Habits in behaviours: the human beauty and vulnerability

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What make us human?

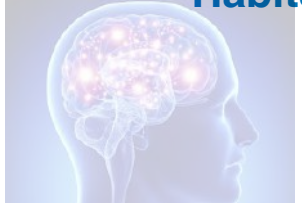
We think

“Humans have a unique ability to understand the beliefs of another person”
(Credit: Thinkstock)”

We feel

"Our open-ended ability to imagine and reflect on different situations, and our deep-seated drive to link our scenario-building minds together.”
(Credit: Suddendorf)“

We behave



Habits, culture, emotions, storytellers, ability to **control and alter our environment…**

"We take advantage of others' experiences, reflections and imaginings to prudently guide our own behaviour”.
(Credit: Suddendorf)

Habits: Routine of behaviors

Daily circadian rhythm

Don’t go away

Unless we form new habits and
make them strong enough to override the previous
habit patterns

PsychMechanics: “Exploring the forces that shape the human psyche”

Humans are complex creatures to study

Technology made it simpler, faster, or scalable

Higher (true and fake) information accessibility

“The new petrol”

Geographical barriers dissipation

Networking pervasiveness

Inria inventors for the digital world

Digital Evolution

5.7 billion mobile subscribers,

about 71% of humans on Earth

Digital Evolution

Concert 90s

Digital Evolution

Concert 90s

Concert 2017

Pervasive connectivity
makes our **real** life and **virtual** activities
seamlessly merged together

Fortunately, **not all events** are seen through the eyes of a smartphone

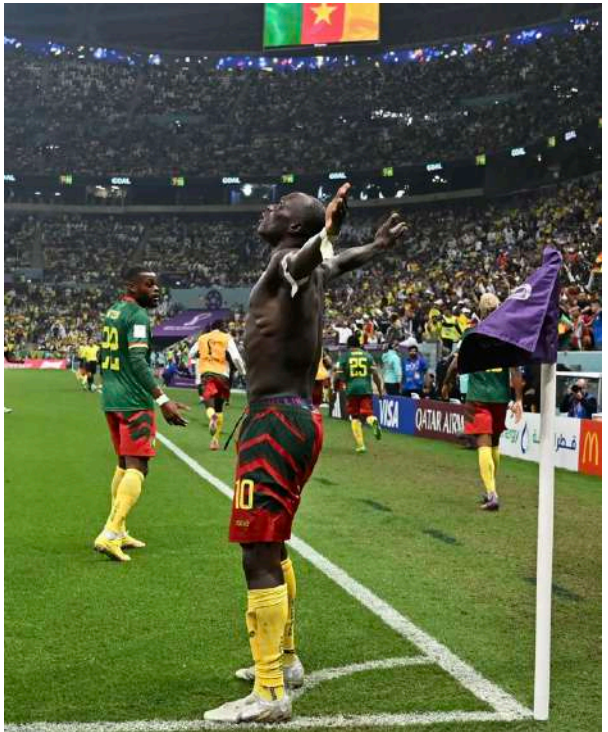
World Football Cup **2022**!!!

Inria
inventors for the digital world

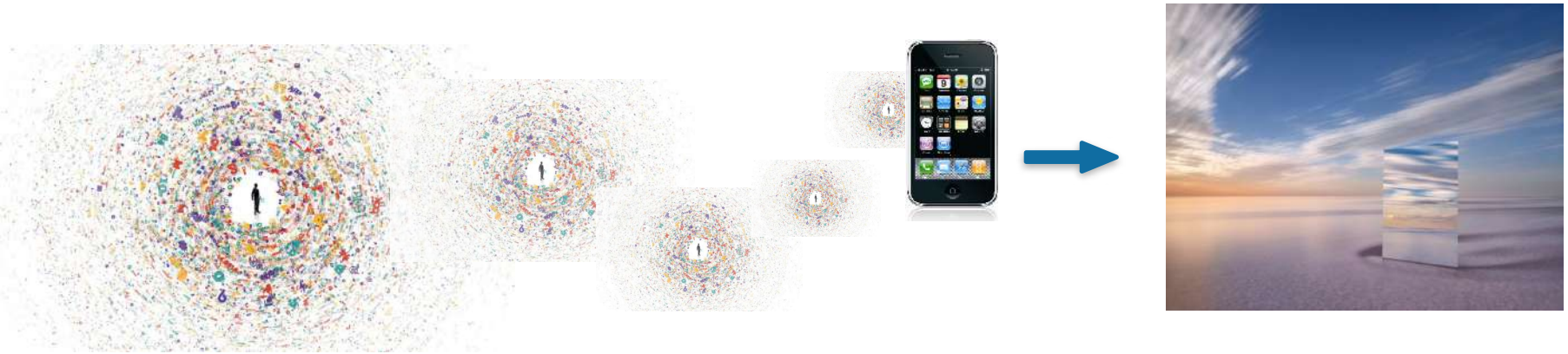
World Football Cup **2022**!!!

Cameroon **1 x 0** Brazil

BRAVO!!!



New opportunities



Digital datasets **mirror** human behaviors

- dynamics, interests, needs, etc

Enforcing the understanding of where, for what, and when network usability happens

Here, human behavior translates in

- Context
- Important locations
- Similarity

Mobility

- Regularity
- Duration
- Similarity…

… in wireless encounters

Interactions

- Application
- Websites

Data traffic

- Regularity
- Duration
- Similarity…

… in on-line social networks

Social ties

…

- Why not Personality Traits, Moods or Emotions?

>20 articles —> http://pages.saclay.inria.fr/aline.viana/

Human

The most studied behavior in literature

Intrinsic of human beings and less impacted by of technology advances

The human mobility beauty

How we move?

Limits of Predictability in Human Mobility

Science
AAAS

Chaoming Song,[1,2] Zehui Qu,[1,2,3] Nicholas Blumm,[1,2] Albert-László Barabási[1,2]*

Understanding individual human mobility patterns

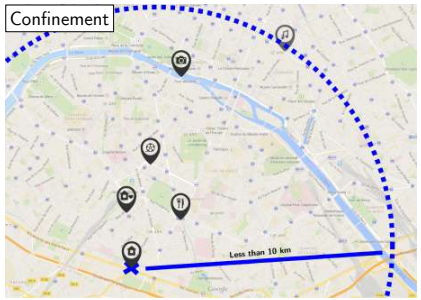
Marta C. González[1], César A. Hidalgo[1,2] & Albert-László Barabási[1,2,3]

[EPJ DataScience11, ACM TSAS21] [ACM SigSpatial19, EPJ DScience21, ACM TSAS21]

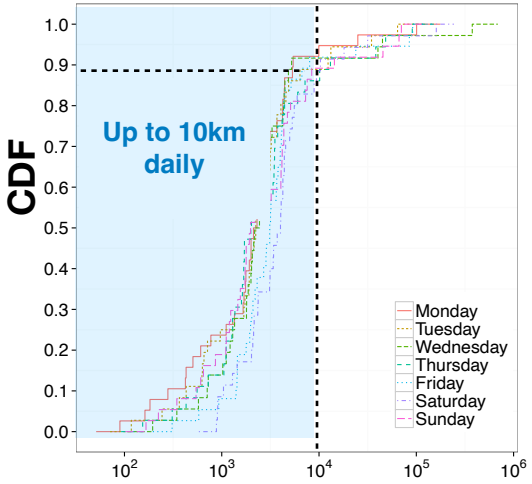
On the Regularity of Human Mobility

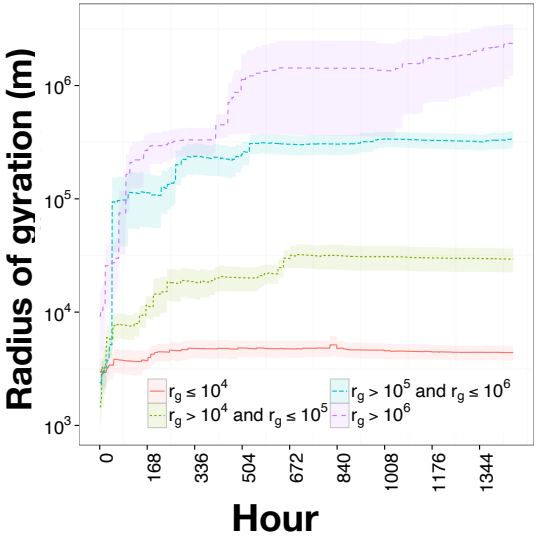
Eduardo Mucelli Rezende Oliveira[a,b,*], Aline Carneiro Viana[b], Carlos Sarraute[c], Jorge Brea[c], Ignacio Alvarez-Hamelin[d]

- Population trip distance distribution follows a truncated power law
- Confined mobility

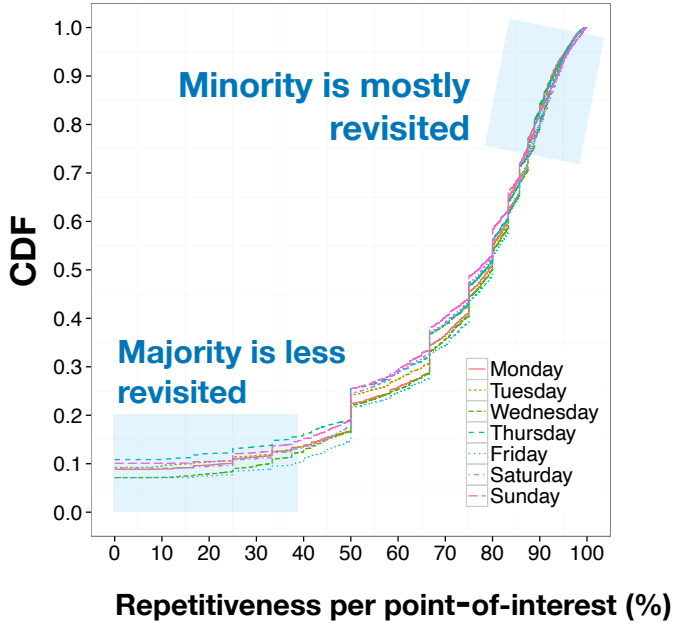


$$r_g^u(t) = \sqrt{\frac{1}{n}\sum_{p=1}^{n}(\vec{r}_p^{\,u} - \vec{r}_{cm}^{\,u})^2} \qquad \vec{r}_{cm}^{\,u} = \frac{1}{n}\sum_{p=1}^{n}\vec{r}_p^{\,u}$$





- Population trip distance distribution follows a truncated power law
- Confined mobility
- Recurrence and time periodicity of visited locations
- Frequent travels to a limited number of *preferable* places



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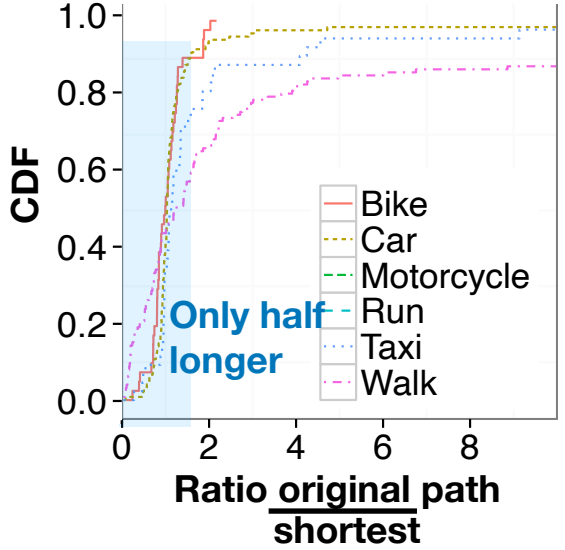
- Shortest path preference - *principle of* ***the least effort***



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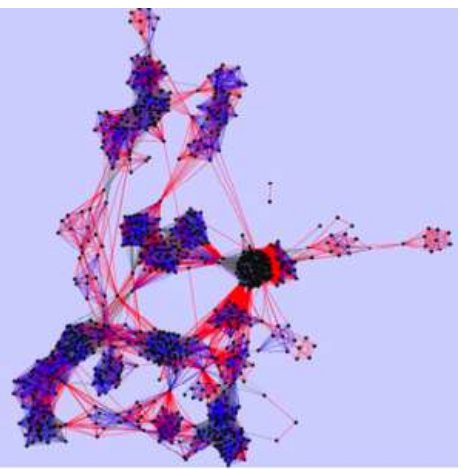


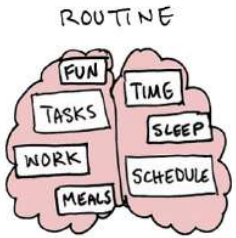
High predictability of human mobility (upper bound: 93%)

Thanks to frequent travels to a limited number of places

In **mobility**: Moments of…

ROUTINE

Habits!



In **mobility**: Moments of…

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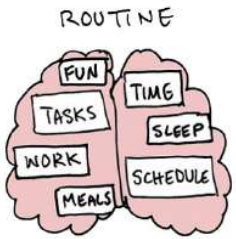


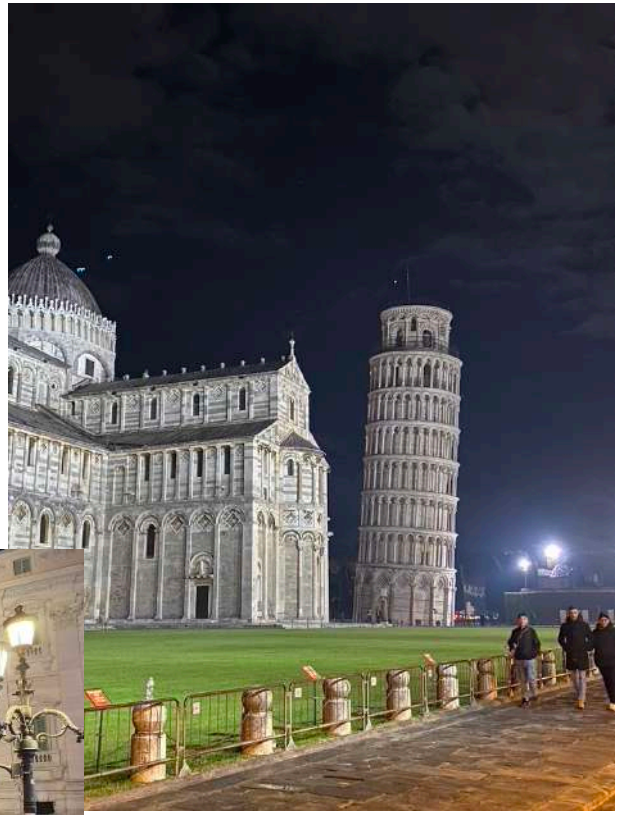
[EPJ DataScience11, ACM TSAS21]
[ACM SigSpatial19, EPJ DScience21, ACM TSAS22]

EXPLORATION

Novelty!

[ACM SigSpatial20, ACM SigSpatial21, ACM TETC22]

Moments of EXPLORATION



Moments of EXPLORATION

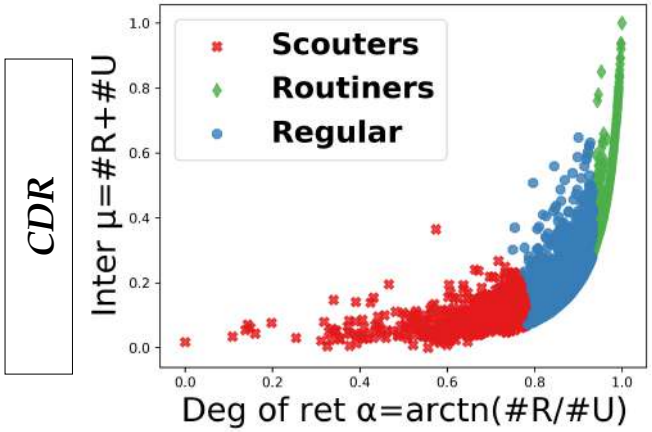
Where is our location of interest?

Moments of EXPLORATION

Moments of EXPLORATION

How often does an individual explore?

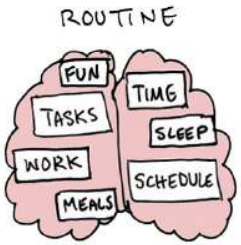
How many new places does she visit consecutively?



	Scouters	***Routiners***
Relocation Activities	- Discover many places - Break routines - Large sets of known places	- Few discoveries - Rarely interrupt routines - Small sets of known places
Temporal Activities	- Explore for large amounts of time	- Spend shorter amount of time exploring
Spatial Activities	- Walk long distances in general	- Have a confined mobility

The human mobility vulnerability

Habits!



Helps mobility prediction

Novelty!

Impacts mobility prediction but still….

Daily circadian rhythm

And contextual influence

We know how to deal with (1) uncertainties and (2) heterogeneous novelty-seeking behaviors

Per individual Spatiotemporal *mobility*

perceptive anticipation

[ACM TSAS22, ACM SigSpatial21, ACM TETC22]

Habits!

Helps mobility prediction

Daily circadian rhythm

And contextual influence

Novelty!

Impacts mobility prediction but still….

Don't know how to deal with (1) uncertainties and (2) heterogeneous novelty-seeking behaviors

They know where you are going the most part of the time!!

Predict individual Spatiotemporal *mobility*

perceptive anticipation

[ACM TSAS22, ACM SigSpatial21, ACM TETC22]

Context-enhanced Trajectory Reconstruction

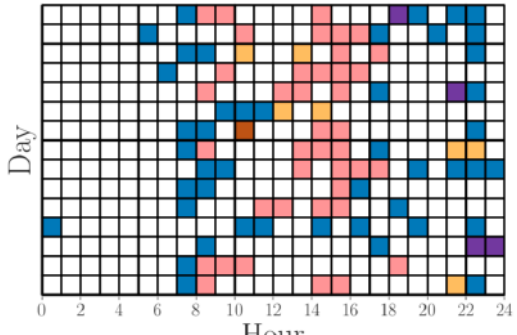
Mitigating sparsity and irregularities

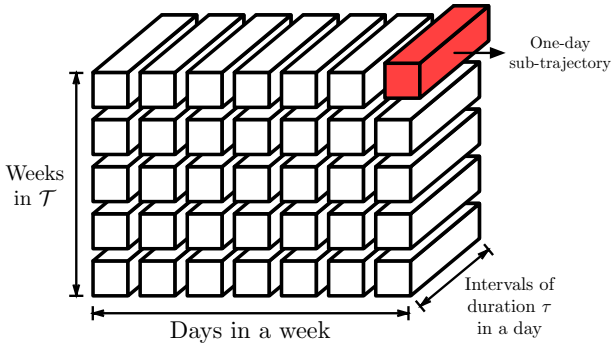
Daily periodicities stronger than weekly ones - repetitive patterns

Consecutive time slots show similarities in locations of the user

Pattern of long static phases with fast movements in between

Overnight invariance





[IEEE Globecom17, COMNET18, EPJ Data Science19]

Even if short segments of your trajectories are revealed…

…they can still track you!!

Unique in the Crowd: The privacy bounds of human mobility

SCIENTIFIC REPORTS

Yves-Alexandre de Montjoye[1,2], César A. Hidalgo[1,3,4], Michel Verleysen[2] & Vincent D. Blondel[2,5]

Uniqueness: 4 random time-ordered locations identify 1 user among 1.5 million, 95% of time

Revisiting "Unique in the Crowd" results: after context-enhanced trajectory reconstruction

Instead, **62** random locations, 85% of time

[EPJ Data Science19]

Unique in the Crowd

Revised once trajectories are reconstructed

Sparsity brings fake uniqueness and hides diverse patterns of mobility

Completeness brings many similar users trajectories, what limit uniqueness

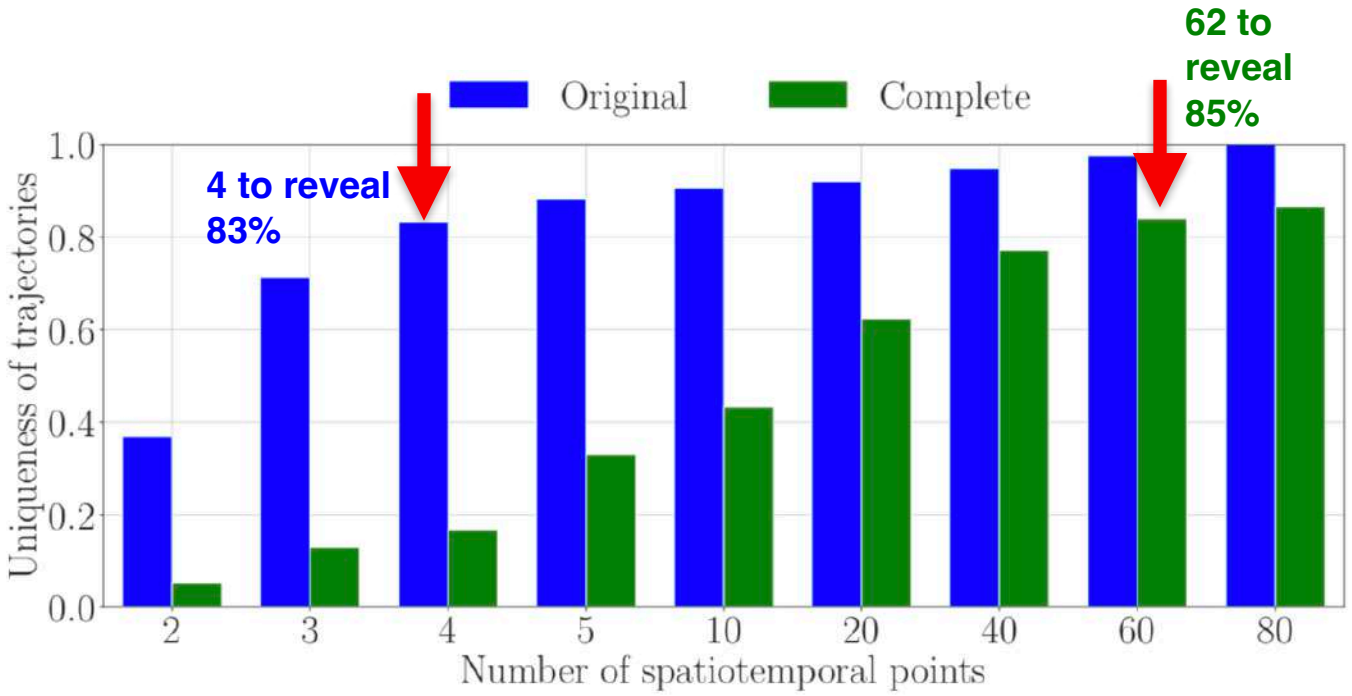


Figure 10 Revisited results from [5]. Ratio of trajectories with uniqueness $|U| = 1$ for a number of spatiotemporal points in the abscissa, for original (left) and complete (right) trajectories.

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Unique in the Crowd: The privacy bounds of human mobility

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SCIENTIFIC REPORTS

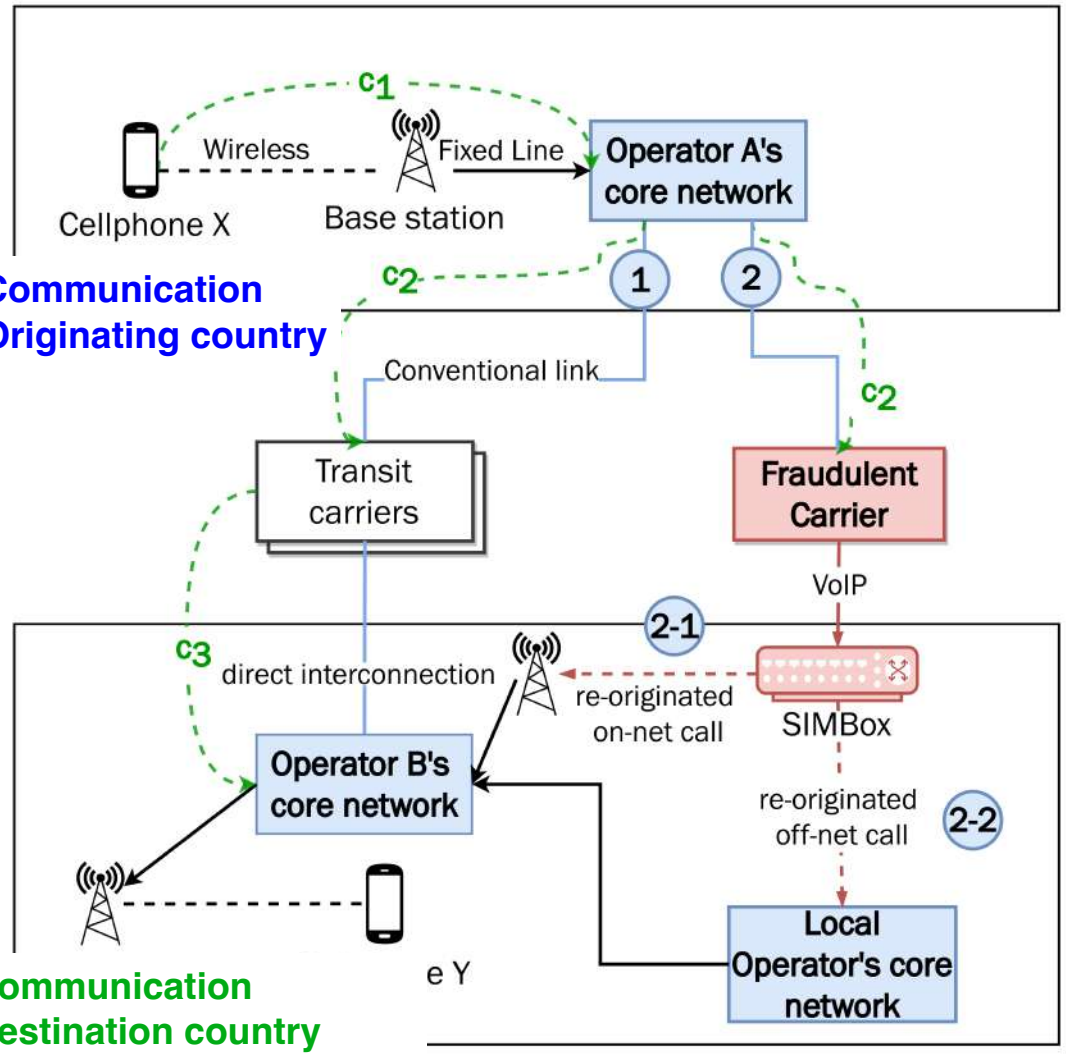
Uniqueness: 4 random locations identify 1 user among 1.5 million, 95% of time

They still know it is you!!

Revisiting "Unique in the Crowd" results: after context-enhanced trajectory reconstruction

Instead, 62 random locations, 85% of time

Frauds in cellular network: The SIMBox type



[IEEE Comm. Tutorial Survey21]

[ACM CoNEXT Student Workshop23]

Frauds in cellular network: The SIMBox type

They are imitating your behaviors!!!

Mobility, traffic generation, social contacts

[IEEE Comm. Tutorial Survey21]

Do not panic: There is still hope

Federated learning but capable of

Perceiving vulnerabilities in individual behaviors

Dependent on users' privacy choices

Adapted to moments of heterogeneity (in mobility, in interest, etc), uncertainties, contextual conditions

Being **simple**, do not add more complexity than *being human* already do

Merci beaucoup!

You are Human Beings!

So think as one when designing solutions for human users!

Students	A. J. Kouam, L. Amichi, D. Do Couto, G. Chen, E. Mucceli, A. Di Luzzio, D. Madariaga, J. Esper, P. Katsikouli
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Period	Since 2014