University of Chicago—Tel Aviv University Workshop on Cities and Urbanism

City Center—Research Center for Cities and Urbanism, Tel Aviv University

April 7-9 2019

The 21st century started as the age of cities: for the first time in human history more than half of world population lives in cities and the process is still on. The implication is that every aspect of human life is becoming associated with urban life and the dynamic of cities. Understanding cities is thus a key to the understanding of society at large. The *Mansueto Institute for Urban Innovation* at the University of Chicago aims to face this challenging reality by bringing together "researchers … from the social, natural, and computational sciences, along with the humanities." In a similar way the *City Center*—**TAU Research Center for Cities and Urbanism** attempts to face the age of cities by bringing "… together the many TAU researchers – faculty members, graduate and postgraduate researchers – who study various aspects of cities and urbanism." A link between the many facets of cities, as well as between urban realities in different parts of the world thus seems to be essential at this stage. This is indeed the motivation behind the "*The University of Chicago—Tel Aviv University Workshop on Cities and Urbanism*": to explore the potential of, and lay the foundations for, research collaboration between urban researchers at the two universities.

We consider this workshop as a first step toward such an exploration and collaboration. We focus on five major aspects of current urbanism: *Social inequality, Justice and the city*—a topic that stands at the center of urban studies since the middle of the 20th century; *Complexity, scaling and the city*—referring to the emergence in the last three decades of complexity theories of cities and the very recent allometric perspective on cities; *Big-data, AoT, IoT and the city*—a research domain that following the so-called "4th industrial revolution" might fundamentally alter the structure of our cities, the way we live and work in them, and the ways people in cities relate to one another; *Cognition and the city*—a new research domain that seeks insight for people's behavior in the city from recent findings in cognitive and brain sciences; *Migration and the city*—an old-new urban process that today, in the age of globalization and smart technology, is already transforming the structure and nature of cities and societies around the world.

City Center—TAU Research Center for Cities and Urbanism
Chicago-TAU Workshop

Sunday April 7, 2019	**Yad Avner Building, room 120**

13.30-14.00 **Gathering**

Opening session | Chair: Juval Portugali

Greetings
14.00-14.30 **Prof. Joseph Klafter, President of Tel Aviv University**

Overviews
14.30-15.00 **Luis Bettencourt:** Towards a science of cities
15.00-15.30 **Charlie Catlett:** Software-defined sensors and virtual sensing instruments
15.30-16.00 **Juval Portugali:** Snow's pendulum and the city

16.00-16.30 Break

Complexity, scaling and the city | Chair: Ronit Purian
16.30-17.00 **Luis Bettencourt:** Complexity, scaling and development in cities
17.00-17.30 **Shlomo Havlin:** Resilience of interdependent urban infrastructures
17.30-18.00 **David Burg, Nir Kaplan & Itzhak Omer:** Scaling of cities in Israel?
18.00-18.30 **Hermann Haken, Guy Moshe Ross & Juval Portugali:** The cognitive dimension of urban allometry

20.30 Dinner

Monday April 8, 2019	**Morning: Sackler Faculty of Medicine, room 100**

09.00-09.30 **Gathering**

Social inequality, justice and the city | Chair: Tovi Fenster
09.30-10.00 **Kate Cagney:** Activity space, neighborhood context and health in later life
10.00-10.30 **Michal Tzur:** Effective and equitable logistics
10.30-11.00 **Talia Margalit:** Israeli planning in the media: New discourse, old borders
11.00-11.30 **Ronit Purian, Nir Kaplan & Itzhak Omer:** The spatial shape of social segregation: Everything is related but near things are more *separated*

11.30-12.00 Break

Big data, AoT, IoT and the city | Chair: Irad Ben-Gal
12.00-12.30 **Charlie Catlett:** Using computation and new sources of data to understand cities
12.30-13.00 **Itzhak Benenson and Eran Ben-Elia:** Public transport in a Smart City: Are commuters endangered species?
13.00-13.30 **Efrat Blumenfeld-Lieberthal, Nimrod Serok, Orr Levy & Shlomo Havlin:** Unveiling the inter-relations between the urban streets network and its dynamic traffic flows
13.30-14.00 **Tal Raviv:** New trends in city logistic – small parcel delivery

14.00-15.00 Lunch

◉ City Center—TAU Research Center for Cities and Urbanism
Chicago-TAU Workshop

◉ Monday April 8, 2019	**Afternoon: Yad Avner Building, room 120**

Cognition and the city | Chair: Matti Mintz

15.00-15.30   **Marc Berman & Kate Schertz:** The benefits of urban greenspace for cognition and behavior

15.30-16.00   **David Eilam:** Animals, humans, homes, and cities

16.00-16.30   **Asaf Degani, Ronit Purian & Yael Shmueli:** Rules and policies that govern automated vehicle behavior

16.30-17.00   **Adva Sahar, Itzhak Omer & Juval Portugali:** Cognitive mapping and the free-energy principle

17.00-17.30 Break

Migration and the city | Chair: Noah Lewin-Epstein

17.30-18.00   **Daniel Zuend:** From population dynamics to Zipf's law

18.00-18.30   **Gilles Benguigui and Idan Porat:** Migration and networks

18.30-19.00   **Miri Yemini:** Mobile nationalism: Mobility, parenting and belonging

19.00-19.30   **Yossi Harpaz:** Citizenship 2.0: Dual nationality as a global asset

| *Concluding notes*	19.30-19.40 **Luis Bettencourt**. 19.40-19.50 **Charlie Catlett** 19.50-20.00 **Juval Portugali**

◉ Tuesday April 9, 2019	Trip

The roots of urbanization	**Tel Megiddo** – early urbanization; **Shorashim** –Alexander's design; and more

The conference is held with the support of

Tel Aviv University

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CODATA, Committee on Data
of the International Council for Science (ICSU)
Task Group "Data Integration & Data Science for
Urban Life and Smart Cities"
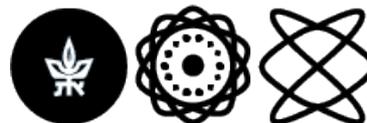
Participants

From The University of Chicago

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Abstracts

Towards a Science of Cities

Luis Bettencourt

There is presently much enthusiasm worldwide about new approaches to studying cities and urbanization, which may yield new practical approaches to planning and policy but also fundamental new insights on the human condition in urban environments. I will present an overview of our efforts at the University of Chicago, with an emphasis on several articulated research themes, which I believe will yield over time an integrated and multidisciplinary science of cities. I will also highlight some of our approach to education and training and opportunities for international collaboration.

Software-Defined Sensors and Virtual Sensing Instruments

Charlie Catlett

New urban sensing projects like the Array of Things (AoT) are producing tens of millions of new time series observations daily—from meteorology data, to air quality data from experimental sensors, to data produced by machine learning (ML) algorithms (e.g., pedestrians or vehicle flow, cloud cover, flooding), and others such as sound, vibration, and light. Remotely programmable high-performance computing hardware collocated with the AoT sensors enables not only in-situ data analytics such as using ML algorithms to extract information from images, but indeed sensors that can respond to local conditions, changing their sampling rates or algorithms: software defined sensors. AoT is one of many emerging data sources, including rapidly expanding "crowdsourced" data sources leveraging improvements in sensor technologies. Collectively these represent an opportunity to construct "virtual" sensing instruments (VSI) using spatial data analytics and ML techniques to enable convergent science investigations that span multiple specific instruments, scales, and geographies.

Snow's Pendulum and the City

Juval Portugali

In 1851, Jean Bernard *Léon Foucault* , a French physicist, conducted an experimental demonstration of the rotation of the Earth on its axis, by means of a pendulum suspended from the roof of the *Panteon* in Paris. This was *the 1st Foucault pendulum.* *The 2nd Foucault pendulum* is the title of Umberto Eco's wise and amusing book in which the story moves back and forth, like a pendulum, between attempts to understand the world by means of Kabbalah, alchemy and other esoteric sources, to attempts to understand it by means of science. By "science" Umberto Eco refers to what in Hebrew as in several other languages is termed "human <u>sciences</u>" (e.g. *sciences humaines* in French), while in English, *humanities* without the "science". In Hebrew French and other languages the notions 'science' and 'human' thus form two aspect of a single entity, In Snow's (1964) *Two Cultures,* they form two poles with an unbridgeable gap between them. In this talk I show that the study of cities in the last 100 years moves, like a pendulum, between two polar *cultures of cities*: An intellectual, social theory oriented, urban culture that approaches cities by means of hermeneutics, and a quantitative-analytic culture that attempts to transform the study of cities into a science. While during most of the 20th century the gap between the two cultures of cities was, to use Snow's words, "unbridgeable", the appearance of *complexity theories of cities* some three decades ago created a potential for a genuine integration of the two cultures of cities. In this talk I'll elaborate on this potential, explore why so far it was only partly realized, and the prospects to realize this potential in full.

Complexity, Scaling and Development in Cities

Luis Bettencourt

In this talk, I hope to demonstrate the development of a number of new fundamental perspectives on the processes that create, sustain, and lead to growth in cities. I will introduce several of the general empirical properties of cities, and discuss urban scaling theory and its recent development in terms of statistical mechanics as an integrated body of theory and modeling that allows us to make sense – in integrated and predictive ways – of many different facets of urban data. I will also demonstrate along the way how, although sharing some properties with other complex systems, cities present a set of unique and novel properties that must be conceptualized and modelled in their own right.

Resilience of Interdependent Urban Infrastructures

Shlomo Havlin

Network science has been focused on the properties of a single isolated network that does not interact or depend on other networks. In reality, many real networks such as power grid, transportation and communication infrastructures interact and depend on each other. I will present a mathematical framework for studying the vulnerability of interacting networks. In interdependent networks, when nodes in one network fail, they cause dependent nodes in other networks to also fail. This may lead to a cascade of failures and to a sudden fragmentation of the system. I will present analytical solutions for the critical threshold and the giant component of a network of n interdependent networks. I will show that the general theory has many novel features that are not present in the classical network theory. I will also show that interdependent networks embedded in space are significantly more vulnerable compared to random networks.

S. Buldyrev, R. Parshani, G. Paul, H.E. Stanley, S. Havlin, Nature, 465, 0893 (2010).
J. Gao, S. Buldyrev, H. E. Stanley, S. Havlin, Nature Physics, 8, 40 (2012).
A Majdandzic et al, Nature Physics 10 (1), 34 (2014); Nature Comm. 7, 10850 (2016).
Daqing Li at al, PNAS 112, 669 (2015).
N. Serok et al, EPP (2019).
M. Danziger et al, Nature Physics, 15, 178 (2019)

Scaling of Cities in Israel?

David Burg, Nir Kaplan & Itzhak Omer

During the last decade, urban research has witnessed an explosion of research tracking macroscopic social quantities in order to generate a "large picture" of urban dynamics. Bettencourt et al. have developed a mathematical framework to describe the fundamental invariant dynamics of cities, where variables of infrastructure are sublinear while socioeconomic determinants exhibit superlinear patterns, increasing exponentially as a function of the size of the city. This has been shown to be consistent with empirical data for megacities globally. We characterize the urban system in Israel and calibrate the power-law scaling model with large datasets to include multiple indicators. Generally, infrastructures like roads and gas stations exhibit sublinear dynamics ($0.60<exp<0.95$). On the other hand, socioeconomic such as wages, energy, businesses and taxation, are superlinear ($1.05<exp<1.15$) as are negative aspects of social interaction - traffic accidents, crime and deaths ($1.15<exp<1.42$). Cities here exhibit allometric patterns with scaling parameter values consistent with those published elsewhere, however, there are important peculiarities displayed by cities in Israel. It is concluded that urban scale invariance is conserved even in a small and densely populated system. Israel constitutes a unique case for implementing applied mathematical modeling in urban studies.

The Cognitive Dimension of Urban Allometry

Hermann Haken, Guy Moshe Ross & Juval Portugali

Three recent studies examine the scaling law of cities from a cognitive perspective: The first, (Portugali and Haken) approaches the issue by means of the complexity theory of synergetics and its two theoretical extensions SIRN (synergetic inter-representation nets), IA (information adaptation) and their conjunction. It elaborates on the interplay between urban agents' information adaptation activities, urban fluctuations and the city's evolutionary dynamics, and the implication thereof for the emergence of several forms of urban scaling laws. The second study (Ross and Portugali 2018) approaches urban scaling from psychologist's Higgins' (1997) *Regulatory Focus Theory* regarding humans' motivational and behavioral tendencies. By means of several laboratory experiments, this study demonstrates that urban context of large, fast-paced cities and that of small slow-paced cities encourage two distinctively different motivations and behaviors on the part of their inhabitants. The third paper (Haken and Portugali) integrates the above two, demonstrating the circularly causal interrelationship between the motivational-behavioral tendencies of urban agents and the dynamics of cities as complex, adaptive, self-organization systems. It demonstrates how the encouraged motivation of the urban agents (second paper) participates in the dynamic of the complex system city (first paper), intensifying its fast-paced dynamics, that then further reinforces and strengthens the agents' motivational-behavioral pattern, and so on in circular causality.

Activity Space, Neighborhood Context and Health in Later Life

Kate Cagney

This paper describes initial data collection for the Chicago Health and Activity Space in Real Time (CHART) study, which employs innovative smartphone-based methods for the identification of older adults' activity spaces (i.e., locations of routine activities in daily life). We report analyses from 450 community-residing older adults from ten Chicago neighborhoods who carried smartphones for GPS tracking and ecological momentary assessments over seven days. We use these data to assess, for instance, how the span, characteristics, and experiences of activity spaces vary across socioeconomic status and racial/ethnic groups. We also illustrate the utility of linking these data to Chicago-based sensor data. A central goal of this research program is to describe the social and spatial environments in which older adults spend their time (e.g., households, neighborhoods, networks) and how this activity space influences health trajectories and may be an unexplored source of inequalities in health.

Israeli Planning in the Media: New Discourse, Old Borders

Talia Margalit

The current phenomenon of urban real-estate development in Israel is vibrant, with a growing variety of large, medium, and small planning schemes and ventures underway, alongside bourgeoning discussions in mushrooming real-estate newspaper sections and news portals. Many actors are now involved in actual ventures and investments: with rising land values and various ambitious government housing plans, not only developers but also 'ordinary' people now engage in real-estate undertakings. As my preliminary results reveal, this evolution feeds the emerging coverage of planning issues in Israeli newspapers. Topics covered by Israeli newspapers\ news portals relate, for example, to property and profits, as well as to building rights and housing prices; they also relate to the uncertainties and conflicts between actors; and even to meaningful redistribution and recognition problems in Israeli society. Notably, this coverage often question accepted planning norms and

existing citizen-government relations. Moreover, it promotes planning democratization simply through unofficial daily discussions of such issues. But do the media challenge old boundaries existing in Israeli planning between people, groups or locations?

The Spatial Shape of Social Segregation: Everything is Related but Near Things are More *Separated*

Ronit Purian, Nir Kaplan & Itzhak Omer

A great deal of pragmatic and ethical value can be gained by just taking the viewpoint of the person on the street. After all, we are physical creatures, designed to live and behave on earth and in nature. The insights already gained by this perspective, either directly or indirectly, are formalized in theories and methods such as embodied cognition, space syntax, and more. In this work we extend paradigms and deepen the investigation into ways in which the spatial configuration of the urban environment is immanently related to the perception, cognitive representation and the behavior within it; as pedestrians, residents, investors, real estate entrepreneurs, and decision makers that evaluate and decide where to walk, navigate, reside and live. Specifically, we show the impact of spatial separation and physical barriers on socio-economic patterns. While previous works elaborated on the connectivity of road networks that promoted socioeconomic integration over time, we tackle spatial separation that captures extreme segregation and evidently exceeds socioeconomic integration.

The findings from the study about social residential segregation and elements of spatial configuration reveal the explanatory power of separation measures compared to centrality, one of the most acknowledged factors in urban studies and networks theories.

Using Computation and New Sources of Data to Understand Cities

Charlie Catlett

There is a growing science community, spanning nearly every discipline, pursuing research related to the growth and operation of cities. With input from scientists, policymakers, and residents of Chicago, Argonne National Laboratory and the University of Chicago created the Array of Things (AoT)—a new form of urban measurement system implemented in partnership with the City of Chicago. AoT provides data with greater spatial and temporal resolution than is currently available for understanding air quality, microclimate, vibration, noise, and other factors, providing measurements at 30 second intervals from hundreds of locations throughout the city. AoT devices include embedded and remotely programmable artificial intelligence capabilities to process images, sound, vibration, and other data in situ, creating measurements that cannot be obtained from standard sensor networks—from the flow of people through a public space to the impact of at-grade rail crossings on emergency response.

Public Transport in Smart City: Are Commuters Endangered Species

Itzhak Benenson (TAU) and Eran Ben-Elia (BGU)

Public Transit (PT) networks remain stable for years, while travelers' behavior changes constantly both over space and in time, inducing patterns that are difficult to predict and serve by PT. This discrepancy can result in the bifurcation of travelers' mode choice. Travelers with no access to private cars become captives of PT, regardless of the PT's level-of-service, while the rest use the car almost exclusively. This is the essence of the "PT is for commuters" hypothesis. To verify this hypothesis, we analyze Israeli PT smartcard transactions of boarding records. Our analysis refutes the "PT is for

commuters" hypothesis. Several weighty facts bring us to assert that Israeli PT users are quite flexible in their mode choice.

For example:

- More than a quarter of smartcard owners board PT once a day only.
- The share of users who use PT 1 or 2 days a week is almost 50%.
- Half of the PT users board less than 15 times during 20 working days of the month.

We thus assert that at least a quarter of Israeli PT users are multi-mode travelers. These travelers plan most of their daily trips each time anew and their behavioral adaptation is an excellent starting point for the future MaaS services.

Unveiling the Inter-Relations Between the Urban Streets Network and Its Dynamic Traffic Flows

Efrat Blumenfeld-Lieberthal, Nimrod Serok, Orr Levy & Shlomo Havlin

Traffic flows have always been one of the major elements affecting the nature of urban streets. Traffic flows influence the location of businesses, residence, and the development of real estate, land values, and built-density. In this study, we suggest that revealing the relations between the static streets-network and the dynamic traffic-flows may provide meaningful and useful insights that could be applied in planning processes. Thus, the objective of this work is to unveil the inter-relations between the dynamics of traffic flows and the urban streets-network in different areas of a city and between cities. We use network percolation analysis (i.e. removal of links with a speed value lower than a predefined threshold) to develop an innovative method to identify functional spatio-temporal streets clusters that represent fluent traffic flow. We employed our method on two datasets of London and Tel Aviv centers and analyzed the dynamics of these clusters, based on their size (in terms of street length) and their spatial stability over time. Our findings revealed both the differences between the two cities as well as differences and similarities between different areas within each city. Thus, our method can be used to develop new, real-time, decision-making tools for urban and transportation planners. Today, new technologies provide big data on urban traffic flow, which can be used in developing new, adaptive tools for planning. However, urban and transportation planning are currently being challenged by real-time navigation apps that aim to find the fastest routes for their users. To be able to intervene and affect urban life quality, planners should adopt new tools that are based on real-time, short-term approaches. These will bridge the gap between static long-term urban planning and the flexible and dynamics urban rhythm and will enable planners to keep their role in the formation of better cities.

The Benefits of Urban Greenspace for Cognition and Behavior

Marc Berman & Kate Schertz

Urban greenspaces provide important psychological benefits for city residents. For example, urban greenspace has been shown to influence self-control and aggression, which have been related to crime levels. In a recent study, we found that active engagement with nature, through park visits, is associated with less violent and non-violent crime, whereas local tree canopy (which provides passive engagement with natural elements) is associated with less non-violent crime. These effects are not explained by social cohesion, which is associated with independent effects on crime levels. One possible mechanism for the effects of park visits on crime levels is suggested by attention restoration theory (ART). ART posits that directed attention networks are fatigued by numerous, fast-changing stimuli found in urban environments, and that nature provides a restorative environment which allows

these networks a chance to recover. Here we discuss one possible mechanism through which this occurs – the perception of the low-level features (e.g., edge density) of natural environments. Previous studies have demonstrated that low-level features can be used to predict naturalness and preference. We present a study showing that these features can also influence higher level cognitive functions, for example thought content. It was found that urban parks provide a location that allow for reflective, restorative thinking, with parks that have a high amount of non-straight edges in particular influencing thoughts about spirituality and one's life journey. Taken together, these sets of studies support the idea that urban greenspace has potential as a public health tool, providing psychological benefits to both individuals and communities as a whole.

Animals, Humans, Homes, and Cities

David Eilam

This survey presents similarities in travel paths and spatial behavior of animals and humans, suggesting that these constitute an expression of similar underlying biobehavioral mechanisms. Both animals and humans organize spatial behavior in reference to a 'home base' with functional partitioning into space for living, storage, toilets and other defined activities or services. This place is where a set of behaviors are performed at rates higher than anywhere else. In rats, home is defined by sleeping, long stays, food hoarding and parental behavior. Spatiotemporal behavior in the living environment is organized in relation to the home. Indeed, home is a hub for activity, with both humans and non-humans taking trips out from and back to their home, traveling regularly along the same paths and usually stopping at the same locations along them. When encountering an unfamiliar environment, both animals and humans undergo similar phases in order to establish a mental representation of the environment. This starts with a gradual sector-by-sector exploration, and culminates in free traveling, which is mainly affected by the physical and social environments. Since the behavior of humans and other animals seems to be similarly affected by the physical structure of the environment, we tested rodents in arenas that simulated specific urban layouts (e.g. grid compared with irregular layout), finding that rats display patterns that recall those of humans in respective urban environments. While there are obvious differences between humans and animals, there are many similarities, and by focusing on the latter, it is suggested that animal spatial behavior could provide insights into the way that humans perceive and conceive urban environments, and that spatial cognition in humans, rests on an evolutionary analogy (or even homology).

Cognitive Mapping and the Free-Energy Principle

Adva Sahar, Itzhak Omer & Juval Portugali

In thermodynamics, free energy is a measure for the amount of work that can be extracted from a system at constant temperature and volume. In recent years, free energy has been developed in the context of neuroscience and brain research, most notably by Karl J. Friston and rephrased as a principle for brain function, perception, cognition and more. Not free from criticism and debate, the free energy principle, as it appears in current discourse, may be relevant to theories of cognitive mapping and spatial knowledge, as discussed in the field of cognitive geography. We hereby suggest an initial integration of active inference and model evidence, as applied by the free energy principle, with cognitive and behavioral geography. We will reassess some issues in cognitive mapping and spatial behavior in free energy framework. Rising from common terms such as information, entropy and surprise, we will suggest interfaces between the theories as insights into exploration and the organization of spatial knowledge, as well as the impact of the spatial configuration on learning

processes. Since the free energy principle is a leading theory in neuroscience, we hold that such integration might be of significance for cognitive geographic research, and nevertheless propose an intriguing challenge.

Rules and Policies that Govern Automated Vehicle Behavior
Asaf Degani, Ronit Purian & Yael Shmueli
With the introduction of automated and autonomous vehicles into the road space, comes the question of what should be the driving rules that will govern their conduct on the road. Should a new set of rules be devised, or should automated vehicles behave in accordance with the current traffic laws? Our analysis of some of the current traffic laws and regulation suggests that they do not cover many contingencies and there are a variety of ambiguous situations that are left for drivers on the scene to resolve ad-hoc. Sometimes these situations are resolved in a cooperative way, but in many cultures they unfortunately erode to self-serving and at times aggressive behavior. Naturally, when vehicles are driven by an automated system, resolutions are difficult to establish, and aggressive behavior by automated and autonomous vehicles may not be acceptable by the driving public. Moreover, our analysis suggests that even if current traffic rules are followed verbatim, it will lead to situations of deadlocks and starvation of some vehicles. In this presentation, we shall describe a process for generating driving rules and illustrate it in the context of vehicle-vehicle negotiations in the context of lane changes and vehicle-pedestrian interaction.

From Population Dynamics to Zipf's Law
Daniel Zuend
Zipf's law for urban systems has puzzled urban scholars ever since it has been first formulated. The strong and simple relation of city sizes and their rank is a stunning property and seems to be empirically very robust in many urban systems throughout space and time. Even though there exist different explanations of how this specific urban hierarchy comes into existence, none of them are able to capture the whole picture and are based on rather strong assumptions. We will provide a novel explanation for the appearance of the law and show that Zipf's law is a special kind of solution, when population dynamics fulfill certain properties. When these properties are not fulfilled, the rank-size distribution of cities shows patterns that are often observed in real urban systems, with non-Zipfian distribution on the upper or lower tails. However, if the population dynamics change to meet the necessary properties, these systems will also develop to Zipf's law, as it is the solution with highest entropy.

Migration and Networks
Gilles Benguigui and Idan Porat
We investigate the world migration phenomenon using the network theory. The countries are the nodes of the network and a link exists between two countries if there is population transfer (links) corresponding to emigration. The statistics of the in-degrees and that of the out-degrees are completely different showing that these two components of the phenomenon must be studied separately. From the determination of the in-closeness and that of the out-closeness as well as the cluster coefficient of each node, we are able to propose a structure of the network based of a division into five groups. The two more important are the group which is the reservoir of emigrants with few links between the nodes; and the main receiver of migrants with numerous links between the nodes. It is very likely that this receiver group form a clique when the majority of the nodes form a subnetwork of diameter 2.

Chicago-Tel Aviv Workshop

The Chicago-TAU Workshop will focus on five major aspects of current urbanism:

- *Social inequality and justice*
- *Complexity and scaling*
- *Big data and IoT*
- *Cognition*
- *Migration*

Researchers, students and faculty are invited to join:
- **Sunday, April 7: Afternoon** – Yad Avner Building, room 120
- **Monday, April 8: Morning** – Faculty of Medicine, room 100
- **Monday, April 8: Afternoon** – Yad Avner Building, room 120

סדנת המחקר שיקגו-ת"א

סדנת המחקר שיקגו-ת"א תעסוק בחמישה היבטים חשובים של ערים ועירוניות כיום:

- אלומטריה ומורכבות עירונית
- צדק ושוויון חברתי
- ביג דטה ו-IoT
- קוגניציה
- הגירה

חוקרות וחוקרים, סטודנטים וסגל, מוזמנים:
- **יום ראשון, 7 באפריל: מהצהרים עד הערב** – בניין יד אבנר, חדר 120
- **יום שני, 8 באפריל: מהבוקר עד הצהרים** – הפקולטה לרפואה, חדר 100
- **יום שני, 8 באפריל: מהצהרים עד הערב** – בניין יד אבנר, חדר 120

Location: Yad Avner Building – Geography Dept. is located north to the campus, 10 Zelig Street.
Monday morning – Faculty of Medicine. The road from Medicine to Geography: https://goo.gl/maps/rqBMkRf1jBN2

Mansueto Institute for Urban Innovation at the **University of Chicago** aims to face this challenging reality in cities by bringing together "researchers … from the social, natural, and computational sciences, along with the humanities." In a similar way **City Center—*Research Center for Cities and Urbanism*** at **Tel Aviv University** attempts to face the age of cities by bringing "… together the many TAU researchers – faculty members, graduate and postgraduate researchers – who study various aspects of cities and urbanism."

The *Chicago-TAU Workshop* is a first step toward the collaboration between urban researchers at the two universities.

להיערכות לקראת הסדנה, אנא הקדימו להירשם – טופס ההרשמה באתר: https://urban.tau.ac.il/events/Chicago2019