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Degree-Constrained Editing of Small-Degree Graphs



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Degree Constrained Editing Small Degree Graphs Nichterlein:

Degree-constrained editing of small-degree graphs Nichterlein, Andre, 2015-07-03 This thesis deals with degree constrained graph modification problems. In particular we investigate the computational complexity of DAG Realization and Degree Anonymity. The DAG Realization problem is given a multiset of positive integer pairs to decide whether there is a realizing directed acyclic graph DAG that is pairs are one to one assigned to vertices such that the indegree and the outdegree of every vertex coincides with the two integers of the assigned pair. The Degree Anonymity problem is given an undirected graph G and two positive integers k and s to decide whether at most s graph modification operations can be performed in G in order to obtain a k anonymous graph that is a graph where for each vertex there are $k - 1$ other vertices with the same degree. We classify both problems as NP complete that is there are presumably no polynomial time algorithms that can solve every instance of these problems. Confronted with this worst case intractability we perform a parameterized complexity study in order to detect efficiently solvable special cases that are still practically relevant. The goal herein is to develop fixed parameter algorithms where the seemingly unavoidable exponential dependency in the running time is confined to a parameter of the input. If the parameter is small then the corresponding fixed parameter algorithm is fast. The parameter thus measures some structure in the input whose exploitation makes the particular input tractable. Considering Degree Anonymity two natural parameters provided with the input are anonymity level k and solution size s . However we will show that Degree Anonymity is $W[1]$ hard with respect to the parameter s even if $k \geq 2$. This means that the existence of fixed parameter algorithms for s and k is very unlikely. Thus other parameters have to be considered. We will show that the parameter maximum vertex degree is very promising for both DAG Realization and Degree Anonymity. Herein for Degree Anonymity we consider the maximum degree of the input graph. Considering DAG Realization we take the maximum degree in a realizing DAG. Due to the problem definition we can easily determine the maximum degree by taking the maximum over all integers in the given multiset. We provide fixed parameter algorithms with respect to the maximum degree for DAG Realization and for Anonym E Ins. The later is the variant of Degree Anonymity when only edge insertions are allowed as modification operations. If we allow edge deletions or vertex deletions as graph modification operations then we can show that the corresponding variants of Degree Anonymity called Anonym V Del and Anonym E Del are NP complete even if the maximum vertex degree is seven. Moreover we provide strong intractability results for Anonym E Del and Anonym V Del proving that they remain NP complete in several restricted graph classes. Studying the approximability of natural optimization problems associated with Anonym E Del or Anonym V Del we obtain negative results showing that none of the considered problems can be approximated in polynomial time better than within a factor of $n^{1/2}$ where n denotes the number of vertices in the input. Furthermore for the optimization variants where the solution size s is given and the task is to maximize the anonymity level k this inapproximability even holds if we allow a running time that is exponential in s . Observe

that DAG Realization also can be seen as degree constrained graph modification problem where only arc insertions are allowed. Starting with an arcless graph the task is to insert arcs to obtain a realizing DAG for the given multiset. The above classification with respect to the parameter maximum degree shows that in graphs with small maximum degree the modification operation edge respectively arc insertion is easier than vertex or edge deletion. There is a plausible explanation for this behavior. When the maximum degree is small then there is a high freedom in inserting edges or arcs as for a given vertex almost all other vertices can be chosen as new neighbor. Observe that for DAG Realization the additional requirement that the directed graph shall be acyclic restricts this freedom. In Anonym E Ins we do not have restrictions on this freedom. In fact exploiting this freedom in our implementation for Anonym E Ins we show that our theoretical ideas can be turned into successful heuristics and lower bounds. Experiments on several large scale real world datasets show that our implementation significantly improves on a recent heuristic and provides provably optimal solutions on about 21 % 56 of 260 of the real world data.

Degree-constrained Editing of Small-degree Graphs André Nichterlein, 2015

Matching minors in bipartite graphs Wiederrecht, Sebastian, 2022-04-19

In this thesis we adapt fundamental parts of the Graph Minors series of Robertson and Seymour for the study of matching minors and investigate a connection to the study of directed graphs. We develop a matching theoretic to established results of graph minor theory. We characterise the existence of a cross over a conformal cycle by means of a topological property. Furthermore we develop a theory for perfect matching width a width parameter for graphs with perfect matchings introduced by Norin here we show that the disjoint alternating paths problem can be solved in polynomial time on graphs of bounded width. Moreover we show that every bipartite graph with high perfect matching width must contain a large grid as a matching minor. Finally we prove an analogue of the well known Flat Wall theorem and provide a qualitative description of all bipartite graphs which exclude a fixed matching minor. In der vorliegenden Arbeit werden fundamentale Teile des Graphminorenprojekts von Robertson und Seymour für das Studium von Matching Minoren adaptiert und Verbindungen zur Strukturtheorie gerichteter Graphen aufgezeigt. Wir entwickeln matchingtheoretische Analogien zu etablierten Resultaten des Graphminorenprojekts. Wir charakterisieren die Existenz eines Kreuzes über einem konformen Kreis mittels topologischer Eigenschaften. Weiter entwickeln wir eine Theorie zu perfekter Matchingweite einem Weiteparameter für Graphen mit perfekten Matchings der von Norin eingeführt wurde. Hier zeigen wir dass das Disjunkte Alternierende Pfade Problem auf bipartiten Graphen mit beschränkter Weite in Polynomialzeit lösbar ist. Weiter zeigen wir dass jeder bipartite Graph mit hoher perfekter Matchingweite ein großes Gitter als Matchingminor enthalten muss. Schließlich zeigen wir ein Analogon des bekannten Flat Wall Theorem und geben eine qualitative Beschreibung aller bipartiter Graphen an die einen festen Matching Minor ausschließen.

Classic graph problems made temporal – a parameterized complexity analysis Molter, Hendrik, 2020

This thesis investigates the parameterized computational complexity of six classic graph problems lifted to a temporal setting. More specifically we consider problems defined on temporal graphs that is a graph

where the edge set may change over a discrete time interval while the vertex set remains unchanged Temporal graphs are well suited to model dynamic data and hence they are naturally motivated in contexts where dynamic changes or time dependent interactions play an important role such as for example communication networks social networks or physical proximity networks The most important selection criteria for our problems was that they are well motivated in the context of dynamic data analysis Since temporal graphs are mathematically more complex than static graphs it is maybe not surprising that all problems we consider in this thesis are NP hard We focus on the development of exact algorithms where our goal is to obtain fixed parameter tractability results and refined computational hardness reductions that either show NP hardness for very restricted input instances or parameterized hardness with respect to large parameters In the context of temporal graphs we mostly consider structural parameters of the underlying graph that is the graph obtained by ignoring all time information However we also consider parameters of other types such as ones trying to measure how fast the temporal graph changes over time In the following we briefly discuss the problem setting and the main results

Restless Temporal Paths A path in a temporal graph has to respect causality or time which means that the edges used by a temporal path have to appear at non decreasing times We investigate temporal paths that additionally have a maximum waiting time in every vertex of the temporal graph Our main contributions are establishing NP hardness for the problem of finding restless temporal paths even in very restricted cases and showing W 1 hardness with respect to the feedback vertex number of the underlying graph

Temporal Separators A temporal separator is a vertex set that when removed from the temporal graph destroys all temporal paths between two dedicated vertices Our contribution here is twofold Firstly we investigate the computational complexity of finding temporal separators in temporal unit interval graphs a generalization of unit interval graphs to the temporal setting We show that the problem is NP hard on temporal unit interval graphs but we identify an additional restriction which makes the problem solvable in polynomial time We use the latter result to develop a fixed parameter algorithm with a distance to triviality parameterization Secondly we show that finding temporal separators that destroy all restless temporal paths is P 2 hard

Temporal Matchings We introduce a model for matchings in temporal graphs where if two vertices are matched at some point in time then they have to recharge afterwards meaning that they cannot be matched again for a certain number of time steps In our main result we employ temporal line graphs to show that finding matchings is NP hard even on instances where the underlying graph is a path

Temporal Coloring We lift the classic graph coloring problem to the temporal setting In our model every edge has to be colored properly that is the endpoints are colored differently at least once in every time interval of a certain length We show that this problem is NP hard in very restricted cases even if we only have two colors We present simple exponential time algorithms to solve this problem As a main contribution we show that these algorithms presumably cannot be improved significantly

Temporal Cliques and s Plexes We propose a model for temporal s plexes that is a canonical generalization of an existing model for temporal cliques Our main contribution is a fixed parameter algorithm that

enumerates all maximal temporal s plexes in a given temporal graph where we use a temporal adaptation of degeneracy as a parameter Temporal Cluster Editing We present a model for cluster editing in temporal graphs where we want to edit all layers of a temporal graph into cluster graphs that are sufficiently similar Our main contribution is a fixed parameter algorithm with respect to the parameter number of edge modifications plus the measure of similarity of the resulting clusterings We further show that there is an efficient preprocessing procedure that can provably reduce the size of the input instance to be independent of the number of vertices of the original input instance

Elements of dynamic and 2-SAT programming: paths, trees, and cuts Bentert, Matthias, 2021-11-18 In dieser Arbeit entwickeln wir schnellere exakte Algorithmen schneller bez gl ich der Worst Case Laufzeit f r Spezialf lle von Graphproblemen Diese Algorithmen beruhen gr tentails auf dynamischem Programmieren und auf 2 SAT Programmierung Dynamisches Programmieren beschreibt den Vorgang ein Problem rekursiv in Unterprobleme zu zerteilen sodass diese Unterprobleme gemeinsame Unterunterprobleme haben Wenn diese Unterprobleme optimal gel st wurden dann kombiniert das dynamische Programm diese L sungen zu einer optimalen L sung des Ursprungsproblems 2 SAT Programmierung bezeichnet den Prozess ein Problem durch eine Menge von 2 SAT Formeln aussagenlogische Formeln in konjunktiver Normalform wobei jede Klausel aus maximal zwei Literalen besteht auszudr cken Dabei m ssen erf llende Wahrheitswertbelegungen f r eine Teilmenge der 2 SAT Formeln zu einer L sung des Ursprungsproblems korrespondieren Wenn eine 2 SAT Formel erf llbar ist dann kann eine erf llende Wahrheitswertbelegung in Linearzeit in der L nge der Formel berechnet werden Wenn entsprechende 2 SAT Formeln also in polynomieller Zeit in der Eingabegr e des Ursprungsproblems erstellt werden k nnen dann kann das Ursprungsproblem in polynomieller Zeit gel st werden Im folgenden beschreiben wir die Hauptresultate der Arbeit Bei dem Diameter Problem wird die gr te Distanz zwischen zwei beliebigen Knoten in einem gegebenen ungerichteten Graphen gesucht Das Ergebnis der Durchmesser des Eingabegraphen geh rt zu den wichtigsten Parametern der Graphanalyse In dieser Arbeit erzielen wir sowohl positive als auch negative Ergebnisse f r Diameter Wir konzentrieren uns dabei auf parametrisierte Algorithmen f r Parameterkombinationen die in vielen praktischen Anwendungen klein sind und auf Parameter die eine Distanz zur Trivialit t messen Bei dem Problem Length Bounded Cut geht es darum ob es eine Kantenmenge begrenzter Gr e in einem Eingabegraphen gibt sodass das Entfernen dieser Kanten die Distanz zwischen zwei gegebenen Knoten auf ein gegebenes Minimum erh ht Wir best tigen in dieser Arbeit eine Vermutung aus der wissenschaftlichen Literatur dass Length Bounded Cut in polynomieller Zeit in der Eingabegr e auf Einheitsintervallgraphen Intervallgraphen in denen jedes Intervall die gleiche L nge hat gel st werden kann Der Algorithmus basiert auf dynamischem Programmieren k Disjoint Shortest Paths beschreibt das Problem knotendisjunkte Pfade zwischen k gegebenen Knotenpaaren zu suchen sodass jeder der k Pfade ein k rzester Pfad zwischen den jeweiligen Endknoten ist Wir beschreiben ein dynamisches Programm mit einer Laufzeit $n O(k)$ f r dieses Problem wobei n die Anzahl der Knoten im Eingabegraphen ist Dies zeigt dass k Disjoint Shortest Paths in

polynomieller Zeit für jedes konstante k gelöst werden kann was für über 20 Jahre ein ungelöstes Problem der algorithmischen Graphentheorie war. Das Problem Tree Containment fragt ob ein gegebener phylogenetischer Baum T in einem gegebenen phylogenetischen Netzwerk N enthalten ist. Ein phylogenetisches Netzwerk bzw ein phylogenetischer Baum ist ein gerichteter azyklischer Graph bzw ein gerichteter Baum mit genau einer Quelle in dem jeder Knoten höchstens eine ausgehende oder höchstens eine eingehende Kante hat und jedes Blatt eine Beschriftung trägt. Das Problem stammt aus der Bioinformatik aus dem Bereich der Suche nach dem Baums des Lebens der Geschichte der Artenbildung. Wir führen eine neue Variante des Problems ein die wir Soft Tree Containment nennen und die bestimmte Unsicherheitsfaktoren berücksichtigt. Wir zeigen mit Hilfe von 2 SAT Programmierung dass Soft Tree Containment in polynomieller Zeit gelöst werden kann wenn N ein phylogenetischer Baum ist in dem jeweils maximal zwei Blätter die gleiche Beschriftung tragen. Wir ergänzen dieses Ergebnis mit dem Beweis dass Soft Tree Containment NP schwer ist selbst wenn N auf phylogenetische Bäume beschränkt ist in denen jeweils maximal drei Blätter die gleiche Beschriftung tragen. Abschließend betrachten wir das Problem Reachable Object. Hierbei wird nach einer Sequenz von rationalen Tauschoperationen zwischen Agentinnen gesucht sodass eine bestimmte Agentin ein bestimmtes Objekt erhält. Eine Tauschoperation ist rational wenn beide an dem Tausch beteiligten Agentinnen ihr neues Objekt gegenüber dem jeweiligen alten Objekt bevorzugen. Reachable Object ist eine Verallgemeinerung des bekannten und viel untersuchten Problems Housing Market. Hierbei sind die Agentinnen in einem Graphen angeordnet und nur benachbarte Agentinnen können Objekte miteinander tauschen. Wir zeigen dass Reachable Object NP schwer ist selbst wenn jede Agentin maximal drei Objekte gegenüber ihrem Startobjekt bevorzugt und dass Reachable Object polynomzeitlich lösbar ist wenn jede Agentin maximal zwei Objekte gegenüber ihrem Startobjekt bevorzugt. Wir geben außerdem einen Polynomzeitalgorithmus für den Spezialfall an in dem der Graph der Agentinnen ein Kreis ist. Dieser Polynomzeitalgorithmus basiert auf 2 SAT Programmierung. This thesis presents faster in terms of worst case running times exact algorithms for special cases of graph problems through dynamic programming and 2 SAT programming. Dynamic programming describes the procedure of breaking down a problem recursively into overlapping subproblems that is subproblems with common subsubproblems. Given optimal solutions to these subproblems the dynamic program then combines them into an optimal solution for the original problem. 2 SAT programming refers to the procedure of reducing a problem to a set of 2 SAT formulas that is boolean formulas in conjunctive normal form in which each clause contains at most two literals. Computing whether such a formula is satisfiable and computing a satisfying truth assignment if one exists takes linear time in the formula length. Hence when satisfying truth assignments to some 2 SAT formulas correspond to a solution of the original problem and all formulas can be computed efficiently that is in polynomial time in the input size of the original problem then the original problem can be solved in polynomial time. We next describe our main results. Diameter asks for the maximal distance between any two vertices in a given undirected graph. It is arguably among the most fundamental graph parameters.

We provide both positive and negative parameterized results for distance from triviality type parameters and parameter combinations that were observed to be small in real world applications In Length Bounded Cut we search for a bounded size set of edges that intersects all paths between two given vertices of at most some given length We confirm a conjecture from the literature by providing a polynomial time algorithm for proper interval graphs which is based on dynamic programming k Disjoint Shortest Paths is the problem of finding vertex disjoint paths between given vertex terminals such that each of these paths is a shortest path between the respective terminals Its complexity for constant $k \geq 2$ has been an open problem for over 20 years Using dynamic programming we show that k Disjoint Shortest Paths can be solved in polynomial time for each constant k The problem Tree Containment asks whether a phylogenetic tree T is contained in a phylogenetic network N A phylogenetic network or tree is a leaf labeled single source directed acyclic graph or tree in which each vertex has in degree at most one or out degree at most one The problem stems from computational biology in the context of the tree of life the history of speciation We introduce a particular variant that resembles certain types of uncertainty in the input We show that if each leaf label occurs at most twice in a phylogenetic tree N then the problem can be solved in polynomial time and if labels can occur up to three times then the problem becomes NP hard Lastly Reachable Object is the problem of deciding whether there is a sequence of rational trades of objects among agents such that a given agent can obtain a certain object A rational trade is a swap of objects between two agents where both agents profit from the swap that is they receive objects they prefer over the objects they trade away This problem can be seen as a natural generalization of the well known and well studied Housing Market problem where the agents are arranged in a graph and only neighboring agents can trade objects We prove a dichotomy result that states that the problem is polynomial time solvable if each agent prefers at most two objects over its initially held object and it is NP hard if each agent prefers at most three objects over its initially held object We also provide a polynomial time SAT program for the case where the graph of agents is a cycle

Dualities in graphs and digraphs Hatzel, Meike, 2023-05-23 In this thesis we describe dualities in directed as well as undirected graphs based on tools such as width parameters obstructions and substructures We mainly focus on directed graphs and their structure In the context of a long open conjecture that bounds the monotonicity costs of a version of the directed cops and robber game we introduce new width measures based on directed separations that are closely related to DAG width We identify a tangle like obstruction for which we prove a duality theorem Johnson Reed Robertson Seymour and Thomas introduced the width measure directed treewidth as a generalisation of treewidth for directed graphs We introduce a new width measure the cyclewidth which is parametrically equivalent to directed treewidth Making use of the connection between directed graphs and bipartite graphs with perfect matchings we characterise the digraphs of low cyclewidth Generalising the seminal work by Robertson and Seymour resulting in a global structure theorem for undirected graphs there is the goal of obtaining a structure theorem based on directed treewidth describing the structure of the directed graphs excluding a fixed butterfly

minor Working in this direction we present a new flat wall theorem for directed graphs which we believe to provide a better base for a directed structure theorem than the existing ones On undirected graphs we present several results on induced subgraphs in the graphs themselves or the square graph of their linegraph These results range from general statements about all graphs to the consideration of specific graph classes such as the one with exactly two mplexes In der vorliegenden Arbeit beschreiben wir Dualit ten in gerichteten sowie in ungerichteten Graphen basierend auf Konzepten wie Weiteparametern Obstruktionen und Substrukturen Der Hauptfokus der Arbeit liegt bei gerichteten Graphen und ihrer Struktur Im Kontext einer lange offenen Vermutung dass die Monotoniekosten einer Variante des R ubers und Gendarm Spiels f r gerichtete Graphen beschr nkt sind f hren wir neue Weiteparameter ein die auf gerichteten Separationen basieren und eng mit DAG Weite verwandt sind Wir identifizieren Tangle artige Obstruktionen zu diesen Weiteparametern und beweisen die Dualit t zwischen diesen beiden Konzepten Johnson Reed Robertson Seymour und Thomas haben die gerichtete Baumweite als gerichtete Verallgemeinerung der Baumweite auf ungerichteten Graphen eingef hrt Wir f hren einen neuen Weiteparameter die Cyclewidth ein der parametrisch equivalent zur gerichteten Baumweite ist Unter Nutzung der Verwandtschaft von gerichteten Graphen und bipartiten Graphen mit perfekten Matchings charakterisieren wir die gerichteten Graphen mit kleiner Cyclewidth Ein einschlagendes Ergebnis in der Graphenstrukturtheorie ist das Strukturtheorem von Robertson und Seymour Basierend darauf gibt es Anstrengungen ein solches Strukturtheorem auch f r gerichtete Graphen zu finden und daf r die gerichtete Baumweite als Grundlage zu nutzen Dieses Theorem soll die Struktur aller gerichteten Graphen beschreiben die einen festen gerichteten Graphen als Butterflyminoren ausschlie en In diesem Kontext beweisen wir ein neues Flat wall theorem f r gerichtete Graphen dass unserer Erwartung nach eine bessere Basis f r ein gerichtetes Strukturtheorem bietet als die bisher betrachteten Alternativen Auf ungerichteten Graphen pr sentieren wir einige Ergebnisse bez glich induzierten Subgraphen in gegebenen Graphen oder ihren Linegraphen Diese Ergebnisse reichen von der Betrachtung spezifischer Graphklassen wie den Graphen mit zwei Mplexen bis zu Ergebnissen auf der allgemeinen Klasse aller Graphen

Graph-Theoretic Concepts in Computer Science Ernst W. Mayr, 2016-08-04 This book

constitutes revised selected papers from the 41st International Workshop on Graph Theoretic Concepts in Computer Science WG 2015 held in Garching Germany in June 2015 The 32 papers presented in this volume were carefully reviewed and selected from 79 submissions They were organized in topical sections named invited talks computational complexity design and analysis computational geometry structural graph theory graph drawing and fixed parameter tractability

Nowhere Dense Classes of Graphs Siebertz, Sebastian, 2016-05-24 We show that every first order property of graphs can be decided in almost linear time on every nowhere dense class of graphs For graph classes closed under taking subgraphs our result is optimal under a standard complexity theoretic assumption it was known before that for all classes C of graphs closed under taking subgraphs if deciding first order properties of graphs in C is fixed parameter tractable parameterized by the length of

the input formula then C must be nowhere dense. Nowhere dense graph classes form a large variety of classes of sparse graphs including the class of planar graphs, actually all classes with excluded minors and also bounded degree graphs and graph classes of bounded expansion. For our proof we provide two new characterisations of nowhere dense classes of graphs. The first characterisation is in terms of a game which explains the local structure of graphs from nowhere dense classes. The second characterisation is by the existence of sparse neighbourhood covers. On the logical side we prove a rank preserving version of Gaifman's locality theorem. The characterisation by neighbourhood covers is based on a characterisation of nowhere dense classes by generalised colouring numbers. We show several new bounds for the generalised colouring numbers on restricted graph classes such as for proper minor closed classes and for planar graphs. Finally we study the parameterized complexity of the first order model checking problem on structures where an ordering is available to be used in formulas. We show that first order logic on ordered structures as well as on structures with a successor relation is essentially intractable on nearly all interesting classes. On the other hand we show that the model checking problem of order invariant monadic second order logic is tractable essentially on the same classes as plain monadic second order logic and that the model checking problem for successor invariant first order logic is tractable on planar graphs. Wir zeigen dass jede Eigenschaft von Graphen aus einer nowhere dense Klasse von Graphen die in der Prädikatenlogik formuliert werden kann in fast linearer Zeit entschieden werden kann. Dieses Ergebnis ist optimal für Klassen von Graphen die unter Subgraphen abgeschlossen sind unter einer Standardannahme aus der Komplexitätstheorie. Um den obigen Satz zu beweisen führen wir zwei neue Charakterisierungen von nowhere dense Klassen von Graphen ein. Zunächst charakterisieren wir solche Klassen durch ein Spiel das die lokalen Eigenschaften von Graphen beschreibt. Weiter zeigen wir dass eine Klasse die unter Subgraphen abgeschlossen ist genau dann nowhere dense ist wenn alle lokalen Nachbarschaften von Graphen der Klasse dann berdeckt werden können. Weiterhin beweisen wir eine erweiterte Version von Gaifman's Lokalitätssatz für die Prädikatenlogik der eine Übersetzung von Formeln in lokale Formeln des gleichen Ranges erlaubt. In Kombination erlauben diese neuen Charakterisierungen einen effizienten rekursiven Lösungsansatz für das Model Checking Problem der Prädikatenlogik. Die Charakterisierung der nowhere dense Graphklassen durch die oben beschriebenen Berdeckungen basiert auf einer bekannten Charakterisierung durch verallgemeinerte Farbungszahlen. Unser Studium dieser Zahlen führt zu neuen verbesserten Schranken für die verallgemeinerten Farbungszahlen von nowhere dense Klassen von Graphen insbesondere für einige wichtige Subklassen z.B. für Klassen mit ausgeschlossenen Minoren und für planare Graphen. Zuletzt untersuchen wir welche Auswirkungen eine Erweiterung der Logik durch Ordnungen bzw. Nachfolgerrelationen auf die Komplexität des Model Checking Problems hat. Wir zeigen dass das Problem auf fast allen interessanten Klassen nicht effizient gelöst werden kann wenn eine beliebige Ordnungs oder Nachfolgerrelation zum Graphen hinzugefügt wird. Andererseits zeigen wir dass das Problem für ordnungsinvariante monadische Logik zweiter Stufe auf allen Klassen für die bekannt ist dass es für monadische

Logik zweiter Stufe effizient gelöst werden kann auch effizient gelöst werden kann Wir zeigen dass das Problem für nachfolgerinvariante Prädikatenlogik auf planaren Graphen effizient gelöst werden kann

Algorithmic aspects of resource allocation and multiwinner voting: theory and experiments Kaczmarczyk, Andrzej, 2021-12-10 This thesis is concerned with investigating elements of computational social choice in the light of real world applications We contribute to a better understanding of the areas of fair allocation and multiwinner voting For both areas inspired by real world scenarios we propose several new notions and extensions of existing models Then we analyze the complexity of answering the computational questions raised by the introduced concepts To this end we look through the lens of parameterized complexity We identify different parameters which describe natural features specific to the computational problems we investigate Exploiting the parameters we successfully develop efficient algorithms for specific cases of the studied problems We complement our analysis by showing which parameters presumably cannot be utilized for seeking efficient algorithms Thereby we provide comprehensive pictures of the computational complexity of the studied problems Specifically we concentrate on four topics that we present below grouped by our two areas of interest For all but one topic we present experimental studies based on implementations of newly developed algorithms We first focus on fair allocation of indivisible resources In this setting we consider a collection of indivisible resources and a group of agents Each agent reports its utility evaluation of every resource and the task is to fairly allocate the resources such that each resource is allocated to at most one agent We concentrate on the two following issues regarding this scenario The social context in fair allocation of indivisible resources In many fair allocation settings it is unlikely that every agent knows all other agents For example consider a scenario where the agents represent employees of a large corporation It is highly unlikely that every employee knows every other employee Motivated by such settings we come up with a new model of graph envy freeness by adapting the classical envy freeness notion to account for social relations of agents modeled as social networks We show that if the given social network of agents is simple for example if it is a directed acyclic graph then indeed we can sometimes find fair allocations efficiently However we contrast tractability results with showing NP hardness for several cases including those in which the given social network has a constant degree Fair allocations among few agents with bounded rationality Bounded rationality is the idea that humans due to cognitive limitations tend to simplify problems that they face One of its emanations is that human agents usually tend to report simple utilities over the resources that they want to allocate for example agents may categorize the available resources only into two groups of desirable and undesirable ones Applying techniques for solving integer linear programs we show that exploiting bounded rationality leads to efficient algorithms for finding envy free and Pareto efficient allocations assuming a small number of agents Further we demonstrate that our result actually forms a framework that can be applied to a number of different fairness concepts like envy freeness up to one good or envy freeness up to any good This way we obtain efficient algorithms for a number of fair allocation problems assuming few agents with

bounded rationality We also empirically show that our technique is applicable in practice Further we study multiwinner voting where we are given a collection of voters and their preferences over a set of candidates The outcome of a multiwinner voting rule is a group or a set of groups in case of ties of candidates that reflect the voters preferences best according to some objective In this context we investigate the following themes The robustness of election outcomes We study how robust outcomes of multiwinner elections are against possible mistakes made by voters Assuming that each voter casts a ballot in a form of a ranking of candidates we represent a mistake by a swap of adjacent candidates in a ballot We find that for rules such as SNTV k Approval and k Borda it is computationally easy to find the minimum number of swaps resulting in a change of an outcome This task is however NP hard for STV and the Chamberlin Courant rule We conclude our study of robustness with experimentally studying the average number of random swaps leading to a change of an outcome for several rules Strategic voting in multiwinner elections We ask whether a given group of cooperating voters can manipulate an election outcome in a favorable way We focus on the k Approval voting rule and we show that the computational complexity of answering the posed question has a rich structure We spot several cases for which our problem is polynomial time solvable However we also identify NP hard cases For several of them we show how to circumvent the hardness by fixed parameter tractability We also present experimental studies indicating that our algorithms are applicable in practice Diese Arbeit befasst sich mit der Untersuchung von Themen des Forschungsgebiets Computational Social Choice im Lichte realer Anwendungen Dabei tr gt sie zu einem besseren Verst ndnis der Bereiche der fairen Zuordnung und der Mehrgewinnerwahlen bei F r beide Konzepte schlagen wir inspiriert von realen Anwendungen verschiedene neue Begriffe und Erweiterungen bestehender Modelle vor Anschlie end analysieren wir die Komplexit t der Beantwortung von Berechnungsfragen die durch die eingef hrten Konzepte aufgeworfen werden Dabei fokussieren wir uns auf die parametrisierte Komplexit t Hierzu identifizieren wir verschiedene Parameter welche nat rliche Merkmale der von uns untersuchten Berechnungsprobleme beschreiben Durch die Nutzung dieser Parameter entwickeln wir erfolgreich effiziente Algorithmen f r Spezialf lle der untersuchten Probleme Wir erg nzen unsere Analyse indem wir zeigen welche Parameter vermutlich nicht verwendet werden k nnen um effiziente Algorithmen zu finden Dabei zeichnen wir ein umfassendes Bild der Berechnungskomplexit t der untersuchten Probleme Insbesondere konzentrieren wir uns auf vier Themen die wir gruppiert nach unseren beiden Schwerpunkten unten vorstellen F r alle Themen bis auf eines pr sentieren wir Experimente die auf Implementierungen der von uns neu entwickelten Algorithmen basieren Wir konzentrieren uns zun chst auf die faire Zuordnung unteilbarer Ressourcen Hier betrachten wir eine Menge unteilbarer Ressourcen und eine Gruppe von Agenten Jeder Agent gibt eine Bewertung des Nutzens jeder Ressource ab und die Aufgabe besteht darin eine faire Zuordnung der Ressourcen zu finden wobei jede Ressource h chstens einem Agenten zugeordnet werden kann Innerhalb dieses Bereiches konzentrieren wir uns auf die beiden folgenden Problemstellungen Der soziale Kontext bei der fairen Zuordnung unteilbarer

Ressourcen In vielen Szenarien in denen Ressourcen zugeordnet werden sollen ist es unwahrscheinlich dass jeder Agent alle anderen kennt Vorstellbar ist beispielsweise ein Szenario in dem die Agenten Mitarbeiter eines gro ßen Unternehmens repräsentieren Es ist höchst unwahrscheinlich dass jeder Mitarbeiter jeden anderen Mitarbeiter kennt Motiviert durch solche Szenarien entwickeln wir ein neues Modell der graph basierten Neidfreiheit Wir erweitern den klassischen Neidfreiheitsbegriff um die sozialen Beziehungen von Agenten die durch soziale Netzwerke modelliert werden Einerseits zeigen wir dass wenn das soziale Netzwerk der Agenten einfach ist zum Beispiel wenn es sich um einen gerichteten azyklischen Graph handelt in manchen Fällen faire Zuordnungen effizient gefunden werden können Andererseits stellen wir diesen algorithmisch positiven Ergebnissen mehrere NP schweren Fällen entgegen Ein Beispiel für einen solchen Fall sind soziale Netzwerke mit einem konstanten Knotengrad Faire Zuteilung an wenige Agenten mit begrenzter Rationalität Begrenzte Rationalität beschreibt die Idee dass Menschen aufgrund kognitiver Grenzen dazu neigen Probleme mit denen sie konfrontiert werden zu vereinfachen Eine mögliche Folge dieser Grenzen ist dass menschliche Agenten in der Regel einfache Bewertungen der gewünschten Ressourcen abgeben beispielsweise könnten Agenten die verfügbaren Ressourcen nur in zwei Gruppen erwünschte und unerwünschte Ressourcen kategorisieren Durch Anwendung von Techniken zum Lösen von Ganzzahligen Linearen Programmen zeigen wir dass unter der Annahme einer kleinen Anzahl von Agenten die Ausnutzung begrenzter Rationalität dabei hilft effiziente Algorithmen zum Finden neidfreier und Pareto effizienter Zuweisungen zu entwickeln Weiterhin zeigen wir dass unser Ergebnis ein allgemeines Verfahren liefert welches auf eine Reihe verschiedener Fairnesskonzepte angewendet werden kann wie zum Beispiel Neidfreiheit bis auf ein Gut oder Neidfreiheit bis auf irgendein Gut Auf diese Weise gewinnen wir effiziente Algorithmen für eine Reihe fairer Zuordnungsprobleme wenige Agenten mit begrenzter Rationalität vorausgesetzt Darüber hinaus zeigen wir empirisch dass unsere Technik in der Praxis anwendbar ist Weiterhin untersuchen wir Mehrgewinnerwahlen bei denen uns eine Menge von Wählern sowie ihre Präferenzen über eine Reihe von Kandidaten gegeben sind Das Ergebnis eines Mehrgewinnerwahlverfahrens ist eine Gruppe oder eine Menge von Gruppen im Falle eines Unentschiedens von Kandidaten welche die Präferenzen der Wähler am besten einem bestimmten Ziel folgend widerspiegeln In diesem Kontext untersuchen wir die folgenden Themen Die Robustheit von Wahlergebnissen Wir untersuchen wie robust die Ergebnisse von Mehrgewinnerwahlen gegen möglicher Fehler der Wähler sind Unter der Annahme dass jeder Wähler eine Stimme in Form einer Rangliste von Kandidaten abgibt modellieren wir einen Fehler als einen Tausch benachbarter Kandidaten in der Rangliste Wir zeigen dass für Wahlregeln wie SNTV k Approval und k Borda die minimale Anzahl an Vertauschungen welche zu einer Ergebnisänderung führt einfach zu berechnen ist Für STV und die Chamberlin Courant Regel ist diese Aufgabe allerdings NP schwer Wir schließen unsere Untersuchung der Robustheit unterschiedlicher Wahlregeln ab mit einer experimentellen Evaluierung der durchschnittlichen Anzahl zufälliger Vertauschungen die zu einer Änderung des Ergebnisses führen Strategische Abstimmung bei Wahlen mit mehreren Gewinnern

Wir fragen ob eine bestimmte Gruppe von kooperierenden Wählern ein Wahlergebnis zu ihren Gunsten manipulieren kann. Dabei konzentrieren wir uns auf die k-Approval Wahlregel. Wir zeigen dass die Berechnungskomplexität der besagten Manipulation eine reiche Struktur besitzt. Auf der einen Seite identifizieren wir mehrere Fälle in denen das Problem in Polynomzeit lösbar ist. Auf der anderen Seite identifizieren wir jedoch auch NP-schwere Fälle. Für einige von ihnen zeigen wir wie die Berechnungsschwere durch parametrisierte Algorithmen umgangen werden kann. Wir präsentieren zudem experimentelle Untersuchungen welche darauf hindeuten dass unsere Algorithmen in der Praxis anwendbar sind.

Exploiting structure in computationally hard voting problems Chen, Jiehua, 2016-11-11. This thesis explores and exploits structure inherent in voting problems. Some of these structures are found in the preferences of the voters such as the domain restrictions which have been widely studied in social choice theory. ASS02 ASS10 Others can be expressed as quantifiable measures or parameters of the input which make them accessible to a parameterized complexity analysis. Cyg 15 DF13 FG06 Nie06 Accordingly the thesis deals with two major topics. The first topic revolves around preference structures e.g. single crossing or one dimensional Euclidean structures. It is covered in Chapters 3 to 5. The second topic includes the parameterized complexity analysis of two computationally hard voting problems making use of some of the structural properties studied in the first part of the thesis. It also investigates questions on the computational complexity both classical and parameterized of several voting problems for two widely used parliamentary voting rules. It is covered in Chapters 6 to 8. In Chapter 3 we study the single crossing property which describes a natural order of the voters such that for each pair of alternatives there are at most two consecutive voters along this order which differ in their relative ordering of the two alternatives. We find finitely many forbidden subprofiles whose absence from a profile is necessary and sufficient for the existence of single crossingness. Using this result we can detect single crossingness without probing every possible order of the voters. We also present an algorithm for the detection of single crossingness in $O(nm^2)$ time via PQ trees. BL76 where n denotes the number of voters and m the number of alternatives. In Chapter 4 we study the one dimensional Euclidean property which describes an embedding of the alternatives and voters into the real numbers such that every voter prefers alternatives that are embedded closer to him to those which are embedded farther away. We show that contrary to our results for the single crossing property finitely many forbidden subprofiles are not sufficient to characterize the one dimensional Euclidean property. In Chapter 5 we study the computational question of achieving a certain property as for instance single crossingness by deleting the fewest number of either alternatives or voters. We show that while achieving single crossingness by deleting the fewest number of voters can be done in polynomial time it is NP hard to achieve this if we delete alternatives instead. Both problem variants are NP hard for the remaining popular properties such as single crossingness or value restriction. All these problems are trivially fixed parameter tractable for the parameter number of alternatives to delete resp. number of voters to delete because for each studied property there are finitely many forbidden subprofiles whose removal

makes a profile possess this property In Chapter 6 we introduce a combinatorial variant of CONTROL BY ADDING VOTERS In CONTROL BY ADDING VOTERS as introduced by Bartholdi III Tovey and Trick BTT92 there is a set of unregistered voters with known preference orders and the goal is to add the fewest number of unregistered voters to a given profile such that a specific alternative wins In our new model we additionally assume that adding a voter means also adding a bundle that is a subset of other voters for free We focus on two prominent voting rules the plurality rule and the Condorcet rule Our problem turns out to be extremely hard it is NP hard for even two alternatives We identify different parameters arising from the combinatorial model and obtain an almost complete picture of the parameterized complexity landscape For the case where the bundles of voters have a certain structure our problem remains hard for single peaked preferences while it is polynomial time solvable for single crossing preferences In Chapter 7 we investigate how different natural parameters and price function families influence the computational complexity of SHIFT BRIBERY EFS09 which asks whether it is possible to make a specific alternative win by shifting it higher in the preference orders of some voters Each shift has a price and the goal is not to exceed the budget We obtain both fixed parameter tractability and parameterized intractability results We also study the optimization variant of SHIFT BRIBERY which seeks to minimize the budget spent and present an approximation algorithm which approximates the budget within a factor of $1 + \epsilon$ and has a running time whose super polynomial part depends only on the approximation parameter ϵ and the parameter number of voters In Chapter 8 we turn our focus to two prominent parliamentary voting rules the successive rule and the amendment rule Both rules proceed according to a linear order of the alternatives called the agenda We investigate MANIPULATION which asks to add the fewest number of voters with arbitrary preference orders to make a specific alternative win AGENDA CONTROL which asks to design an appropriate agenda for a specific alternative to win and POSSIBLE NECESSARY WINNER which asks whether a specific alternative wins in every completion of the profile and the agenda We show that while MANIPULATION and AGENDA CONTROL are polynomial time solvable for both rules our real world experimental results indicate that most profiles cannot be manipulated by only few voters and that a successful agenda control is typically impossible POSSIBLE WINNER is NP hard for both rules While NECESSARY WINNER is coNP hard for the amendment rule it is polynomial time solvable for the successive rule All considered computationally hard voting problems are fixed parameter tractable for the parameter number of alternatives Die vorliegende Arbeit beschäftigt sich mit Wahlproblemen und den darin auftretenden Strukturen Einige dieser Strukturen finden sich in den Wahlerpräferenzen wie zum Beispiel die in der Sozialwahltheorie engl social choice theory intensiv erforschten domain restrictions ASS02 ASS10 wo die Wahlerpräferenzen eine bestimmte eingeschränkte Struktur haben Andere Strukturen lassen sich wiederum mittels Problemparametern quantitativ ausdrücken was sie einer parametrisierten Komplexitätsanalyse zugänglich macht Cyg 15 DF13 FG06 Nie06 Dieser Zweiteilung folgend ist die Arbeit in zwei Themengebiete untergliedert Das erste Gebiet beinhaltet Betrachtungen zu Strukturen in Wahlerpräferenzen wie z B Single

Crossing Strukturen oder eindimensionale euklidische Strukturen Es wird in den Kapiteln 3 bis 5 abgehandelt Das zweite Themengebiet umfasst die parametrisierte Komplexitätsanalyse zweier NP-schwerer Wahlprobleme wobei die neu gewonnenen Erkenntnisse zu den im ersten Teil der Arbeit untersuchten Strukturen verwendet werden Es beschäftigt sich außerdem mit Fragen sowohl zur klassischen als auch zur parametrisierten Komplexität mehrerer Wahlprobleme für zwei in der Praxis weit verbreitete parlamentarische Wahlverfahren Dieser Teil der Arbeit erstreckt sich über die Kapitel 6 bis 8 Kapitel 3 untersucht die Single Crossing Eigenschaft Diese beschreibt eine Anordnung der Wähler bei der es für jedes Paar von Alternativen höchstens zwei aufeinanderfolgende Wähler gibt die unterschiedlicher Meinung über die Reihenfolge dieser beiden Alternativen sind Wie sich herausstellt lässt sich diese Eigenschaft durch eine endliche Anzahl von verbotenen Strukturen charakterisieren Ein Wählerprofil ist genau dann single crossing wenn es keine dieser Strukturen beinhaltet Es wird außerdem ein Algorithmus vorgestellt der die Single Crossing Eigenschaft unter Verwendung von PQ-trees [BL76] in $O(nm^2)$ Schritten erkennt wobei n die Anzahl der Wähler und m die Anzahl der Alternativen ist Kapitel 4 behandelt Wählerprofile die eindimensional euklidisch sind d.h. für die sich die Alternativen und Wähler so auf die reelle Achse abbilden lassen dass für jeden Wähler und je zwei Alternativen diejenige näher zum Wähler abgebildet wird die er der anderen vorzieht Es stellt sich heraus dass es im Gegensatz zur Single Crossing Eigenschaft nicht möglich ist eindimensionale euklidische Profile durch endlich viele verbotene Strukturen zu charakterisieren Kapitel 5 beschäftigt sich mit der Frage wie berechnungsschwer es ist eine bestimmte strukturelle Eigenschaft wie z.B. die Single Crossing Eigenschaft zu erreichen indem man eine möglichst kleine Anzahl von Wählern oder Kandidaten aus einem Profil entfernt Es zeigt sich dass dieses Problem für die Single Crossing Eigenschaft durch das Löschen von Wählern zwar in polynomieller Zeit gelöst werden kann es durch das Löschen von Kandidaten jedoch NP-schwer ist Für alle anderen Eigenschaften sind beide Lösungsvarianten ebenfalls NP-schwer Allerdings lässt sich für jedes der Probleme auf triviale Weise mittels des Parameters Anzahl der zu löschenden Wähler bzw. Alternativen fixed parameter tractability zeigen Das bedeutet dass sie effizient lösbar sind wenn der Parameter klein ist Der Grund dafür ist dass sich alle hier betrachteten Eigenschaften durch eine endliche Anzahl verbotener Strukturen charakterisieren lassen deren Zerstörung die gewünschte Eigenschaft herstellt Kapitel 6 führt die kombinatorische Variante des bekannten Problems CONTROL BY ADDING VOTERS ein das erstmals durch Bartholdi III, Tovey und Trick [BTT92] beschrieben wurde In der klassischen Problemstellung gibt es eine Menge von nichtregistrierten Wählern mit bekannten Präferenzen und es wird eine kleinste Teilmenge von nichtregistrierten Wählern gesucht sodass deren Hinzufügen zu einem gegebenen Profil einen bestimmten Kandidaten zum Gewinner macht In der hier beschriebenen Variante wird zusätzlich angenommen dass für jeden hinzugefügten Wähler auch eine Menge von weiteren Wählern kostenlos hinzugefügt werden kann Dieses Problem wird für die beiden bekannten Wahlregeln Condorcet-Wahl und Mehrheitswahl untersucht Wie sich herausstellt ist die Problemstellung schon für zwei Alternativen NP-schwer Desweiteren werden Parameter identifiziert die

sich aus den kombinatorischen Eigenschaften dieses Problems ergeben Für diese lässt sich eine beinahe erschöpfende Beschreibung der parametrisierten Komplexität des Problems erstellen In einem Fall bleibt unser Problem für sogenannte Single Peaked Präferenzen berechnungsschwer während es für Single Crossing Präferenzen in polynomieller Zeit lösbar ist Kapitel 7 untersucht wie verschiedene natürliche Parameter und Preisfunktionen die Berechnungskomplexität des SHIFT BRIBERY Problems EFS09 beeinflussen Darin fragt man ob eine gegebene Alternative zum Gewinner gemacht werden kann indem sie in den Präferenzen einiger Wähler nach vorne verschoben wird Jede Verschiebung hat einen Preis und das Ziel ist es ein gegebenes Budget nicht zu überschreiten Die Ergebnisse sind gemischt einige Parameter erlauben effiziente Algorithmen während für andere das Problem schwer bleibt z.B. für den Parameter Anzahl der beeinflussten Wähler ist das Problem sogar $W[2]$ schwer Für die Optimierungsvariante von SHIFT BRIBERY bei der das verwendete Budget minimiert wird erzielen wir einen Approximationsalgorithmus mit einem Approximationsfaktor von $1 + \epsilon$ dessen Laufzeit in ihrem nicht polynomiellen Anteil nur von ϵ und der Anzahl der Wähler abhängt Kapitel 8 konzentriert sich auf zwei weitverbreitete parlamentarische Wahlregeln die successive rule und die amendment rule Beide Regeln verwenden eine lineare Ordnung der Alternativen auch Agenda genannt Es werden drei Probleme untersucht MANIPULATION fragt nach der kleinstmöglichen Anzahl von Wählern mit beliebigen Präferenzen deren Hinzufügung einen bestimmten Kandidaten zum Gewinner macht AGENDA CONTROL fragt ob es möglich ist eine Agenda derart festzulegen dass ein bestimmter Kandidat gewinnt POSSIBLE NECESSARY WINNER fragt für unvollständige Wählerpräferenzen und oder eine nur teilweise festgelegte Agenda ob eine bestimmte Alternative überhaupt bzw. sicher zum Sieger machen kann Es stellt sich heraus dass sowohl MANIPULATION als auch AGENDA CONTROL für beide Wahlregeln in polynomieller Zeit lösbar sind Allerdings deuten die Ergebnisse einer auf realem Wählerverhalten basierenden experimentellen Studie darauf hin dass die meisten Profile nicht durch einige wenige Wähler manipuliert werden können und dass eine erfolgreiche Kontrolle mittels Agenda typischerweise nicht möglich ist POSSIBLE WINNER ist für beide Regeln NP schwer während NECESSARY WINNER für die amendment rule coNP schwer und für die successive rule in polynomieller Zeit lösbar ist Alle betrachtete NP schwere oder coNP schwere Wahlprobleme sind fixed parameter tractable für den Parameter Anzahl der Alternativen

On the Foundations of Dynamic Coalitions Arbach, Youssef, 2016-09-16 Dynamic Coalitions denote a temporary collaboration between different entities to achieve a common goal A key feature that distinguishes Dynamic Coalitions from static coalitions is Dynamic Membership where new members can join and others can leave after a coalition is set This thesis studies workflows in Dynamic Coalitions by analyzing their features highlighting their unique characteristics and similarities to other workflows and investigating their relation with Dynamic Membership For this purpose we use the formal model of Event Structures and extend it to faithfully model scenarios taken as use cases from healthcare Event Structures allow for workflows modeling in general and for modeling Dynamic Membership in Dynamic Coalitions as well through capturing the join and leave events of members To this end we

first extend Event Structures with Dynamic Causality to address the dynamic nature of DCs Dynamic Causality allows some events to change the causal dependencies of other events in a structure Then we study the expressive power of the resulting Event Structures and show that they contribute only to a specific kind of changes in workflows namely the pre planned changes Second we present Evolving Structures in order to support ad hoc and unforeseen changes in workflows as required by the use cases Evolving Structures connect different Event Structures with an evolution relation which allows for changing an Event Structure during a system run We consider different approaches to model evolution and study their equivalences Furthermore we show that the history of a workflow should be preserved in our case of evolution in Dynamic Coalitions and we allow for extracting changes from an evolution to support Process Learning Third to capture the goals of DCs we equip Evolving Structures with constraints concerning the reachability of a set of events that represents a goal The former extensions allow for examining the changes and evolutions caused by members and examining members contributions to goal satisfaction through their join and leave events Finally we highlight many modeling features posed as requirements by the domain of our Dynamic Coalition use cases namely the healthcare which are independent from the nature of Dynamic Coalitions e g timing We examine the literature of Event Structures for supporting such features and we identify that the notion of Priority is missing in Event Structures To this end we add Priority to various kinds of Event Structures from the literature Furthermore we study the relation between priority on one side and conjunctive causality disjunctive causality causal ambiguity and various kinds of conflict on the other side Comparing to Adaptive Workflows which are concerned with evolutions of workflows that occur as a response to changes e g changes in the business environment or exceptions this thesis shows that Dynamic Coalition workflows are not only Adaptive but also Goal Oriented Besides it adds one extra trigger for evolution in workflows unique to Dynamic Coalitions namely the join of new members who contribute to goal satisfaction in a Dynamic Coalition Finally the thesis contributes to bridging the gap in modeling between theory and domain experts by supporting step by step modeling applied regularly in healthcare and other domains

Dynamische Koalitionen DKen bezeichnen eine temporäre Kollaboration zwischen verschiedenen Entitäten zum Erreichen eines gemeinsamen Ziels Ein Schlüsselaspekt welcher dynamische Koalitionen von statischen Koalitionen unterscheidet ist die dynamische Mitgliedschaft durch die neue Mitglieder hinzukommen und andere die Koalitionen verlassen können nachdem sie entstanden ist Diese Arbeit studiert Workflows in dynamische Koalitionen durch eine Analyse ihrer Eigenschaften das Herausstellen ihrer einzigartigen Charakteristika und Ähnlichkeiten zu anderen Workflows und durch eine Untersuchung ihrer Beziehung zu dynamischer Mitgliedschaft In diesem Sinne nutzen wir das formale Modell der Ereignisstrukturen ESEN und erweitern es um Fallstudien aus der Medizin angemessen zu modellieren ESEN erlauben sowohl eine generelle Workflow Modellierung als auch eine Darstellung von Eintritt und Austrittsereignissen von Mitgliedern Zu diesem Zweck erweitern wir ESEN zuerst um Dynamische Kausalität um die dynamische Natur von DKs abzubilden Dynamische Kausalität erlaubt bestimmten Ereignissen die kausalen

Abhängigkeiten anderer Ereignissen in einer Struktur zu verordnen. Dann untersuchen wir die Ausdrucksmuster der resultierenden ESN und zeigen dass sie nur eine spezifische Art der Veränderung abbilden die sogenannten vorgeplanten Veränderungen. Als Zweites präsentieren wir Evolving in ESN um ad hoc und unvorhergesehene Veränderungen zu unterstützen wie es durch unsere Fallstudien bestätigt wird. Evolving in ESN verbindet verschiedene ESN mit einer Relation welche eine Veränderung einer ESN während eines Ablaufes erlaubt. Wir ziehen verschiedene Ansätze der Modellevolution in Betracht und untersuchen ihre Äquivalenzen. Des Weiteren zeigen wir dass in unserem Fall der Evolution in DKN die Geschichte eines Workflows erhalten bleiben muss und wir ermöglichen das Extrahieren von Veränderungen einer Evolution um Process Learning zu unterstützen. Drittens um die Ziele von DKN abzubilden fügen wir den Evolving in ESN mit Einschränkungen bezüglich der Erreichbarkeit einer Menge von Ereignissen hinzu welche das Ziel repräsentieren. Die genannten Erweiterungen erlauben es sowohl die Veränderungen und Evolutionen die vom Mitgliedern verursacht werden als auch die Beiträge der Mitglieder zur Zielerreichung durch deren Eintritt und Austrittsereignissen zu untersuchen. Schlussendlich stellen wir viele Modellierungseigenschaften dar welche von den DK Fallstudien aus der Medizin bestätigt werden und unabhängig von der Natur der DKN sind wie z.B. Timing. Wir untersuchen die Literatur zu ESN bezüglich Unterstützung für solche Eigenschaften und stellen fest dass der Begriff Priorität in ESN fehlt. Daher fügen wir Priorität zu verschiedenen ESN aus der Literatur hinzu. Des Weiteren untersuchen wir die Beziehungen von Priorität auf zu Konjunktiver Kausalität disjunktiver Kausalität kausal Uneindeutigkeit und verschiedenen Formen von Konflikt. Im Vergleich zu Adaptive Workflows welche sich mit der Evolution von Workflows beschäftigt die als Reaktion auf Veränderungen entsteht wie z.B. Veränderungen im Business Environment oder Exceptions zeigt diese Arbeit dass DKN nicht nur adaptiv sondern auch zielorientiert sind. Außerdem fügen sie einen zusätzlichen Auslöser für Evolution in Workflows hinzu welcher ausschließlich DKN eigen ist das Hinzukommen neuer Mitglieder welche zur Zielerreichung der DK beitragen. Zuletzt trägt diese Arbeit bei die Lücke der Modellierung zwischen der Theorie und den Domänenexperten zu überbrücken in dem sie eine Schritt für Schritt Modellierung unterstützt welche regelmäßig in der Medizin und anderen Bereichen angewandt wird.

Algorithm Theory -- SWAT 2014 Inge Li Gørtz, R. Ravi, 2014-06-25 This book constitutes the refereed proceedings of the 14th International Scandinavian Symposium and Workshops on Algorithm Theory SWAT 2014 held in Copenhagen Denmark in July 2014. The 33 papers were carefully reviewed and selected from a total of 134 submissions. The papers present original research and cover a wide range of topics in the field of design and analysis of algorithms and data structures including but not limited to approximation algorithms parameterized algorithms computational biology computational geometry and topology distributed algorithms external memory algorithms exponential algorithms graph algorithms online algorithms optimization algorithms randomized algorithms streaming algorithms string algorithms sublinear algorithms and algorithmic game theory.

The Parameterized Complexity of Degree Constrained Editing Problems Luke Mathieson, 2009 This thesis examines degree

constrained editing problems within the framework of parameterized complexity A degree constrained editing problem takes as input a graph and a set of constraints and asks whether the graph can be altered in at most k editing steps such that the degrees of the remaining vertices are within the given constraints Parameterized complexity gives a framework for examining problems that are traditionally considered intractable and developing efficient exact algorithms for them or showing that it is unlikely that they have such algorithms by introducing an additional component to the input the parameter which gives additional information about the structure of the problem If the problem has an algorithm that is exponential in the parameter but polynomial with constant degree in the size of the input then it is considered to be fixed parameter tractable Parameterized complexity also provides an intractability framework for identifying problems that are likely to not have such an algorithm Degree constrained editing problems provide natural parameterizations in terms of the total cost k of vertex deletions edge deletions and edge additions allowed and the upper bound r on the degree of the vertices remaining after editing We define a class of degree constrained editing problems WDCE which generalises several well known problems such as Degree r Deletion Cubic Subgraph r Regular Subgraph f Factor and General Factor We show that in general if both k and r are part of the parameter problems in the WDCE class are fixed parameter tractable and if parameterized by k or r alone the problems are intractable in a parameterized sense We further show cases of WDCE that have polynomial time kernelizations and in particular when all the degree constraints are a single number and the editing operations include vertex deletion and edge deletion we show that there is a kernel with at most $O(kr)$ vertices If we allow vertex deletion and edge addition we show that despite remaining fixed parameter tractable when parameterized by k and r together the problems are unlikely to have polynomial sized kernelizations or polynomial time kernelizations of a certain form under certain complexity theoretic assumptions We also examine a more general case where given an input graph the question is whether with at most k deletions the graph can be made r degenerate We show that in this case the problems are intractable even when r is a constant

Graph Editing to a Given Neighbourhood Degree List is Fixed-parameter Tractable

Vijay Subramanya, 2016 Graph editing problems have a long history and have been widely studied with applications in biochemistry and complex network analysis They generally ask whether an input graph can be modified by inserting and deleting vertices and edges to a graph with the desired property We consider the problem textsc Graph Edit to NDL GEN where the goal is to modify to a graph with a given neighbourhood degree list NDL The NDL lists the degrees of the neighbours of vertices in a graph and is a stronger invariant than the degree sequence which lists the degrees of vertices We show textsc Graph Edit to NDL is NP complete and study its parameterized complexity In parameterized complexity a problem is said to be fixed parameter tractable with respect to a parameter if it has a solution whose running time is a function that is polynomial in the input size but possibly superpolynomial in the parameter Golovach and Mertziou ICSSR 2016 studied editing to a graph with a given degree sequence and showed the problem is fixed parameter tractable when

parameterized by $\Delta \ell$ where Δ is the maximum degree of the input graph and ℓ is the number of edits. We prove $\text{textsc{Graph Edit to NDL}}$ is fixed parameter tractable when parameterized by $\Delta \ell$. Furthermore, we consider a harder problem $\text{textsc{Constrained Graph Edit to NDL}}$ (CGEN) that imposes constraints on the NDLs of intermediate graphs produced in the sequence. We adapt our FPT algorithm for $\text{textsc{Graph Edit to NDL}}$ to solve $\text{textsc{Constrained Graph Edit to NDL}}$, which proves $\text{textsc{Constrained Graph Edit to NDL}}$ is also fixed parameter tractable when parameterized by $\Delta \ell$. Our results imply that for graph properties that can be expressed as properties of NDLs, editing to a graph with such a property is fixed parameter tractable when parameterized by $\Delta \ell$. We show that this family of graph properties includes some well known graph measures used in complex network analysis: Degree constrained subgraphs, covers, codes and K-graphs (James Frederic Desler, 1969), **Degree Constrained Subgraphs of Linear Graphs** (Robert John Urquhart, 1967), **Short Disjoint Cycles in Graphs with Degree Constraints** (Andres Brandstädt, Heinz-Jürgen Voss, 1993), *Short disjoint cycles in graphs with degree constraints* (Andreas Brandstädt, Heinz-Jürgen Voss, 1993).

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