Big Data in Transportation: Ethical and Societal Issues

Roberto V. Zicari

Frankfurt Big Data Lab
Goethe University Frankfurt
http://www.bigdata.uni-frankfurt.de/

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Big Data and Transportation

Big Data opens up new opportunities to define "*Intelligent*" mobility and transportation solutions.

The transportation industry is a leader in creating the so-called *Internet of Everything (IoE).*

The concept of *the Internet of Everything,* originated at Cisco, defines IoE as "*the intelligent connection of people, process, data and things*."

We can think of IoE as an extension of the Internet of Things (IoT) which is primarily focused on machine-to-machine interactions.

In the transportation industry, each day vast volumes of data are generated, for example through sensors in passenger counting and vehicle locator systems and ticketing and fare collection systems, just to name a few.

This huge amount of data needs to be stored and accumulates over time.

The goal to accumulate such Big Data is to create value out of this raw data.

By analysing data, we can provide a comprehensive picture of what's happening.

Using data analytics, leveraging big data tools and predictive analytics, we can help transportation stakeholders, to make better decisions, improve operations, reduce costs, streamline processes, and hopefully better serve travellers and customers.

An example on how the transportation industry is using advanced AI and Data Analytics is offered by one of the LeMO use cases*: Raligent.*

Raligent [Kress 2018] is a cloud based platform, by Siemens, designed to help rail operators and rail asset owners, to improve fleet availability and improve operations, for example by enabling intelligent data gathering, monitoring, and analysis for prescriptive maintenance in the rail transport industry.

*Railigen*t contains a cloud based platform layer to support ingest and storage of large and diverse data sets, high end data analytics and applications. This layer is open, both for customers and partners.

On top of this layer, *Railigen*t provides a large set of applications for monitoring and analyzing rail assets. Also here applications and components can be provided by partners or customers. Target is to help customers improve fleet availability and improve operations.

But, as it is often the case, the use of new technologies, such as in this case big data-driven technologies, creates new ethical and policy issues.

> "*Normative assessments of transportation plans and policies invoked by policy-makers, researchers and activists often use concepts such as equality, equity, fairness and justice, which are informed by ethical views. Despite the increased interest in these issues in policy debates and research, there are few examples of actual attempts to explicitly address them in transport planning*. **"** **[**Anciaes et al.2014 **]**

In the rest of this section, we are going to address how the use of data and the deployment of new data-driven technologies may have a strong impact on the *Ethical* and S*ocietal* discussions.

Whenever possible, we will use examples from the Transport sector, which is the domain of the LeMo project, but the issues presented here are valid for other domains as well.

The reader interested in understanding the implication of Big Data and related data-driven technologies for the transportation sector, can refer to two LeMo deliverables:

D 1.1 UNDERSTANDING AND MAPPING BIG DATA IN TRANSPORT SECTOR,

where we offered an introduction to Big Data in the transport sector, we identified untapped opportunities and challenges and describes numerous data sources. In this report we covered six transportation modes (air, rail, road, urban, water and multimodal) and two transportation sectors (passenger and freight), identified several opportunities and challenges of big data in transportation, by using: several subject matter expert interviews, nineteen applied cases, and a literature review. We also indicated that the combination of different means and approaches will enhance the opportunities for successful big data services in the transport sector. We also presented an intensive survey of the various data sources, data producers, and service providers.

D 1.3 BIG DATA METHODOLOGIES, TOOLS AND INFRASTRUCTURES

where the technological infrastructure needed for analysing Big Data in Transportation are explained. In this deliverable we offer an in-depth introduction to relevant technologies for Big Data Analytics and Big Data Management. The report also looks at how these technologies are applied to build a Big Data Platform suitable for the transport sector. We present in detail how application-specific benchmarking can be used in order to evaluate which Big Data technologies are most suited for the domain. We conclude

Data as an Economic Asset

The discussion on Ethics in Transportation is not new!

Back in 1996, Professor Barbara Richardson suggested the need for the establishment of a new field of study and method of analysis to be known as *Transportation Ethics*.

This new discipline was needed, she wrote, to

> *"recognize the impact of proposed changes in the transportation system upon elements without our society, and to ensure equity in the distribution of the benefits and the allocation of the harms that together make up that impact. " [Hosmer, L T, 1996]*

What has changed since 1996 is the huge technological development in AI and Big Data.

Data has become a new economic asset.

Today, there is more then ever, a great need to look at the *Ethical* and *Societal* implications of using Big Data and AI Data-driven technologies in Transportation. [WEF 2018]

What is more important, vast data pools, sophisticated algorithms or deep pockets?

However, data per se, as no value. It is only by using it that data creates value. This poses several interesting challenges and opportunities in the *societal* and *ethical* space.

Professor Andrew Ng, Stanford professor, and a famous AI scientist, was quoted saying in *[Steve Lohr 2016]*:

"No one can replicate your data. It's the defensible barrier, not algorithms."

-- Andrew Ng,

Data and Economic Power

In fact, the companies with big data pools do have great economic power.

Today, that shortlist includes USA companies such as Google, Microsoft, Facebook, Amazon, Apple and Chinese companies such as Baidu.

None of these companies are European. USA and China are clearly ahead of Europe in developing Data-driven services and solutions, often based on AI.

The motivation behind such research and developments greatly vary, and in some cases pose severe ethical and societal issues.

Algorithms and Data

It is important to note that Big Data is of NO use unless it is used.

In other words, all data collected and stored will not generate any value unless it is used by some "*intelligent*" software algorithms, which analyse data, learn from data, and make/suggest decisions or predictions.

"AI is akin to building a rocket ship. You need a huge engine and a lot of fuel. The rocket engine is the learning algorithms but the fuel is the huge amounts of data we can feed to these algorithms."

– Andrew Ng,

quoted in [Steve Lohr 2016].

More and more often, AI-driven algorithms are used to create "Intelligence" solutions/services using Big Data.

We will not illustrate here the various AI technologies available, such as *Machine Learning* and *Deep Learning*. The readers can find numerous sources.

In this subsection, we are going to address the societal and ethical implications when data is used to create some sort of *Automation*.

Interplay and implications of big data and Artificial Intelligence

It is key to note that the *data revolution* has made the recent *AI advances* possible.

Challenges

AI and Big Data for higher-stakes decisions. Not only Marketing and Advertising

The initial use of Big Data technologies started with Marketing. One stage in the life cycle of an emerging science, marketing is a low-risk – and, yes, lucrative [Steve Lohr 2016]:

> *"In marketing and advertising, a decision that is better on average is plenty good enough. You've increased sales and made more money. You don't really have to know why."*
>
> --Steve Lohr (New York Times).

But as soon as Big Data Technology moved beyond increasing the odds of making a sale, to being used in higher-stakes decisions like medical diagnosis, loan approvals, hiring and crime prevention, *societal implications arose.*

What is the difference between using data for marketing and for other more critical decisions? Ethical Implications

This is a key question which has a societal and ethical impact.

Let`s use an example from the Transportation sector : "*Amazon Prime Air*".

Amazon started "*Amazon Prime Air*" as their future delivery system designed to get packages to customers using unmanned aerial vehicles (also called drones).

From the web site of Amazon:

"*We're excited about Prime Air — a delivery system from Amazon designed to safely get packages to customers in 30 minutes or less using unmanned aerial vehicles, also called drones. Prime Air has great potential to enhance the services we already provide to millions of customers by providing rapid parcel delivery that will also increase the overall safety and efficiency of the transportation system.*" (Amazon)
(source https://www.amazon.com/Amazon-Prime-Air/b?ie=UTF8&node=8037720011)

Prime Air is an example of a data-drive service implemented using Advanced AI technologies.

Now, the potential business benefits of Prime Air are decreasing the delivery and waiting time (which is good for customers) and the delivery cost (which is good for both Amazon itself and the customers).

However, Prime Air is also a good example of how a new technological-driven innovation creates social and ethical concerns.

Here are some possible social and ethical concerns, when using *Amazon Prime Air*:

- Is it safe to have drones delivering packages?
- When can drone fly over homes and properties?
- What if the package gets damaged when dropping it off or flying in the air?
- Will drones replace people?

We will come back on these issues later on in this section.

Another example is in healthcare, where predictive analytics are used for example to forecast if patient will develop a particular disease.

The ethical issues arising are illustrated by Claudia Perlich- a well known data scientist- ex Chief scientist at Dstillery, which poses this controversial question, quoted by [Steve Lohr 2016]:

"What happens if my algorithm is wrong? Someone sees the wrong ad. What's the harm? It's not a false positive for breast cancer."

-- Claudia Perlich

When we use Big Data in domains such as healthcare, decisions are practically and ethically very different then marketing and advertising.

These are crucial decisions about individual people's lives. Better on average isn't good enough.

For these kinds of decisions, issues of *accuracy*, *fairness* and *discrimination* come into play.

Automate or Augment humans?

Since Data is useful only when it is used, we can distinguish between two approaches of using data: You can use AI technologies either to *automate* or to *augment* humans.

In the first case, machines replace people, in the second case machine complements people (at least in theory).

What are the ethical responsibilities of designers of intelligent systems?

Are computer system designers (i.e. Software Developers, Software Engineers, Data Scientists, Data Engineers, etc,), the ones who will decide what the impact of these technologies are and whether to replace or augment humans in society?

Two relevant quotes are worth to be mentioned here, to support the need for ethical responsibility.

[Oren Etzioni 2016]:

"We have a profound ethical responsibility to design systems that have a positive impact on society, obey the law, and adhere to our highest ethical standards."

–Oren Etzioni, CEO of the Allen Institute for Artificial Intelligence

[Markoff 2016]:

"I think the most important aspect of this question is the simple acknowledgement that intelligent system designers do have ethical responsibilities."

--John Markoff (The New York Times)

It seems that professional codes of ethics do little to change peoples' behaviour.

An interesting question here is if we can design intelligent software that uses data with Ethical principles. We will come back to this in the subsection *Ethics by Design*.

Quoting [Murphy 1992]:

"*Murphy et al, developed propositions — based on both previous ethics research as well as the larger organizational behavior literature — examining the impact of attitudes, leadership, presence/absence of ethical codes and organizational size on corporate ethical behavior. The results, which come from a mail survey of 149 companies in a major U.S. service industry, indicate that attitudes and organizational size are the best predictors of ethical behavior. Leadership and ethical codes contribute little to predicting ethical behavior.*"

How is it possible to define incentives for using an ethical approach to software development, especially in the area of AI?

Professor Zwitter writes in [Zwitter 2014]:

"We are moving towards changes in how ethics has to be perceived: away from individual decisions with specific and knowable outcomes, towards actions by many unaware that they may have taken actions with unintended consequences for anyone."

Professor Pedro Domingos-a famous researcher in AI- mentioned in a recent interview [Domingo 2018]**:**

"I think ethical software development for AI is not fundamentally different from ethical software development in general. The interesting new question is: when AIs learn by themselves, how do we keep them from gowing astray?

Fixed rules of ethics, like Asimov's three laws of robotics, are too rigid and fail easily. (That's what his robot stories were about.) But if we just let machines learn ethics by observing and emulating us, they will learn to do lots of unethical things.

So maybe AI will force us to confront what we really mean by ethics before we can decide how we want AIs to be ethical."

--Pedro Domingos

The last sentence of this quote opens up a very interesting direction in the Ethical debate which needs further work.

How to Understand Decisions?

At present we do not really understand how Advanced AI-techniques such as used in Deep learning (Neural networks) really works. It is a try and error and this poses ethics issues. This is due to the technical complexity of such advanced neural networks, which need huge amount of data to learn properly.

This poses an ethical and societal problem:

What if the decision made using AI-driven algorithm harmed somebody, and you cannot explain how the decision was made?

Transportation is using a lot of AI-driven algorithms, so this discuss is relevant for this deliverable.

As an example on how the Transport industry is using advanced AI and Data Analytics is offered by one of the LeMO use cases: Raligent.

Raligent is a cloud based platform, by Siemens, designed to help rail operators and rail asset owners, to improve fleet availability and improve operations, for example by enabling intelligent data gathering, monitoring, and analysis for prescriptive maintenance in the rail transport industry.

Railigent contains a cloud based platform layer to support ingest and storage of large and diverse data sets, high end data analytics and applications. This layer is open, both for customers and partners.

On top of this layer, Railigent provides a large set of applications for monitoring and analyzing rail assets. Also here applications and components can be provided by partners or customers. Target is to help customers improve fleet availability and improve operations.

This use case will be further analysed later on in the project.

It seems no one really knows how the most advanced AI algorithms do what they do. Why?

Pedro Domingos explains [Pedro Domingos 2018] :

"*Since the algorithms learn from data, it's not as easy to understand what they do as it would be if they were programmed by us, like traditional algorithms. But that's the essence of machine learning: that it can go beyond our knowledge to discover new things. A phenomenon may be more complex than a human can understand, but not more complex than a computer can understand.*
And in many cases we also don't know what humans do: for example, we know how to drive a car, but we don't know how to program a car to drive itself. But with machine learning the car can learn to drive by watching video of humans drive."

Transportation example 1: Autonomous Cars

Let`s consider an autonomous car that relies entirely on an algorithm that had taught itself to drive by watching a human do it. What if one day the car crashed into a tree, or even worst killed a pedestrian?

According to Pedro Domingos [Domingo 2018]**:** *"If the learning took place before the car was delivered to the customer, the car's manufacturer would be liable, just as with any other machinery. The more interesting problem is if the car learned from its driver. Did the driver set a bad example, or did the car not learn properly?"*

This is referred in the literature as the *crash assignment*, especially between automated vehicles and non automated vehicles.

Some researchers have indicated that automated vehicles will need to be programmed with some sort of ethical system in order to make decisions on how to crash. We will come back to this point later in this section when we talk about *Ethics by Design*.

Few studies however, have been conducted on how particular ethical theories will actually make crash decisions and how these ethical paradigms will affect automated vehicle programming. [Wesley 2015]

Specifically in the area of autonomous vehicle, there are initiatives to define Ethical principles, spanning from independent associations such as:

- *The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems* , which aims [IEEE 2018] :

"To ensure every stakeholder involved in the design and development of autonomous and intelligent systems is educated, trained, and empowered to prioritize ethical considerations so that these technologies are advanced for the benefit of humanity"

(source: https://standards.ieee.org/develop/indconn/ec/autonomous_systems.html)

to political bodies such as the German *Ethics Commission on Automated Driving*.

The commission was set up by **Federal Minister Alexander Dobrindt,** recently presented a report, written by a body of experts, headed by Professor Udo Di Fabio, a former Federal Constitutional Court judge, developing guidelines for the programming of automated driving systems.

"The Ethics Commission on Automated and Connected Driving has developed initial guidelines for policymakers and lawmakers that will make it possible to approve automated driving systems but that set out special requirements in terms of safety, human dignity, personal freedom of choice and data autonomy."

-- Prof. Di Fabio

(source https://www.bmvi.de/SharedDocs/EN/PressRelease/2017/084-ethic-commission-report-automated-driving.html)

The Ethics Commission's report comprises 20 propositions. The key elements are: (from the web site : https://www.bmvi.de/SharedDocs/EN/PressRelease/2017/084-ethic-commission-report-automated-driving.html)

- Automated and connected driving is an ethical imperative if the systems cause fewer accidents than human drivers (positive balance of risk).
- Damage to property must take precedence over personal injury. In hazardous situations, the protection of human life must always have top priority.
- In the event of unavoidable accident situations, any distinction between individuals based on personal features (age, gender, physical or mental constitution) is impermissible.
- In every driving situation, it must be clearly regulated and apparent who is responsible for the driving task: the human or the computer.
  It must be documented and stored who is driving (to resolve possible issues of liability, among other things).

- Drivers must always be able to decide themselves whether their vehicle data are to be forwarded and used (data sovereignty).

The Ethics Commission's complete report can be found here: www.bmvi.de/report-ethicscommission

Transportation example 2: Drones

A drone is an unmanned aircraft system that is remotely controlled and can be used for many things such as military use, civilian use, and business use.

We will not consider here the use of Drones in military context which is subject to many Ethical issues [Hopkins 2017]

Drones collect Data. Drones acquire geographic information. And therefore, drones are becoming effective data acquisition tools that can be used in a variety of applications, from agriculture to rescue due natural calamities, to name a few.

As compared with traditional methods of gathering imagery via aircraft, drones offer a cheaper and quicker method of gathering higher resolution geographic information (UAV and GIS, 2014).

However, along with the benefits that drones provide in gathering information are some ethical and legal issues. [Caitlin 2015]

Businesses are starting to implement this new technology into their business model.

Amazon recently started "*Amazon Prime Air*": announced as their future delivery system designed to get packages to customers in 30 minutes or less using unmanned aerial vehicles (i.e. drones).

"Prime Air has great potential to enhance the services we already provide to millions of customers by providing rapid delivery that will increase overall safety and efficiency of the transportation system" (source Amazon https://www.aboutamazon.de/innovationen/prime-air)

Prime Air has many advantages such as decreasing the delivery and waiting time and the delivery cost for Amazon itself.

However, there are a few concerns with Prime Air.

Here are some examples of the ethical and legal issues for Prime Air :

- Is it safe to have drones delivering packages?

- Can drone fly over homes and properties?

- What if your package gets damaged when dropping it off or flying in the air?

- Will drones replace people?

- Is it ethical for companies to fire a deliveryman and hire someone possibly at a higher pay because they want to make delivery faster?

Opportunities

Ethics by Design

"*Solving actual moral problems is not simply a matter of choosing the "best" of several possible responses. It is also a matter of devising possible responses. Design practice in engineering affords important lessons about addressing practical problems*" [Whitbeck 1996]

Shall we then build ethically-aware AI software? If yes, this would require some sort of Ethics by Design.

Here is one possible definition of Ethics by Design:

"Ethics by Design concerns the methods, algorithms and tools needed to endow autonomous agents with the capability to reason about the ethical aspects of their decisions, and the methods, tools and formalisms to guarantee that an agent's behavior remains within given moral bounds. In this context some questions arise: How and to what extent can agents understand the social reality in which they operate, and the other intelligences (AI, animals and humans) with which they coexist? What are the ethical concerns in the emerging new forms of society, and how do we ensure the human dimension is upheld in interactions and decisions by autonomous agents?. But overall, the central question is: "Can we, and should we, build ethically-aware agents?"

Source: Ethics by Design: necessity or curse? http://www.aies-conference.com/wp-content/papers/main/AIES_2018_paper_68.pdf

How can learned results by machines be physically plausible or be made understandable by us?

We can define the concept of *"Transparency"*: i.e. being able to "transparently" *understand* how an AI-driven decision has been made using Big Data.

There are several design choices to be made:

- Do we need some sort of auditing tool?
- Should technology be able to explain itself, to explain how a data-driven algorithm came to the decision or recommendation that it did?
- How much "*transparency*" is desired/needed?
- Do we wish "*Human in the loop*" for most of these kinds of decisions for the foreseeable future?

If humans delegate decisions to machines, who will be responsible for the consequences?

Ben Shneiderman (University of Maryland) argues against autonomous systems. His point is that it is essential to keep a human in the loop. If not you run the risk of abdicating ethical responsibility for system design.

Is it realistic? If something can be partially automated, will it eventually be fully automated?

Several AI scientists around the world would like to make computers learn so much about the world, so rapidly and flexibly, as humans (or even more). How can learned results by machines be physically plausible or be made understandable by us?

Pedro Domingos explains in [Doming 2018]: *"The results can be in the form of "if . . . then" rules, decision trees, or other representations that are easy for humans to understand. Some types of models can be visualized. Neural networks are opaque, but other types of model don't have to be.*

Would it be possible to create some sort of "AI-debugger" that let you see what the code does while making a decision?

A "debugger" is a software tool that helps software developers explore the code and understand the execution.

Quoting Pedro Domingos [Doming 2018]:

" Many researchers are hard at work on this problem. Debugging AI systems is harder than debugging traditional ones, but not impossible. Mainly it requires a different mindset, that allows for nondeterminism and a partial understanding of what's going on. Is the problem in the data, the system, or in how the system is being applied to the data?

"Debugging an AI is more like domesticating an animal than debugging a program."

-- **Pedro Domingos**

How can computers learn together with us still in the loop?

Pedro Domingos [Doming 2018]:
"In so-called online learning, the system is continually learning and performing, like humans. And in mixed-initiative learning, the human may deliberately teach something to the computer, the computer may ask the human a question, and so on. These types of learning are not widespread in industry yet, but they exist in the lab, and they're coming."

Who is responsible?

Data, AI and Intelligent systems are becoming sophisticated tools in the hands of a variety of stakeholders, including political leaders.

Ethical Issues in Transportation

General ethical issues in Transportation- independent from the data and technologies used- have already pointed out.

We are going to address Ethical issues in Transportation from three different point of views: the one of *Industry*, the one of *Government* and the *Individual and collective society*.

Ethical Issues: Transportation Industry

Ethical issues for the *Transportation Industry* sector, have been defined for example in [Roi].

"*On the supply side the process of deregulation of the transportation sector in many countries raises questions regarding the social responsibilities of companies in the private*

transportation sector. Critics of these processes often point to the fact that private companies cannot attend to these issues to the same degree that organizations in the public sector do, as this can compromise their commercial viability. The survival of these companies may be incompatible with some of society's objectives. For example, the level of the fares that maximizes economic efficiency may exclude some users from the system. Private operators also do not have the incentive to serve areas with small demand, such as rural areas, dispersed suburban areas, and areas with high rates of car ownership, while car manufacturers do not have the incentive to reduce the environmental impact of their products. Employment issues are also relevant as women and racial minorities tend to be underrepresented in managerial positions and in certain professions in companies in the transportation sector.

Some sectors in the [Transportation] industry face particularly complex ethical challenges. Aviation is one of the human activities with higher share of responsibility for the emission of greenhouse gas and has a substantial impact on the local environment in areas around airports. As such, the consequences of the growth of aviation companies, including the increase in air traffic and the construction or expansion of airports, are always subject to much public discussion. Safety is also a crucial aspect in air transportation, and public authorities and companies in the industry usually impose strict regulations and codes of conduct to minimize risk.

Companies in the freight transportation industry also face specific moral issues. The globalization of channels of production and distribution of goods has increased the environmental impact of the transportation of goods, contributing to the depletion of natural resources and climate change. There is no consensus on whether freight transport companies are morally responsible for these effects, as they depend on national and international regulations and, ultimately, on the demand and supply of the products carried. The transportation of some goods, such as hazardous materials, also involves public health risks.

Decisions involving the routes taken in their transport are politically sensitive, and activists have often claimed that these routes tend to cross low-income and ethnic communities. „

The use of data and advanced technologies is making these ethical issues even more actual.

Ethical Issues: Public Intervention

Governments in most countries have some type of intervention in the transportation sector.

As stated in [Roi] "*At a broad level, this intervention needs to consider a balance between different societal objectives, such as economic efficiency, social justice and environmental sustainability. At the level of each policy, there are also trade-offs among the welfare of users and non-users of the system, among different types of users, and among different types of nonusers. Competing ethical principles may apply in the resolution of these conflicts. These principles are not necessarily universal, as each society has different concerns at each moment in time. Conflicts may arise in the allocation of investment in the transportation system in different regions. The concept of territorial justice is often applied in these cases. This concept may be supported by economic arguments but also by the moral responsibility of governments to promote regional cohesion and correct for imbalances in variables such as economic or demographic vitality of each region, given the crucial role played by transportation investment in the determination of these variables. "*

Further ethical issues arise in decisions about the construction of new transportation infrastructure.

It is important to note as stated in [Roi] that"*regardless of the philosophical standings used to judge the desirability of public interventions, one should consider that policy makers are not a neutral apparatus applying policies to achieve the maximum social good. „*

Also in this case, the use of intelligence data-driven systems in transportation makes this concerns even more actual.

Ethical Issues : *Human Motivations* Ethical Aspects of Individual Be**havior**

- *The Individual and Collective Conscience*

A third element in our analysis of Ethical and Societal issues in Transportation, besides Industry and Government is the Individual beahavior and motivation.

No matter how good we designed intelligent systems to analyse data, human motivatuon plays a key role:

"It is absolutely essential that we control the machines, and every indication is that we will be able to do so in the foreseeable future. I do worry about human motivations too. Someone said: I'm not worried about robots deciding to kill people, I'm worried about politicians deciding robots should kill people."

-- Oren Etzioni

"The individual and collective conscience is the existential place where the most significant things happen. Research, Change, Decision and Choice can take two diametrically opposite directions: can be either "pro or contra" the human person".

Source: "The good society and the future of jobs: Can solidarity and fraternity be part of business decisions?" MAY 8 -10, 2014 – Vatican City

"The thing that motivates my actions will determine the direction I am going."

--Seth Walter (BayCurch)

Let´s consider the ethical aspects of individual behavior in the transport sector:

„While ethical considerations are relevant for policy makers and researchers judging the social worth of transport projects and policies, they may also inform the preferences and choices of individuals and companies making decisions in the transportation market.

Ethical motivations are especially relevant in decisions over modal choice, such as the use of public transit (versus private vehicle) and land transport (versus air transport). These decisions may be partially based on altruistic or environmental reasons. These reasons may also be applied in decisions over the type of vehicle owned (such as the choice of electric cars). Individuals may also choose to reduce the number of trips or the distance travelled (for example, in commuting to work). There is still little quantitative research, however, on the role of these types of motivations in people's willingness to pay for improvements in the social and environmental aspects of transportation policies. [Rui]

"Data for Humanity"

"Data for Humanity" is an initiative started by Professor Roberto V. Zicari and Professor Andrej Zwitter at the end of 2015, with the goal to bring people and institutions together who share the motivation to use data for the common good, which calls for the use of five ethical principles for the use of data:

- Do no harm
- Use data to help create peaceful coexistence
- Use data to help vulnerable people and people in need
- Use data to preserve and improve natural environment
- Use data to help create a fair world without discrimination

Source: www.bigdata.uni-frankfurt.de/dataforhumanity/

Moving Forward

The future of data analytics in transportation has many applications and opportunities.

The main challenge is using significantly improved technologies and methods to gather and understand the data in order for business decisions to be informed by better insights and respect Ethical principle and contribute to societal wellbeing.

Innovation is a driving force in Transportation.

What are the main challenges, barriers and limitations that transport researchers, engineers and policy makers today face as they work to build efficient, safe, and sustainable transportation systems?

In a recent interview, Gerhard Kress, who is heading Data Services globally for the Rail business at Siemens, and who is part of the Advisory Board of the LeMo project stated in a recent interview [Kress 2018]:

> *"I think the biggest challenge is that in the rail business we have a very large set of old and country specific regulations that date back many decades. These regulations are meant to protect passengers, but some of them are not anymore fitting to the modern capabilities of technology and instead drive cost and slow innovation down dramatically."*
>
> -- Gerhard Kress (Siemens)

Transportation is changing rapidly due to the use of Big Data and Data-driven technologies.

Who will control in the future the Algorithms and Big Data that drive AI?

Do we need to regulate the development of artificial intelligence? **The answer to this question is not easy.**

Pedro Domingos in an interview **[Domingos 2018] states:**

"It should be all of us. Right now it is mainly the companies that have lots of data and sophisticated machine learning systems, but all of us – as citizens and professionals and in our personal lives – should become aware of what AI is and what we can do with it. How can I use AI to do my job better, to find the things I need, to build a better society?

Just like driving a car does not require knowing how the engine works, but it does require knowing how to use the steering wheel and pedals, everyone needs to know how to control an AI system, and to have AIs that work for them and not for others, just like they have cars and TVs that work for them."

-- **Pedro Domingos**

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