Hyejin Youn

CONTACT INFORMATION

Northwestern University
Kellogg School of Management — Email: hyejin.youn@kellogg.northwestern.edu
Evanston, IL 60208, USA — Web: http://hyoun.me/

ACADEMIC POSITIONS

Northwestern University, Evanston, IL, USA
Assistant Professor, — Sep 2017 – current
Management & Organizations, Kellogg School of Management
Core faculty, Northwestern Institute on Complex Systems (NICO)

Royal Society for Arts, London, UK
RSA Fellow — Mar 2017 – current

London Mathematical Laboratory, London, UK
External Fellow — Sep 2017 – current

Harvard University, Cambridge, MA, USA
CID Fellow at John F. Kennedy School of Government — Apr 2017 – Sep 2017

Massachusetts Institute of Technology, Cambridge, MA, USA
Media Lab Visiting Scientist — Oct 2016 – Mar 2017

University of Oxford, Oxford, UK
Senior Research Fellow at the Mathematical Institute — Sep 2013 – Sep 2016
James Martin Fellow at Oxford Martin School — Dec 2013 – Nov 2016

Santa Fe Institute, Santa Fe, NM, USA
Research Fellow — Aug 2013 – May 2017
Postdoctral Fellow — Jan 2011 – Aug 2013
Graduate Fellow — Sep 2009 – Dec 2010

EDUCATION

Ph. D. Physics, KAIST (Daejeon, South Korea), February 2011
Thesis topic: Quantifying Collective Dynamics and Emergent Behaviors in Complex Systems
Advisor: Hawoong Jeong
M. S. Physics, KAIST (Daejeon, South Korea), February 2006
Exchange program at Royal Institute of Technology, Sweden, 2003–2004
B. S. Physics, KAIST (Daejeon, South Korea), February 2003

RESEARCH INTERESTS

Innovation and technological change
Urban scaling and dynamics (economic diversity, energy consumption, human mobility)
Historical and computational linguistics (language universality, linguistic cognitive space)
Transportation network (traffic in decentralized system)
Network theory (topology and dynamics)

GRANT AND CONSULTING

Co-PI "the Structure of Technology"
joint with J. McNerney and R. Hausmann (Harvard Kenedy School)
National Science Foundation SciSIP,
Workshop (USA), No. SMA-2034026, $18,271.00 — 2020 – 2021

PI, "Understanding Technological Change from the Map of Capabilities."
joint with Aaron Clauset (University of Colorado at Boulder)
National Science Foundation SciSIP,
EAGER (USA), No. SMA-1312294, $152,500 — 2013 – 2017

Consultant, Merck KGaA, Germany — Sep 2015

Co-PI, "Understanding Urban Energy Consumption in UK"
REU mentor for Kevin Carlson under the NSF Grant No. 1005075 — 2011 – 2011

PI, "Quantifying Complex Systems",
National Research Foundation (Korea) ca. $10,000 — 2009 – 2010

PUBLICATIONS **Peer-reviewed**

(1) Inho Hong, Morgan R. Frank, Iyad Rahwan, Woosung Jung, Hyejin Youn "The universal pathway to innovative urban economies" *Science Advances* **6** (34) eaba4934.

(2) Hyejin Youn, Sutton, Eric Smith, Bill Croft, Jon Wilkins, Tanmoy Bhattacharya, Ian Maddieson, Cris Moore "On universal structure of human lexical semantics", *Proc. Natl. Acad. Sci USA* **113** (7) 1766–1771.

(3) Hyejin Youn, José Lobo, Luís M.A. Bettencourt, Debora Strumsky "Invention as a combinatorial process: Evidence from U.S. Patents", *J. R. Soc. Interface* **12** 20150272.

(4) Deryc Painter, Frank van der Wouden, Manfred Laubichler, Hyejin Youn "Quantifying Simultaneous innovations in Evolutionary Medicine" *Theory in Biosciences* **139** (4), 319-335.

(5) Morgan R. Frank et al. "Toward understanding the impact of artificial intelligence on labor" *Proc. Natl. Acad. Sci USA* **116** (14) 6531–6539.

(6) Morgan R. Frank, Lijun Sun, Manuel Cebrian, HyeJin Youn, Iyad Rahwan, "Small cities face greater impact from automation", *J. R. Soc. Interface* **15** 20170946.

(7) Minjin Lee, Hugo Barbosa, Hyejin Youn, Gourab Ghoshal, Petter Holme, "Urban socioeconomic patterns revealed through morphology of travel routes", *Nature Communications* **8** 2229.

(8) Daniel Kim, Dan Cerigo, Hawoong Jeong, Hyejin Youn, "Technological novelty profile and invention's future impact", *EPJ Data Science* 2016 **5**:8.

(9) Hyejin Youn, José Lobo, Deborah Strumsky, Horacio Samaniego, Geoffrey B. West, Luís M. A. Bettencourt "Scaling and universality in urban economic diversification", *J. R. Soc. Interface* **13**:20150937.

(10) Tanmoy Bhattacharya et al, "Studying language evolution in the age of Big Data", *Journal of Language Evolution* **3** 94–129.

(11) Xue-Mei Cui, Chang No Yoon, Hyejin Youn, Sang Hoon Lee, Jean S. Jung, Seung Kee Han, "Dynamic burstiness of word-occurrence and network modularity in textbook systems", *Physica A: Statistical Mechanics and its Applications* **487**, 103-110.

(12) Paula L.W. Sabloff, Stefan Thurner, Rudolf Hanel, and Hyejin Youn, "Demographics and Democracy: A Network Analysis of Mongolians' Political Cognition," *Journal of Anthropological Research* **73**, no. 4: 617-646.

(13) Marcus Hamilton, José Lobo, Eric Rupley, Hyejin Youn, and Geoffrey B. West "The ecological and evolutionary energetics of hunter-gatherer residential mobility", *Evolutionary Anthropology* **25** 124–132.

(14) Elsa Arcaute, Erez Hatna, Peter Ferguson, Hyejin Youn, Anders Johansson, and Michael Batty, "Constructing cities, deconstructing scaling laws", *J. R. Soc. Interface* **12** 20140745.

(15) Vsevolod Salnikov, Daniel Schien, Hyejin Youn, Renaud Lambiotte, and Michal Gastner "The geography and carbon footprint of mobile phone use in Cote d'Ivoire", *EPJ Data Science* **3** 3.

(16) Luís Bettencourt, Horacio Samaniego, Hyejin Youn "Professional diversity and the productivity of cities", *Scientific Reports* **4** 5393.

(17) Andres Gomez-Lievano, Hyejin Youn, Luís M. A. Bettencourt "The Statistics of Urban Scaling and Their Connection to Zipf's Law" *PLoS ONE* **7(7)** e40393.

(18) Hyejin Youn, Michael T. Gastner, Hawoong Jeong, "Inefficiency in Networks with Multiple Sources and Sinks", *Complex '2009* (USST, Shanghai, China, Feb. 23-25).

(19) Hyejin Youn, Michael T. Gastner, Hawoong Jeong, "The Price of Anarchy in Transportation Networks: Efficiency and Optimality Control", *Phys. Rev. Lett.* **101** 128701.

(20) Hyejin Youn, Fabian Roth, Matthew Silver, Marie-Helene Cloutier, Peter Ittzes, and Hawoong Jeong, "Price of Anarchy on Boston Road Network", *J. Korean Phys. Soc.* **48** 217

Book
43 Visions for complexity *World Scientific* January, 2017
Edited by: Stefan Thurner (ISBN: 9789813206847)

Working Paper
(21) J. Park, M. R Frank, L. Sun, H. Youn, "Industrial Topics in Urban Labor System" arXiv:2009.09799 [cs.SI] *in review*

(22) Luís M. A. Bettencourt, Jose Lobo, Geoffrey B. West, Hyejin Youn "The Hypothesis of Urban Scaling: formalization, implications, and challenges", arXiv: 1301.5919 [physics.soc-ph]

(23) Frank van der Wouden, Hyejin Youn "Impact of geographical distance on acquiring know-how through scientific collaboration" *in resubmit*

(24) Jose Lobo et al. Report submitted to the NSF on the Present State and Future of Urban Science, 2020. Available at SSRN: http://dx.doi.org/10.2139/ssrn.3526940

In Preparation
(25) Hyunuk Kim, Marcus J. Hamilton, Woo-Sung Jung, Hyejin Youn, "Deeply nested structure of mythological traditionsworldwide" *available upon request.*

(26) Hyunuk Kim, Daniel Kim, Young-Ho Eom, and Hyejin Youn, "Quantifying the Stream of Technological Innovation" *available upon request.*

(27) Luís M. A. Bettencourt, Jose Lobo, Geoffrey B. West, Hyejin Youn "The Hypothesis of Urban Scaling: formalization, implications, and challenges", arXiv: 1301.5919 [physics.soc-ph]

Moh Hosseinioun, Hyejin Youn, Ali Tafti "Anchor-based Representation to Predict the Value of Technologies in Different Domains" *in preparation*

Hyejin Youn et al., "paradigm shift in technological innovation" *in preparation*

Hyejin Youn, Panjun Kim, Seungwoo Son, Hawoong Jeong, "Effective Population Density and Its Applications", *in preparation*.

Hyejin Youn, "Paradox of Taxation", *in preparation*

OTHER HONORS & AWARDS

Bridge Grant for Young Researchers of the Complex Systems Society	2021
Northwestern Faculty Recognition List	2020
Northwestern the Provost Faculty Mentoring Program	2020
Northwestern Kellogg Certificate of Impact	2019
London Mathematical Laboratory Fellowship	2017-2020
Royal Society for Arts Fellowship	2017-2020
NSF SciSIP award	2013-2016
D4D (Data for Development) Challenge from Orange (Mobile phone data in Ivory Coast)	2012
Congress Fellowship of XVI International Congress on Mathematical Physics	2009
The Best prize of CYRAM Social Network Analysis competition	2008
Springer Prize for the Best Presentation at APPC10 (The 10th Asia Pacific Physics Conference)	2007
Distinguished Teaching Award, Dept. of Physics	2007
The Best Student of the Year 2001, Dept. of Physics	2001

EDITORIAL WORK

Editorial Board, Academic Editor at *PLOS One*.
Guest Editor, *Energies*, special issue.
Review Editor, *Big Data*, special section of *Frontiers in ICT*.

REFEREE WORKS

Funding Agencies: U.S. National Science Foundation (NSF)
General: Science, PNAS, Nature Communication, Scientific Reports, PLOS One, Journal of the Royal Society Interface
Physics: Physical Review Letter, Physical Review E, Physical A, European Physical Journal B, European Physical Letter, JSTAT
Network Science: Journal of Complex Networks
Social Science: Research Policy, Organization Science, GECON
Computer Science: ICWSM, Socinfo

TEACHING & ADVISING & FUNDING

Advising & Co-advising

Dr. Jaehyuk Park (Postdoc), Inforamtion Science, Indiana University Bloomington.	2020 – 2021
Taehun Kim, Ms in Computer Science, Northwestern University	2019 – 2020
Moh Hosseinioun, PhD in Management Information Systems, UIC	2019 – 2021
Seolmin Yang, PhD in Science and Technology Policy, KAIST	2019 – 2021
Daehyun Kim, PhD in School of Business and Technology Management, KAIST	2019 – 2021
Hee Youn Kwon (Postdoc), PhD in Systems & Entrepreneurial Engineering, UIUC	2018 – 2019
Dr. Frank Van der Wouden, PhD in Economic Geography, UCLA (now in faculty, HKU)	2018 – 2019
Hyunuk Kim, PhD in Industrial and Management Engineering, Postech	2016 – 2019
Inho Hong, PhD in Physics, Postech	2016 – 2018
Minjin Lee, PhD in Energy Science, SKKU	2016 – 2017
Alex McCormick, Undergraduate in Physics, University of Oxford	2015 – 2016
Daniel Burkhardt Cerigo, Undergraduate in Physics, University of Oxford	2015 – 2016
Dr. Daniel Kim, PhD in Physics, KAIST	2016
Dr. Ross Richardson, PhD in Finance, UCL	2016
Kelvin Carlson, NSF-REU, Indiana University	2011

Tutoring

Network Analysis of UK Patent Data (MSc), University of Oxford	2016
Physics and Urban Scaling (Undergraduates), University of Oxford	2014

Lecture

Social Dynamics Network Analysis, Kellogg School of Management at Northwestern	2018-2020
The New England Complex Systems Institute Winter School, Cambridge, MA	2020
The Santa Fe Institute Complex Systems Summer School, Santa Fe, NM	2019
The New England Complex Systems Institute Summer School, Cambridge, MA	2019
KAIST CIFS Research Boot Camp on Innovation and Entrepreneurship, KAIST, Korea	2019
Guest lecture for econometrics, School of Future Strategy, KAIST	June 2016
Guest lecture for scalable cooperation, MIT	Mar 2016
Lecture for high school students at Hertford College, University of Oxford	Oct 2015
Lecture for undergraduate students, the Department of Mathematics and Statistics the University of New Mexico	July 2012

Teaching Assistant

Statistical Mechanics, KAIST (best teaching award in the department)	2005
Thermodynamics, KAIST	2005
General Physics II, KAIST	2004
General Physics I, KAIST	2004

PROFESSIONAL SERVICE

Workshops (Organizer or co-organizer)

the Structure of Technology the Santa Fe Institute, NM
organised with J. McNerney and R. Haussmann — June 14-16 2021

Frontiers of Physics: Push the Envelope of Statistical Physics
APCTP Headquater, Pohang, Korea
organised with W. Jung, S. Son, J. Jo — Dec 12-14, 2016

Building an integrated framework for innovation, organiztions, and society
Caucus session at Academy of Management (AOM), Anaheim, CA, USA
organised with K. Kim — Aug 8, 2016

Networks and technology evolution,
Satellite Workshop at NetSci16, Seoul, Korea
organised with J. McNerney, I. Rahwan, and C. Hidalgo — May 30, 2016

Technological change,
the satellite meeting at the Conference of Complex System (CCS'15)
Arizona State University, USA
organised with J. Alstott, B. Yan, F. Lafond, G. Triulzi — Sep 30, 2015

Theory and practice of innovation: Different perspectives under the same name
University of Oxford, UK
organised with L. Bloom (Oxford) and G. Zanello (Oxford) — Feb 27, 2015

Program Committees

Conference on Complex Systems (CCS)	2017–2021
Annual International Conference on Computational Social Science (IC2S2)	2017–2021
Social Informatics (SocInfo)	2017-2019
International School and Conference on Network Science (NetSci-17)	2017-2019
The International AAAI Conference on Web and Social Media (ICWSM)	2015–2017

Institutional Committees

Northwestern Univeristy, Center for Artificial Intelligent Committee	2020 – 2021
Northwestern Univeristy, Data Science Fellows Program Review Committee	2021
Northwestern Univeristy, MORS Seminar Series Committee	2020
Northwestern Univeristy, MORS Brown Bag Series Committee	2021
Northwestern Univeristy, Kellogg Innovation Speaker Series Committee	2017 – 2021
Northwestern Univeristy, Department Strategy Committee	2019
Northwestern University, Graduate Students, Search Committee	2017 – 2021
University of Oxford, Postdoc Fellow Search Committee	2015
University of Oxford, Research Fellow Search Committee	2014
University of Oxford, Research Fellow Search Committee	2013

MEDIA

NBC News “Manufacturers embrace robots, the perfect pandemic worker” Apr 8, 21
Business Insider “The pandemic could accelerate job automation — here’s how the change would impact cities, the labor force, and inequality” Apr 13, 2021
WIRED “Robots will take jobs from men, the young, and minorities” Jan 24, 2019
Bloomberg “Self-driving cars might kill auto insurance as we know it” Feb 19, 2019
New Scientist “Automation will have a bigger impact on jobs in smaller cities,” May 15 2017
Nature “Languages have common structure,” *Nature* **530**, 133, 2016
The Economist:
“The process of invention: Now and then,” April 25, 2015
“Queuing conundrums,” September 13, 2008
Nature Physics “Innovation Slowdown,” Mark Buchanan, **11**, 2, 2015
MIT Technology Review:
“In these small cities, AI advances could be costly,” Oct 23, 2017
“Data Mining 200 Years of Patent Office Records To Reveal The Nature of Invention,” June 16, 2014
Forbes “The hidden universal rule that helps govern the way businesses grow in a city, ” Feb 10, 2016
Smart Planet “How will our cities grow?” July 27, 2011
NEXT CITY: Science of Cities “When it comes to making money, Big Data reveals cities have a pattern” Jan 29, 2016
National Geographic “Do languages ’think’ alike?” Feb, 2016
QUARTZ “Scientists say the ways humans describe nature transcends culture and geography” Feb 2016
Scientific American “Detours by Design” January, 2009
CIO “The coming IT job apocalypse: Rise of the machines” May 28, 2019
Others: Gizmodo, Phys.org, News and Tribune, Ars technica, SpringerOpen, National Geography, Mathematical Institute at the University of Oxford, News in Santa Fe Institute, Highlights in PNAS, Next City.

KEYNOTE, PLENARY, INVITED, PANEL AND COLLOQUIUM

Artificial Intelligence and the Future of Lawyering and Law Firms
Northwestern University — Jan 28, 2021

The Impact of AI on Innovation (Panel)
Artificial Intelligence at Northwestern University — Jan 6, 2021

Map of Innovation Pathways (Invited)
MIT Media Lab — Dec 2, 2020

Understanding Urban Systems as Complex Systems (Keynote)
Korea Academy of Complexity Studies — Nov 28, 2020

Future of Work at the Human-Technology Frontier (Panel)
NSF workshop on Future of Work — Aug 6, 2020

Restructuring the Physical and Virtual Workspace (Panel)
NSF workshop on Future of Work — July 23, 2020

Future of Work with AI (Invited)
AI Institute at Northwestern University — May 13, 2020

Computational social science in innovation studies (Invited)
University of Chicago — Mar 6, 2020

The 2019 Workshop on Economic Complexity and Development (keynote)
Federal University of Parana - UFPR — Dec 9, 2019

The Conference on Complex Systems 2019 (invited), NTU, Singapore — Oct 1, 2019

Self-organization and complexity in social system (invited)
Satellite meeting of CCS2019, NTU, Singapore — Oct 3, 2019

Complexity of Commerce (invited), Santa Fe Institute ACtioN, San Francisco, CA — Sep 12, 2019

On Universal Structure of Human Lexical Semantics (colloquium)
Johns Hopkins University, CLSP, Whiting School of Enginnering, Baltimore, MD — Sep 9, 2019

Universality in linguistic semantics (keynote), *NetSci 2019*, University of Vermont — May 31, 2019

The Future of work, Microsoft Faculty Summit 2019, Redmond, WA — July 17-18, 2019

Artificial Intelligence and the Next Frontier of Organizational Modeling (invited)
Annual Meeting of the Academy of Management, Boston, MA — Aug 13, 2019

Data-driven Innovation study, CIFS workshop, KAIST, Korea — Aug 20, 2019

Doctoral Student Consortium (invited panel)
Annual Meeting of the Academy of Management, Boston, MA — Aug 11, 2019

the Young Scholars Initiative (YSI) North America Convening (invited)
INET, University of Southern California — Feb 23, 2019

The determinants and impact of recombinant novelty (invited)
Universite de Lorraine, BETA, Nancy, France — Oct 4, 2018

Understanding Socio-Economic Structure using Big Data (invited)
Industrial Engineering & Management Science, Northwestern University — May 22, 2018

Diversity That Makes Us Creative and Innovative (invited)
Complexity of Diversity Short Course, Salesforce, San Francisco — Mar 23, 2018

Information created by patent activities (invited)
The Complexity of the Patent System, Santa Fe Institute — Mar 14, 2018

Scaling theory in physics, biology, cities and beyond (keynote)
International Conference on Artificial Life, Tokyo, Japan — July 23, 2018

Lost and found in translation: linguistic universality (colloquium)
Northwestern Institute on Complex Systems, Northwestern University — Jan 24, 2018

Scaling in Physics, Biology, Cities, and Beyond (colloquium)
Civil & Environmental Engineering, Northwestern University — Jan 26, 2018

Scaling in Physics, Biology, Cities, and Beyond (colloquium)
Engineering Sciences & Applied Mathematics, Northwestern University — Jan 22, 2018

Pathway of Technology Innovation: from Conventionality to Novelty (invited)
Next Generation Network Analytics, Royal Statistical Society, London — Jan 4, 2018

KEYNOTE, PLENARY, INVITED, PANEL AND COLLOQUIUM

On universal structure of human lexical semantics (invited)
Conference on Complex Systems, Cancun, Mexico — Sep 19, 2017

Lost and found in translations (invited), Northeastern University, Boston, MA — July 20, 2017

Collective knowledge (invited),
Takeda: complex systems theory retreat Santa Fe Institute, Santa Fe, NM — July 12, 2017

Diversification in urban economy (invited)
Updating the Production Function for the Algorithmic Economy, Menlo Park, CA — Feb 28, 2017

Scaling theory: from biology to society (colloquium), KAIST, Korea — Dec 5, 2017

Urbanisation and Innovation (keynote in satellite),
Institutions, Industry Structure, Evolution at CCS 17, Cancun, Mexico — Sep 21, 2017

Collective creativity (keynote),
2017 KDD Workshop on Datadriven Discovery Halifax, Nova Scotia, Candada — Aug 14, 2017

Urban physics: scaling in physics, biology, society and beyond (colloquium)
Indiana University Bloomington, Indiana, USA — Apr 17, 2017

Innovation and urbanisation (invited)
International Workshop: Frontiers of Physics, Pohang, Korea — Dec 12, 2016

Scaling and universality in urban economic diversification (invited)
Cities as complex systems symposium (VW-Foundation), Hanover, Germany — July 13, 2016

Scaling in urban systems (colloquium),
Land & Housing Institute, Korea — Jun 3, 2016

Big Data in social physics (invited)
Grand open conference, Complexity Science HUB, Vienna, Austria — May 23, 2016

Combinational inventions as nature of innovation (colloquium),
Merck KGaA, Darmstadt, Germany — Sep 23, 2015

Physics in urban systems: scaling, Zipf's law, fractality and beyond (invited)
City Analytics: Future Cities Catapult, Urban Innovation Centre, London, UK — Sep 10, 2015

Understanding Innovation by Mapping Technology Space (invited),
King's College, University of Cambridge, UK — Feb 17, 2015

The nature of invention (keynote), *The Future of Fund Management*, London, UK — Mar 10, 2015

Invention as a Combinatorial Process (invited),
the 4^{th} International Symposia: Green, Smart, Development & Vision,
Seoul National University, Korea — Dec 22, 2014

Recipes and Inventions as Combinatorial Process (invited),
Computational Gastronomy–Food in the Age of Data
Kavli Royal Society International Centre, UK — Sep 29, 2014

Cities: Emergence of Order, Erice International Seminars on Planetary Emergencies (invited),
47th sessions, Energy, Cities, and the Control of Complex Systems Workshop,
the Ettore Majorana Centre, Erice, Italy — May 12, 2014

Understanding technological change as dynamics in ecosystem (invited),
seminar of Center for International Development, Harvard University, USA — Apr 2014

Cities as Complex Systems: Universal Structure of Urban Economic Diversity (invited),
Quantitative & Applied Spatial Economic Research Lab., UCL, London, UK — Mar 2014

Towards the Scientific Theory of Cities, Measuring Up Cities (keynote)
the Long Finance Symposium, the Museum of London, UK — Jan 2014