

# Industry 4.0 Technologies in Tourism Education

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## ABSTRACT

In this paper, we present a brief on the Industry 4.0 framework and the importance of these technologies for the tourism sector, motivating the reasons why it is crucial to transfer the theoretical, methodological and practical framework of the Fourth Industrial Revolution into tourism education paths.

We then present the main topics developed and the critical skills that according to our educational experimentation have been chosen, mostly related to the analysis of textual and image big data on tourists' behaviour.

Data were taken from social media and processed with Artificial Intelligence tools, such as Machine Learning and Big Data algorithms, capable to provide a better understanding of tourists' behaviour. The acquired skills and the results of the processes on tourists' behaviour data were then used by the students to create a communication product such as a marketing campaign, a website, a blog or an Instagram site, an advertising video on the touristic offer of their usual residences, typical Italian towns in the South of Italy. The results clearly demonstrated that students enjoyed the experimentation and gained awareness about the importance of the proposed technologies.

**Keywords:** I4.0 technologies framework; Students' training; Tourism education innovation; Students' new skills; Tourism communication products

## INTRODUCTION

In the paper "Industry 4.0 technologies in tourism education: Nurturing students to think with technology" [1], a scenario on the innovative technologies of Industry 4.0 revolution together with a short course on practical skills acquisition has been planned for the Tourism course students. The goal of this course was to adapt students' competencies with knowledge and new skills to be in line with the cultural, methodological and technological renewal that is taking place in the tourism industry. The initial educational experimentation has been on the following key points:

- Presentation of Industry 4.0 technologies for the tourism sector;
- Analysis of directly usable technologies by students, by means of the Mathematica program;
- Use of Machine Learning and Big Data Analytics algorithms for the analysis of consumer behaviour, tweets, levels of satisfaction, directly accessing Social Media data;
- Practical implementation of these skills for the creation of tourist relevant products using the processed data.

This article is organized as follows. In the second section, we

present a summary of the Industry 4.0 technology framework. In the third section, the educational approach, the main steps of the experimentation, and the topics about tourists' behaviour on which the students have been trained are highlighted. In the fourth section, the results obtained from the educational activity are briefly outlined. In the five section, we draw conclusions on the effectiveness of technology and skills transfer in tourism students.

## METHODOLOGY

### The Industry 4.0 framework applied to tourism sector

The Industry 4.0 (I4.0) approach is becoming more pervasive in the world of manufacturing and services, but also in our lives. Technologies are becoming more and more incorporated into our world, both in work and free time. I4.0 technologies are enablers and it is expected to lead to long-term paradigmatic changes [2]. Organizations are undergoing a profound process of change and the same is happening to consumers who will be increasingly involved in the production processes of I4.0. The new technological scenario draws a radical change in all sectors but in tourism in particular. Today, while we are experiencing an unprecedented pandemic in the human history [3], the use of technologies in the

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tourism sector becomes essential. Tourism students, that will be in the future tourism operators, need to be trained focusing on all

aspects of Industry 4.0 technologies that will be useful to create new opportunities for providers and consumers. In Table 1, a summary

**Table 1:** I4.0 applied to tourism sector, with benefits for tourist and the skills in which tourism operator must to be trained i.

Industry 4.0 technologies	Customers improvements in the tourism and hospitality sector	Skills to be developed for tourism operators
<p>The technology of Virtual Reality (VR) together with Augmented Reality (AR) will have a dramatic influence in the tourism and hospitality sector. These technologies create computer-generated 3D environments passing through a continuum between the physical reality and a completely simulated environment. VR systems has three main characterizing elements: (a) Visualization, allowing customers to look around by the HMD; (b) Immersion in the 3D generated world; (c) Interactivity with the objects of the simulated world, usually achieved with sensors and an input device (Guttentag, 2010) [4].</p> <p>Since 2017, the major corporations of the sector have included AR and VR devices on the market, ready for massive use. These technologies are giving new shape to the experienced reality, thus restructuring the consumer experience in the tourism sector. Although the applications of VR and AR have not been fully explored, scholars identify the following fundamental points that enquiry in the tourism sector should identify (Yung &amp; Khoo-Lattimore, 2019) [5]:</p> <p>(1) tourism sectors and contexts in which VR and AR research have been established;</p> <p>(2) the arrangements of VR and AR which have gained particular attention in tourism research;</p> <p>(3) methodologies being utilized to research VR and AR in tourism;</p> <p>(4) theories being utilized in VR and AR research in tourism;</p> <p>and (5) possible research gaps in VR and AR tourism research.</p>	<p>While Virtual Reality (VR) replace the physical world, allowing the customer to enter in another world, AR (especially Location Based Augmented Reality - LBAR, Tsai, 2019) [6] allows to operators to provide their customers with the following functions:</p> <p>Direct, real-time new experiences of the real physical environments that the hotels offer, changing their perception of the surroundings, thus increasing the customer's satisfaction, proposing Augmented Hotel Environments. Make information available to guests before and after their arrival, thus providing them with Interactive Hotel Rooms.</p> <p>Allow guests to open and close their rooms via beacon technology.</p> <p>Capturing technologically advanced customers, especially millenials, by using emarketing and AR (Shabani, Munir &amp; Hassan, 2019) [7].</p>	<p>VR programming languages Computer-Aided Design 3D Modelling Video editing Rich 3D Contents Creation</p>
<p>The term Internet of things (IoT), refers to a set of technologies that allows any type of device or system to be connected to the Internet, offering new opportunity and challenges in the tourism sector, creating smart cities and collecting data related to (1) personal sensing (2) social sensing and (3) public sensing (Wise &amp; Heidari, 2019) [8]. The purpose of this set of technologies (made by distributed sensors in the environments, connected among them) is to monitor, control and transfer information to the end customers that can then perform subsequent actions. The term Internet of things, (IoT) refers to a set of technologies that allow any type of device or system to be connected to the Internet. The purpose of this type of solution is to monitor, control and transfer information and then perform subsequent actions. In the most advanced forms, these systems can process data through Machine Learning (ML) systems and transmit only those necessary for the functions in which the devices are involved, performing the actions based on the information received, depending on the local processing capacity or connecting to a cloud systems based. IoT services are linked by natural language interfaces to devices already present in our homes, such as Amazon's Alexa, Google Home smart speakers, other devices such as smart watches or smartphones.</p>	<p>Applied in the Tourism sector (Kaur &amp; Kaur, 2016) [9], especially to enhance travel planning and satisfaction (Huang, Goo, Nam &amp; Yoo 2017) [10], IoT supplies the customers with the following services:</p> <p>Mobile crowd sensing in smart cities to avoid traffic jam or unpleasant surprise.</p> <p>Transportation availability.</p> <p>Geographical on line Services.</p> <p>Weather forecasting.</p> <p>Checking of the flights by a smart device.</p> <p>Tracking Rental Cars.</p> <p>Making more efficient Customer Processes.</p> <p>Searching for hotels and booking rooms even at the last minute.</p> <p>Giving real time information to customers about their lost luggage.</p> <p>Providing real time parking information.</p> <p>Checking health issues if customers are disabled or ageing people, providing them with the best travelling conditions.</p>	<p>Machine learning and Artificial Intelligence skills Big Data Analytics User Interfaces - Centric Approach methods</p>

On vacation, tourists are continuously connected to Social Media, posting images, videos and recommendations about the beauties and the services they are enjoying. This means that tourism choices, preferences and experiences are embodied into their diaries, posted on social media. Therefore, to investigate tourists' behaviour, specialists of the sector need to study this large amount of data by using Big Data Analytics. Even if there is not yet an accepted definition of Big Data, the oldest in time, identifies their essential characteristics, described by the 3Vs (Volume, Variety and Velocity - Laney, 2001) [11]. Later, another V has been given for Value (Gantz & Reinsel, 2011) [12], to highlight the benefit of Big Data for the contemporary digital ecosystems. Technologies and researches in this sector, and consequently in the tourism sector, focus on 3 types of sources that continuously generate Big Data, customers, devices and operations. Other researchers (Hashem et al., 2015) [13] grouped big data into five categories: data sources, content format, data stores, data staging, and data processing. The use of the Internet has allowed the huge production of data by users such as texts, photos, videos and especially reviews (User Generated Content, UGC), (Xiang, Du, Ma, & Fan, 2017; Marine-Roig, 2017) [14,15]. On UGD, applications to improve tourism design can be built (Jin, Cheng & Xu, 2018; Giglio, Bertacchini, Bilotta & Pantano 2019a; Giglio, Bertacchini, Bilotta & Pantano, 2020) [11,16,17], although many critical aspects are still to be solved (Sivarajah, Kamal, Irani & Weerakkody, 2017; Sheng, Amankwah-Amoah & Wang, 2017) [18,19]. Furthermore, the diffusion of IoT platforms, with the employment of distributed sensors, the applications of the global positioning system (GPS), of Bluetooth, roaming data, etc., allowed to monitor the movements of the tourists and the weather forecasts, providing both spatial and temporal data, by applying tracking technologies in tourism studies (Shoval & Ahas, 2016) [20]. Tourism, like other productive sectors, is organized with multiple activities that include internet searches, financial transactions, user log data, etc. Besides, consumers send their reviews, tweet their evaluations, post their images, book online, etc. This obviously allows us to analyse the behaviour of tourists, their choices and preferences and, thereby, improving tourism marketing. It follows that on these three strands it is possible to base understanding and academic study, the results of which can then be provided and / or transferred in the training of tourist operators.

Autonomous robots are intelligent machine capable to carry out tasks, without the human intervention. If robots that help in jobs such as cleaning, washing, self-check-out, automatic teller machines (ATMs), etc. represent a mature technology in the tourism sector, with automatic tasks, not subject to change, other types of social, human-like robots that develop customer supporting activities (Bertacchini, Bilotta & Pantano, 2017) [17] are entering the hospitality and tourism sector with more complex and adaptive tasks. In China, robots have been introduced as waiters (Cheong, Lau, Foo, Hedley & Bo, 2016) [22]. In many countries of the world, especially Japan, robot hotels (Zhong, Sun, Law & Zhang, 2020) [23] and service robotic agents (Ivanov & Webster, 2017) [24] are being tested (van Doorn et al., 2017) [25], also analysing customers' responses to these new technologies (Pan et al., 2015) [26], expanding the interaction between consumers and humanoid service robots (HSRs) (Mende, Harding & Turner, 2019) [27]. Social Robotics is defining new spaces of interaction between man and robot (HRI) or between machines (M2M). Interactions take place both in physical or in completely digital environments, through physical interaction with humanoid robotic agents such as Physical Conversational Agents (e.g. Nao), Mixed-Reality Conversational Agents (e.g. Pepper), Embodied Conversational Agents (e.g. Sergeant Star), to fully digital interactions such as with Disembodied Conversational Agents (e.g. Alexa, Siri, AliGenie, Google) (De Keyser, Köcher, Alkire, Verbeeck & Kandampully, 2019) [28].

According to some authors (Li, Xu, Tang, Wang & Li, 2018) [21], Big Data are produced with the following percentage distributions:

47% are UGC (21% are images entered on social media such as Facebook and Instagram, the 26% are textual data, such as reviews and blogs data for lodging, eating and traveling);

17% of data derive from transactions (at least 11% are data generated by Web searches, while 6% are data related to reservations, booking, commercial data of consumers);

36% of the data comes from devices (such as smart phones or tablets). They concern 21% data coming from GPS 4% from Mobile Roaming Data, 3% from Bluetooth data, 5% from RFID data, 1% from WIFI data, 2% from Meteorological data.

In general, these types of data produce significant improvements for consumers and stakeholders of the tourism sector. Through images and texts, it is possible to identify consumers' preferences, measuring tourist satisfaction. This leads stakeholders to customize tourist offers in relation to their needs.

Consumers will gain extra benefits by obtaining special treatment or discounts, while companies will increase more and more the satisfaction and loyalty of their secure consumers.

Basic of some programming Languages  
Machine learning and AI  
Data mining  
Interpretation and data visualization  
Problem solving

Some researchers provide a detailed overview of the potential services and benefits achieved by a full application of automation and robotics in the travel, hospitality and tourism sectors, according to categories such as Hotels, Restaurants, Meetings and Events, Theme and Amusement Parks (Ivanov, Dolgui, Sokolov & Ivanova, 2017) [29].

Basic of some programming Languages  
Machine learning and AI  
Data mining

Cyber security is a key aspect of the 4.0 industry framework. Due to the huge amount of traces that consumers leave in physical cyber systems, data security in all types of transactions become a key element that allows consumers to access network products and services safely. In addition, the 4 general principles that inform Industry 4.0 (interoperability, transparency of information, online technical assistance and decentralised decisions) make the system more prone to digital attacks. Consequently, all technologies create security problems, which are currently being studied extensively and intensively, to generate confidence in contemporary digital systems. Challenges can range from simple threats to massive attacks, which can cause the entire system to collapse. For these reasons, several metrics are being created to try to have case studies of the cyber-attacks, in order to be able to assess the level of risk and the measures to be taken. As Lezzi, Lazoi & Corallo (2018) [30] point out, there are four kinds of threats, related to Cyber-security: Cybercrime, assaults with criminal intents, for deception or stealing any kind of data or intellectual property, cyber spying that regards the acquisition of data with non-commercial value, cyber terrorism, threads base on political ends and cyber warfare, devoted to the acquisition of military advantages.

Key benefits are related to privacy, transparency inside the organization, prevention from fraudulent attacks, and prevention from any kind of physical troubles in order to ensure the highest level of physical and digital security.

Basic of some programming Languages  
Machine learning and AI  
Data mining  
Cyber-Security techniques

Artificial Intelligence (AI) technology, based on human like-algorithms such as Machine Learning (ML) can analyse data and learn from them, changing and improving over time without human intervention. These systems are starting to have a dramatic effect on tourism and hospitality industry. Usually these algorithms are embodied into smart assistants. For this reason, these tools recognize spoken language and learn from users. Furthermore, they are used to analyse data of all kinds, such as Big Data created on Social Media Networks by customers. The term Machine Learning, invented by Arthur Lee Samuel (Samuel, 1969) [31], defines the science of allowing computers to behave without being explicitly programmed.

In the context of Business management support, AI will bring the following benefits to the tourism societies:

Improvement of decision making and strategic planning

Improving of the organization functionality

Automation of tasks

In the context of customers' analytics, AI is used primarily in relation to marketing tourism destinations, allowing to identify:

specific target group of clients, informing about the possibility of customers to access last minute products and services, conducting effective up-selling and cross-selling campaigns,

customer segmentation,

optimization of tourism activities,

tracking customer behaviour over time,

analysis of customer behaviour,

analysis of tourism destinations trends.

Basic of some programming Languages  
Machine learning and AI  
Data mining  
Interpretation and data visualization  
Problem solving

Simulation processes have been used in contemporary science for many years (Bertacchini, Bilotta, Caldarola, Pantano & Bustamante, 2016; Bertacchini, Bilotta, Caldarola & Pantano, 2019) [32,33] and in this case also represent simulation of continuous and discrete dynamical systems (Bilotta, Lafusa & Pantano, 2003; Bilotta & Pantano, 2006; Bilotta, Di Blasi, Stranges & Pantano, 2007; Bilotta, Stranges & Pantano, 2007; Abdechiri, Faez, Amindavar & Bilotta, 2017) [34-38], physical, chemical, engineering, architectural systems, neuroscience applications (Lombardo et al., 2017; Bertacchini, Bilotta, Lombardo, Sammartino & Pantano, 2018; Bertacchini et al., 2019) [39-41], related to Computer Graphics and Computer Animations that have a dynamic output or mathematical results. Simulation and visualization processes are in turn computer-generated environments such as Virtual Reality, but here the aim is not interaction or entertainment, but above all the possibility of providing data, processed in a short time by large computing capacities and in a short time for scientific purposes. Simulation processes are the basis of scientific calculation.

In the tourism sector, the applications of simulation technologies and related mathematical models make it possible to measure tourism in its many variables and dynamics. The tourism sector is in fact a complex system, so it is formed by numerous subsystems that in turn contribute to the emergence of phenomena on a global level. For which the main scientific techniques can be used to evaluate tourist flows and their direct, indirect and induced effects on macro, micro environmental, socio-cultural and economic scenarios (Sedarati, Santos & Pintassilgo, 2019) [42]. Thanks to the adoption of simulation techniques, benefits could be attained for the political-strategic planners of the tourism sector, the managers of the activities, in order to improve the services for the final customers (Baggio, 2019) [43].

Programming languages  
Computer-Aided Design  
3D Modelling  
Video editing  
Rich 3D Contents  
Creation

Thanks to the digitization processes that allow to have digital copies of objects, present in reality, integrated by the Cyber-Physical Systems, smart manufacturing (Zheng et al., 2018) [44] is a new approach to production that companies are adopting, in the Industry 4.0 paradigm. It is about advanced innovation in both production processes and final products that consumers buy and use. Smart manufacturing is an emerging form of industrial production that by integrating the technologies of Industry 4.0 creates innovative industrial assets that have distributed sensor platforms, communication technologies, control, simulation, modelling. This approach uses and integrates the concepts of cyber-physical systems driven by the Internet of Things, cloud computing, service-oriented computing, artificial intelligence, data science. The fundamental principles are sharing, sustainability, shared services, quality of service, sharing of resources and networking, through supply chains integrated in production (Kusiak, 2018) [45]. Smart manufacturing has the following characteristics:

- a. Adoption of parametric object modelling processes, i.e. changes in the shape and organization of objects, usually customized according to consumer preferences;
- b. additive or subtractive digital 3D printing processes. This allows to significantly reduce time and costs of the prototyping processes, thus realizing better and improved products at lower costs, with significant economic benefits for companies and consumers;
- c. the final embodiment of sensors into the items will transform simple everyday objects into intelligent systems capable of interacting with the Cyber-physical systems and with other objects.
- d. Objects will also be valuable thanks to the use of innovative and extremely flexible materials.

Design adaptable because it involves users and their experience of use (User Experience, UX), both with the development of questionnaires or group focus methods, and with the use of specific digital equipment such as the eye-tracker and video-cameras to reflect the perception of users towards the process of co-design in the creation of tourism products and services.

Development of graphic interfaces and applications to facilitate the co-design of products and services.

Use of 3D scanners to capture user-specific characteristics, while geometric parameters are then optimized for subsequent 3D printing.

Use of intelligent platforms to test product prototyping and developed functions that will then be incorporated into new products or mobile applications.

In particular, the design processes include a series of experiments with the participation of users. These experiments are conducted in order to: a. discover the relationship between UX and users' preferences for the basic product (designed by the company's designer), a product designed together with users in the co-design process, a custom product, designed entirely by the user; b. discover which is the best method to achieve a better UX in some production contexts, such as the visualization of the product design (e.g. in virtual or augmented reality, rapid prototyping of the product with 3D printing; c. Discover the relationships between the intelligent attributes of the developed product or service and the developed UX environment; d. analyze user behavior in the human-machine-interaction co-design process and, e. create useful guidelines for companies to develop the user-centred products.

Basic of some programming languages  
Computer-Aided Design  
3D Modelling  
3D printing processes

#### Cyber-Physical Systems

Industry 4.0 is the term used to label the Fourth Industrial Revolution embracing a set of technological improvement and advances developments that are having a strong impact in the current industrial landscape (Pereira & Romero, 2017) [46]. The concept appeared for the first time during the Hannover Fair in Germany in order to promote a strategic approach to digitalization in manufacturing. Indeed, one of the key features of Industry 4.0 is the creation of highly automated industries through Human-Machine Interaction (Xu, Xu & Li, 2018) [47]. This scenario shows a set of advancements in modern technology grouped in the following nine pillars: Big Data and Analytics, Autonomous Robots, 2D and 3D Simulation, Horizontal and Vertical System Integration, Industrial Internet of Things, Cyber Security and Cyber Physical Systems (CPS), Cloud computing, Additive Manufacturing and Augmented Reality (Rüßmann et al., 2015) [48]. Indeed, in the last decade, technology has brought many changes, Industry 4.0 represents a state of industry characterized by thorough digitization of economic, and production flows. The Industry 4.0 paradigm is based on communication and cooperation with cyber-physical systems (CPS) and with people in real time thus to improve the performances in terms of productivity, resource efficiency, cost and security with Cyber-Physical Systems (CPS) and on Internet of Things (IoT). In other words, the aim of the CPS is to provide real-time to acquire and manage high volume data (Big Data) from the physical world and information from the cyber space so to allow intelligent data management and analytics (Xu & Duan, 2019) [49]. This contribute to reduce human errors and improve the workers' ability to be flexible problem-solvers whom can guarantee a higher system efficiency, with lower cost and less consumption of resources (Lee, Bagheri & Kao, 2015) [50].

The benefits for this type of system partially overlap with the already described benefits for IoT systems.

Machine learning and Artificial Intelligence skills  
Big Data Analytics  
UI-centric Approach methods  
Sensor technologies basics

of the pillars of Industry 4.0, the technical and economic benefits for tourists and the potential skills to be developed in tourism operators are highlighted.

### Basic activities of the lab courses

The experimental work program was given in the academic year of 2018–2019, in the General Psychology class, Course Degree in Tourism Science (University of Calabria), involving 30 students (27% male and 73% female). Lessons were held twice a week for two hours for a total of 42 hours. All lessons have been given in a Lab environment, with face-to-face lessons and hands-on lab hours on technological tools. After canonical lessons on General Psychology topics, Industry 4.0 framework and the related technological trends have been introduced. Lab hands-on lessons have been organized on the following functions:

**A. Search for data and collect the most relevant ones:** collecting text (tweets, reviews, suggestions and images) posted by customers on the Social Media. For this task, students were encouraged to focus more on texts and images that would express the individuals' emotions when using a particular tourist product, place or service. In more general terms, the study data were focused on six main aspects of interest to the tourism industry:

- Where possible, data concerning emails or web addresses, nicknames;
- Data regarding the geographical aspects of the site visited by tourists;
- Data about cultural features (historical monuments, churches, other remains or architectural beauties, Museums and other places of interest);
- Data on the services offered by the infrastructure;
- Reception levels of the place, from the tourist point of view;
- Presence/absence of technological infrastructures.

**B. Organize data:** In many instances, collected data required to be cleaned up. Consequently, students learned to organize the data by macro categories (text and images, email addresses, different types of data) in order to analyse their own organization with the techniques used in point c.

**C. Use AI tools to understand data:** The students had to use in practice the tools of Artificial Intelligence to organize the data and to be able to better understand their use in point d.

**D. Design thinking approach:** Stickdorn et al. [51]. At the end of the course, students had to plan, design and develop a simulated communication system, to promote a Calabrian location. Students could develop a digital brochure, website, a spot, a blog to advertise on the attractiveness of the chosen location.

With regard to the design and implementation of the communication system, the students had to carry out the following tasks:

- Select a Calabria location.
- Use collected data on natural, historical and cultural points of interest, together with geographical and demographic information.

- Design a simulated communication system.
- Implement a running prototype.
- Test the implemented system, running a user experience with almost five subjects to collect errors or critical points of the system.
- Delivery the final project, showing their work to selected stakeholders.

## RESULTS AND DISCUSSION

### Basic skills developed

**A. Search for data:** First of all, students learnt to acquire both image and textual data from Social Media by using the Mathematica software Package [52]. In more detail, the students employed algorithms that allowed them to access different services on the network. These services, when not subject to payment, connect to organizations from which to download data as excel sheets, making it possible to process them with the appropriate statistics. The most important algorithms used by the students are listed below:

Service Connect ["service"] provides a list of possible service to whom it is possible to connect to get freely available or paid data. Services are related to Social Media, such as Twitter, LinkedIn, Facebook, Instagram, Reddit; to Communication systems that allow to send SMS or push images and text and file to other devices; to Storage Services such as Drop box or Flickr; to Business Services such as Google Analytics, Survey Monkeys, etc.; Personal Information such as Google Calendar or Google Contacts; Health and Fitness Devices; Research Data; Web Search, Web Image Search, etc. A detailed guide is also available on how to access all these information services. As an example we report the procedure used to connect to Flickr. Students use the algorithm Service Connect ["Flickr"], instantiating a connection to Flickr through a query. This procedure allowed them to download photos taken by tourist from Flickr, related to the City chosen as target of their analysis. As regards text, Wolfram Mathematica allows students to collect recent tweets using specific hashtags concerning the selected locations, or to the above listed sources of information, always using the Mathematica connection algorithms. Students collected Tweet, reviews and Images related 15 Calabrian cities.

**B. Data organizations:** Students grouped information on the selected places combining digital resources in three main categories: Tourism site facilities, Geographical, Historical and Cultural attractions and Tourists' Behavioural variables, among which the most noticeable was related to Experienced Tourists' emotions (see Figure 1). The aim of the students' analysis is to understand how tourists show their emotions, how they behave in places of leisure and the things in the environments they love to take pictures of. A fundamental element of this process concerns the visualization of the data, realized above all through a series of Mathematica functions that concern the representation of geo-referenced data. The main command is Geo Graphics [primitives,options]. Particularly important for students has been the possibility to display data related to their cities, with the functions: City Data [name] that gives a list of the full specifications of cities whose names are consistent with name and City Data [name,"property"] that gives the value of the specified property for the city with the

specified name. Mathematica's language provides access to a wide range of geographic data, including detailed world-wide maps and information that can be calculated on millions of geographical entities. By providing the linguistic data of the city to be searched in free form, it is possible to symbolically represent the geographical constructs, together with detailed physical-geographic-demographic properties of the place, with the added possibility of performing sophisticated geodetic calculations, as well as calculations on socio-economic data and other data.

Most of the students organized data as shown in Figure 1. That is, the students searched for relevant data to identify the tourist facilities on the territory they identified for their survey. In particular, the students found companies providing health and fitness services, accommodation facilities, quality and variety of food present in the place, environmental safety and quality of the place, transportation facilities. With regard to geographical, historical and cultural attractions data, students focused on the types of images that are present in Social Media, the historical and archaeological resources present for the chosen location, the benefits expectations from the tourists site in terms of in terms of the quality of the stay and the services offered, the relevant historical and cultural resources. Instead, the behaviour of the tourist was analysed according to the following variables: the requests and wishes of the tourist regarding the exploration of the cultural places, adventure search, enjoying night life and shopping opportunities, the search for novelties, the emotions in photos and texts posted on Social Media, while the tourists carried out the typical activities of exploration, shopping, entertainment, etc.

**C. Big data analytics:** Machine Learning (ML) techniques were used for data analysis. These techniques cover a wide range of applications that, properly trained on complex models, enable to extract structures from disorganized data, thus discovering unknown but valuable models in the tourism sector. Deep learning is part of a broader family of ML methods that are used both in text and image processing. Wolfram Mathematica software has a series of pre-trained classifiers useful for different tasks, widely applied in various fields. These classifiers have been trained with large dataset and their parameters have been tuned for optimal performance [52]. Students used unsupervised learning algorithms already available in Wolfram Mathematica. In particular, students used sentiment analysis on the collected tweets, reviews and other textual data extracted from Social Media with the aim to identify

emotional contents. In particular, people emotions recognition has been used. The Mathematica Classify module has a built-in pre-trained function "Sentiment" that allows to recognise emotions that a piece of text conveys. It is a pre-trained Machine Learning algorithm. Sentiment analysis can be done on text and images or video. Concerning the text data, it concerns the extraction of emotional meanings behind the texts posted by tourists' while they are on travelling, in order to trying to draw a psycho-emotional profile of them [53]. It also allows understanding tourists' preferences, desires, and motivational drivers that push them to the consumption of goods and services. This analysis is becoming a popular method to understand people's opinions and emotions, as it requires systematic and automatized procedures [54,55]. Sentiment analysis can facilitate a number of opinion-oriented classification problems. This is one of the most important area of research to understand consumers, especially in the tourism sector. "Sentiments analysis" algorithm in regards to images is mainly devoted to extract the emotional feelings, generally expressed on the face by the expression of the emotions, in order to understand complex tourists' orientations in specific application domain [56]. In addition, image analysis allows to identify objects, locations and people, providing significant information for tourism stakeholders. After collecting the images, students applied different Mathematica algorithms. These functions allowed them to define the categories of objects, people, places, buildings. Students learnt how useful it is to classify images according to categories such as physical variables, geographical and cultural variables, variables related to the of tourists' behaviour. Image Identify allows a rich gathering of information on the images stored by tourists on the Social Media. On the collected image datasets, students applied the Image Identify module to perform several tasks such as provide labels on the content images and creating a categorization [57]. In particular, the algorithms that it is possible to use are:

Image Identify [image] that identifies what or who an image represents;

Image Identify [image,category], which limits the identification of image to objects within the specified category;

Image Identify [image,category,n] that gives a list of up to n possible identifications.

Image Identify [image, category,n, "prop"], that gives the specified property for each identification.

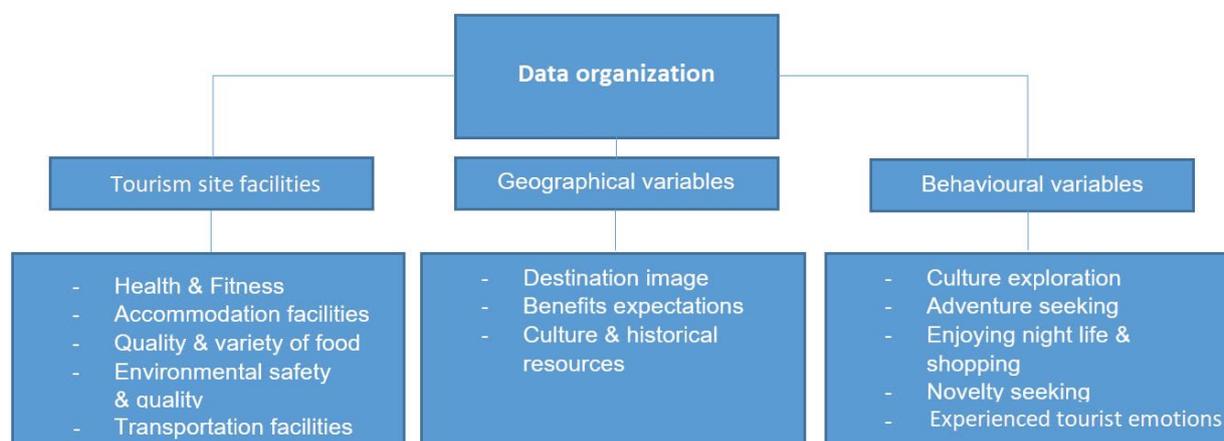


Figure 1: Variables useful to collect social network data.

**Table 2:** Main Wolfram Mathematica functions presented during the course and the related skills obtained by students.

Mathematica functions	Skills acquired by students
Service Connect ["service"]	Ability to connect and be aware of the vast amount of information, services and data that social media and services offer.
Geo Graphics [primitives,options] City Data [name] City Data [name,"property"]	Ability to access and display geo-referenced data in order to create maps with places, monuments, services, facilities, itineraries that are essential in the tourism industry.
Many functions related to Socioeconomic & Demographic Data	Ability to access and display Socioeconomic & Demographic Data
Many functions related to Cultural data	Ability to access and display Cultural data
Machine Learning algorithms for data analysis of customers' behaviour and organizations.	Ability to detecting and extracting features that are useful for organizing data. Using a variety of ML methods, the Wolfram Language allows functions for detecting and extracting features in images and other arrays of data.
Image Identify Facial Expression Find Face Find Objects	Ability to perform several tasks such as provide labels on the content images and creating a categorization. Ability to analyse customers and their images. Ability to analyse customers and their emotional expressions by faces. Ability to analyse objects in the images
Text analysis Sentiment analysis Semantic analysis	Ability to analyse customers and the text they produce. Ability to analyse customers and their emotional expressions by text. Ability to analyse text according to tourism companies' needs.

As far as the expression of emotions in images is concerned, first the Mathematica algorithm finds the face(s) inside the image (Find Face), and then it defines the expressions that are identified with different labels (Facial Expression). It is a pre-trained algorithm that aims at labelling each picture into certain categories. All the pictures are labelled in different categories. Facial Expression module has a built-in classifier that automatically chooses the best algorithm to adopt according to the available models built and trained through a large Wolfram database (Net Neural Repository) to identify the right emotion in an image [52]. Benefits from both text and image analysis include the possibility to understand tourists 'emotional connection with the place or the location they visited. Stakeholders could use this kind of analysis for changing their marketing strategies grounding on people emotional reactions. The above-mentioned Mathematica functions allow achieving specific expertise in selecting data, methods of analysis, and results interpretation to be a successful tourism practitioner. The final table of Mathematica functions acquired and the final skills acquired by students are presented in Table 2.

Society will become increasingly technology-based. In particular, those of Industry 4.0 are radically changing the world of manufacturing and services [58].

Tourism is a pillar sector in the industry of the future. For this reason, it is necessary to think carefully about the skills that these technologies presuppose in order to try to adapt them to tourism students.

The author have a proved scientific track [59], with a proven track record in the field of educational technologies [60-65] and in their application in different fields [66-68] we implemented an educational laboratory based on Industry 4.0 technologies.

## CONCLUSION

In this paper we have reported a summary of an experimentation carried out with such students and we have tried to create an experimental course to start proposing artificial intelligence algorithms, machine learning and big data analytics to students.

It is obviously a first attempt, which however has already given interesting results both in terms of the realizations that students have developed and in terms of knowledge and skills that students have learned.

We plan to continue the experimentation, starting to provide in the future elements of programming languages and other advanced tools for the analysis of Big Data.

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