crossdateR: an interactive crossdating and standardization tool

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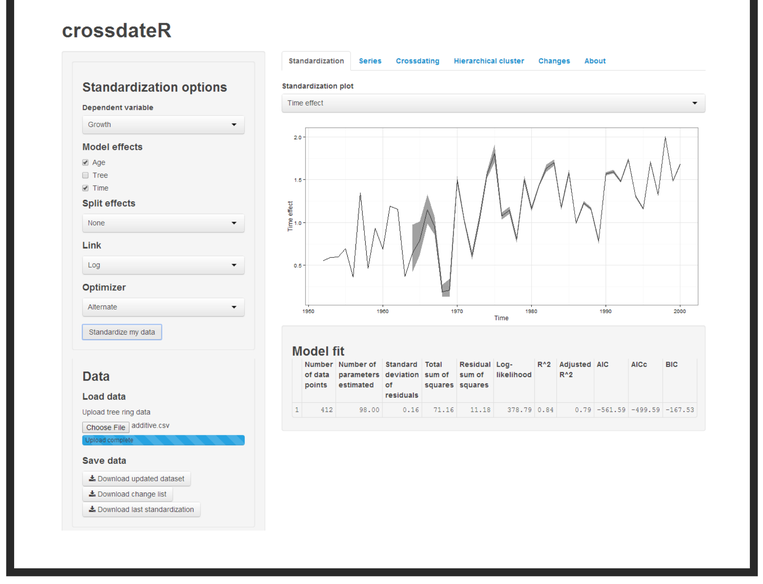
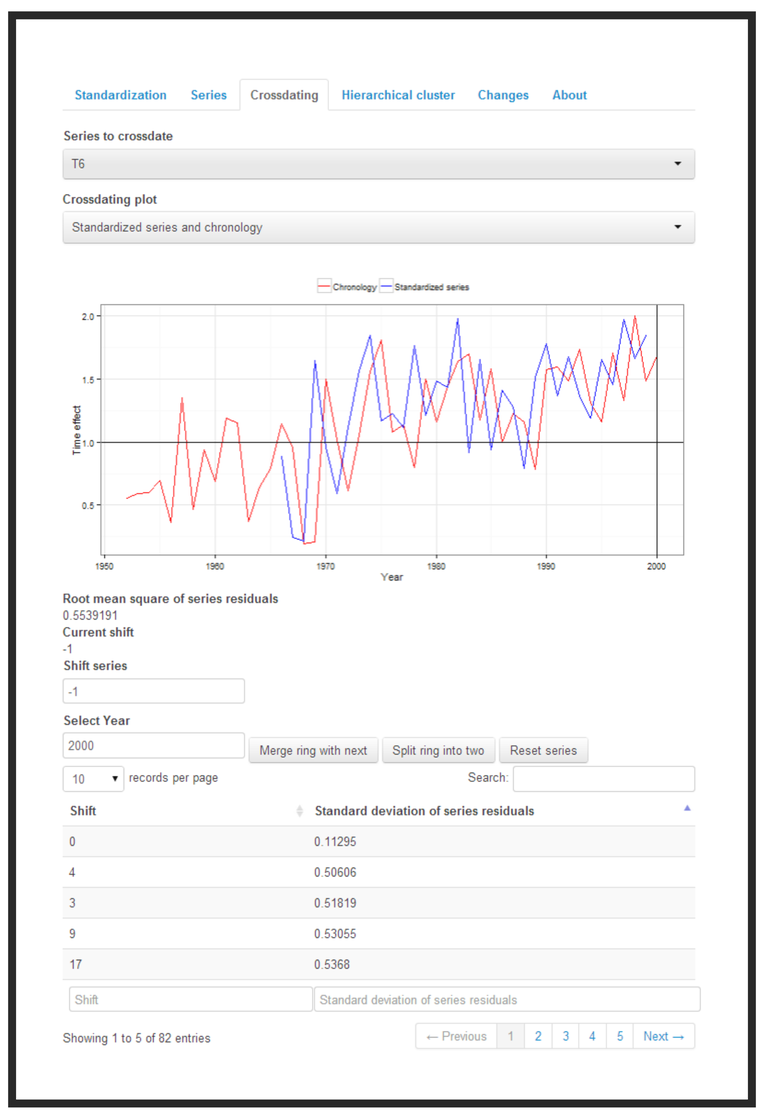
About

Crossdating doesn't have to be painful. Crossdating is the essential process of assigning true dates to each of the tree rings collected during dendrochronology. By examining the common, climate-induced pattern of large and small rings, we can line up the cores collected to extend our chronologies back into the past.

Unfortunately, many of the existing tools are antiquated and hard to use. Making changes and exploring possibilities is often a convoluted process and users can be left to drown in a sea of warning flags. Other tools lack a coherent theoretical basis and present users with a dizzying array of ad hoc heuristics.

crossdateR is a new crossdating and standardization tool that uses a novel model-based framework and modern user interface to make tree ring analysis easier and better. It is free, open source, platform agnostic and always open to new suggestions.





Technology

1. Free and open source
2. Written in R using a Shiny interface
3. Direct integration with R: download your analysis and move on to the next step
4. Command line alternatives available for all functions
5. Upload data in any of several common dendrochronological file formats
6. Automatically creates common graphs
7. Download original graphs so you can modify, save and export them to your heart's content
8. Download your updated dataset and a full list of changes with notes
9. Runs locally across all platforms with a consistent user interface

Standardization

1. Model-based standardization powered by regression
2. Interactive, visual exploration of standardization options
3. Model fit statistics help you come to a rational decision on standardization technique
4. Confidence intervals and standard errors for estimated parameters
5. Superior model fitting increases accuracy for free and breaks the segment length curse
6. Generalized additive models power nonparametric smooth age effects
7. Control for differences in productivity and eliminate modern sample bias by adding a Tree effect
8. Split effects allow for multiple regional curves and divergent climate signals
9. Switch between additive and multiplicative models using GLM link parameters
10. Example data sets provided to explore the effects of different options on traditional dendrochronological problems (segment length curse, modern sample bias, etc.)

Crossdating

1. Integrated standardization and crossdating to correctly isolate desired time signal
2. Simple clear plots of standardized series and residuals
3. Easily merge and split rings
4. Include and exclude series from the chronology
5. Censor suppressed or unreliable sections of series
6. One simple metric of series fit
7. Find the “distance” between series and use hierarchical clusters to identify patterns and outliers
8. Automated suggestions for series shifts
9. Detect suppression and missing / extra rings using change point analysis

Theory

At its heart, tree ring analysis is about seperating signals. The size and characteristics of each ring formed is the result of interactions between a large number of abiotic and biotic factors affecting the growth of the tree. We can aggregate these influences according to the common patterns they produce in the tree rings. Weather and insect outbreaks may affect all tree rings from the same year similarly while soil depth and heavy metal concentration may likewise affect all rings from the same tree.

Once we've found these intermediate latent variables we can then explore their relationship with other environmental properties. For example the coefficients for the latent Time effect can be related to the climatic variables recorded in those years to understand the link between growth and climate while controlling for differences caused by other terms in the model.

The techniques used here are powered by Generalized Linear Models but are largely a reconceptualization of traditional techniques in dendrochronology. The Time effect for example is analagous to a standardized chronology while regional curve standardization is analogous to a model wtih a Time and Age effect.

The primary benefits of this model-based approach are:

1. Conceptual clarity
2. Improved model fitting
3. Model fit statistics for model evaluation and selection
4. Theoretically sound estimates of uncertainty
5. Modular, extensible flexibility

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