = case_when(
  personID == 1 ~ "Vernon",
  personID == 2 ~ "Marjorie",
  personID == 3 ~ "Petunia",
  personID == 4 ~ "Lily",
  personID == 5 ~ "James",
  personID == 6 ~ "Dudley",
  personID == 7 ~ "Harry",
  personID == 8 ~ "Ginny",
  personID == 9 ~ "Arthur",
  personID == 10 ~ "Molly",
  personID == 11 ~ "Ron",
  personID == 12 ~ "Fred",
  personID == 13 ~ "George",
  personID == 14 ~ "Percy",
  personID == 15 ~ "Charlie",
  personID == 16 ~ "Bill",
  personID == 17 ~ "Hermione",
  personID == 18 ~ "Fleur",
  personID == 19 ~ "Gabrielle",
  personID == 20 ~ "Audrey",
  personID == 21 ~ "James",
  personID == 22 ~ "Albus",
  personID == 23 ~ "Lily",
  personID == 24 ~ "Rose",
  personID == 25 ~ "Hugo",
  personID == 26 ~ "Victoire",
  personID == 27 ~ "Dominique",
  personID == 28 ~ "Louis",
  personID == 29 ~ "Molly",
  personID == 30 ~ "Lucy",
  personID == 101 ~ "Mother",
  personID == 102 ~ "Father",
  personID == 103 ~ "Mother",
  personID == 104 ~ "Father",
  personID == 105 ~ "Mother",
  personID == 106 ~ "Father"
)
)

# Load Google fonts for styling
font_add_google(name = "Cormorant", family = "cormorant")
showtext_auto() # Load the showtext package to render Google fonts

# Set the WFU style guidelines for the plot
text_color_wfu <- "#222222" # dark grey for text labels
focal_fill_color_values_wfu <- c(
  "#9E7E38", "#000000", "#FDC314", "#CEB888", "#53565A")
family_wfu <- "cormorant"
text_size_wfu <- 14

# Create Panel A
m1 <- ggPedigree(df_potter %>% filter(personID %in% c(1:7, 101:104)),
  famID = "famID",
  personID = "personID",
  config = list(

```

```

label_include = TRUE,
label_column = "name",
point_size = 8,
# outline_include = TRUE,
focal_fill_personID = 8,
outline_multiplier = 1.5,
segment_linewidth = 0.5,
label_text_size = 12,
label_text_color = text_color_wfu,
axis_text_color = text_color_wfu,
label_text_family = family_wfu,
focal_fill_include = TRUE,
label_nudge_y = -0.30,
focal_fill_method = "manual",
focal_fill_color_values = focal_fill_color_values_wfu,
focal_fill_force_zero = TRUE,
label_method = "geom_text",
focal_fill_na_value = text_color_wfu,
focal_fill_scale_midpoint = 0.40,
focal_fill_component = "matID",
focal_fill_labels = NULL,
sex_legend_show = FALSE,
sex_color_include = FALSE
)
) + guides(shape = "none") + theme(
  plot.title = element_blank(),
  plot.title.position = "plot",
  text = element_text(family = family_wfu,
    size = 14)
) + coord_cartesian(ylim = c(3.25, 1),
  clip = "off")
# Create Panel B
m2 <- ggPedigree(df_potter,
  famID = "famID",
  personID = "personID",
  config = list(
    label_include = TRUE,
    label_column = "name",
    point_size = 8,
    focal_fill_personID = 8, # Molly Weasley
    outline_multiplier = 1.5,
    segment_linewidth = 0.5,
    label_text_size = 9,
    label_text_family = family_wfu,
    label_text_color = text_color_wfu,
    axis_text_color = text_color_wfu,
    label_nudge_y = -0.3,
    label_nudge_x = .1,
    focal_fill_include = TRUE,
    focal_fill_method = "gradient2",
    focal_fill_high_color = "#9E7E38",
    focal_fill_mid_color = "#9E7E38",
    focal_fill_low_color = text_color_wfu[2],
    focal_fill_scale_midpoint = 0.85,
    focal_fill_component = "mitochondrial",

```



```
focal_fill_force_zero = TRUE,
label_method = "geom_text",
focal_fill_na_value = text_color_wfu,
label_text_angle = -30,
sex_legend_show = FALSE,
sex_color_include = FALSE
)
) + theme(
  legend.position = "none",
  plot.title = element_blank(),
  plot.title.position = "plot",
  text = element_text(family = family_wfu,
                      size = text_size_wfu, face = "bold")
) + coord_cartesian(ylim = c(4.25, .9), clip = "off")

# Combine the two plots using patchwork
showtext_auto()
result <- m1 + m2 +
  plot_layout(
    ncol = 1, heights = c(1.1, 2.5),
    guides = "collect", tag_level = "new"
  ) +
  plot_annotation(
    tag_levels = list(c("(a)", "(b)")),
    theme = theme(plot.margin = margin(0, 0, 0, 0), )
  ) +
  guides(shape = "none") &
  theme(
    legend.position = "none",
    plot.margin = unit(c(0, 0, 0.0, 0), "lines"),
    plot.tag = element_text(family = family_wfu,
                          size = 2*text_size_wfu, face = "bold")
  )
)

# save as a png
ggsave(
  filename = "wfu_potter_pedigree.png",
  plot = result,
  width = 9.5, height = 6, dpi = 300, units = "in"
)
```