

Data and text mining

Shuffle & untangle: novel untangle methods for solving the tanglegram layout problem

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Abstract

Motivation: A tanglegram is a plot of two-tree-like diagrams, one facing the other, and having their labels connected by inter-tree edges. These two trees, which could be both phylogenetic trees and dendrograms stemming from hierarchical clusterings, have thus identically labelled leaves but different topologies. As a result, the inter-tree edges of a tanglegram can be intricately tangled and difficult to be analysed and explained by human readers. To better visualize the tanglegram (and thus compare the two dendrograms) one may try to untangle it, i.e. search for that series of flippings of the various branches of the two trees that minimizes the number of crossings among the inter-tree edges. The untangling problem has received significant interest in the past decade, and several techniques have been proposed to address it. These techniques are computationally efficient but tend to fail at finding the global optimum configuration generating the least tangly tanglegram.

Results: We leverage the existing results to propose untangling methods that are characterized by an overall slower convergence method than the ones in the literature, but that produce tanglegrams with lower entanglements.

Availability and implementation: One of the algorithms is implemented in Python, and available from <https://github.com/schlegelp/tanglegram>.

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1 Introduction

A common strategy to visually compare two different dendrograms relative to the same sets of terminal vertices is by using tanglegrams, i.e. comparative drawings (embeddings) of a pair of dendrograms, side-by-side, with matching objects connected by straight-line segments called inter-tree edges (Andreas *et al.*, 2012). A crossing occurs in a tanglegram when two inter-tree edges intersect, while there is no crossing inside the individual trees. The number of crossings, in its turn, depends on the layout (also known as drawing) of the two dendrograms in the tanglegram. In practical terms, layouts, which lead to a high number of crossings are harder to interpret (Andreas *et al.*, 2012). This calls for finding a drawing of the tanglegram with as few crossings as possible. Finding a tanglegram layout (TL) of two trees that produces zero crossings, sometimes referred to as a drawable layout (Fertus *et al.*, 2010), is known as the planar embedding problem (Andreas *et al.*, 2012). It is known that every pair of trees of size smaller or equal to three has a drawable layout (Fertus *et al.*, 2010). However, only special cases allow for a layout with zero crossings. The problem of finding a graphical layout of

two trees that gives the minimum number of crossings is known as the TL problem (Ramsal *et al.*, 2009), or the two-tree crossing minimization (TTCM) problem (Fertus *et al.*, 2010). The TTCM problem is known to be NP-complete, meaning that there is no known algorithm to solve this problem in polynomial time with the tree size, but only in exponential time (Fertus *et al.*, 2010).

When one tree is fixed, the problem above is referred to as the one-tree crossing minimization (OTCM) (Fertus *et al.*, 2010). For arbitrary trees, the OTCM problem can be solved in $O(n \log n)$ time (with n the number of leaves) as in Venkatasubramanian *et al.* (2009) and Fertus *et al.* (2010). Ramsal *et al.* (2009), instead, presented an $O(n \log^2 n / \log \log n)$ algorithm for a generalized tanglegram.

A heuristics-based algorithm to tackle the TTCM problem was proposed in Dwyer and Schreiber (2004). Here, the authors repeatedly solve the OTCM problem for each tree, and eventually provide 2.5D graphical representations of the results. Another approximation algorithm for complete tanglegrams is provided in Buchin *et al.* (2009).

The TTCM for binary trees problem was shown in Fertus *et al.* (2010) to be fixed parameter tractable (FPT) with parameter k (the

Untangle A Novel

Jack Kornfield



Untangle A Novel:

Canaan: A Novel Donald McCaig, 2008-02-17 A bred in the bones storyteller Geraldine Brooks Canaan fills a vast canvas Its points of reference are Richmond in the throes of Reconstruction the trading floors of Wall Street a Virginia plantation and the Great Plains where the splendidly arrogant George Custer Yellowhair rides to his fate against Sitting Bull s warriors This is the story of America over twenty years of its most turbulent history The characters are black white and red ex Union and ex Confederate and the principal narrator is a Santee woman She Goes Before who marries an ex slave Through her eyes we witness the hanging of her father by whites in the mass execution of 1863 Red Cloud s banquet with President Grant and that final confrontation on the bluffs above the Little Bighorn **Northanger Abbey - Second Edition** Jane Austen, 2002-04-29 First accepted by a publisher in 1803 Northanger Abbey was eventually published posthumously in 1818 In it Austen weaves a romance full of suspense and comedy around the heroine Catherine Morland s first foray into society The style of the novel is a unique hybrid along the way Austen parodies the eighteenth century novel of manners the Gothic novel and even the educational treatises of the time The second Broadview edition includes a revised introduction notes bibliography and expanded appendices of background contextual materials **Novel Ideas** Barbara Shoup, Margaret-Love Denman, 2013-05-01 Novel Ideas provides a substantial introduction to the elements of fiction followed by in depth interviews with successful novelists who speak with candor and insight into the complex process by which a novel is made This edition includes new and updated interviews as well as writing exercises to enhance its use in the writing classroom Dorothy Allison recalls deliciously self indulgent days of writing in her bathrobe wrapped in misery and exultation Peter Cameron explains how he made the move from short fiction to the novel with the aid of a music composer s notebook to track the movement of his characters Writers as different as Ha Jin Jill McCorkle Richard Ford and Michael Chabon describe their unique approaches to their work while consistently affirming the necessity of committing to the hard effort of it while also remaining open to surprise Aspiring novelists will find hands on strategies for beginning working through and revising a novel accomplished novelists will discover new ways to solve the problems they face in process and serious readers of contemporary fiction will enjoy a glimpse into the way novels are made Includes interviews with Dorothy Allison Larry Brown Peter Cameron Michael Chabon Michael Cunningham Robb Forman Dew Richard Ford Ha Jin Patricia Henley Charles Johnson Wally Lamb Valerie Martin Jill McCorkle Sena Jeter Naslund Lewis Nordan Sheri Reynolds S J Rozan Jane Smiley Lee Smith Theodore Weesner **Hybrid Novels** George Kowalik, 2025-10-03 The phrase post postmodernism has appeared in Contemporary Literary Studies since the 20th century but what does it mean Scholars have defined the term in various often contradictory ways Existing studies also rarely centralise race an essential component in the transition from postmodern irony to post postmodern sincerity Hybrid Novels analyses post postmodernism s only consistency and certainty hybridity This speaks for a broader social issue concerning the ethics of categorisation and the conflicting labels imposed on

subjectivity Hybrid Novels considers landmark American British novels by Percival Everett Jonathan Franzen Zadie Smith and David Foster Wallace published from 1996 to 2001 It positions these authors at the centre of the post postmodernism debate together for the first time This book suggests that 2010s autofiction further develops post postmodern tensions of irony and sincerity at the turn of the 21st century Major American Canadian novels by Sheila Heti Ben Lerner Teju Cole and Tao Lin are discussed published from 2010 to 2013 *Rewriting Wrongs* Angela Kimyongür, Amy Wigelsworth, 2014-10-02 *Rewriting Wrongs* French Crime Fiction and the Palimpsest furthers scholarly research into French crime fiction and within that broad context examines the nature functions and specificity of the palimpsest Originally a palaeographic phenomenon the palimpsest has evolved into a figurative notion used to define any cultural artefact which has been reused but still bears traces of its earlier form In her 2007 study *The Palimpsest* Sarah Dillon refers to the persistent fascination with palimpsests in the popular imagination embodying as they do the mystery of the secret the miracle of resurrection and the thrill of detective discovery In the context of crime fiction the palimpsest is a particularly fertile metaphor Because the practice of rewriting is so central to popular fiction as a whole crime fiction is replete with hypertextual transformations The palimpsest also has tremendous extra diegetic resonance in that crime fiction frequently involves the rewriting of criminal or historical events and scandals This collection of essays therefore exemplifies and interrogates the various manifestations and implications of the palimpsest in French crime fiction **A Path with Heart** Jack Kornfield, 2009-10-21 This important guidebook shows in detail and with great humor and insight the way to practice the Buddha's universal teachings here in the West Jack Kornfield is a wonderful storyteller and a great teacher Thich Nhat Hanh Jack is helping to pave the path for American Buddhism bringing essential basics into our crazy modern lives And the language he uses is as simple and as lovely as our breath Natalie Goldberg Perhaps the most important book yet written on meditation the process of inner transformation and the integration of spiritual practice into our American way of life *A Path with Heart* brings alive one by one the challenges of spiritual living in the modern world Written by a teacher psychologist and meditation master of international renown this warm inspiring and expert book touches on a wide range of essential issues including many rarely addressed in spiritual books From compassion addiction and psychological and emotional healing to dealing with problems involving relationships and sexuality to the creation of a Zen like simplicity and balance in all facets of life it speaks to the concerns of many modern spiritual seekers both those beginning on the path and those with years of experience *A Path with Heart* is filled with practical techniques guided meditations stories koans and other gems of wisdom that can help ease your journey through the world The author's own profound and sometimes humorous experiences and gentle assistance will skillfully guide you through the obstacles and trials of spiritual and contemporary life to bring a clarity of perception and a sense of the sacred into your everyday experience Reading this book will touch your heart and remind you of the promises inherent in meditation and in a life of the spirit the blossoming of inner peace wholeness and understanding and the

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analysis of the plots scenes and characters of these selected TV serials the book provides timely interpretations of contemporary Chinese society its political inclinations social fashions and cultural tendencies The book also demonstrates how popular media narratives of TV drama serials engage with sensitive civic issues and cultural phenomena of modern day China which in turn encourages a broader social imagination and potential for change Advancing our understanding of contemporary China this book will appeal to students and scholars of contemporary Chinese culture society and politics as well as those with research interests in television studies more generally **Mexico in Its Novel** John S.

Brushwood,2014-06-23 Mexico in Its Novel is a perceptive examination of the Mexican reality as revealed through the nation's novel The author presents the Mexican novel as a cultural phenomenon a manifestation of the impact of history upon the nation an attempt by a people to come to grips with and understand what has happened and is happening to them Written in a clear and graceful style this study examines the life of the novel as a genre against the background of Mexican chronology It begins with a survey of the mid twentieth century novel the Mexican novel which came of age in the period following the 1947 publication of Agustín Yáñez's *The Edge of the Storm* During this time the novel resolved some of its most complicated problems and as a result offered a wider and deeper view of reality Having established this circumstance John Brushwood goes back in time to the Conquest and then moves forward to the twentieth century novel Passing from the Colonial Period into the nineteenth century the author recognizes the relationship between Romanticism and the desire for logical social behavior and then views this relationship in the perspective of the Reform an attempt to bring order out of chaos The novel under the Díaz dictatorship is seen in three different phases and the last Díaz chapter actually moves into the Revolution itself The novel during the years of fighting is considered along with the first post Revolutionary fiction From that point the developing conflict within Mexican reality itself a conflict between introversion and extroversion nationalism and cosmopolitanism reaches out to seek its solution in the novels of the first chapter **Love, Love, Love (Three**

contemporary romance novels: Falling Fast - Seattle Girl - Sparks Fly) Lucy Kevin,2014-01-01 Fans of Sophie Kinsella Meg Cabot Nora Roberts SEATTLE GIRL Chick lit about love dating and my really big mouth SPARKS FLY A romance about the magic of falling in love *David Foster Wallace: Fiction and Form* David Hering,2016-09-08 A fresh reassessment of David Foster Wallace's entire fictional career and writing process

The American Novel of Manners Helen Gertrude Bannan,1915 **Rogue One Junior Novel** Lucasfilm Press,2016-12-16 An official novelization of Rogue One A Star Wars Story follows a band of rebels on a daring mission to steal the Death Star plans

Tragic Novels, René Girard and the American Dream Carly Osborn,2020-05-14 This book draws on the philosopher René Girard to argue that three twentieth century American novels Jeffrey Eugenides's *The Virgin Suicides* Rick Moody's *The Ice Storm* and Richard Yates's *Revolutionary Road* are tragedies Until now Girardian literary analysis has generally focused on representations of human desire in texts and neglected both other emotions and the place of tragedy Carly Osborn addresses these omissions by using

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Mark A. Gluck, David E. Rumelhart, 2013-02-01 Written for cognitive scientists psychologists computer scientists engineers and neuroscientists this book provides an accessible overview of how computational network models are being used to model neurobiological phenomena Each chapter presents a representative example of how biological data and network models interact with the authors research The biological phenomena cover network or circuit level phenomena in humans and other higher order vertebrates *Handbook of the American Short Story* Erik Redling, Oliver Scheiding, 2022-01-19 The American short story has always been characterized by exciting aesthetic innovations and an immense range of topics This handbook offers students and researchers a comprehensive introduction to the multifaceted genre with a special focus on recent developments due to the rise of new media Part I provides systematic overviews of significant contexts ranging from historical political backgrounds short story theories developed by writers print and digital culture to current theoretical approaches and canon formation Part II consists of 35 paired readings of representative short stories by eminent authors charting major steps in the evolution of the American short story from its beginnings as an art form in the early nineteenth century up to the digital age The handbook examines historically methodologically and theoretically the coming together of the enduring narrative practice of compression and concision in American literature It offers fresh and original readings relevant to studying the American short story and shows how the genre performs American culture *The Bookman* ,1919

[The Blackwell Companion to Jesus](#) Delbert Burkett, 2013-11-11 The Blackwell Companion to Jesus features a comprehensive collection of essays that explore the diverse ways in which Jesus has been imagined or portrayed from the beginnings of Christianity to the present day Considers portrayals of Jesus in the New Testament and beyond Jesus in non Christian religions philosophical and historic perspectives modern manifestations and representations in Christian art novels and film Comprehensive scope of coverage distinguishes this work from similar offerings Examines both Christian and non Christian perspectives on Jesus including those from ethnic and sexual groups as well as from other faiths Offers rich and rewarding insights which will shape our understanding of this influential figure and his enduring legacy

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