# New Digital Tendencies for Cities*

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## 1 Introduction

This document summarizes the Master Class that was held for the CARD4ALL transfer network (`https://urbact.eu/card4all`), via the `zoom` video conferencing system, at 3rd December of 2020. The main topic was "New Digital Tendencies for Cities". Firstly, the presentation assumed initial holistic view of several digital concepts, listing and describing briefly a total of 15 digital trends. Then, the class was followed by the discussion of several real-world application examples, including some researched by the presenter. The Master Class ended with some questions and answers.

This document is organized as follows. Section 2 briefly details the 15 digital trends that can have a potential positive impact on cities. Section 3 presents examples of recent real-world applications that use digital technologies within urban areas. Finally, Section 4 provides a list of some useful links that were used to support the discussed topics.

## 2 Digital Tendencies

The list of presented digital topics was:

1. Information and Communication Technology (ICT);
2. Telecommunications;

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3. Big Data;
4. Computational Power;
5. Algorithms;
6. Artificial Intelligence (AI);
7. Collective Intelligence;
8. Digital Transformation;
9. Digital Twin;
10. Digital Identity;
11. Blockchain;
12. Augmented Reality;
13. Gamification;
14. Smart Cities; and
15. Smart Mobility.

**ICT** is a scientific and technological area that includes the study and development of computational devices, networking components, software and systems that allow people to interact with the digital world (`https://searchcio.techtarget.com/definition/ICT-information-and-communications-technology-or-technologies`). Due to advances in ICT, nowadays it is easy to collect, store, share and process data. Indeed, there has been a rise of (Darwiche, 2018): **telecommunications**, including Internet-of-Things (IoT) and 5G; **big data**; **computational power**; and sophisticated **algorithms** for fitting data (e.g., Deep Learning). These phenomena have increased the power and widespread usage of **AI**, which can be defined as intelligence demonstrated by machines (Russell and Norvig, 2010). AI includes many subfields. In particular, Machine Learning (ML) can be used to generate data-driven prediction models (Alpaydin, 2020), while Modern Optimization, also known as Metaheuristics, can be used to perform prescriptive analytics (Cortez, 2014). On the other hand, **Collective Intelligence** (or Crowd Sourcing), uses an aggregation of individual human responses and it is valuable to solve several complex real-world tasks (e.g., via Amazon Mechanical Turk service, `https://www.mturk.com/`).

ICT (e.g., IoT, Big Data, AI) is adopted in **Digital Transformation** processes, which involves the digitalization of diverse aspects of the physical world (e.g., objects, people, organizations) (Matt et al., 2015). In particular, **Digital Twins** (`https://www.networkworld.com/article/3280225/what-is-digital-twin-technology-and-why-it-matters.html`) assume that a physical object can be modeled by a computer program, allowing to perform computational simulations of how the physical object would be affected by changing some selected control parameters (Schleich et al., 2017). Another relevant Digital Transformation aspect is related with **Digital Identity**, which can assume multiple forms (e.g., digital cards, passwords and other biometrics, `https://www.forbes.com/sites/forbestechcouncil/2020/03/16/the-future-of-identity-looking-ahead-to-the-2020s/?sh=482475a13ecc`. **Blockchain** is a recent ICT (Nofer et al., 2017) that can provide a secure, transparent and traceable recording of digital transactions (including digital identifications and digital cards). Moreover, the usage of digital cards can be enhanced by using **Augmented Reality** (e.g., when visiting a museum), which combines real and 3D virtual worlds (Carmigniani et al., 2011). Also, the adoption of digital cards can be increased by using **Gamification** strategies (e.g., points, badges, discounts, see `https://www.gamify.com/what-is-gamification`).

The application of ICT to urban areas allows the development of **Smart Cities**. The goal of a Smart City is to use ICT to make an improved and more efficient use of the city networks and services, benefiting its citizens and businesses. Some relevant Smart Cities themes are (Ismagilova et al., 2019):

- **Smart Mobility** - improving urban traffic and transportation systems;
- **Smart Living** - improving quality of life, health and safety;
- **Smart Environment** - making a better usage of natural resources (e.g., water);
- **Smart Citizens** - enhancing the engagement and social interactions of the citizens;
- **Smart Government** - supporting the definition of strategies and policies that improve public services;
- **Smart Economy** - promoting the city businesses and increasing its economy.

All previously mentioned ICT topics (e.g, IoT, Big Data, AI, Augmented Reality) can be used to build **Smart Cities**. As

for future trends in this area, the famous Gartner group published in August 2020 a list of interesting digital technologies for **Smart Cities** (`https://www.gartner.com/en/documents/3988437/hype-cycle-for-smart-city-technologies-and-solutions-202`), which includes: Artificial General Intelligence, Citizen and Government Twins, Smart Buildings, Smart City as a Service, Blockchain, IoT, 5G, Vehicle-to-Vehicle Communications, Digital Security and City Operations Center.

# 3 Application Examples

There is a vast amount of real-world examples of applications of ICT in urban environments. For instance, Ismagilova et al. (2019) review several research studies involving Smart City applications. This section presents some recent examples that were selected by the author of this document, aiming to demonstrate specific usages of digital technologies for cities.

The `deepindex` (`https://deepindex.org`) website provides a list with more than eight hundred AI applications, grouped into several categories (e.g., "Government & Nonprofit", "Transport"). A few examples retrieved from the website and that are linked with the concept of Smart Cities are:

- help cities to get feedback from their residents (usage of Big Data and AI; `https://zencity.io`);
- suggest ways to reduce pollution (IoT, Big Data and AI; `https://www.ambiencedata.com`); and
- predict parking availability (Big Data, AI and Collective Intelligence; `https://ai.googleblog.com/2017/02/using-machine-learning-to-predict.html`).

The Special Section of Latin America region of the *Communications of the ACM* journal (11/2020, Vol. 63, No 11) includes two interesting articles, namely:

- Kon et al. (2020) present three Smart Cities applications: a real-time Bus dashboard (Big Data, ML), a bike cycling tool for mobility flows (Big Data) and a beacon network for tourists (IoT).
- Milano et al. (2020) describe the technological approach used in Uruguay to handle the COVID-19 pandemic (Big Data, Telecommunications).

Also, the *Wired* magazine contains an interesting article about the social credit system adopted in China (https://www.wired.co.uk/article/china-social-credit-system-explained).

A few research works that involved the author of this document were also presented at the Master Class. Afsar et al. (2018) proposed a ML method to automatically predict human trajectory destinations from video. In another similar application, Nova et al. (2018) developed another ML system to detect violent behavior from video images. A different research was conducted by Zola et al. (2020), where a ML algorithm used only historical tweets to detect the implicit city-level location of a Twitter user. The ML method works by matching written nouns (from the tweets) with popular city-level Google searches (via Google Trends service). As for the theme of Smart Mobility, Fernandes et al. (2020) employed a Modern Optimization approach to perform a electric scooter rebalancing. Several computational experiments were held by using data from a real electric scooter service from the city of Barcelona, Spain.

# 4 List of some useful links

Additional information about the lectured topics can be found at:

- https://urbact.eu/card4all - CARD4ALL transfer network;
- https://searchcio.techtarget.com/definition/ICT-information-and-communications-technology-or-technologies - definition of ICT;
- https://www.mturk.com/ - Amazon Mechanical Turk service;
- https://www.networkworld.com/article/3280225/what-is-digital-twin-technology-and-why-it-matters.html - digital twins article;
- https://www.forbes.com/sites/forbestechcouncil/2020/03/16/the-future-of-identity-looking-ahead-to-the-2020s/?sh=482475a13ecc - digital identity article;
- https://www.gamify.com/what-is-gamification - definition of Gamification;
- https://www.gartner.com/en/documents/3988437/hype-cycle-for-smart-city-technologies-and-solutions-202 - Gartner hyper cycle of digital trends for smart cities;

- https://deepindex.org - large list of real-world AI applications;
- https://zencity.io - zencity website;
- https://www.ambiencedata.com - Ambience Data website;
- https://ai.googleblog.com/2017/02/using-machine-learning-to-predict.html - predicting vehicle park availability application;
- https://www.gub.uy/ministerio-salud-publica/coronavirus - Uruguay platform to handle COVID-19;
- https://interscity.org - InterSCity project;
- https://www.wired.co.uk/article/china-social-credit-system-explained - article about the social credit system used in China;
- https://trends.google.com/trends/ - Google Trends service; and
- http://algoritmi.uminho.pt/ts-cities/ - ALGORITMI R&D Center Thematic Strand of "Smart Cities and People".

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