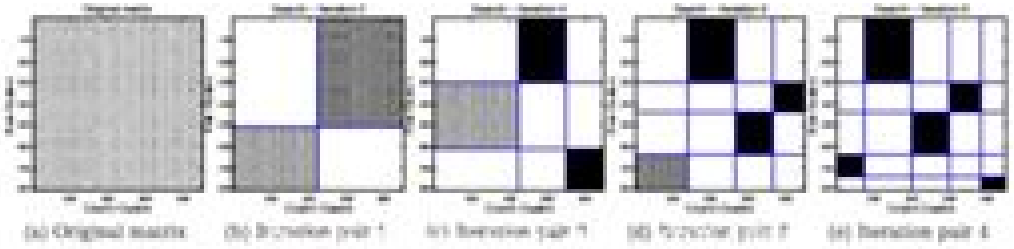
Co-Clustering - Details

- Using Information Theoretic Co-clustering, as parallelized for Hadoop architecture in:
  - Disco: Distributed co-clustering with Map-Reduce: A case study towards petabyte-scale end-to-end mining, Papadimitriou et.al, *Data Mining* 2008
- Partition entire matrix into row groups, col groups
  - Minimize length of encoding of resulting partitioned matrix
    - Competing code length factors: number of row groups & col groups, homogeneity of clusters
  - Iterate over rows, rearrange and sub-partition to find better encoding using heuristic
  - Repeat for columns, then rows again, until local optimum is found
  - Complexity: $O(n*fp*(row\_groups+col\_groups)^{2}*iters)$



Co Clustering

Amit M. Salunke

Co Clustering:

Co-Clustering Gérard Govaert,Mohamed Nadif,2013-12-11 Cluster or co cluster analyses are important tools in a variety of scientific areas The introduction of this book presents a state of the art of already well established as well as more recent methods of co clustering The authors mainly deal with the two mode partitioning under different approaches but pay particular attention to a probabilistic approach Chapter 1 concerns clustering in general and the model based clustering in particular The authors briefly review the classical clustering methods and focus on the mixture model They present and discuss the use of different mixtures adapted to different types of data The algorithms used are described and related works with different classical methods are presented and commented upon This chapter is useful in tackling the problem of co clustering under the mixture approach Chapter 2 is devoted to the latent block model proposed in the mixture approach context The authors discuss this model in detail and present its interest regarding co clustering Various algorithms are presented in a general context Chapter 3 focuses on binary and categorical data It presents in detail the appropriated latent block mixture models Variants of these models and algorithms are presented and illustrated using examples Chapter 4 focuses on contingency data Mutual information phi squared and model based co clustering are studied Models algorithms and connections among different approaches are described and illustrated Chapter 5 presents the case of continuous data In the same way the different approaches used in the previous chapters are extended to this situation **Co-clustering Algorithms** Hyuk Cho,2008 Co clustering is rather a recent paradigm for unsupervised data analysis but it has become increasingly popular because of its potential to discover latent local patterns otherwise unapparent by usual unsupervised algorithms such as k means Wide deployment of co clustering however requires addressing a number of practical challenges such as data transformation cluster initialization scalability and so on Therefore this thesis focuses on developing sophisticated co clustering methodologies to maturity and its ultimate goal is to promote co clustering as an invaluable and indispensable unsupervised analysis tool for varied practical applications To achieve this goal we explore the three specific tasks 1 development of co clustering algorithms to be functional adaptable and scalable co clustering algorithms 2 extension of co clustering algorithms to incorporate application specific requirements extensions and 3 application of co clustering algorithms broadly to existing and emerging problems in practical application domains applications As for co clustering algorithms we develop two fast Minimum Sum Squared Residue Co clustering MSSRCC algorithms CDGS04 which simultaneously cluster data points and features via an alternating minimization scheme and generate co clusters in a checkerboard structure The first captures co clusters with constant values while the other discovers co clusters with coherent trends as well as constant values We note that the proposed algorithms are two special cases bases 2 and 6 with Euclidean distance respectively of the general co clustering framework Bregman Co clustering BCC BDG 07 which contains six Euclidean BCC and six I divergence BCC algorithms Then we substantially enhance the performance of the two MSSRCC

algorithms by escaping from poor local minima and resolving the degeneracy problem of generating empty clusters in partitional clustering algorithms through the three specific strategies 1 data transformation 2 deterministic spectral initialization and 3 local search strategy Concerning co clustering extensions we investigate general algorithmic strategies for the general BCC framework since it is applicable to a large class of distance measures and data types We first formalize various data transformations for datasets with varied scaling and shifting factors mathematically justify their effects on the six Euclidean BCC algorithms and empirically validate the analysis results We also adapt the local search strategy initially developed for the two MSSRCC algorithms to all the twelve BCC algorithms Moreover we consider variations of cluster assignments and cluster updates including greedy vs non greedy cluster assignment online vs batch cluster update and so on Furthermore in order to provide better scalability and usability we parallelize all the twelve BCC algorithms which are capable of co clustering large scaled datasets over multiple processors Regarding co clustering applications we extend the functionality of BCC to incorporate application specific requirements 1 discovery of inverted patterns whose goal is to find anti correlation 2 discovery of coherent co clusters from noisy data whose purpose is to do dimensional reduction and feature selection and 3 discovery of patterns from time series data whose motive is to guarantee critical time locality Furthermore we employ co clustering to pervasive computing for mobile devices where the task is to extract latent patterns from usage logs as well as to recognize specific situations of mobile device users Finally we demonstrate the applicability of our proposed algorithms for aforementioned applications through empirical results on various synthetic and real world datasets In summary we present co clustering algorithms to discover latent local patterns propose their algorithmic extensions to incorporate specific requirements and provide their applications to a wide range of practical domains Security Solutions and Applied Cryptography in Smart Grid Communications Ferrag, Mohamed Amine,Ahmim, Ahmed,2016-11-29 Electrical energy usage is increasing every year due to population growth and new forms of consumption As such it is increasingly imperative to research methods of energy control and safe use Security Solutions and Applied Cryptography in Smart Grid Communications is a pivotal reference source for the latest research on the development of smart grid technology and best practices of utilization Featuring extensive coverage across a range of relevant perspectives and topics such as threat detection authentication and intrusion detection this book is ideally designed for academicians researchers engineers and students seeking current research on ways in which to implement smart grid platforms all over the globe Data Warehousing and Knowledge Discovery Alfredo Cuzzocrea,Umeshwar Dayal,2011-08-19 This book constitutes the refereed proceedings of the 13th International Conference on Data Warehousing and Knowledge Discovery DaWak 2011 held in Toulouse France in August September 2011 The 37 revised full papers presented were carefully reviewed and selected from 119 submissions The papers are organized in topical sections on physical and conceptual data warehouse models data warehousing design methodologies and tools data warehouse performance and optimization pattern mining matrix based

mining techniques and stream sensor and time series mining *Fine-grained complexity analysis of some combinatorial data science problems* Froese, Vincent,2018-10-10 This thesis is concerned with analyzing the computational complexity of NP hard problems related to data science For most of the problems considered in this thesis the computational complexity has not been intensively studied before We focus on the complexity of computing exact problem solutions and conduct a detailed analysis identifying tractable special cases To this end we adopt a parameterized viewpoint in which we spot several parameters which describe properties of a specific problem instance that allow to solve the instance efficiently We develop specialized algorithms whose running times are polynomial if the corresponding parameter value is constant We also investigate in which cases the problems remain intractable even for small parameter values We thereby chart the border between tractability and intractability for some practically motivated problems which yields a better understanding of their computational complexity In particular we consider the following problems General Position Subset Selection is the problem to select a maximum number of points in general position from a given set of points in the plane Point sets in general position are well studied in geometry and play a role in data visualization We prove several computational hardness results and show how polynomial time data reduction can be applied to solve the problem if the sought number of points in general position is very small or very large The Distinct Vectors problem asks to select a minimum number of columns in a given matrix such that all rows in the selected submatrix are pairwise distinct This problem is motivated by combinatorial feature selection We prove a complexity dichotomy with respect to combinations of the minimum and the maximum pairwise Hamming distance of the rows for binary input matrices thus separating polynomial time solvable from NP hard cases Co Clustering is a well known matrix clustering problem in data mining where the goal is to partition a matrix into homogenous submatrices We conduct an extensive multivariate complexity analysis revealing several NP hard and some polynomial time solvable and fixed parameter tractable cases The generic F free Editing problem is a graph modification problem in which a given graph has to be modified by a minimum number of edge modifications such that it does not contain any induced subgraph isomorphic to the graph F We consider three special cases of this problem The graph clustering problem Cluster Editing with applications in machine learning the Triangle Deletion problem which is motivated by network cluster analysis and Feedback Arc Set in Tournaments with applications in rank aggregation We introduce a new parameterization by the number of edge modifications above a lower bound derived from a packing of induced forbidden subgraphs and show fixed parameter tractability for all of the three above problems with respect to this parameter Moreover we prove several NP hardness results for other variants of F free Editing for a constant parameter value The problem DTW Mean is to compute a mean time series of a given sample of time series with respect to the dynamic time warping distance This is a fundamental problem in time series analysis the complexity of which is unknown We give an exact exponential time algorithm for DTW Mean and prove polynomial time solvability for the special case of binary time series Diese Dissertation befasst sich mit der Analyse der

Berechnungskomplexit t von NP schweren Problemen aus dem Bereich Data Science F r die meisten der hier betrachteten Probleme wurde die Berechnungskomplexit t bisher nicht sehr detailliert untersucht Wir f hren daher eine genaue Komplexit tsanalyse dieser Probleme durch mit dem Ziel effizient l sbare Spezialf lle zu identifizieren Zu diesem Zweck nehmen wir eine parametrisierte Perspektive ein bei der wir bestimmte Parameter definieren welche Eigenschaften einer konkreten Probleminstanz beschreiben die es erm glichen diese Instanz effizient zu l sen Wir entwickeln dabei spezielle Algorithmen deren Laufzeit f r konstante Parameterwerte polynomiell ist Dar ber hinaus untersuchen wir in welchen F llen die Probleme selbst bei kleinen Parameterwerten berechnungsschwer bleiben Somit skizzieren wir die Grenze zwischen schweren und handhabbaren Probleminstanzen um ein besseres Verst ndnis der Berechnungskomplexit t f r die folgenden praktisch motivierten Probleme zu erlangen Beim General Position Subset Selection Problem ist eine Menge von Punkten in der Ebene gegeben und das Ziel ist es m glichst viele Punkte in allgemeiner Lage davon auszuw hlen Punktmengen in allgemeiner Lage sind in der Geometrie gut untersucht und spielen unter anderem im Bereich der Datenvisualisierung eine Rolle Wir beweisen etliche H rteergebnisse und zeigen wie das Problem mittels Polynomzeitdatenreduktion gel st werden kann falls die Anzahl gesuchter Punkte in allgemeiner Lage sehr klein oder sehr gro ist Distinct Vectors ist das Problem m glichst wenige Spalten einer gegebenen Matrix so auszuw hlen dass in der verbleibenden Submatrix alle Zeilen paarweise verschieden sind Dieses Problem hat Anwendungen im Bereich der kombinatorischen Merkmalsselektion Wir betrachten Kombinationen aus maximalem und minimalem paarweisen Hamming Abstand der Zeilenvektoren und beweisen eine Komplexit tsdichotomie f r Bin rmatrizen welche die NP schweren von den polynomzeitl sbaren Kombinationen unterscheidet Co Clustering ist ein bekanntes Matrix Clustering Problem aus dem Gebiet Data Mining Ziel ist es eine Matrix in m glichst homogene Submatrizen zu partitionieren Wir f hren eine umfangreiche multivariate Komplexit tsanalyse durch in der wir zahlreiche NP schwere sowie polynomzeitl sbare und festparameterhandhabbare Spezialf lle identifizieren Bei F free Editing handelt es sich um ein generisches Graphmodifikationsproblem bei dem ein Graph durch m glichst wenige Kantenmodifikationen so abge ndert werden soll dass er keinen induzierten Teilgraphen mehr enth lt der isomorph zum Graphen F ist Wir betrachten die drei folgenden Spezialf lle dieses Problems Das Graph Clustering Problem Cluster Editing aus dem Bereich des Maschinellen Lernens das Triangle Deletion Problem aus der Netzwerk Cluster Analyse und das Problem Feedback Arc Set in Tournaments mit Anwendungen bei der Aggregation von Rankings Wir betrachten eine neue Parametrisierung mittels der Differenz zwischen der maximalen Anzahl Kantenmodifikationen und einer unteren Schranke welche durch eine Menge von induzierten Teilgraphen bestimmt ist Wir zeigen Festparameterhandhabbarkeit der drei obigen Probleme bez glich dieses Parameters Dar ber hinaus beweisen wir etliche NP Schwereergebnisse f r andere Problemvarianten von F free Editing bei konstantem Parameterwert DTW Mean ist das Problem eine Durchschnittszeitreihe bez glich der Dynamic Time Warping Distanz f r eine Menge gegebener Zeitreihen zu berechnen Hierbei handelt es sich um ein grundlegendes Problem der

Zeitreihenanalyse dessen Komplexit t bisher unbekannt ist Wir entwickeln einen exakten Exponentialzeitalgorithmus f r DTW Mean und zeigen dass der Spezialfall bin rer Zeitreihen in polynomieller Zeit l sbar ist **Advanced Data Mining and Applications** Xue Li,Osmar R. Zaiane,Zhanhuai Li,2006-07-27 Here are the proceedings of the 2nd International Conference on Advanced Data Mining and Applications ADMA 2006 held in Xi an China August 2006 The book presents 41 revised full papers and 74 revised short papers together with 4 invited papers The papers are organized in topical sections on association rules classification clustering novel algorithms multimedia mining sequential data mining and time series mining web mining biomedical mining advanced applications and more Advances in Knowledge Discovery and Data Mining Takashi Washio,2008-05-08 This book constitutes the refereed proceedings of the 12th Pacific Asia Conference on Knowledge Discovery and Data Mining PAKDD 2008 held in Osaka Japan in May 2008 The 37 revised long papers 40 revised full papers and 36 revised short papers presented together with 1 keynote talk and 4 invited lectures were carefully reviewed and selected from 312 submissions The papers present new ideas original research results and practical development experiences from all KDD related areas including data mining data warehousing machine learning databases statistics knowledge acquisition automatic scientific discovery data visualization causal induction and knowledge based systems

Proceedings of the Fourth SIAM International Conference on Data Mining Michael W. Berry,2004-01-01 The Fourth SIAM International Conference on Data Mining continues the tradition of providing an open forum for the presentation and discussion of innovative algorithms as well as novel applications of data mining This is reflected in the talks by the four keynote speakers who discuss data usability issues in systems for data mining in science and engineering issues raised by new technologies that generate biological data ways to find complex structured patterns in linked data and advances in Bayesian inference techniques This proceedings includes 61 research papers *Co-Similarity Approach to Co-Clustering* Fawad Hussain,2011-02 Clustering is an important tool for many applications such as document clustering gene expression analysis etc In many such cases the data can be represented as a set of instances expressed by their attributes in the form of a matrix Clustering instances such as documents depends on their attributes words and vice versa thus forming a dual relationship between instances and their attributes Co Similarity Approach to Co Clustering emphasizes on a technique that exploits the dual nature between instances and their attributes to find similarities between objects in each set It provides and analyzes results of applying this technique on two different domains Document clustering and Gene Expression Analysis

Evolutionary Spectral Co-clustering Nathan S. Green,2010 The field of mining evolving data is relatively new and evolutionary clustering is among the latest in this trend Presently there are algorithms for evolutionary k means agglomerative hierarchical and spectral clustering These have been excellent in showing the advantages of using evolving data snapshots for better clustering results From these algorithms the key portion of the conversion from static data handling to evolving data handling has been the addition of the historical cost function The cost function is what determines

whether or not instances should be moved from one cluster to the next between time steps based on the historical cuts made between the instances in the dataset These cost functions are then the method by which evolutionary clustering provides smooth transitions as there is a tunable tolerance for shifts in cluster membership This also means that transitions between clusters become much more significant For example if an author word matrix were clustered over ten years and an author changed clusters part way through the time line it is a likely indicator that the author has changed research topics Methods for mining evolving data have not yet expanded into co clustering for this reason I have contributed a new algorithm for co clustering evolving data The algorithm uses spectral co clustering to cluster each time step of instances and features Using the previous example cluster changes in features or words for an author word matrix is significant in that it may indicate a change in meaning for the word This contribution to the field provides an avenue for further development of evolutionary co clustering algorithms Abstract Effective Strategies for Co-clustering Zhao Li,2012 3 Fast Co clustering by Ranking and Sampling By discriminately sampling representative data points the computational complexity of co clustering analysis is achieved in linear time with competitive results **Co-Clustering by Bipartite Spectral Graph Partitioning for Out-of-Tutor Prediction** Shubhendu Trivedi,Zachary A. Pardos,Gabor N. Sarkozy,Neil T. Heffernan,2012 Learning a more distributed representation of the input feature space is a powerful method to boost the performance of a given predictor Often this is accomplished by partitioning the data into homogeneous groups by clustering so that separate models could be trained on each cluster Intuitively each such predictor is a better representative of the members of the given cluster than a predictor trained on the entire data set Previous work has used this basic premise to construct a simple yet strong bagging strategy However such models have one significant drawback Instances such as students are clustered while features tutor usage features items are left alone One way clustering by using some objective function measures the degree of homogeneity between data instances Often it is noticed that features also influence final prediction in homogeneous groups This indicates a duality in the relationship between clusters of instances and clusters of features Co Clustering simultaneously measures the degree of homogeneity in both data instances and features thus also achieving clustering and dimensionality reduction simultaneously Students and features could be modelled as a bipartite graph and a simultaneous clustering could be posed as a bipartite graph partitioning problem In this paper we integrate an effective bagging strategy with Co Clustering and present results for prediction of out of tutor performance of students We report that such a strategy is very useful and intuitive even improving upon performance achieved by previous work Contains 4 figures and 2 tables Additional funding for this research was provided by the United States Army For the complete proceedings Proceedings of the International Conference on Educational Data Mining EDM 5th Chania Greece June 19 21 2012 see ED537074 Semi-supervised Heterogeneous Evolutionary Co-clustering Pankaj Andhale,2012 One of the challenges of the machine learning problem is the absence of sufficient number of labeled instances or training instances At the same time generating labeled data is

expensive and time consuming The semi supervised approach has shown promising results to solve the problem of insufficient or fewer labeled instance datasets The key challenge is incorporating the semi supervised knowledge into the heterogeneous data which is evolving in nature Most of the prior work that uses semi supervised knowledge has been performed on heterogeneous static data The semi supervised knowledge is incorporated into data which aid the clustering algorithm to obtain better clusters The semi supervised knowledge is provided as constrained based or distance based I am proposing a framework to incorporate prior knowledge to perform co clustering on the evolving heterogeneous data This framework can be used to solve a wide range of problems dealing with text analysis web analysis and image grouping In the semi supervised approach we incorporate the domain knowledge by placing the constraints which aid the clustering process in performing effective clustering of the data In the proposed framework I am using the constraint based semi supervised non negative matrix factorization approach to obtain the co clustering on the heterogeneous evolving data The constraint based semi supervised approach uses the user provided must link or cannot link constraints on the central data type before performing co clustering To process the original datasets efficiently in terms of time and space I am using the low rank approximation technique to obtain the sparse representation of the input data matrix using the Dynamic Colibri approach
Abstract Matrix Factorization Framework for Simultaneous Data (co-)clustering and Embedding Kais Allab,2016
Advances in computer technology and recent advances in sensing and storage technology have created many high volume high dimensional data sets This increase in both the volume and the variety of data calls for advances in methodology to understand process summarize and extract information from such kind of data From a more technical point of view understanding the structure of large data sets arising from the data explosion is of fundamental importance in data mining and machine learning Unlike supervised learning unsupervised learning can provide generic tools for analyzing and summarizing these data sets when there is no welldefined notion of classes In this thesis we focus on three important techniques of unsupervised learning for data analysis namely data dimensionality reduction data clustering and data co clustering Our major contribution proposes a novel way to consider the clustering resp coclustering and the reduction of the dimension simultaneously The main idea presented is to consider an objective function that can be decomposed into two terms where one of them performs the dimensionality reduction while the other one returns the clustering resp co clustering of data in the projected space simultaneously We have further introduced the regularized versions of our approaches with graph Laplacian embedding in order to better preserve the local geometry of the data Experimental results on synthetic data as well as real data demonstrate that the proposed algorithms can provide good low dimensional representations of the data while improving the clustering resp co clustering results Motivated by the good results obtained by graph regularized based clustering resp co clustering methods we developed a new algorithm based on the multi manifold learning We approximate the intrinsic manifold using a subset of candidate manifolds that can better reflect the local geometrical structure by making

use of the graph Laplacian matrices Finally we have investigated the integration of some selected instance level constraints in the graph Laplacians of both data samples and data features By doing that we show how the addition of priory knowledge can assist in data co clustering and improves the quality of the obtained co clusters **Evolutionary Star-structured Heterogeneous Data Co-clustering** Amit M. Salunke,2012 A star structured interrelationship which is a more common type in real world data has a central object connected to the other types of objects One of the key challenges in evolutionary clustering is integration of historical data in current data Traditionally smoothness in data transition over a period of time is achieved by means of cost functions defined over historical and current data These functions provide a tunable tolerance for shifts of current data accounting instance to all historical information for corresponding instance Once historical data is integrated into current data using cost functions co clustering is obtained using various co clustering algorithms like spectral clustering non negative matrix factorization and information theory based clustering Non negative matrix factorization has been proven efficient and scalable for large data and is less memory intensive compared to other approaches Non negative matrix factorization tri factorizes original data matrix into row indicator matrix column indicator matrix and a matrix that provides correlation between the row and column clusters However challenges in clustering evolving heterogeneous data have never been addressed In this thesis I propose a new algorithm for clustering a specific case of this problem viz the star structured heterogeneous data The proposed algorithm will provide cost functions to integrate historical star structured heterogeneous data into current data Then I will use non negative matrix factorization to cluster each time step of instances and features This contribution to the field will provide an avenue for further development of higher order evolutionary co clustering algorithms Abstract **Efficient Implementation of Multi-dimensional Co-clustering** Xiaoyang Gao,2011 ABSTRACT Co Clustering is an important data mining operation that can automatically cluster along two or more dimensions Most of the work in the literature focuses on co clustering on two dimensions In this report we develop extensions of ITCC Information Theoretical Co Clustering for multi dimension data We first extend the approach to more than two dimensions We also develop parallel algorithms for the resulting approach Our experimental results show that our algorithms and implementation scale well to handle large datasets both on sequential and parallel machines The Multi Dimensional ITCC has been used to help the analysis of multi dimensional wireless data records to find out the hidden model of user activities

Automatic Co-clustering for Social Network and Medical Data Juan Ignacio Casse,2014 The task of clustering is a fundamental task in many important human endeavors In machine learning parlance it is an unsupervised learning tool for discovering patterns in data Specifically its goal is to find groups of objects in the data that are similar in some sense Some important fields where clustering is used include medical diagnostics bioinformatics social network analysis and market analysis Clustering is also used behind the scenes as a preprocessing step to other tasks such as Web search and recommender systems Scalable Co-clustering Algorithm Using Hadoop Mapreduce Avinash Kumar,2015 Key Phrase

Extraction and Co-clustering for Web Search Result Visualization Shixian Chu,2011 *Relation Co-clustering for Fast Join Query Processing* Metab Asiri,2017 Relational databases have been utilized in a variety of applications such as airline reservation systems healthcare systems accounting systems etc In relational databases data are spread among interrelated relations Relationships among tuples in different relations can be reconstructed by matching join attribute values namely performing the equi join operations Unfortunately the join operation is arguably the most important but expensive operation in query processing Unlike conventional approaches in this thesis we propose to reorganize tuples in relations so that joins can be performed easily and efficiently We attempt to place tuples in different relations that have the matching join attribute values at corresponding positions in their respective relations called relation co clustering In this thesis we discuss how to co clustering relations perform joins on co clustered relations on Microsoft SQL server 2017

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