

# <sup>1</sup> `ggpedigree`: Visualizing Pedigrees with ‘`ggplot2`’ and <sup>2</sup> ‘`plotly`’

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## Software

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## <sup>5</sup> 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; Hunter, Garrison, Burt, & Rodgers, 2021). That complexity exposes the limitations of existing tools, which often struggle with large and complex datasets. `ggpedigree` addresses this need by combining a vectorised layout algorithm, `ggplot2` output, and optional `plotly` interactivity.

## <sup>22</sup> Statement of need

Pedigree visualization has traditionally relied on proprietary software (e.g., Progeny, GenoPro, Pedigree Viewer) or R packages like `kinship2` (Sinnwell et al., 2014), `pedtools` (Vigeland, 2021a), or `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 R packages focus on base graphics or simple `ggplot2` implementations.

Existing R solutions face three main challenges. First, current solutions are often poorly integrated with tidyverse workflows and do not expose the full theming and layering capabilities familiar to `ggplot2` users (Wickham, 2016). In animal-focused workflows, rapid rendering seems to takes precedence over aesthetic flexibility. I suspect that this is because users tend to work with more uniform data and fewer phenotypes. By contrast, human-focused workflows—particularly in behavior genetics and genetic epidemiology (Garrison et al., 2023; Lyu et al., 2025; McArdle & McDonald, 1984)—require closer integration with tidyverse pipelines and more flexible plotting systems to accommodate complex pedigree structures and harmonization of phenotypes across data sources. In other words, the needs are different.

Second, most 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` (Vigeland, 2021b), which offers a sister shiny

41 app, QuickPed ([Vigeland, 2022](#)). While the R ecosystem includes libraries, like `plotly`, that  
42 support interactive plotting, these features have yet to be integrated into pedigree functions.

43 Third, scalability and extensibility remain limited across existing tools. Several R packages  
44 attempt to address these challenges with built-in pedigree plotting functions. `kinship2`  
45 ([Sinnwell et al., 2014](#)) remains widely used but produces static base graphics and relies on non-  
46 vectorized recursive layout functions that do not scale well to large families. A partial `ggplot2`  
47 implementation exists in a modernized `kinship2` (called `Pedixplorer`, [Le Nézet, Sinnwell,  
48 Letko, André, & Quignon, 2025](#)), but is non-vectorized and incompatible with other `ggplot2`  
49 layers. `pedtricks`, a revival of `pedantics` ([Morrissey & Wilson, 2010](#)), provides a `ggplot2`-  
50 based implementation for large animal pedigrees but lacks extensibility and interactivity. The  
51 `geneHapR` ([Zhang, Jia, & Diao, 2023](#)) package focuses on haplotype visualization rather than  
52 general pedigree structure. The `pedgene` package ([Schaid & Sinnwell, 2024](#)) offers some  
53 plotting functions but is primarily designed for association testing. The `pedigreejs` package  
54 ([Carver et al., 2018](#)) provides an interactive pedigree editor but does not integrate with R or  
55 `ggplot2`, limiting its utility for R users.

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

## 61 Software Architecture

62 `ggpPedigree` is built on a modular architecture that separates data processing, layout calculation,  
63 and visualization layers. The core workflow involves: (1) data standardization and family  
64 restructuring using `BGmisc` functions, (2) coordinate calculation using algorithms adapted  
65 from `kinship2`, (3) relationship connection mapping, and (4) layer-based plot construction  
66 using `ggplot2` geometry functions. This design allows users to customize any aspect of the  
67 visualization while maintaining computational efficiency for large pedigrees. The package  
68 integrates tightly with the broader R ecosystem, particularly the `tidyverse` ([Wickham et al.,  
69 2019](#)) and `BGmisc` ([Garrison, Hunter, Lyu, Trattner, & Burt, 2024](#)). All functions return  
70 standard R objects (`ggplot` or `plotly`) that can be further customized.

71 `BGmisc`, as described in Garrison et al. (2024), is a dependency for its relatedness-heavy  
72 workflows, supplying network-based validation utilities (`checkParentIDs()`) and relatedness  
73 components, like `ped2fam()`, `ped2paternal()`, and `ped2maternal()`. These components  
74 allow `ggpPedigree` to visualize how related any two individuals are based on additive genetic,  
75 mitochondrial, or other relationship matrices.

## 76 Features

77 I describe the main features of the `ggpPedigree` package below. Detailed descriptions of features  
78 and usage are available in the [package vignettes](#), including how to create static and interactive  
79 pedigree plots, customize aesthetics, and visualize relatedness matrices. Additional example  
80 data include squirrels from the Kluane Red Squirrel Project ([McFarlane et al., 2014, 2015](#))  
81 and Targaryens from the Song of Ice and Fire universe ([G. R. R. Martin, 1997, 2018](#)).

- 82     ▪ Data Standardization and Family Structure Analysis: `ggPedigree()` integrates with  
83         network-based functions from `BGmisc` like `ped2fam()` to organize individuals by family and  
84         `checkParentIDs()` to validate pedigree structures. The function handles consanguineous  
85         relationships and individuals appearing in multiple pedigree positions. More details are  
86         in the [complex pedigree data vignette](#), as well as in Garrison et al. (2024), and Hunter,  
87         Garrison, et al ([Hunter et al., 2025, 2021](#)).
- 88     ▪ Coordinate Calculation: `calculateCoordinates()` computes optimal positioning for indi-  
89         viduals using algorithms adapted from `kinship2::align_pedigree`, with enhancements

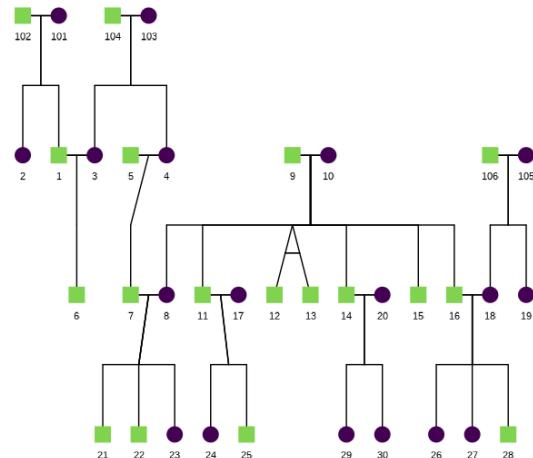
90 for large multi-generational pedigrees and complex family structures. These steps are  
 91 vectorized as much as possible to ensure efficient computation and compatibility with  
 92 ggplot2.  
 93 ▪ Relationship Connection Mapping: calculateConnections( ) generates connection paths  
 94 between family members, mapping parent-child, sibling, spousal, and twin relationships.  
 95 The function determines midpoints for line intersections and handles overlapping connec-  
 96 tions with curved segments. These calculations are optimized for large datasets by using  
 97 vectorized operations rather than the loop-based approaches used in kinship2.  
 98 ▪ Layer-based Plot Construction: ggPedigree( ) constructs plots using ggplot2 geometry  
 99 functions, returning standard ggplot2 objects that integrate with existing R workflows.  
 100 ggPedigreeInteractive( ) extends plots into interactive plotly widgets. A config system  
 101 allows customization of over 150 aesthetic and layout parameters. More details are in  
 102 the [configuration vignette](#).  
 103 ▪ Individual Highlighting: Advanced functionality to highlight specific individuals and their  
 104 relatives based on additive genetic, mitochondrial, or other relationship matrices.  
 105 ▪ Specific Visualization Functions: ggPedigree( ) creates static pedigree plots using  
 106 ggplot2. ggPedigreeInteractive() generates interactive pedigree plots using plotly.  
 107 ggRelatednessMatrix() creates customizable heatmaps for relatedness matrices with  
 108 support for hierarchical clustering, and seamless integration with BGmisc relatedness  
 109 calculations. ggPhenotypeByDegree( ) visualizes phenotypic correlations as a function  
 110 of genetic relatedness, including confidence intervals and statistical summaries for  
 111 quantitative genetic analysis.

### 112 Code example

113 This example shows how to use ggpedigree to visualize a pedigree. The potter dataset  
 114 includes several wizarding families from the Harry Potter series.

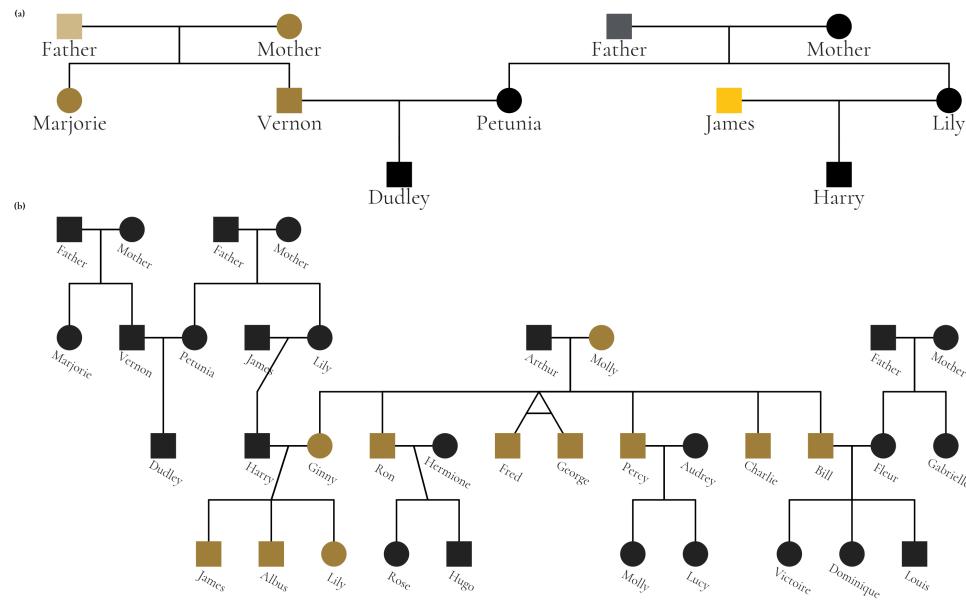
```
ggPedigree(potter,
  famID = "famID",
  personID = "personID"
)
```

115 This code produces the following pedigree plot:



116  
 117 The package supports extensive customization of visual aesthetics. The following example  
 118 is a figure from Hunter et al. (2025) that used the Potter pedigree data. The figure has  
 119 been restyled according to Wake Forest University brand identity guidelines to demonstrate

120 ggpedigree's customization capabilities. The figure combines two panels: panel (a) highlights  
 121 unique mitochondrial lines in the Dursley and Evans families, while panel (b) shows the full  
 122 pedigree with Molly Weasley's mitochondrial descendants in gold.



123 The complete source code for this example is available in the package documentation [website](#).

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

## 129 Availability

130 The ggpedigree package is open-source and available on both [GitHub](#) and the [Comprehensive](#)  
 131 [R Archive Network \(CRAN\)](#). It is licensed under the GNU General Public License.

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