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# Tools for Analytics and Cognition Framework for a Car-Sharing Use Case

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**Abstract**—The development of tools that can improve efficiency and inject intelligent insights into operational and mission-critical social media businesses through guided analytics is crucial for consumers, prosumers, and business markets. These tools will provide contextualised socially aware and spatial-temporal data aggregation, knowledge extraction, cognitive learning about users' behaviour, and risk quantification for the car-sharing use case. The proposed Tools for Analytics and Cognition (TAC) framework will provide a tool-set of guided analytics software for smart aggregation, cognition and interactive visualisation with a monitoring dashboard for the car-sharing use cases. The proposed TAC framework uses the dashboard to visually analyse the behaviour and engagement of the social media actors, diagnose performance risks and provide guided analytics to consumer prosumers and application providers to improve collaboration and revenues, using the established car-sharing qualitative mapping model. This framework has supplied a seamless coupling with distributed blockchain-based services for early alert, real-time tracking and updated data triggers for reach and engagement analysis of car-sharing events. Moreover, the TAC framework will allow car-sharing providers to analyse, control and track their investment to enhance monetary inclusion in the collaborative social media ecosystem.

**Index Terms**—Guided Analytics, Data Aggregation, car-sharing, Augmented Cognitive, Microservices, Social Media

## I. INTRODUCTION

The ARTICONF 'smART socIal media eCOsystem in a blockchaiN Federated environment' [1] is an EU project that addresses the urgent industrial need for a novel set of trustworthy, resilient, and globally sustainable decentralised social media services. These popular services consider issues of trust, time-criticality and democratisation for a new generation of federated infrastructure. By, fulfilling the privacy, robustness, and autonomy related promises that proprietary social media platforms have failed to deliver so far. The social media platforms have the potential to shape and mobilise patterns of communication, practices of exchange and business creation and learning and knowledge acquisition. Typically, social media are centralised platforms with a single proprietary organisation controlling the network. This poses critical issues of trust and governance over created and propagated content. This is becoming very problematic when there occur

data breaches that are happening regularly at the hands of centralised intermediaries.

The ARTICONF project has been envisioned to overcome the common barriers for the existing social platforms, such as (i) non-transparent and centralised infrastructure control when defining the social media network (ii) inefficient methodologies for identification of malicious actors (iii) lack of a democratic paradigm in existing social media networks, (iv) an inefficient resource provisioning for dynamic and time-critical social media applications such as the one based on crowds and (v) lack of mechanisms to support social cohesion. The proposed ARTICONF platform will provide a universal backbone for an open and federated platform that accommodates trust, democratisation, and time-critical based QoS requirements with incentivization opportunities for a large and diverse user base, including consumers, prosumers and business markets. The main goal of this project is to introduce a new type of social media network with democratic decision making, dynamic infrastructure provisioning and addressing trust and privacy issues. The project aims to create a decentralized and federated social media ecosystem, supported by an underlying blockchain technology that will ensure portable intra-platform and cross-platform social media data, interpretable in a range of different contexts for preservation, analysis and visualization via four frameworks (i) Trust and Integration Controller (TIC), (ii) Co-located and Orchestrated Network Fabric (CONF), (iii) Semantic Model with self-adaptive and Autonomous Relevant Technology (SMART) and (iv) Tools for Analytics and Cognition (TAC).

The TAC is a crucial tool-set of a decentralized social media ecosystem which enhances business productivity by tracking updated data triggers from diverse social media events. The TAC is seamlessly coupled with SMART and provisions socially-contextual geospatial and temporal data aggregation microservices to gain intelligent insights and prediction. The SMART tool initiates the TAC configuration providing aggregation, monitoring, cognitive reasoning and learning modules that analyse the behaviour and engagement of the social media actors. The TAC tool interacts with the CONF component in continuity to avail intelligently provisioned tool based on social media application requirements, operational conditions at the infrastructure level, and time-critical event triggering. TAC

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has a microservices-based architecture organised in modules displayed in Fig. 1.

The SMART framework initiates the TAC configuration providing aggregation, monitoring, cognitive reasoning and learning modules that analyse the behaviour and engagement of the car-sharing social media actors. The outcome is to diagnose performance risks, and provide guided analytics to consumer, prosumers, and application providers to improve collaboration and revenues for a car-sharing use case. The TAC framework will interact with the CONF component in continuity to avail intelligently provisioned frameworks based on social media car-sharing application requirements, operational conditions at the infrastructure level, and time-critical event triggering. The TAC is a fundamental part of the ARTICONF platform which is used to collect and aggregate data for the car-sharing pilot use case scenario, run data aggregation analysis based on the TIC, SMART and CONF frameworks (see Figure 1). The ARTICONF data flow architecture model handles the pre-processing microservices for geospatial and temporal data to be visualized in a guided analytics dashboard, part of the TAC framework.



Fig. 1. The ARTICONF data flow architecture model

The remainder of the paper is organised as follows. Section II gives an overview of the car-sharing use-case in the context of TAC ARTICONF framework. Section III explains the TAC microservices, providing details for the geospatial, temporal and visualization components. Section IV describes TAC implementation for a car-sharing scenario. Finally, section V concludes the paper and provides future directions.

## II. CAR-SHARING USE-CASE IN CONTEXT OF TAC ARTICONF FRAMEWORK

This section will provide a short overview of the car-sharing platform and give insight into how the car-sharing use-case can be deployed in the context of the TAC framework.

The car-sharing platform is a new collaborative model providing an alternative solution to private car ownership. This model allows customers to temporarily use and share a vehicle (on-demand) at a variable fee, charged depending on the distance travelled or time used. It is based on a sharing economy concept, which is an umbrella term for new business

models where the most important thing is saving money and reducing pollution.

The car-sharing use case is composed of four microservices: (i) social network, (ii) blockchain, (iii) storage, and (iv) prescriptive microservice.

The social network is used by customers to interact, plan (where and when a vehicle is available), hire a service, or share content like photos and short videos. The availability of a social network will improve user communication and will be intended to create a community in each city. Using this network, a user can report any issue detected by posting in this social network. This includes providing information about the service, asking other users for a route, or reporting problems with the vehicle (battery, engine, etc). In order to facilitate the use of the social network and to reduce risk about the user data, this social network would be used anonymously.

Companies or private users of this system carry out payments while maintaining anonymity through permissionless blockchain networks. They can deploy smart contracts in the blockchain which will be verified and resolved automatically. These contracts will have coded penalties which will be applied automatically in case of contract breaches.

The data coming from the social media network, service utilization and geolocation system (user geolocation data) are stored in the data storage system, implemented using the CouchDB database in Fabric.

Several algorithms will run over these data providing information for management and maintenance of the system. The prescriptive microservice aims to provide suggestions to the system administrators or users to increase revenues from the system.

In conclusion, using these microservices, the use-case allows the user to rent and share a car at any place and time through smart contracts based on blockchain. Thanks to this technology, their money will be safe throughout the process and the contracts will be fulfilled automatically, including penalties. Through social networks, users can interact with others and report issues directly to the company, vehicle owner or other users: the platform will gather all the information generated by the anonymous user (geolocation, social network interaction, external events...) and this data will be used by ARTICONF, which will help to classify users. Finally, the AI (Artificial Intelligence) system will analyse this data and will use it to boost user experience and the economic benefits for users and vehicle providers involved in the model.

The proof of concept of the proposed TAC framework depicted in Fig. 1 is done using a car-sharing use-case.

The proposed TAC framework will develop and design a qualitative mapping model with context knowledge and context-sensitive interpretation. It takes car-sharing use-case data as input, structured according to the dimension's data model, and computes output data, which are also structured according to the metrics' output data modules (geospatial, temporal and cognitive). Default dimensions for the modules come with default generic functions that remain at the partners' disposal for creating custom use-case functions. For

example, the default function scenario rating to the default dimensions calculates the average score per scenario, which is the filtering input data end-user rating. A typical example of an analytical platform for integrating and computing spatio-temporal metrics, which supports intensive cluster-based data processing is given in [2]. Here the use of a microservices is supported. The stream-processing method is part of the data ingestion microservice intended for storing collected data, this can be implemented and realised as a distributed, micro-service based cloud architecture.

The TAC framework is developed using multiple individual microservices internally interconnected among them, as is depicted in Fig. 1. For the purpose of developing and designing a qualitative mapping model with context knowledge and context-sensitive interpretation, three separate microservices are provided: geospatial, temporal and visualisation. Their aim is explained in the following section.

### III. TAC MICROSERVICES

The main purpose of the TAC service, as the part of the general ARTICONF platform, is supporting the analytic system, injecting additional information to improve operational tasks, planning and management of the fleet. The TAC framework is developed as a concept of interconnected microservices. The aim is producing meaningful insights for providers to improve their businesses and profits; and for users to enhance their experience and earn some extra revenues by using the ARTICONF platform. This paper put focus on creating microservices for the concrete car-sharing use case. The work can be extended for various use cases that willing to be added in the ARTICONF platform.

Thus, three separate TAC microservices are developed: geospatial, temporal and visualisation. In the sections below a comprehensive state-of-the-art for each component and descriptions of the developed car-sharing TAC microservices are given.

#### A. Geospatial microservice

1) *Geospatial Component - overview:* Geospatial analysis can essentially be described as the gathering, display, and manipulation of imagery, GPS, satellite photography, and historical data. This information is usually represented in terms of geographic coordinates or implicitly, in terms of a street address, postal code, or forest stand identifier as they are applied to geographic models. There exist a variety of use cases where the geospatial analysis is applicable, such as crisis management, weather monitoring, climate change modelling, sales analysis, human population forecasting, and the list goes on. Usually, the geospatial data is represent as Geographic Information Systems (GIS) data. Other geospatial data can originate from GPS data, satellite imagery, and geotagging. There are several software and tools available today which can assist with the utilization of geographically referenced data in population research. Some of them are FalconView - an open source GIS software that displays various types of maps and geographically referenced overlays, GeoDa's GIS software

for introducing new users into spatial data analysis with main functionality of geostatistics, GRASS GIS designed as tool for environment planning and land management, MapWindow software performs map viewer, identify features, processing tools, and print layout and other given in [3]. Geospatial data usage and analysis are crucial to be applied in all ARTICONF use-cases: crowd journalism, car-sharing, smart energy and co-created video for successful sustainability and appropriate functioning of the same. Regarding the crowd journalism scenario, the geospatial data are significant for on-time crisis informing, like the Nepal earthquake by providing a medium for citizens to communicate with one another and with those seeking to help victims. The benefits of affected peoples are immediate information sharing and visualization of dire and urgent events [4]. Therefore, crowdsourcing geospatial data has a key role in such situations. Traditional mapping is nearly exclusively coordinated and often also carried out by large organisations, crowdsourcing geospatial data refers to generating a map using informal social networks and web 2.0 technology [5]. Geospatial data can also contribute to the car-sharing use-case, helping in finding effective ways to relieve the problems of traffic jams, parking difficulties, and air pollution. Using the GIS data are targeted potential users, potential travel demand, potential travel purposes, hence, distance from existing stations are selected as the decision criteria [6]. The new model of urban transport, gives users access for short periods of rental, thus providing the benefits of using private vehicles while avoiding the inherent property charges of a vehicle. The adopted methodology of demand analysis identifies the spatial patterns of the intervening variables of socioeconomic information, transportation and land use, to understand the current panorama of the demand for transport in the wanted location [7]. The integration of energy system models and Geographic Information Systems (GIS) is still in its infancy. This integration can help in boosting the essential trends concerning energy infrastructure planning, energy generation and storage: from planned production towards fluctuating production based on renewable energy sources, from centralized generation towards decentralized generation and expensive energy carriers towards cost-free energy carriers [8].

2) *TAC geospatial microservice:* The main purpose of this microservice is to handles the gathering, display, and manipulation of all data consisting of longitude and latitude as information. Considering the needs of the specific car-sharing scenario the data are reused for creating meaningful information available for the car companies and the vehicle owners for boosting the experience and improving the economic benefits.

The insights that can be offered based on the geospatial information are coordinates and address of the place where the car is parked; all possible offered places where the trip can end (the company can follow whether the car is left on a right position, otherwise the user can be penalised); the reward that can be gain if the trip ends on one of the suggested destinations; list of users who started the trip and users who checked for that trip but still have not joint (this goes with the exact dates and coordinates); and the location from where

some user sends message to the platform.

### B. Temporal microservice

1) *Temporal Component - overview*: Visualization is a powerful tool for analysing complex social networks to provide users with actionable insights even against a large amount of data. Numerous social network analysis (SNA) methods have been coupled with visualization to uncover influential actors, find helpful bridging people, and identify destructive spammers. There are many research tools and a growing number of commercial software packages, some designed for innovative large scale data analysis, while others deal with common business intelligence needs. However, few approaches or tools sufficiently address the problem of how to analyse the social dynamics of change over time. Communities are not static. Like living organisms, they evolve because of cultural, environmental, economic, or political trends, external interventions, or unexpected events. Technological developments have also strong impacts on social changes, a phenomenon that has become influential with the arrival of mobile communications devices and social networking services [9].

Temporal data usage and analysis are crucial to be applied in all ARTICONF use-cases: crowd journalism, car-sharing, smart energy and co-created video for successful sustainability and revenue growth. Regarding the crowd journalism scenario the geospatial temporal are significant for anomaly detection, correlation of events, prediction over time series data and event stream [13], allowing the tracking of verified active accounts, and allowing the system to push notifications to proven contributors and track, and increase the engagement of users. Both active posters and lurkers are almost twice as likely to return to the site when they have received an alert [14]. Temporal data can also contribute to the car-sharing use-case, helping in finding an effective way to relieve the problems of traffic jams, and seasonality is a key feature in achieving high accuracy traffic prediction [15]. Also, it makes it possible to statistically model the users' demand in terms of drop-off and pickup rates, and the parking times of vehicles to understand the current panorama of the demand for transport in the wanted location [16]. The original Bitcoin community made much out of the "trustless" nature of the technology—the fact that it does not rely on trusted central intermediaries—but newer groups are expanding the vision into one of the trust-enabling decentralized cooperatives, or "distributed collaborative organizations" [17], improving trust and security in open marketplaces and shared economies.

2) *TAC temporal microservice*: This microservice is designed such that to support complex analyses of the car-sharing social network. Providers and users will benefit from actionable insights, although it is about a large amount of data produced over a short time.

Considering the performed analysis coupled with visualisation users can follow the amount of their savings; when there is an available car for renting or when some certain car will become unavailable; the status of some travel whether is booked, started, finished, checked or cancel. The provider can

identify the rating of the user, which reveal their behaviour during the trip; the date when the trip should start or end; or if the trip has not started or finished in a range of five minutes then to penalised the user by losing their deposit. Hence, the company can follow kilometres travelled by a concrete car; the rating of the travel given by the passengers; list of users who already started the trip together with the dates and the coordinates; plus the date of publications made by the users.

### C. Visualisation microservice

1) *Visualisation Component-overview*: Modern applications produce large amounts of data in the form of logs and events to facilitate quick failure diagnosis and mitigation. Special Big Data database systems are needed to store and manage these logs. Through such a system, the data is used to query different events and trace down issues that appear in the application. There are several software and tools available today which can assist with the utilization of time series data in population research. A popular one is a Jupyter, an open-source project that displays various types of maps and geographically referenced overlays, the enabling Big Data analysis, visualization and real-time collaboration on software development across more than a dozen of programming languages [10].

Other commonly used monitoring tools in this field can be found presented in papers [11]. Some of them are Splunk used for storing and analyzing high amounts of log data, which has support for numerous related applications and plugins; Sumo Logic able to process logs and generate real-time insights from them, which makes it useful in quick analysis and troubleshooting of infrastructure issues; Loggly a cloud-based log analyzer. This tool compared to others let the administrators know of what issues have occurred in their system, Loggly focuses more on finding the source of the problem; Graphite a scalable tool for storing data, creating graphs based on it and monitoring performance parameters; and Cacti designed as a front-end application and it is able to store system data and display graphs constructed from it.

2) *TAC visualisation microservice*: The process of guiding the social network users through the ARTICONF workflow will analyse only the parameters of its interest through a car-sharing use case recommendation. In this way, the analysis moves beyond reporting shallow summary data to acquire strong and actionable insights from users. The aggregated and summarized information will be shown on the ARTICONF dashboards to keep the car-sharing use case providers aware of what happens in the platform with the users and to summarize what happened in the past period with the scenario. As a background technology for the realisation of the above mentioned is chosen the Elastic Stack (formally known as ELK Stack). The structure of this technology is explained in [12].

The TAC visualisation microservice is responsible for aggregating and exploiting the car-sharing content diffusion supply chain across different providers, communities, groups and users. It provides information that supports user engagement in collaborative economies with monetary inclusion and increase

the provider's awareness of the users' activity on the platform and helps them track the rating and functioning of their application.

The TAC car-sharing visualisation dashboard enables the following insights depicted in Fig. 2

- A timeline series that shows the average, minimum, maximum and middle of the price for time rent.
- A gauge that gives information about the average satisfaction rating score for a concrete travel.
- Which brands of cars are the most used, hence, the types of car the most used from that same brand are depicted with a pie chart.
- A heat map showing what are the most common places where the travels start.
- A group of words, sized according to their importance, that indicates users who are active in the use-case platform.
- A horizontal bar chart that gives view of car brands and types that produce the most revenue.

#### IV. TAC IMPLEMENTATION FOR CAR-SHARING

This section covers all needed technical setups for development of the TAC microservices, elaborated in section III. Hence, gives results in a final form of a dashboard for the concrete car-sharing scenario.

##### A. Background technology and configuration setup

For achieving the results presented in this paper the Elastic Stack (ELK) technology is chosen. The ELK represent an open-source tool that provides end-to-end data analysis solutions, and helps with deep searching, analyzing and visualization of data provided across different machines. The Elastic Stack is structured of three main parts [12]:

- **Logstash** which is specialized in data collection and transformation.
- **Elasticsearch** an open-source distributed database system capable of real-time full-text search and analytics. It is built in Java based on Apache Lucene library [18].
- **Kibana** a GUI tool developed by elastic team that connects to an Elasticsearch server to navigate and display stored data [19]. Kibana offers various visualisation type outputs. The most frequently used visualisations include: line, area and bar charts; pie chart; data table; metric, goal and gauge; tag cloud, etc. Most of them are used for displaying our results.

One advantage of the ELK is that can be shared amongst the team to enable internal collaboration and boost the teamwork on the data analysis. That can be achieved by use of Beats, which is collection of lightweight data shippers.

The configuration setup used for development of the TAC framework is following: first, the Elastic Stack version 7.4.0 was installed on a Docker container on a local machine with basic license and with the following specification: CPU with 4 cores, 4 threads and 3.3GHz clock speed, 8GB RAM, 1TB HDD, internet connection with 30Mbps download speed and 40Mbps upload speed, Ubuntu 18.04. Additionally, for

assuring certain security in the work-environment a basic authentication was set up. For starting the Elasticsearch node port 9200, for the Logstash port 9600, and Kibana interface port 5601 were used. In order the server to be accessible not only internally, but also externally an IP tunnel was created.

In the process of the configuration the server was set up in such manner to be capable to put, delete and get documents stored on the Elasticsearch node. Further, the Logstash was also connected with the Elasticsearch node, and now this piece of software can ingest and send data to the Elasticsearch node. By default Kibana is configured to cooperate with the Logstash that makes it ready for visualization activities.

##### B. Results and discussion

The TAC microservices developed for the specific car-sharing use-case, explained in section III, were integrated in the ELK. The most meaningful insights for this provider were created and presented in a form of a visualisation dashboard depicted in Fig. 2.

- Fig. 2.1 is created by use of timeline series aggregation. In this insight can be notice how the average, maximum, minimum and median price for time rent was changing in respect to time. Base on this information the car provider can plan some future concept of working and charging. The type of visualisation used here is a line chart.
- Fig. 2.2 uses metric aggregation for depicting the final result. The aim of this insight is to be find the average score of all present ARTICONF users authenticated on the car-sharing network. The result here is shown by help of a gauge visualisation type.
- Fig. 2.3 was done using the bucket aggregation. The result is visualised by a pie chart, and represents which brand car is most used by the users, and also what type of car of a certain brand was the favourite one amongst the users.
- Fig. 2.4 was created using the metric aggregation, adding now plus the count aggregation that considers the geographical points on a map. This visualisation of type heat map enables to be find what are the most common locations on the map for a starting places of all travels.
- Fig. 2.5 uses again the metric aggregation, but now for visualisation type is taken the tag cloud. Using this aggregation and visualisation, can be revealed the user who most have been checked for travel.
- Fig. 2.6 for its creation uses bucket aggregation. Bar chart type of visualisation is used, which illustrates the car that made the most revenue, and also, from the top five cars brands the producing the top level revenue, what are the most productive car types.

#### V. CONCLUSION AND FUTURE WORK

The ARTICONF ecosystem has provided a robust tool for analytics and cognition (TAC) monitoring for a car-sharing use case scenario. The main contribution of the proposed TAC framework was to provide social media consumers with analytics dashboard data from the collaborative participation of the car-sharing scenario. In this way, the qualitative mapping



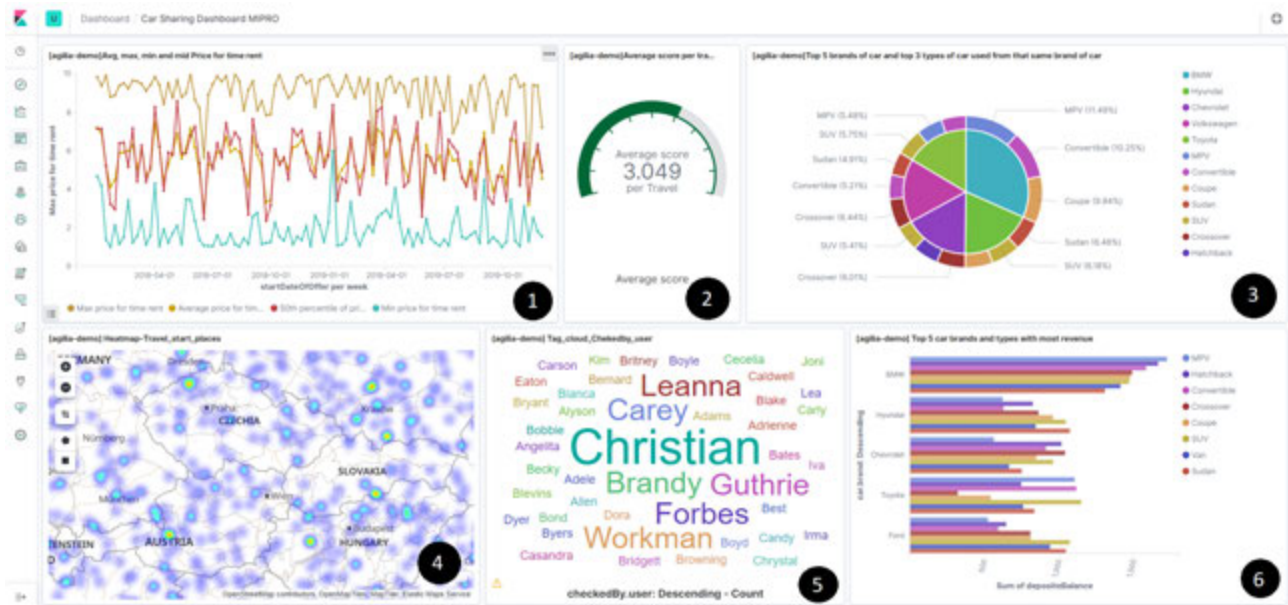


Fig. 2. TAC dashboard car-sharing implementation

model with context knowledge and context-sensitive interpretation that will improve collaboration amongst intelligently defined car-sharing communities.

The TAC framework has used the geospatial, temporal and visualization microservices to deliver a strategy for car-sharing data aggregation and group recommendation generation that is most appropriate when dealing with a specific group of intended users. The proposed tools for analytics and cognition has successfully been demonstrated in a car-sharing use case. In future, the ARTICONF platform will be piloting use cases for a crowd journalism platform; a smart energy sharing platform and video commenting technologies scenarios.

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