Annotated Bibliography

Sam Longenbach & Minkun Liu

Author: Alicia Bargar, Amrita Gupta* , Srishti Gupta, Ding Ma
Title: Interactive Visual Analytics for Multi-City Bikeshare Data Analysis

Venue: The 3rd International Workshop on Urban Computing (UrbComp 2014), New York, USA, vol 45, 2014

Year: 2014

Number citations: 17

Aim: This paper aims to provide an accessible interface for examining bike share programs across cities through the use of various algorithms for clustering data, namely ST-DBSCAN. Conducting some experiments combining the data filters, algorithms and visualization. Providing some help for future research or policymakers according to the value of interactive visual analytics for highlighting notable differences between established bike share systems.

Conclusion: By coupling back-end algorithms with visualizations on a city map overlay, their results become accessible to potential users seeking to identify systems usage patterns. Furthermore, by including a variety of filtering capabilities for exploratory visual analysis, users of this tool can narrow the data they examine to answer more specific questions or discover behaviors unique to certain time periods or subpopulations.

How the work informs our project?
ST-DBSCAN the algorithms in this paper used for clustering data inform us we can use the same or similar algorithms to preprocessing data, clear data filtering and clustering can make it more easy to define issue in a specific way.

Author: Hans Martin Espegren, Johannes Kristianslund, Henrik Andersson, Kjetil Fagerholt

Title: The Static Bicycle Repositioning Problem-Literature Survey and New Formulation

Venue: International Conference on Computational Logistics

Year: 2016

Number citations: 7

Aim: This paper considers the static bicycle repositioning problem (SBRP), which deal with optimally re-balancing bike sharing systems (BSS) overnight. One contribution of this paper is presenting an exhaustive literature survey on SBRP, including a systematic comparison of the existing models. Another contribution is they would propose a new mathematical model of the problem that captures more real-life aspects.

Conclusion: They have proposed a new mathematical model for the SBRP that makes fewer assumptions and allows more possibilities than many existing models.For instance, a model allow a heterogeneous fleet, multiple visits to each station, and non-perfect re-balancing.

How the work informs our project?
Since they have focused on the modeling and not on solution algorithms in this study, they are only able to solve relatively small instances. However, the model should provide a good starting point for proposing more advanced solution methods, for instance as an important part of a clustering algorithm for solving realistically sized instances. This encourage us to explore more methods to solve the realistic issue in our project.

Author: Guilherme N.Oliveira, Jose L.Sotomayor, Rafael P.Torchelsen, Claudio T.Silva, Joao L.D.Comba

Title: Visual analysis of bike-sharing systems

Venue: Computers & Graphics

Year:2016

Number citations: 16

Aim: This paper aims to encoding of the system usage data in pixel-oriented visualization designs that help understand the dynamics of station states and trip circulation patterns. Exploring visual designs that support flexible partial reordering of the pixel-oriented representation using an interactive brush that selects time intervals and station groups. Conducting analysis scenarios on real data from Citi Bike illustrate the capabilities of the proposed solutions to reveal relevant spatial and temporal patterns.

Conclusion: The design this paper proposed introduced different matrix visualizations of the data, combined with a brushing interface that created partial re-orderings of the data. The results to validate the applicability of the proposed solution over a 10-month long period, which can be used to justify the adoption of the bike-sharing as a new transportation mode.

How the work informs our project?
There are three types of users can benefit from their research, BSS administrator, rebalancing researcher and big data analyst. Because we also assume BSS management level as our potential audience. Their research on the station state timeline matrix with partial re-ordering to forecast a group of top ranked stations' outages inform us the usage of bikes has great difference between different stations at different time during a day.

Author: Patrick Vogel, Torsten Greiser, Dirk Christian Mattfeld

Title: Understanding Bike-Sharing Systems using Data Mining: Exploring Activity Patterns

Venue: Procedia-Social and Behavioral Sciences

Year:2011

Number citations: 202

Aim: This paper aims to make following contributions: A taxonomy for measures alleviating bike imbalances in BSS. A Geographical Business Intelligence (Geo BI) process which includes data mining (DM) methods for location planning. They present results from an exploratory data analysis and from clustering stations according to their pickup and return activity to understand temporal and spatial causes of imbalances.

Conclusion: BSS enhance inner-city public transport options. Ensuring high bike availability is crucial for the acceptance of such systems. Due to one-way use and short rental times imbalances in the spatial distribution of bikes occur. One measure alleviating imbalances is a suitable location planning of bike stations with operation research (OR). With the help of Geo BI, exploratory and cluster analysis of ride data reveal spatio-temporal dependencies of pickup and return activity patterns at bike stations.

How the work informs our project?
The presented findings from the spatio-temporal analysis show that reasons for certain pickup and return activities at bike stations are complex and diverse. The presumption that activity patterns and the station's location are correlated seems promising according to first results from the Geo BI process. A further investigation of the stations surroundings is needed to fully support the hypothesis.

Author: Yuyu Yan, Yubo Tao, Jin Xu, Shuilin Ren, Hai Lin

Title: Visual analytics of bake-sharing data based on tensor factorization

Venue: Journal of Visualization

Year:2018

Number citations: 8

Aim: From the bike-sharing data, this paper aims to explore the user activity patterns, which are helpful to guid the bike station placement and the bake schedule. Moreover they can study the urban structures from these patterns in the bike-sharing data, and this is important for urban planning, such as avoiding traffic congestion.The bike-sharing data is a mixture of user activity patterns, so that they can infer the latent user activity patterns by analyzing the bike-sharing data. In this paper, they propose an interactive visual analytics system designed for exploring the latent user activity patterns in bike-sharing data and comparing these patterns in/between cities.

Conclusion: They present a visual analytics system to investigate the user's daily activity patterns based on tensor factorization from bike-sharing data. To better capture the relation between patterns, they adopt hierarchical clustering to cluster the patterns. In addition, they developed multiple coordinated views to analyze and compare activity patterns in/between cities, such as pattern time view, dashboard view and map view.

How the work informs our project?
Bike-sharing data can not perfectly represent user activity patterns of a city. Fusing different data, such as taxi data, tourism data, and social media data can construct a suitable tensor to represent it, and employing tensor co-factorization to capture the latent user activity patterns.

Author: Tal Raviv, Michal Tzur, Iris A. Forma

Title: Static repositioning in a bike-sharing system: models and solution approaches

Venue (conference, book title): EURO Journal on Transportation and Logistics

Year: 2013

Number citations: 151

Aim: A crucial factor in the success of a bike-sharing system is its ability to meet the fluctuating demand for bicycles at each station. In this paper, it focus on the static mode of operation which benefits from a practical advantage because it allows the repositioning fleet to travel swiftly in the city without contributing to traffic congestion and parking problems. The contribution of this paper is in presenting a new and practical approach to modeling the SBRP.

Conclusion: This paper defines and formulates a new rich inventory routing model that is motivated by the need to regulate the newly emerging bike-sharing systems. This paper considers many aspects of the static repositioning problem, in particular the stochastic and dynamic nature of the demand. They formulate the problem as a MILP, address various technical obstacles that arise in solving large instances, and analyze the results of obtained.

How the work informs our project?
This paper focus the same issue we are going explore in our project, how to meet the fluctuating demand for bicycles at each station. The measurement of user dissatisfaction with the system through the expected number of shortage events strengthen the necessity to improve the repositioning issue for BSS management level.

Author: Yan Guo, Xingfa Shen, Quanbo Ge, Landi Wang

Title: Station function discovery: exploring trip records in urban public bike-sharing system

Venue: IEEE Access

Year: 2018

Number citations: n/a

Aim: They aim to present the BSS function discovery method by combining Latent Dirichlet Allocation (LDA) model and K-means clustering algorithm. Conducting the analysis of traffic patterns in station clusters with different functions.

Conclusion: The purpose of bicycle riders is to fulfill their certain social activities, such as commuting, amusement, dining, etc. Therefore, the mobility patterns could reflect the function of BSS stations. They use this feature to guide the bike redistribution strategy of BSS to balance the utilization rate of stations and slow the situation of “no bike can be rented” and “no slot can be used to return bicycles” down.

How the work informs our project?
The experiment is carried out by using the historical dataset of Capital Bikeshare system. Furthermore, point of interest (POI) and station name data are used to validate the results. This method has certain practical value in the function identification of the stations in urban BSS.

Author: Daniel Chemla, Frederic Meunier, Roberto Wolfler Calvo

Title: Bike sharing systems: Solving the static rebalancing problem

Venue: Discrete Optimization

Year: 2013

Number citations: 256

Aim: This work restrains to the rebalancing problem with on vehicle and in the static case. Static means that users cannot act on the bikes during the rebalancing process. The static rebalancing problem can be classified as a Single Vehicle One-commodity Capacitated Pickup and Delivery Problem (SVOCPDP). The goal of the SVOCPDP is to find the minimal cost route, is a sequence of vertices.

Conclusion: This paper deals with a new problem (SVOCPDP). They emphasize that they are not only interested by efficient algorithms for solving it, but also theoretical results linked with these algorithms and giving a better understanding of the problem.

How the work informs our project?
A feasible solution for the SVOCPDP, also called a route, is a sequence of vertices, starting and finishing with the depot 0, together with bike displacements within the limits of capacity constraints, at the end of which the system is balanced: each vertex i has been brought from its initial state p(i) to its target state q(i) .

Author: Leonardo Caggiani, Michele Ottomanelli

Title: A dynamic simulation based model for optimal fleet repositioning in bike-sharing systems

Venue: Procedia-Social and Behavioral Sciences

Year: 2013

Number citations: 56

Aim: From the real-time management standpoint, to increase the system capacity and users satisfaction, it is necessary to properly relocate the bikes among the station of the BBS. The operator based reallocation problem is defined as Pickup and Delivery Problem (PDP). The BSS reallocation can be carried out either during the night when the bikes demand is negligible (static repositioning, as defined in literature), or during the day when the bikes distribution among the stations rapidly changes due to the high demand level (dynamic repositioning).

Conclusion: In this paper a micro-simulation model for optimal relocation of bikes in bike-sharing systems has been presented. In particular, the proposed model jointly determines the optimal carrier vehicles route and the number of bikes to be repositioned with the relevant stations. The results show that the relocation management increases of users satisfaction in term of probability of finding available bikes or free docking point. In particular the proposed Decision Support System (DSS) is more suitable for non congested bike-sharing systems. The method is modular so that it can be used for wider systems.

How the work informs our project?
In this paper a simulation model for dynamic bikes redistribution process is presented. The objective of the model is to minimize the vehicles repositioning costs for bike-sharing operators, aiming at a high level users satisfaction, and assuming that it increases with the probability to find an available bike or a free docking point in any station at any time.

Author: Gernardo Berbeglia, Jean-Francois Cordeau, Irina Gribkovskaia, Gilbert Laporte

Title: Static pickup and delivery problems: a classification scheme and survey

Venue: TOP

Year: 2007

Number citations: 601

Aim: Pickup and delivery problems (PDPs) constitute an important class of vehicle routing problems in which objects or people have to be transported between origins and destinations. In static problems, all information is assumed to be deterministic and known a priori. In dynamic problems, information is gradually revealed over time. Solving dynamic problems entails devising a solution strategy that will adjust a current solution in the light of new information. This paper is devoted to static problems which have been studied the most.

Conclusion: They have provided an overview of static pickup and delivery problems (PDPs). They have proposed a general framework embedding a large collection of PDPs. The literature on these problems is growing fast with the advent and development of new sophisticated exact and heuristic algorithms.

How the work informs our project?
In this paper it classifies the PDPs problem into one-to-one, one-to-many, multiple vehicle routing problems. That makes clarification to define each station with different attributes, which could be much more easier for clustering and analyzing the station.

Author: Zulqarnain Haider, Alexander Nidolaev, Jee Eun Kang, Changhyun Kwon

Title: Inventory rebalancing through pricing in public bike sharing systems

Venue: European Journal of Operational Research

Year: 2018

Number citations: 8

Aim: Demand variability causes certain stations to become too full or too empty to effectively service new customers. The contribution of this work lies in the development of methods-both exact and heuristic-and algorithms that bike sharing system managers can use to reduce the number of imbalanced stations by rebalancing their inventory through price incentives/disincentives.

Conclusion: This paper explores pricing and incentive schemes as a way to rebalance the network of a public bike sharing system. The objective is to minimize the number of imbalanced stations to fully or partially obviate the need for a manual repositioning operation using trucks and crew. As a practical solution to the repositioning problem, based on their findings, they recommend to have a dynamic pricing scheme during the day time complementing a static repositioning at the end of the day when the bike system is closed to the riders.

How the work informs our project?
This paper presents a new conceptual approach to improve the operational performance of public bike sharing systems using pricing schemes. Its methodological developments are accompanied by experimental analyses with bike demand data from Capital Bikeshare program of Washington, DC (USA). An optimized price vector determines the incentive levels that can persuade system customers to take bikes from, or part them at, neighboring stations so as to strategically minimize the number of imbalanced stations. This strategy intentionally makes some imbalanced stations even more imbalanced, creating hub stations,this reduces the need for trucks and dedicated staff to carry out inventory repositioning. That inspires us to think more about the solutions to rebalancing issue for further steps about our project.

Author: Patrice Leclaire, Florent Couffin

Title: Method for static rebalancing of a bike sharing system

Venue: IFAC

Year: 2018

Number citations: n/a

Aim: This paper aims to propose hereafter a method for helping decision-maker to construct a mathematical model of a system (for instance, a bike sharing system in this particular case) that can afterwards be exploited for optimization purposes (for instance, maximize the bike and dock availability of a bike sharing system)

Conclusion: This paper presents a method for helping the building of a linear program from a Unified Modeling Language (UML) class diagram. They consider the framework of static rebalancing operations using dedicated vehicles. The proposed method is applied for the optimization of the bikes and docks availability of a bike sharing system.

How the work informs our project?
In this paper, they propose a method for helping the building of these mathematical models through the use of UML graphical class diagrams which describe the structure and properties of a bike sharing system. Transformation rules are defined to extract some constraints of the problem from the system class diagram.

Author: Sin C.Ho, W.Y.Szeto

Title: Solving a static repositioning problem in bike-sharing systems using iterated tabu search

Venue: Transportation Research Part: Logistics and Transportation Review

Year: 2014

Number citations: 68

Aim: The repositioning problem involves pick-up and drop-off quantity variables in addition to routing variables. For this purpose, they develop specific operators to ensure solution feasibility. In order to accelerate the search when evaluating a neighbor solution, several ideas are incorporated into the heuristic in order to avoid re-computing all the pick-up/drop-off quantities. To improve the solution quality, the tabu search procedure is embedded into an iterative framework, where several intensification/diversification mechanisms are applied to the solution obtained from tabu search.

Conclusion: In this paper, they present an iterated tabu search heuristic for the static bike repositioning problem. The implemented heuristic makes use of specialized neighborhood structures and perturbation to obtain diversification in the search. Experiments were conducted on 156 instances. Computational results show that this simple iterated tabu search heuristic produces high quality solutions using very short computing times.

How the work informs our project?
This paper proposes a modification to the existing bike reposition problem to improve its realism and to reduce the solution space. This paper develops an efficient and novel heuristic to obtain high quality solutions to solve the proposed problem. The specific operators developed can also be incorporated in other heuristics to solve the same repositioning problem or other repositioning problems with different objective functions.

Author: Pierre Borgnat, C´eline Robardet, Jean-Baptiste Rouquier Patrice Abry, Eric Fleury, and Patrick Flandrin

Title: Shared bicycles in a city: a signal processing and data analysis perspective

Venue: HAL

Year: 2011

Number citations: 183

Aim: This paper contributes to use of methods from signal processing and data analysis to study the V´elo'v system, so as to exhibit some features of the system and to begin to answer some economical questions linked to such community system. Many social questions can be addressed using this dataset, and some specific ones are chosen in this study.

Conclusion: Two kinds of analyses were performed. First, carefully combining standard statistical signal processing tools dedicated both to cyclostationarity or nonstationary trend analysis and to forecasting, enabled them to model the time evolution of hourly aggregated bicycle rentals. Second, computer science data mining tools were tailored to the analysis of the V´elo'v dataset to extract clusters of stations based either on an intra versus inter community preferred exchanges measure (modularity), yielding communities of stations exchanging regularly a large number of bicycles, or on a similarity measure in the time patterns of bicycle flows.

How the work informs our project?
Analyses enabled us to gain a significant understanding on the social usage of the V´elo'v program in Lyon: Communities remain geographically concentrated (hence indicating a preferred short-range use of the bicycles) while time patterns of flows between stations display similarities so that they are grouped in clusters separating trips related to professional activities (week days and major communication hubs) from those used during leisure time (week end and parks). Finally, they showed that, depending on the time in the week, some stations are alternatively sinks or sources of V´elo'v.

Author: Iris A. Forma, Tal Raviv, Michal Tzur

Title: A 3-step math heuristic for the static repositioning problem in bike-sharing systems

Venue: Transportation Research Part B: Methodological

Year: 2015

Number citations: 100

Aim: In particular, the goal of this paper is to minimize a weighted sum of the expected number of unserved users (due to shortage of both bicycles and lockers) during the next working day, and the total traveling distance. In the first step, stations are clustered according to geographic as well as inventory (of bicycles) considerations. In the second step the repositioning vehicles are routed through the clusters while tentative inventory decisions are made for each individual station. Finally, in the third step the exact routing of the repositioning vehicles is determined, along with the (possibly revised) number of bicycles to be loaded and unloaded at each station.

Conclusion: This paper presents a new math-heuristic for the SBRP, referred to as a 3-step algorithm. It enables operators of bike sharing systems to obtain a near optimal solution of the problem. For larger systems, a practical approach is to decompose the system into several geographical areas, such that each area is served by two or three vehicles. The 3-step algorithm could be a building block of such a solution approach.

How the work informs our project?
One of the innovative components of their heuristic is the idea of reducing the size of the routing problem by clustering together sets of points that are likely to be visited consecutively. Given the newly defined network, the routes among these clusters are optimized and the solution is used to guide the search for a good feasible route in the original network. Such a decomposition approach can be useful to many other rich vehicle routing problems, for example, inventory routing problems.