FONDAZIONE BRUNO KESSLER
MAGAZINE

Deep Gravity: the algorithm that explains how people travel

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Fondazione Bruno Kessler, with the CNR Institute of Science and Information Technologies and the Argonne National Laboratory in the U.S., has developed an artificial intelligence-based algorithm, capable of predicting and explaining mobility flows in detail. The study has been published in Nature Communications

The traditional model used for the **prediction of mobility flows**, both on foot and with vehicles, is called “gravitational”. Inspired by Isaac Newton’s law of universal gravitation, it establishes that the flow of mobility between two places, for example two neighborhoods in a city, is proportional to their population and inversely proportional to their geographical distance.

In practice, the gravitational model is often inaccurate because it is based on only two variables, distance and population, and is unable to capture complex relationships between them.

Fondazione Bruno Kessler together with the Institute of Science and Information Technologies of the National Research Council (Cnr-Isti) and the Argonne National Laboratory in the U:S., has developed “Deep Gravity”, an algorithm that adds to the gravitational model two fundamental ingredients, namely: the use of different variables that describe the points of interest in a place such as restaurants, hotels, hospitals and streets, and the ability to capture complex relationships between these variables thanks to the use of deep learning.

“Experiments conducted in three countries (Italy, England and New York State) have shown that **Deep Gravity** is able to **predict flows** with an accuracy that is **up to a thousand times better** than that of the gravitational model,” says **Luca Pappalardo** from **Cnr-Isti** and lead author of the paper. The use of “Explainable AI” techniques allowed scientists to understand the motivations behind the movement flows between areas in the three countries under analysis.

Unlike what predicted by the gravitational model, the **variables** that guide travel vary between countries and also within them, and distance and population are not always the most important. “For example, places with large numbers of food, retail sales and industrial facilities attract more commuters than places with health and commercial points of interest. Furthermore, the reasons for

travel between two locations is not symmetrical: the points of interest that prompt travel from place A to place B are not necessarily the same ones that prompt travel from B to A", Pappalardo added. "This study is an important step towards explaining complex phenomena such as human mobility with relevant practical implications such as the calculation of the probability of spread for an epidemic, such as Covid-19, based on the points of interest in a local area".

This algorithm could also provide useful information to policy makers. "Knowing the reasons behind travel between two locations can help to understand why a place is attractive, and in case a lockdown were needed, to impose closures that would take into account the specificity of flows in a local area", concluded **Massimiliano Luca**, a PhD student at the University of Bolzano and a researcher with **Fondazione Bruno Kessler**.

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