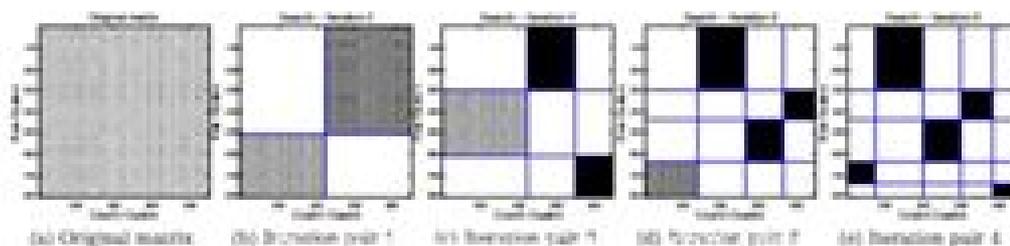# Co-Clustering - Details

- 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: $O(n \ast fp \ast (row\_groups + col\_groups)^2 \ast iters)$



(a) Original matrix    (b) Iteration pair 1    (c) Iteration pair 9    (d) Iteration pair 3    (e) Iteration pair 4

# [Co Clustering](#)

SJ Ball

**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 <u>Security Solutions and Applied Cryptography in Smart Grid Communications</u> 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 *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 **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 **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 **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 *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 *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 **A Nature Inspired Algorithm for Biclustering Microarray Data Analysis** B. Rengeswaran,A.M. Natarajan,K. Premalatha,2018-01-23 Research Paper undergraduate from the year 2015 in the subject Computer Science Bioinformatics grade 1 Bannari Amman Institute of Technology language English abstract Extracting meaningful information from gene expression data poses a great challenge to the community of researchers in the field of computation as well as to biologists It is possible to determine the behavioral patterns of genes such as nature of their interaction similarity of their behavior and so on through the analysis of gene expression data If two different genes show similar expression patterns across the samples this suggests a common pattern of regulation or relationship between their functions These patterns have huge significance and application in bioinformatics and clinical research such as drug discovery treatment planning accurate diagnosis prognosis protein network analysis and so on In order to identify various patterns from gene expression data data mining techniques are essential Major data mining techniques which can be applied for the analysis of gene expression data include clustering classification association rule mining etc Clustering is an important data mining technique for the analysis of gene expression data However clustering has some disadvantages To overcome the problems associated with clustering biclustering is introduced Clustering is a global model where as biclustering is a local model Discovering such local expression patterns is essential for identifying many genetic pathways that are not apparent otherwise It is therefore necessary to move beyond the clustering paradigm towards developing approaches which are capable of discovering local patterns in gene expression data Biclustering is a two dimensional clustering problem where we group the genes and samples simultaneously It has a great potential in detecting marker genes that are associated with certain tissues or diseases However since the problem is NP hard there has been a lot of research in biclustering involving statistical and graph theoretic The proposed Cuckoo Search CS method finds the significant biclusters in large expression data The experiment results are demonstrated on benchmark datasets Also this work determines the biological relevance of the biclusters with Gene Ontology in terms of function *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      KDD ... ,2006

**Terrorism and Counterterrorism Methods and Technologies** W. Y. Ishimoto,1997      *Journal of Machine Learning Research* ,2007 An international forum covering all areas of machine learning      Aluminium Alloys 2006 - ICAA10 Warren J. Poole,Mary A. Wells,David J. Lloyd,2006-07-15 Innovation Through Research and Technology Proceedings of the 10th International Conference on Aluminum Alloys Vancouver Canada July 9 13 2006      **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      **Functional Nanomaterials for Energy and Environmental Applications** M.A. Shah,M. Amin Bhat,P. Davim,2013-07-01 Special topic volume with invited peer reviewed papers only      Emergent Information Technologies and Enabling Policies for Counter-Terrorism Robert L. Popp,John Yen,2006-06-05 The papers in this volume examine the homeland security capabilities of emerging technologies in order to enhance the reader s understanding of the public policy and privacy issues related to various technologies It provides a rigorous examination and offers several entirely new concepts innovative technologies and corresponding enabling policies for defending against terrorism in the post Cold War era      *Dissertation Abstracts International* ,2009

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