From Game Theory to Complexity Science and Agent-Based Modeling in World Politics

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Game theory is a traditional tool of analysis in global politics and international relations, e.g.

✸ the prisoner's dilemma

✸ the North-South divide.

Complexity Science is

✸ a multiplayer extension of Game Theory in the global community

International Relations (or global politics)

✸ relates to an anarchic community of some 200 countries and a few thousands of other supranational or nonstate actors

✸ would benefit from fresh simulation approaches such as **Agent-Based Modeling**.

(In this presentation, I omit the Agent-Based Modeling review of journal papers.)

GAME THEORY IN WORLD POLITICS

Lacking a **world government**, the world is an **anarchic** community of 206 sovereign nation-states that strive to survive.

In response to the international anarchy, states realize that their dominant strategy
✳ externally is to try to secure their survival by increasing their **power**;
✳ internally, they can afford to focus on **quality of life** for their citizens.

Wars and conflict erupt as a result of this **international anarchy**.

The **Cold War** was an example of such a mad spiral

✳ two global superpowers (**bipolarity**) were trying to outpower one another

✳ this resulted (rather surprisingly) in a **nuclear peace** that lasted for almost five decades.

Game Theory examines decision problems

✴ two or more agents (**players**)

✴ choose between alternative **strategies**

✴ in order to maximize their **payoff**.

Games may be

✴ **simultaneous** or

✴ **sequential**.

Their "solution" is

✴ determined by the strategic interdependence of players

✴ called **equilibrium**

　　※ dominant strategy equilibrium

　　※ **Nash** equilibrium

　　※ focal point equilibrium.

Game theoretic models that are useful in analyzing the interpersonal relationships of **daily life** include

✳ **coordination** game

✳ battle of the **sexes**

✳ **chicken** game and

✳ the infamous **prisoner's dilemma**

　※　illustrates the difficulty of cooperation when the interests of the player do not match those of the community.

Business and **economic** activity has been shown to be a suitable area for applying game theoretic tools.

✳ When companies try to increase the pie (e.g. opening up new markets) then it is to their interest to **cooperate**;

✳ when attempting to increase their share of the pie (e.g. split up existing markets) then it is to their advantage to **compete**.

This mixed type of business interaction is called **co-opetition** (i.e. cooperative competition).

Business applications of game theory
✸ pure competition
✸ incentives for increased productivity
✸ oligopolies
✸ bargaining
✸ auctions
　　※ the famous dollar auction
✸ even one's professional career.

Schelling demonstrated that game theory may be used as a tool for the analysis of conflict in IR.

✴ The **Prisoner's dilemma** is the best known game theoretic model of transnational cooperation, characterized by the existence of a **cooperative solution** (good for the community) that is distinct from the **dominant strategy equilibrium** (good for a player).
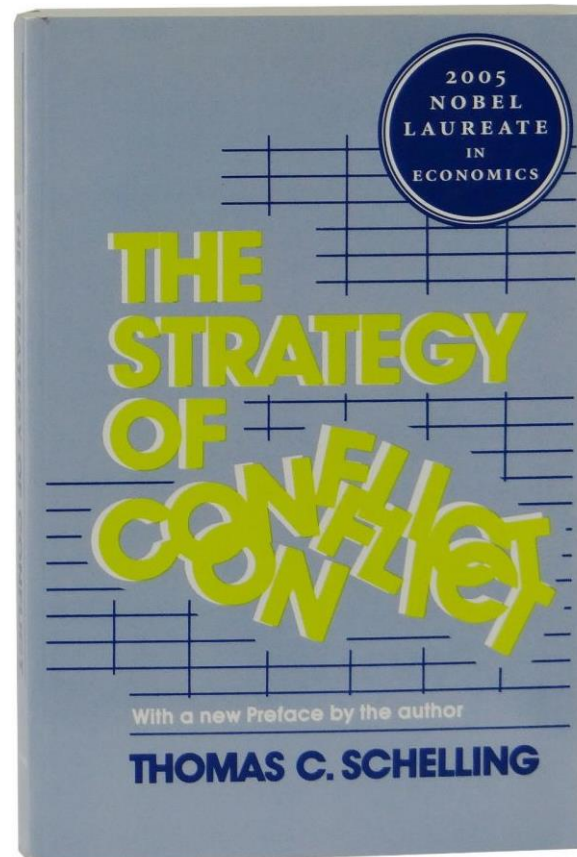
The **Cuban missile crisis** that transpired in **October 1962**, pitting the government of **John F. Kennedy** against that of **Nikita Khrushchev**, is perhaps the international crisis that has been analyzed with game theoretic concepts more than any other crisis in world politics.

✴ The crisis has been characterized as a real-time **chicken** game

✴ A more elaborate game theoretic analysis of the Cuban Missile Crisis with unknown Soviet payoffs, used Kennedy's estimate for the chances of the blockade leading to war to calculate the conditions for successful **brinkmanship**, i.e.

 ※ gradual escalation of the risk of mutual harm (on behalf of the Americans.)

✴ This approach rendered a deeper understanding of the strategic manipulation of risk that the crisis entailed.

The New York Times.

LATE CITY EDITION

VOL. CXII..No. 38,298.   NEW YORK, TUESDAY, OCTOBER 23, 1962.   FIVE CENTS

U.S. IMPOSES ARMS BLOCKADE ON CUBA ON FINDING OFFENSIVE-MISSILE SITES; KENNEDY READY FOR SOVIET SHOWDOWN

U.S. JUDGES GIVEN POWER TO REQUIRE VOTE FOR NEGROES

High Court Upholds Order Forcing the Registration of 54 in Alabama County

Chinese Open New Front; Use Tanks Against Indians

Nehru Warns of Peril to Independence —Reds Attack Near Burmese Border and Press Two Other Drives

SHIPS MUST STOP

Other Action Planned If Big Rockets Are Not Dismantled

PRESIDENT GRAVE

Asserts Russians Lied and Put Hemisphere in Great Danger

ANNOUNCES HIS ACTION: President Kennedy speaking to the nation last night on radio and television. He told of moves to keep offensive equipment away from Cuba.

After you've watched the first 10 minutes, you'll know why this is going to be one of the most incredible dramas you've ever seen. Anywhere.
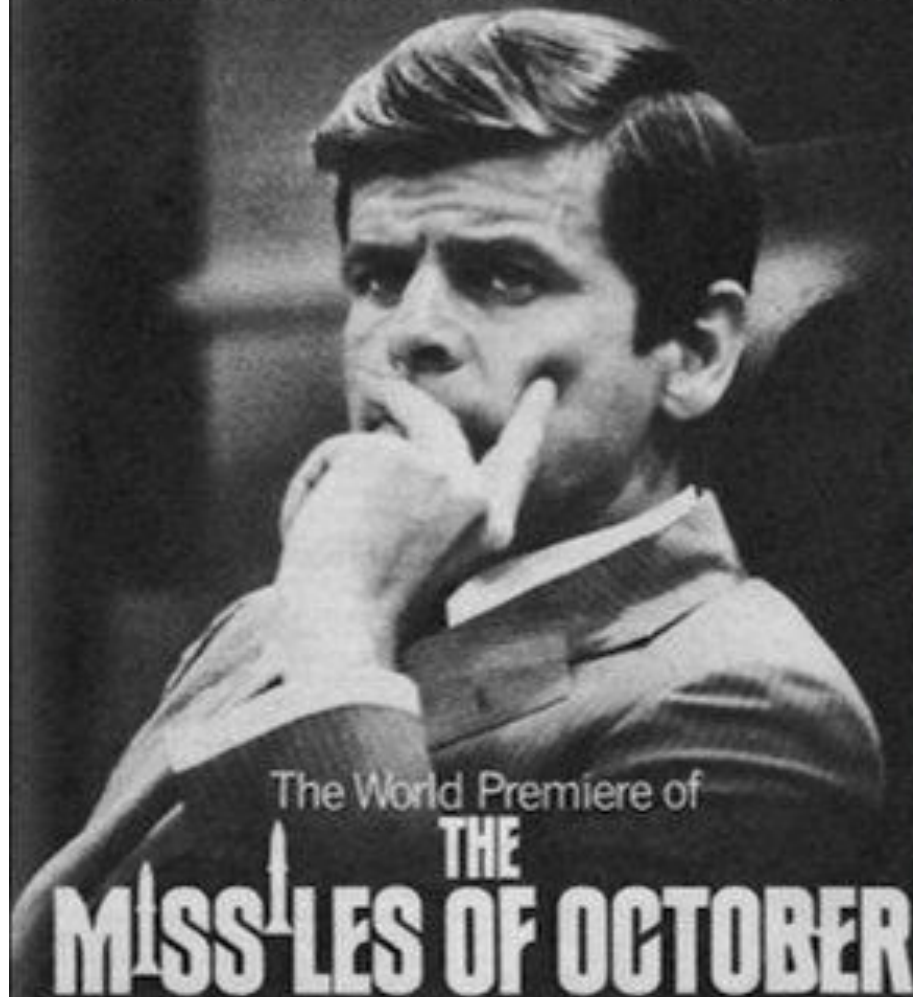
The World Premiere of
THE
MISSILES OF OCTOBER

AN ABC THEATRE PRESENTATION
SPECIAL TONIGHT 8:00 ⑤ ㉓ ㉔ ㉝
Presented by The Travelers Insurance Companies, and your local Travelers Agent or Broker

KEVIN COSTNER

THIRTEEN DAYS

You'll never believe how close we came.

National and international political situations that have been analyzed as bargaining games included:

* the **Geneva Conference** on Indochina (1954) that highlighted the privileged position of the status quo;
* the **Watergate** scandal (1973-74) which led to the resignation of President Nixon;
* the strategy of President Carter at the **Camp David** negotiations between Israelis and Arabs (September 1978);
* the role of **Kissinger** as an arbitrator between Israelis and Arabs during the Yom Kippur war (October 1978);
* the role of threats in the conflict between the **Solidarity** trade union of Lech Walesa and the Government of the Polish Communist Party (1980-1981);
* the **SDI** (Strategic Defense Initiative or "Star Wars") program of President Reagan (1984-1993);
* even terrorism (e.g. Al Qaeda, ISIS).

STRATEGIC DEFENSE INITIATIVE

The **countries** that are represented in global environmental negotiations include:

✳ democracies

✳ dictatorships

✳ nations that struggle with poverty and hunger

✳ deprived countries with low per capita income

✳ nations experiencing rapid population growth

✳ newly industrializing countries with little or no enforcement of environmental protection measures

✳ and developed countries with elaborate environmental management systems.

Stakeholders in such international environmental meetings include
✴ businesses,
✴ industries,
✴ environmental groups,
✴ activists and
✴ scientific organizations.

These parties are pressured by groups not participating in such conferences directly.

Transboundary environmental problems often put countries that are long-term partners and allies, to rival positions on specific environmental issues such as

* global climate change
* conservation of biodiversity
* protection of oceans and
* promotion of sustainable development.

In additions, interests often clash on a grander scale, e.g.

* Brussels would not want the European **environmental** negotiating committee to take a position that damages the EUs relationship with allies and partners in bilateral negotiations on **security** or **economic cooperation**.

A host of **nongovernmental organizations** (NGOs) supplement the actors trying to influence national delegations and include:

✴ grass roots groups;
✴ extremist environmentalists;
✴ followers of neoclassical economics and free markets;
✴ consumer protection institutes and left movements;
✴ real estate brokers;
✴ bankers;
✴ and representatives of scientific groups.

The diplomacy of international negotiations on global environmental problems include five specific types of confrontations involving:

* the **rich North** against the **poor South** countries;
  * ※ developed countries have resolved many environmental problems through economic growth
  * ※ in the developing countries, public interest in environmental quality is not seen as a priority
* **pollution haven** countries, having lax environmental regulations to gain a competitive advantage;
* **idealists** against **realists**
  * ※ as regards their expectations on what constitutes reasonable progress in the solution of global environmental problems
* **optimists** against **pragmatists**
  * ※ as regards the improvements in environmental quality
* and reformers against conservatives
  * ※ mainly in reference to the structure of the United Nations.
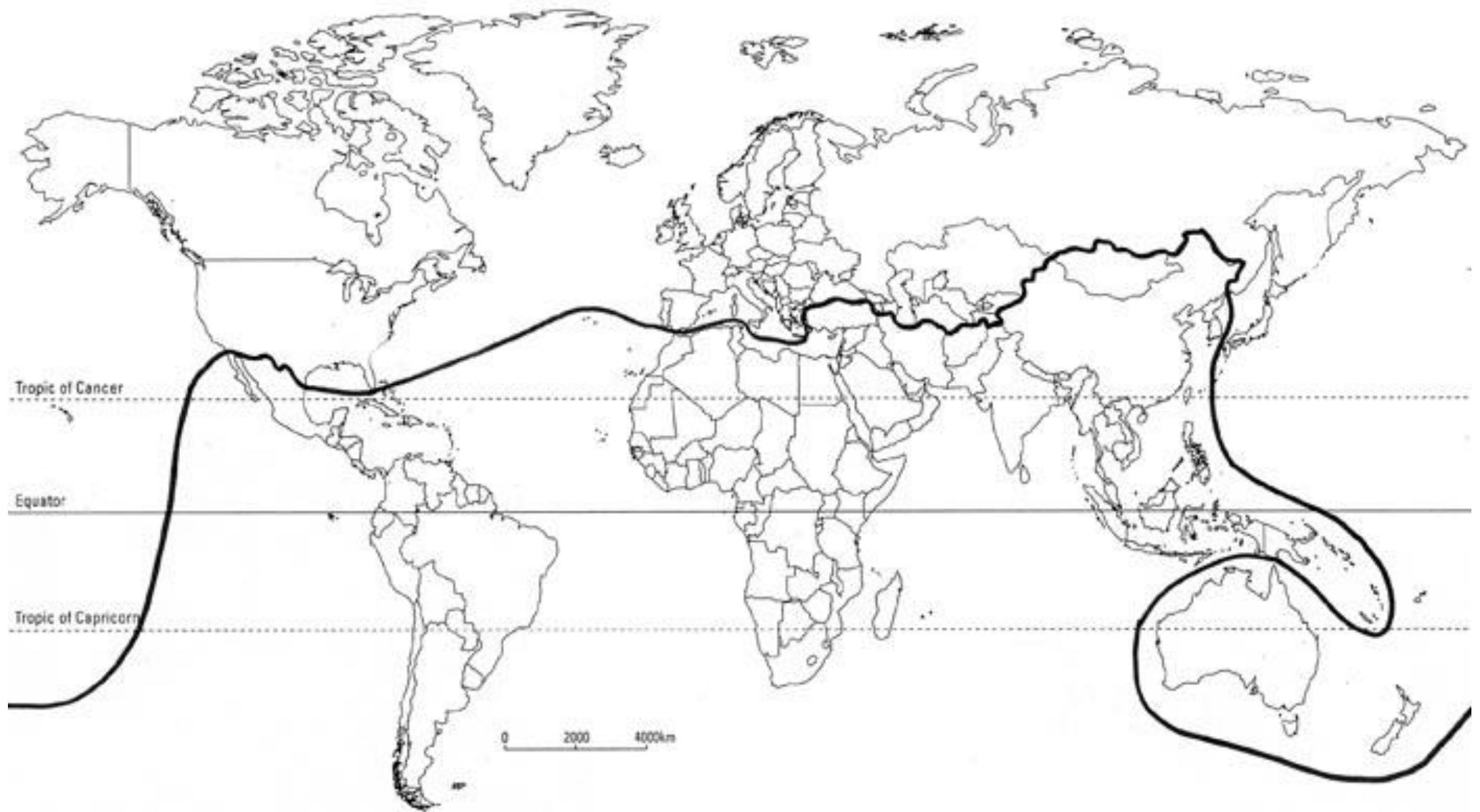
FROM GAME THEORY TO COMPLEXITY

Game theory typically analyzes games of a few players.

✳ The world is a system of

　　※ 206 sovereign **states**

　　※ hundreds of **supranational** entities such as the EU, North American Free Trade Agreement (NAFTA) and the United Nations (UN) as well as

　　※ thousands of other **non-state** actors and institutions.

The global community constitutes a multi-agent (i.e. multi-player) **Complex Adaptive System** (CAS).

✳ This tutorial examines whether such a methodological approach might be productive as an additional tool in the research of world politics.

The global community of **7 billion people** and **206 nations**

✴ has become a turbulent arena of volatility, random events and uncertainties in which

✴ **crises** succeed one another and propagate beyond national borders including

　※ the US subprime lending

　※ the EU sovereign debt and

　※ the **Arab Spring**.
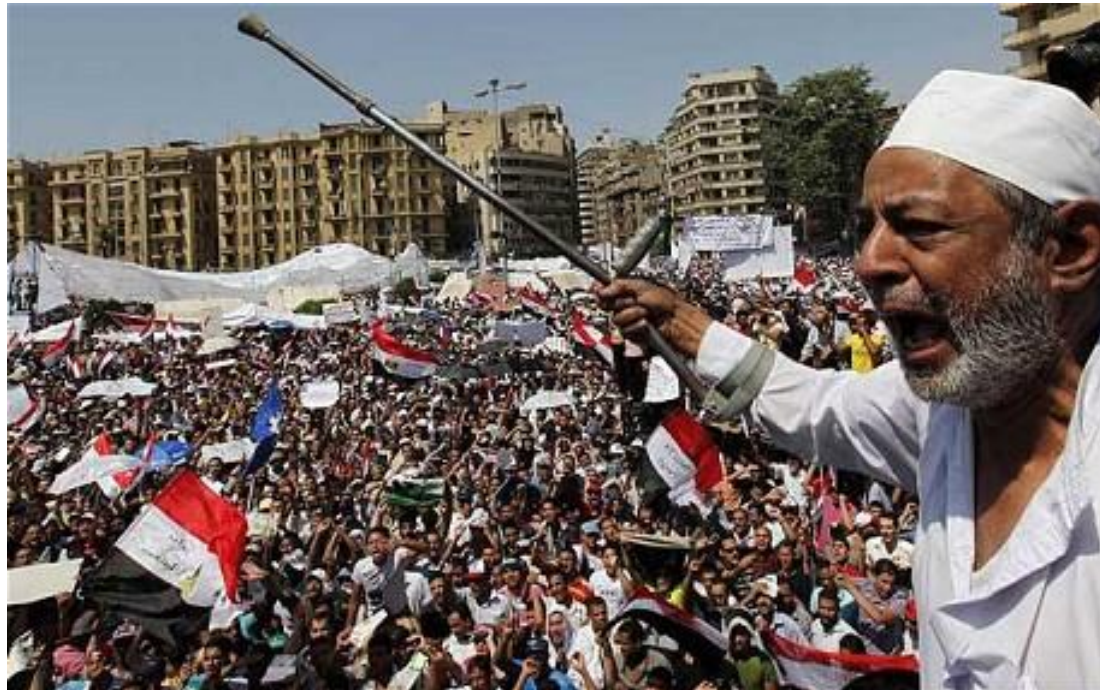
The world is changing

✴ from one of measurable (economic, geopolitical, environmental, societal and technological) **risks**

✴ to one of discontinuous **uncertainties** that

　※ cannot be known in advance and

　※ cannot be measured.

Global affairs are

✴ multidimensional

✴ interconnected and interdependent

✴ dominated by a multitude of **cross-border** relationships.

These **interconnections** breed more complexity

✴ arithmetic increase in the number of system elements

✴ geometric increase in the number of potential links

✴ exponential increase in the number of possible patterns.

Intersecting **social**, **political**, and **economic** phenomena make the global community a system of complex systems which

* taxes the capability of **analysts** to understand systems
* overwhelms the capabilities of **politicians** to analyze problems and suggest appropriate policies to solve them.

The anarchic global community may be considered a complex system in which states are **agents** that

* compete for power and security
* can both aid or harm one another.

In fact, the global community constitutes a complex network, in which states exhibit memory, i.e. their behavior is influenced by
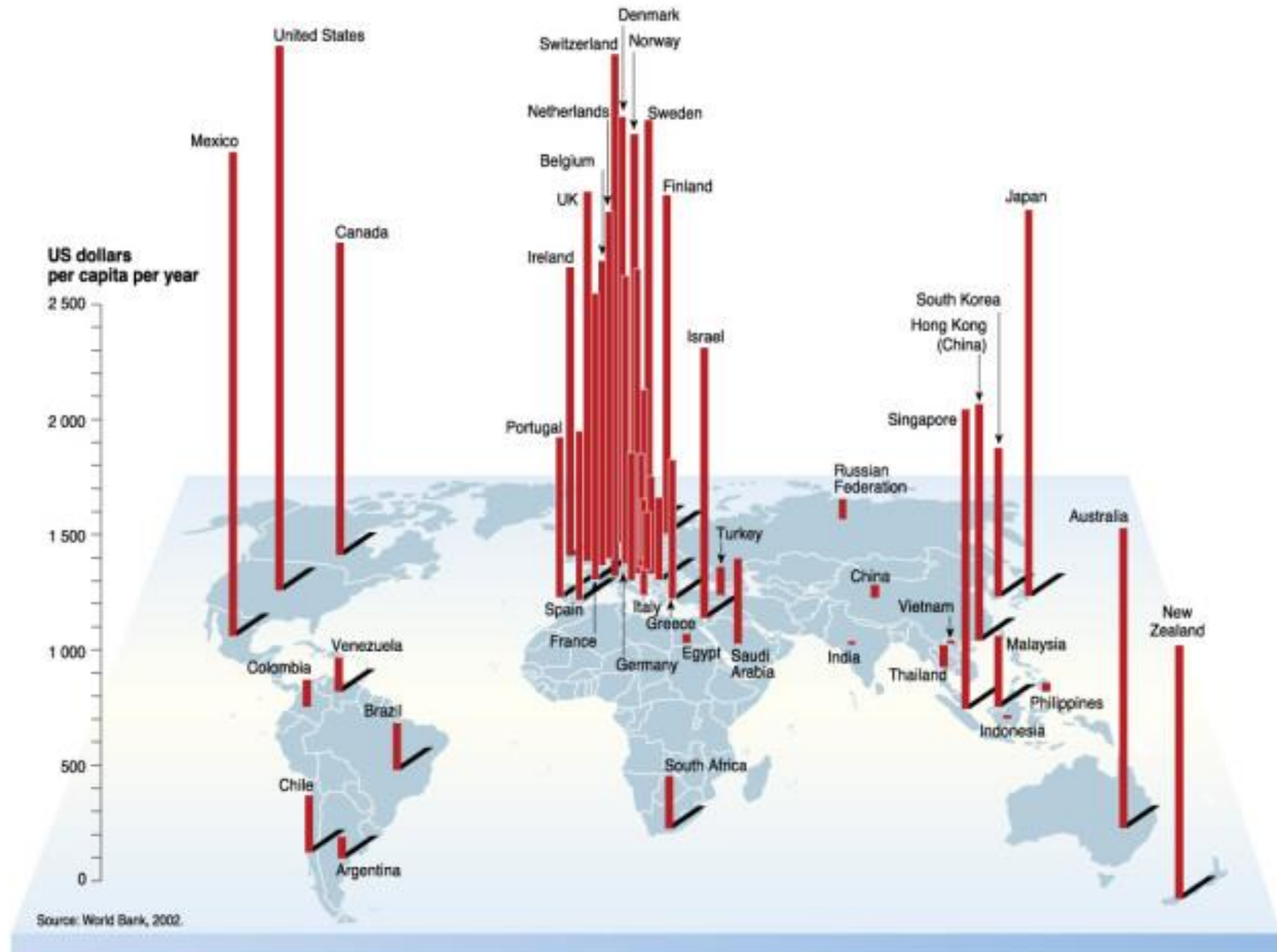
* past experiences with the interaction among IR agents (**memory** or [positive] feedback) as well as
* what takes place in another part of the world (**knock on** effect).

Information and Communication Technologies (ICT)
* ✸ have formed a complex, dynamic global system
* ✸ containing billions of entities that
* ✸ interact over multiple spatial and temporal scales,
* ✸ making the world a highly interconnected and interdependent complex system.

Radical shifts occurring in the fields of geopolitics, economics, society, energy and natural resources are all underscored by momentous technological advances in the form of **waves** posing unprecedented challenges to world leaders.

Information and communication technology expenditures

US dollars per capita per year. Source: World Bank, 2002.

Countries shown: United States, Mexico, Canada, Denmark, Switzerland, Norway, Netherlands, Sweden, Belgium, Finland, UK, Ireland, Japan, Israel, South Korea, Hong Kong (China), Singapore, Portugal, Russian Federation, Australia, Turkey, China, Spain, Italy, Greece, France, Germany, Egypt, Saudi Arabia, India, Vietnam, New Zealand, Venezuela, Colombia, Brazil, Malaysia, Thailand, Philippines, Indonesia, Chile, Argentina, South Africa.

No one in the **1930s** or **1940s** could have foreseen how personal computers and telecommunications would change the world!
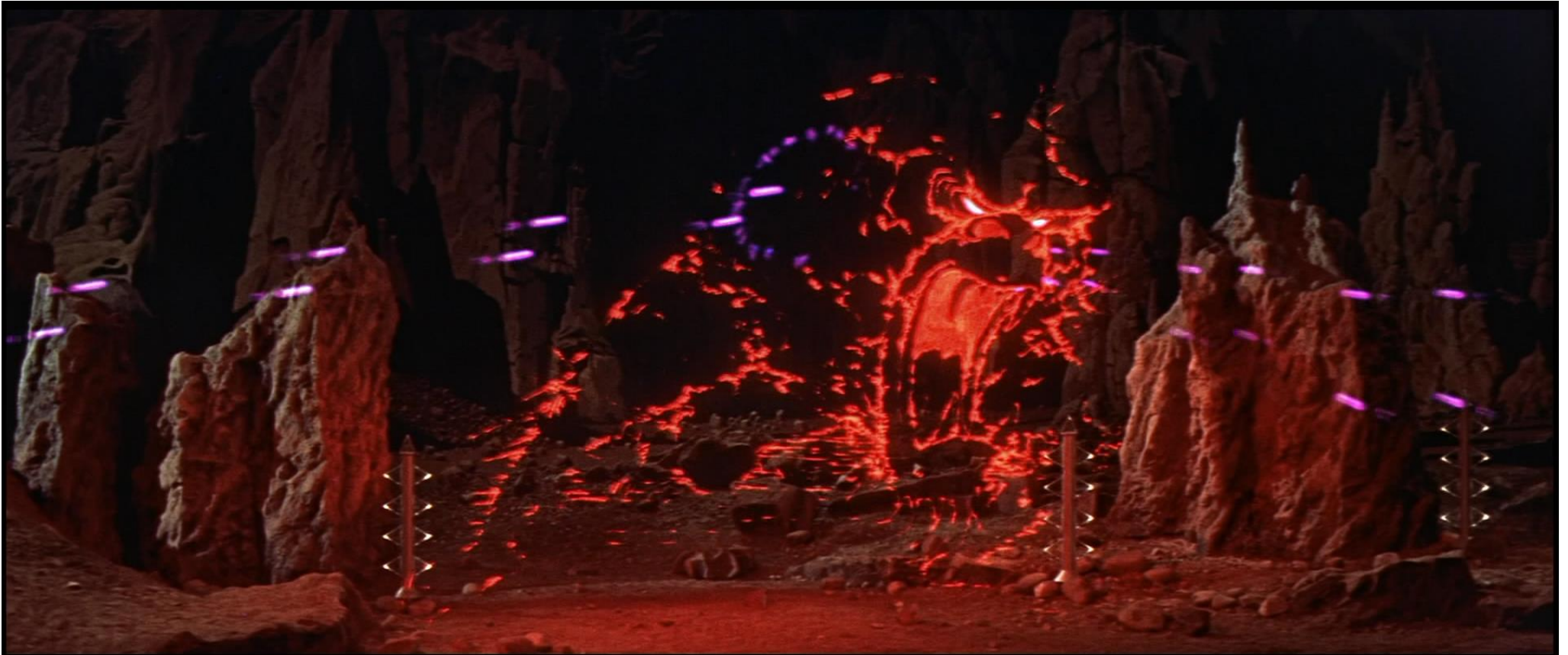
The advent of the **Internet** and the **World Wide Web** opened up new possible futures with services like

✳ file sharing

✳ email

✳ search engines and

✳ social media.

These catalyzed the occurrence of important regional events such as the **Arab Spring**.

Education and **knowledge transfer** have been globalized

✳ books have become e-books and are purchased and downloaded instantaneously

✳ product and industry life cycles have been shortened

✳ financial markets react immediately to almost everything that happens

This has resulted in an **information overload** that has put the modern man in a situation not unlike that of one trying to drink from a fire hydrant.

Getting information off the Internet is like taking a drink from a fire hydrant.

— Mitchell Kapor

Complexity is analogous to

✴ the number of **components** of a system,

✴ the **interconnectedness** of these components and

✴ the **nonlinearity** of the elements of the system.

In a complex system, it is typical for changes in one component of the system to lead to unexpected and surprisingly disproportionate effects elsewhere, e.g.

✴ the **Fukushima** nuclear accident impacted the energy policy of European countries such as Germany.

Quotes on the global complexity:

* In the 2007 annual meeting of the World Economic Forum, **Tony Blair** called interdependence the defining feature of the 21st century.
* **Thomas Freedman** of the New York Times called the world hyper-connected.
* Professor and former diplomat **Kishore Mahbubani** coined an apt metaphor for what he called the greatest transformation ever, saying that
    * ※ the world used to be like **170 distinct ships**
    * ※ now it is like **193 cabins on the same boat**.

In such a complex network, risk is systemic, e.g.

* it is often the weakest link that brings about a system-wide crisis such as **Greece** (a seemingly insignificant player in terms of size) in the recent Eurozone crisis.

A similar example is provided by the **United States** and **China** that are interdependent in a very complex and deep way.

✳ On the one hand, China has a huge population of hardworking people, but a poor resource base and possibly a diminished moral and political code.

✳ On the other hand, the United States possesses vast hard and soft power assets, but suffers from a growing deficit of wisdom and smart power.

✳ The two countries could build on their complementary need and maintain **peace** or enter into **conflict**, with neither course being predetermined nor predictable.

In global politics, there are complex multilevel cross-border interactions of **agents** such as

﹡ individuals

﹡ special interest groups

﹡ non-governmental organizations (such as Greenpeace)

﹡ multinational companies (such as Toshiba or 3M)

﹡ terrorist organizations (such as Al Qaeda)

﹡ social classes

﹡ entire societies

﹡ political parties

﹡ governments

﹡ states

﹡ entire civilizations as well as

﹡ international and transnational organizations

　　※　such as the EU or the United Nations.

Four forces constitute the key characteristics of the global community today:
* interdependence
* velocity
* transparency and
* immediacy.

Through the continuous and cumulative action of these forces, the global community exhibits the **nonlinearity** typical of complex systems, e.g.
* **shocks** propagate surprisingly fast
* minor **causes** bring about major impacts.

Velocity and **immediacy**, mediated by information and communication technologies (ITCs) especially the Internet, have created a "dictatorship of urgency" that

❊ runs global events fast forward and

❊ allows no time to pause and ponder over developments.

The social media have fathered **transparency** as the Internet

❊ makes the younger generation more aware of the corruption of its leaders

❊ facilitates the orchestration of its reactions

  ※ as in the case of **Tunisia** and **Egypt**.

Social media has been vested with the power to transcend occasionally the power of authorities

❊ anxiety about the social media is evident in countries such as **Saudi Arabia** and **China**.

Transparency has also limited **confidentiality**

✳ Swiss banks are forced to divulge information about their clients to foreign authorities or governments.

✳ There can be no privacy on the Internet as long as every move of its users is worth something to someone.

In addition, several **positive feedback** loops are in operation in CASs

✳ small-scale disturbances are amplified to nonlinear large-scale effects

✳ outcomes are not proportional to causes.

Complex systems oftentimes create situations of **asymmetric** information

✳ one party is in possession of (much) more knowledge of the specifics of a situation than other parties

✳ may use this asymmetry to its advantage.

Cyber conflict

✳ epitomizes the power of asymmetry

✳ illustrates that some global events are beyond the control of even the most powerful states.
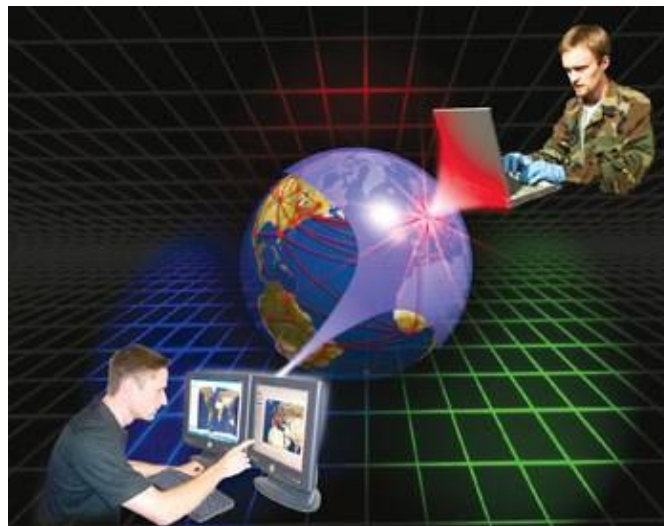
CASs are also characterized by **tipping points**, i.e.

✴ levels after which cascading effects are kick started by connections that used to absorb shocks

✴ after a certain point they become shock multipliers, amplified and accelerated by positive feedback.

The term **black swans** is used to refer to such exceptional critical events that appear to occur with a probability higher than expected and oftentimes determine world affairs such as

✴ the **First World War**.

SECOND EDITION

WITH A NEW SECTION: "ON ROBUSTNESS & FRAGILITY"
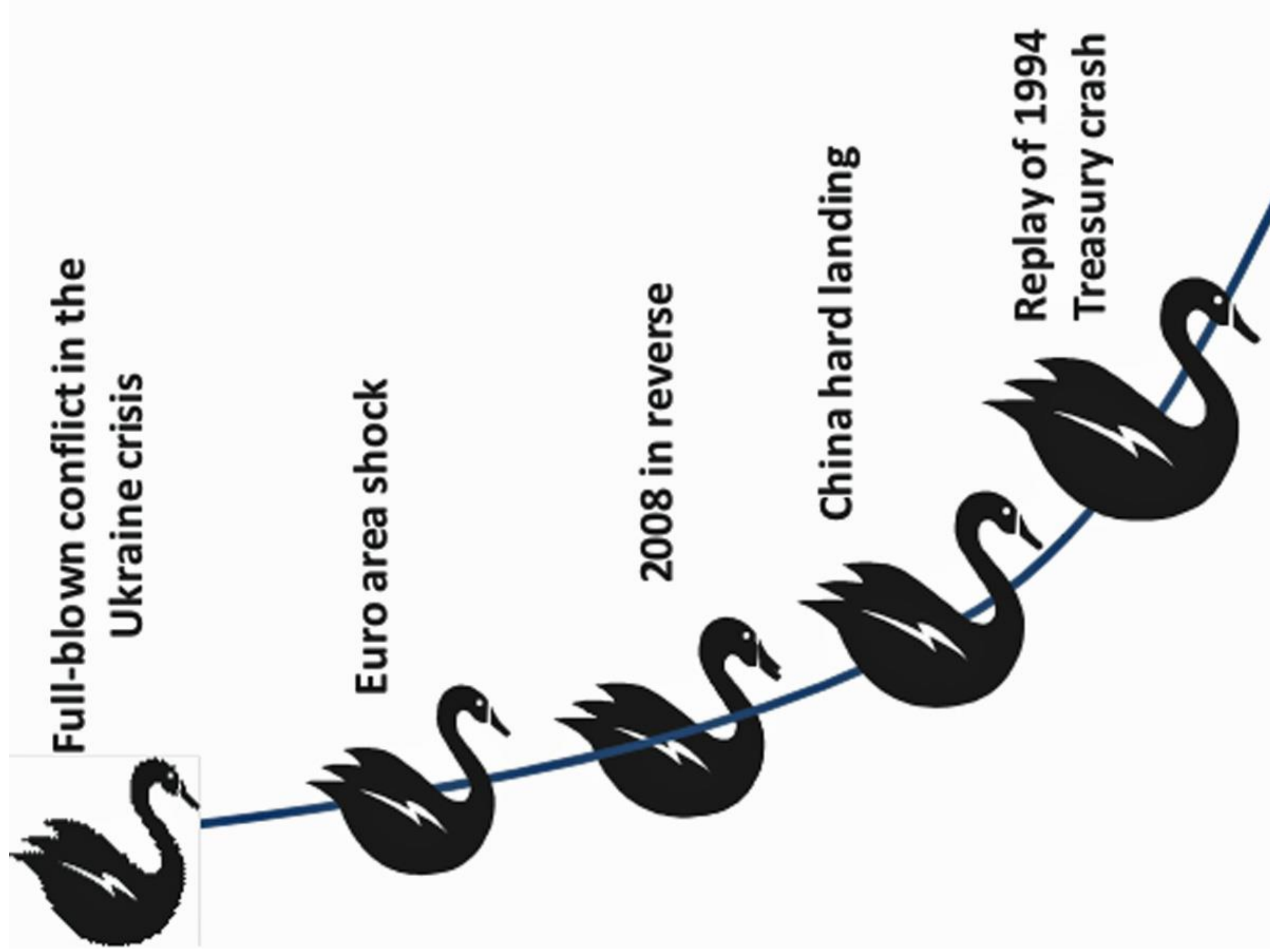
NEW YORK TIMES BESTSELLER

THE
BLACK SWAN

The Impact of the
HIGHLY IMPROBABLE

"The most prophetic voice of all."
—*GQ*

Nassim Nicholas Taleb

Full-blown conflict in the Ukraine crisis

Euro area shock

2008 in reverse

China hard landing

Replay of 1994 Treasury crash

Another important aspect of complexity is that it empowers the influence of **individual** men and women on global politics.

✳ As an example, other alternative possibilities might have opened up in the Cuban missile crisis if **Nikita Khrushchev**, the **Kennedy** brothers and **Robert McNamara** were not present.

✳ In a similar vein, the 20th century might not have been the same without **Hitler**, **Mussolini**, and **Stalin**.

✳ A more recent example of how a personal relationship may have facilitated state politics is given by the evident existence of good chemistry between **Papandreou** and **Netanyahu**, Prime Ministers of Greece and Israel correspondingly that appears to have helped move the Greek-Israeli relationship forward.

CASs are composed of interacting agents whose behavior may be described with **stimuli-response rules**.

These agents **learn** from their environment and **modify** their behavioral rules as experience accumulates.

This way, CASs **evolve** over time and may form unexpected **emergent** properties oftentimes shaped by co-opetition.
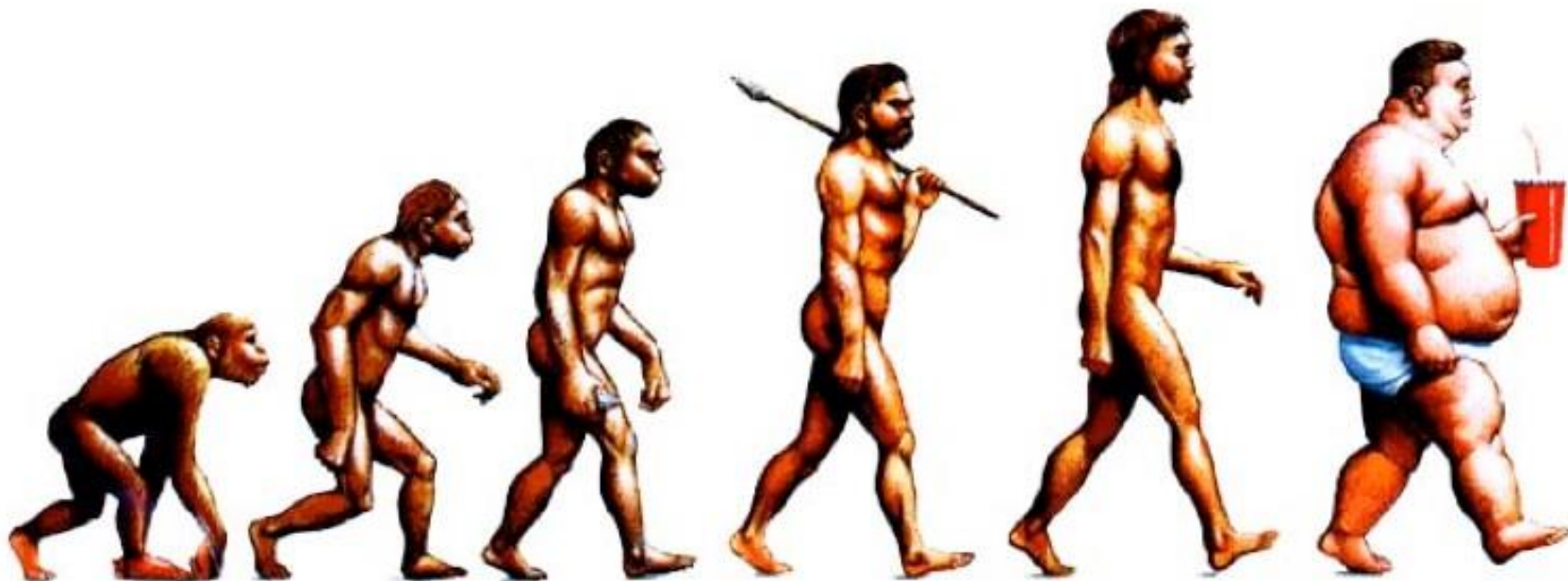
Although **evolution** and **adaptation** characterize CAS, the timescale of adaptive modifications varies from one system to another, e.g.

✸ in CASs such as the central nervous system or the immune system, adaptation takes seconds to hours or days

✸ in the field of business and economics it takes months to years

✸ in ecology and the environment it takes days to years or even centuries.

In any case, the direction of evolution is impossible to predict, e.g.

✸ consider how mainframe computers gave rise to portable computers which, in turn, opened the way to mobile telephones, the Internet, social networking and the **Arab Spring**.

The world may be thought of as a CAS in which actors, i.e. agents of world politics, continuously **adapt** their behavior to the external **signals** they receive.

In such a complex political world, **uncertainty** (amplified by complexity and fear) and **nonlinear dynamics** play a significant role as global events unfold.

Such a complexity science approach essentially introduces concepts of **adaptability**, **evolution** and **fitness** to the analysis of world politics.
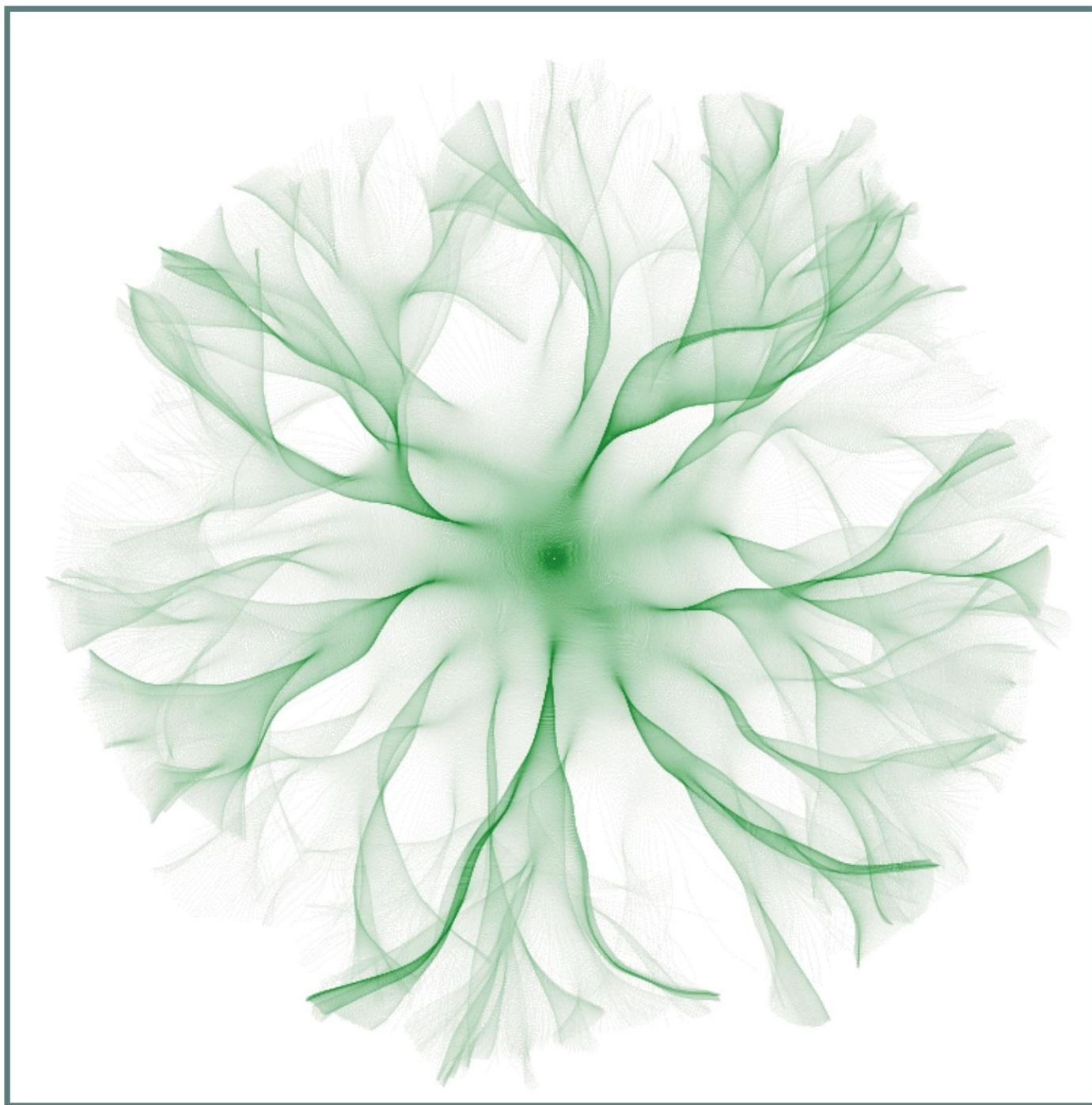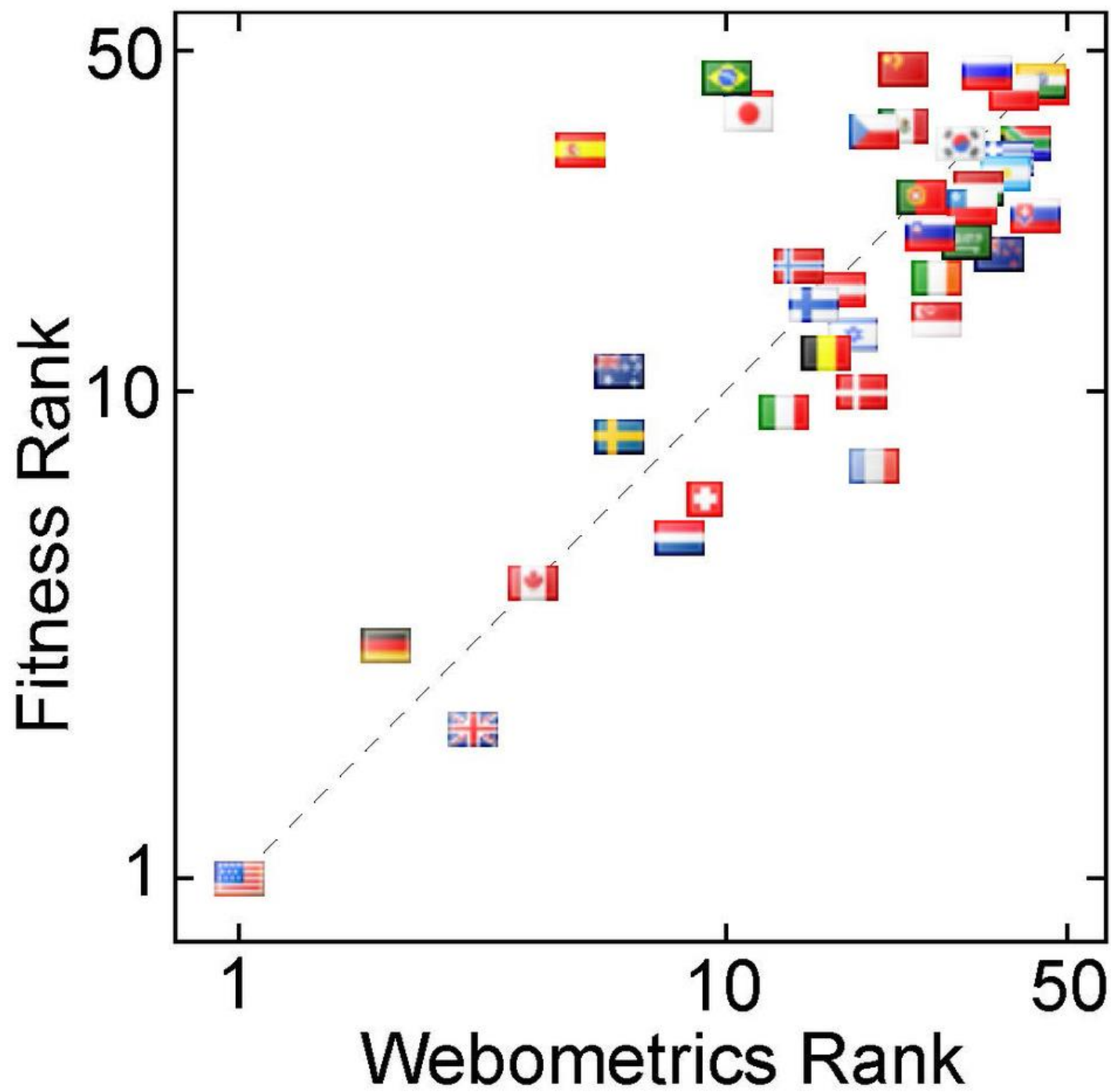
Fitness results from evolution and measures the ability of states to cope with the complex global community, being a function of an array of factors not least of which is smart power, i.e. the ability to amalgamate aspects of both hard and soft power into wise policies.

Quantitative measures of fitness of countries could be estimated with data such as
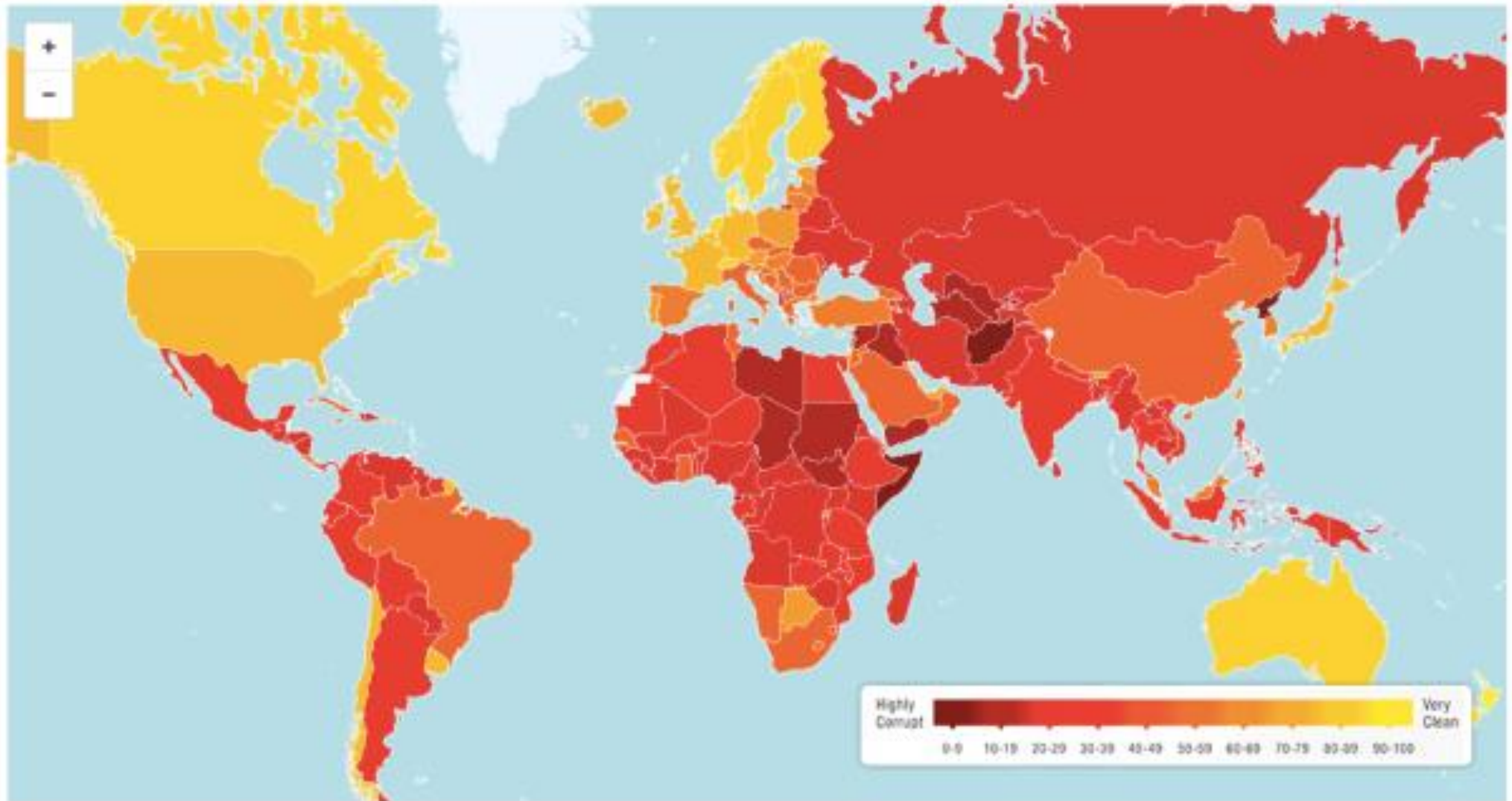
✸ the **United Nations Human Development Index** (HDI, measuring longevity education and income)
✸ rankings of democratization etc. such as those of
　※ the Freedom House
　※ the Bertelsmann Foundation
　※ Transparency International and
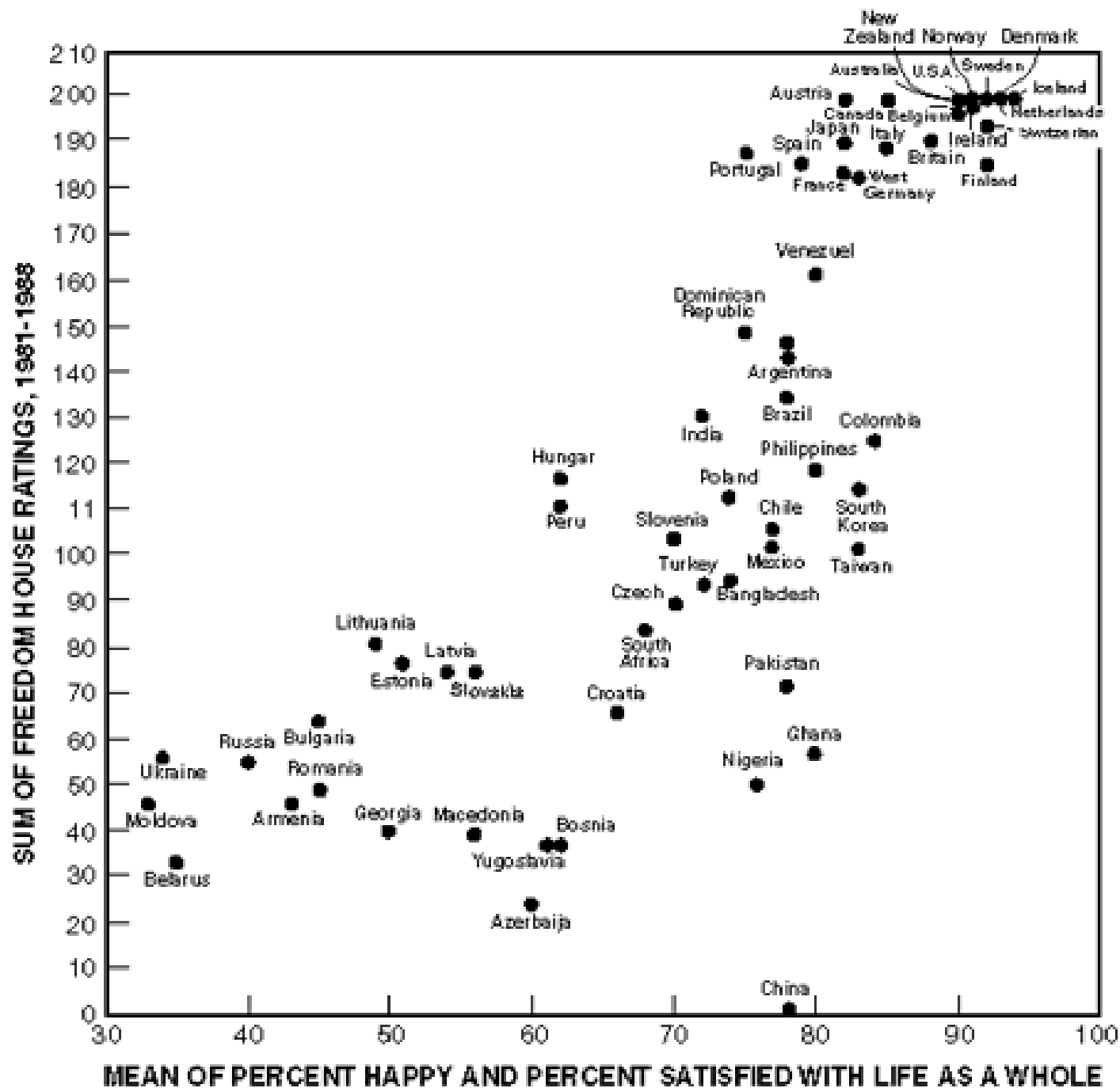　※ the Harvard-MIT Index of Economic Complexity.

The quantification of the fitness of state actors may not always be helpful, e.g.

✴ it would be erroneous to conclude that **Italy** (that has had about 60 changes in its governmental regime since the Second World War) is less stable than **Saudi Arabia** (that has been run by the same family for the last 40 years.)

CORRUPTION PERCEPTIONS INDEX 2013

Y-axis: SUM OF FREEDOM HOUSE RATINGS, 1981-1988

X-axis: MEAN OF PERCENT HAPPY AND PERCENT SATISFIED WITH LIFE AS A WHOLE

Countries plotted: New Zealand, Norway, Denmark, Australia, U.S.A., Sweden, Iceland, Austria, Canada, Belgium, Netherlands, Japan, Italy, Switzerland, Spain, Britain, Ireland, Portugal, France, West Germany, Finland, Venezuel, Dominican Republic, Argentina, India, Brazil, Colombia, Hungar, Poland, Philippines, Peru, Slovenia, Chile, South Korea, Turkey, Mexico, Taiwan, Czech, Bangladesh, Lithuania, South Africa, Pakistan, Latvia, Estonia, Slovakia, Croatia, Russia, Bulgaria, Ghana, Ukraine, Romania, Nigeria, Moldova, Armenia, Georgia, Macedonia, Bosnia, Belarus, Yugoslavia, Azerbaija, China

Gideon Rachman of the **Financial Times** has identified six divides (i.e. games) that are likely to constitute fault lines that perturb the geopolitical landscape in the 21st Century:

* surplus countries (like Germany, China, Japan and Saudi Arabia) versus deficit countries;
* currency manipulator versus "manipulated" countries;
* "tightener" (like the UK) versus "splurger" countries;
* democracies versus autocracies;
* interventionist versus souverainist countries; and
* big versus small countries, pitting the G20 countries against the rest of the world.

The world is also likely to see a number of dominant power in the coming decades of the 21st century, i.e.

* **China** in East Asia,
* **India** in South Asia,
* **Brazil** in Latin America,
* **Nigeria** in West Africa, and
* **Russia** being a major oil and gas power.

Questions of world politics that are worth addressing via the complexity approach include:

✸ Will **conflict** or **cooperation** be more prevalent in the years to come?

✸ Is **unipolarity**, **bipolarity** or **multipolarity** of the distribution of international power more conducive to the overall fitness and stability of the global community?

✸ Will the **US** decline, will **Europe** fade into irrelevance and will the **BRICS** overtake the world?

✸ Was the world more stable during the four and a half decades of relative calm of the **Cold War**?

　　※　Would more nuclear weapons in the hands of even states like Iran be conducive to a more stable world, as **Kenneth Waltz** has argued?

90 YEARS

JULY/AUGUST 2012

FOREIGN AFFAIRS

Why Iran Should Get the Bomb

Kenneth Waltz

Plus Graham Allison on Negotiating Lessons From the Cuban Missile Crisis and Amatzia Baram on Deterrence Lessons From Saddam's Iraq

The Debate Over Decline

Robert Keohane on the Future of American Global Leadership

• 68 out of 92 •

✳ Will the **pauperization** of the middle class continue and dominate the social arena?

✳ Will the complexity that results from global interdependence make **war** unthinkable and foster **peace**, as the numerous intersecting interests that link countries render no single interest worth fighting for?

　※　Or do the current troubles of the **EU** mean that the more interconnected countries are, the easier it is for them to disagree and enter into **dispute**?
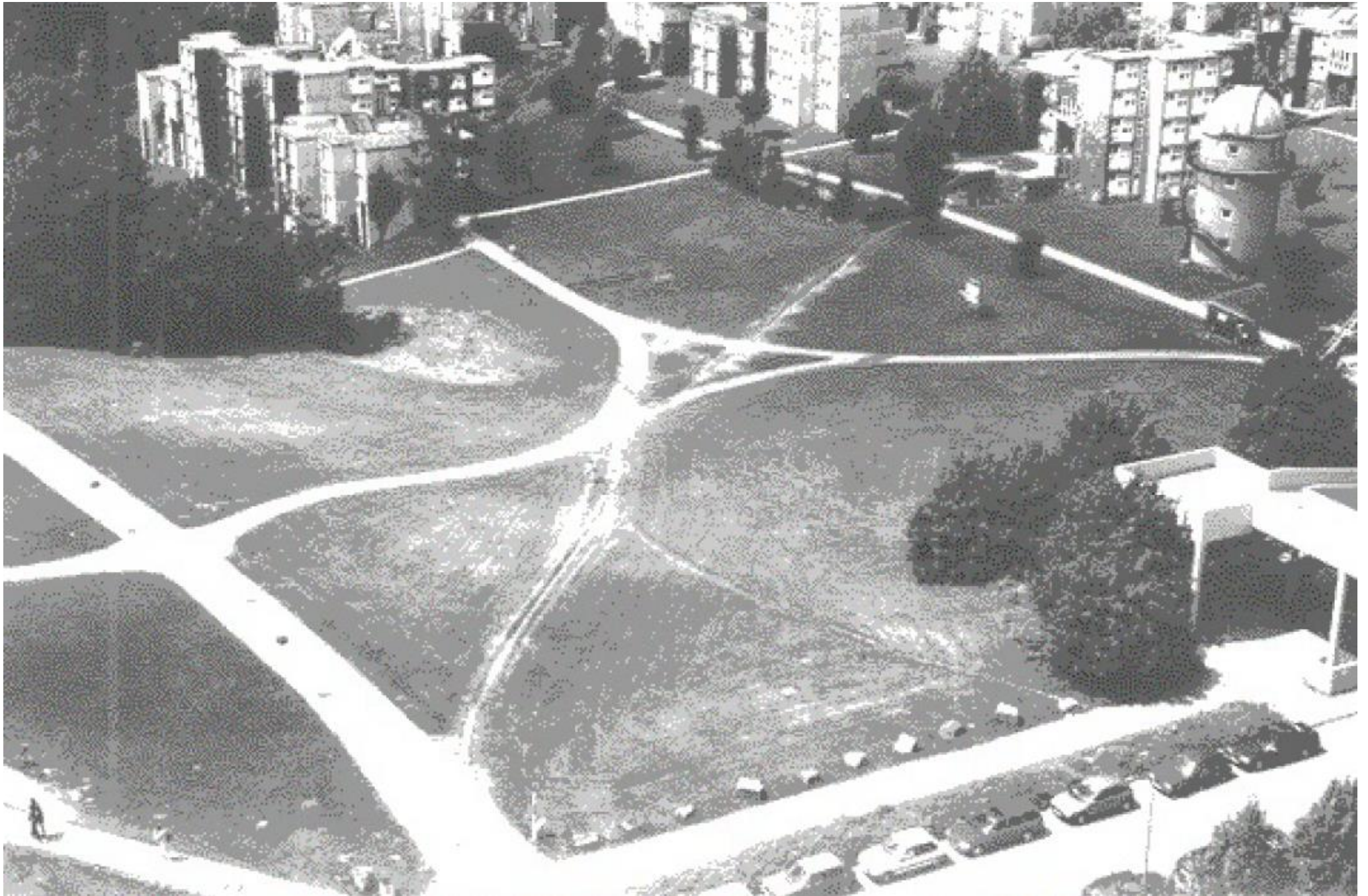
SIMULATING COMPLEXITY WITH AGENT-BASED MODELING

The complexity approach to world politics
* a highly interconnected global network of **actors**
  * organized as **agents** and **meta-agents**
* a multiplayer extension of game theory
  * helps with understanding and anticipating (not predicting) global events.

Important characteristics of the complex world of global politics:
* interconnections
* **positive feedback**
* technology
  * imagine the world without the **Internet**
* **individual empowerment**
  * did the social media enable the **Arab Spring**?
* evolution and adaptation
  * **fitness**!

Many events of world politics constitute emergent phenomena of the complex international community of state and non-state actors.

✵ may be **simulated**!

Agent-Based Modeling (ABM) is the traditional tool of analysis via simulation, with research being done in

✵ social science
✵ political science
✵ defense
✵ world politics
✵ the global environment.

The author of this tutorial teaches Game Theory and Complexity regularly to his undergraduate and graduate students in the **Department of International and European Studies** of the **University of Piraeus**.

✺ Both subjects are well fitted to **participatory simulation** in class.
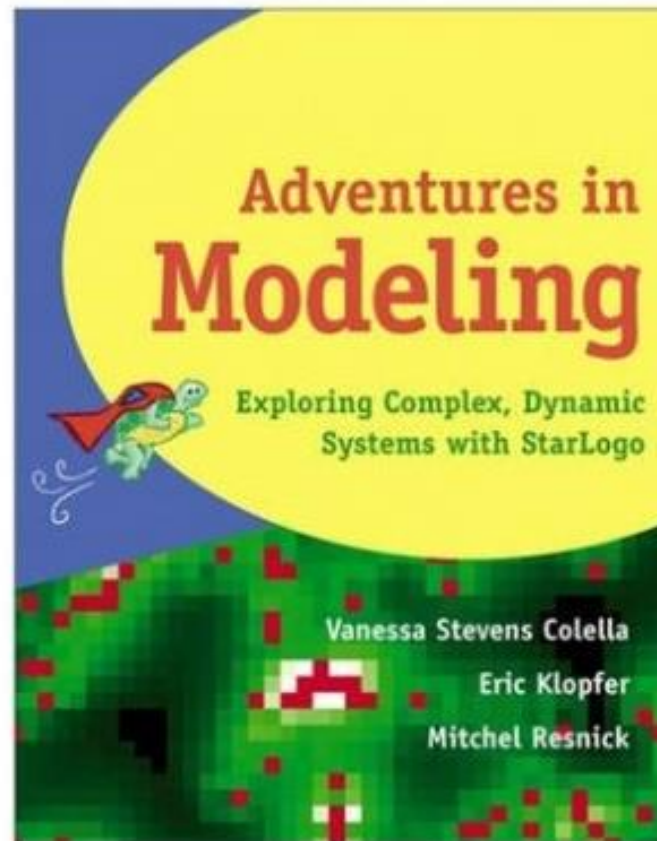
In one of his favorite in-class activities, the author tells his students to stand up and walk around and then he asks them to disperse so that they are homogeneously scattered in the classroom.

✴ In a first version of the activity, the author assigns the role of **coordinator** to one of the students, who directs each student's movement so that they all are dispersed.

✴ In a subsequent version, the author just tells the student to move as they see appropriate so that they are all dispersed more or less at an equal distance from one another and the walls.

The students quickly realize that the easiest way to achieve dispersion is when each moves on his or her own without a coordinator issuing directions.

✴ With the help of the author, they understand that all they need to do to disperse homogeneously is follow a **simple rule**:

　※　see who is closest to you and move away from him or her.

This activity is then demonstrated to the students with the help of a simple agent-based model programmed in the **PowerBASIC Console Compiler**.

✳ BASIC is a procedural language and, despite its age, remains a fine way to implement quick programming tasks

  ※ especially with **social scientists** who may not be as well versed in modern object-oriented programming techniques.
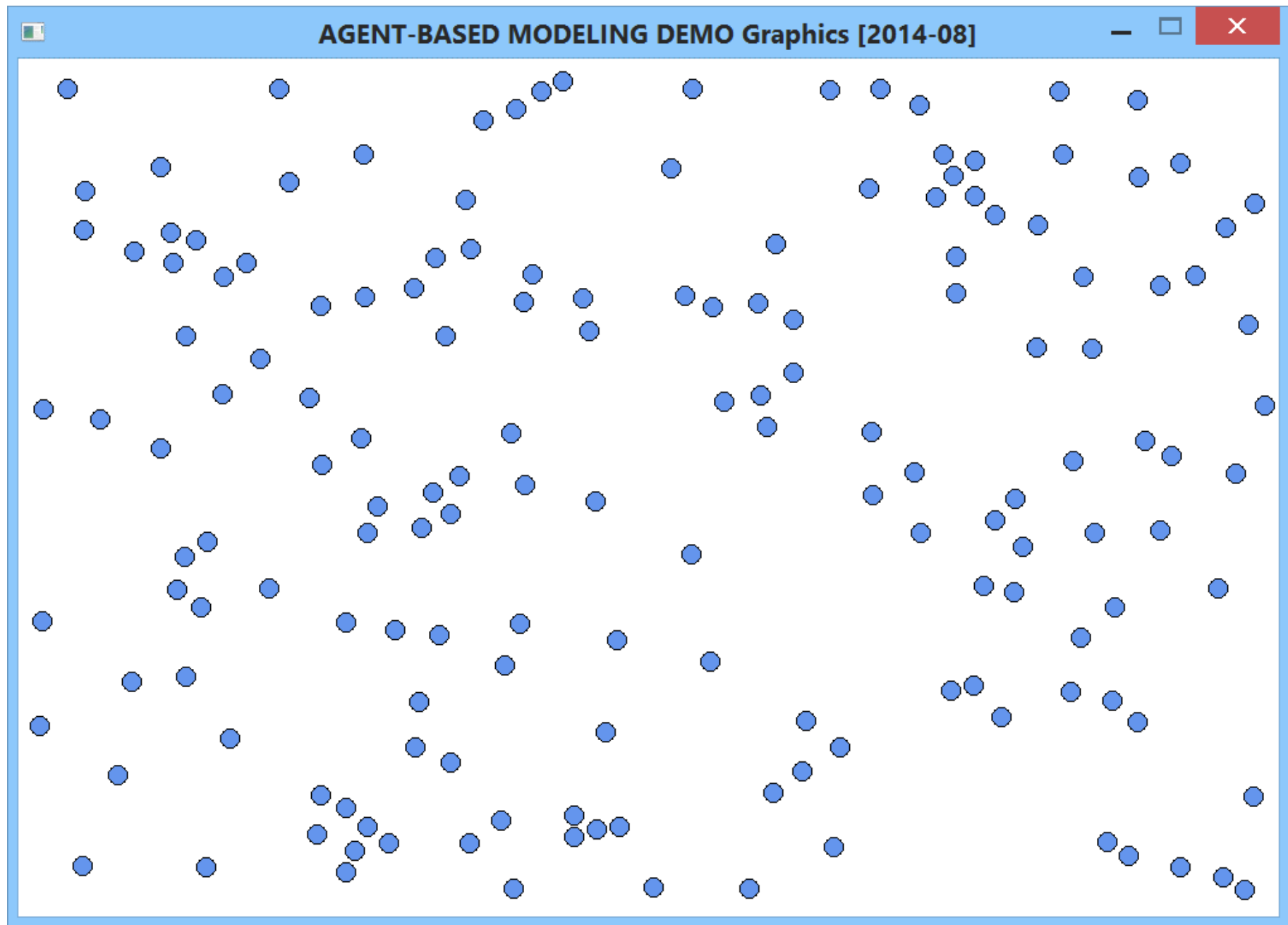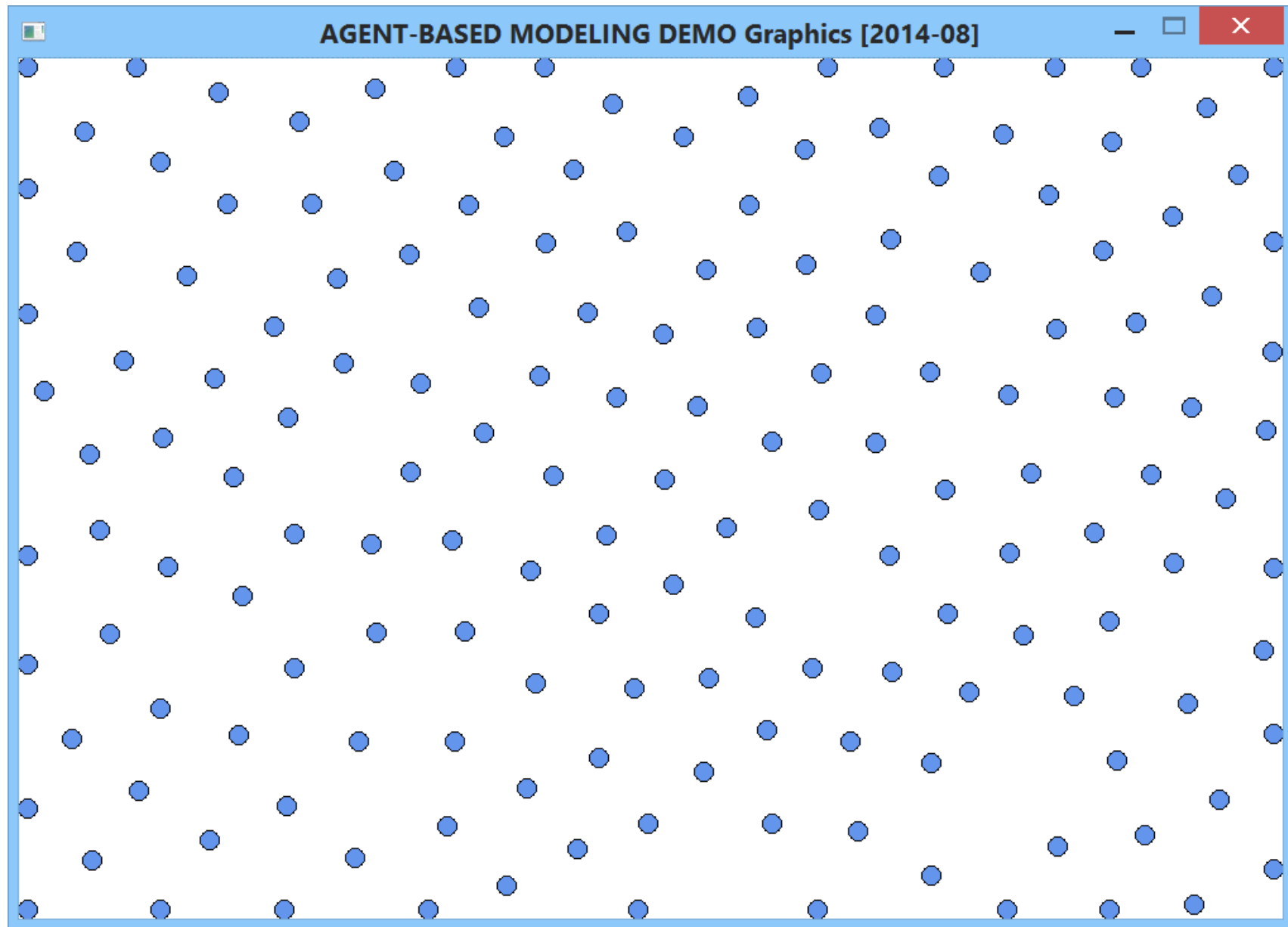
160 agents moving randomly

• 77 out of 92 •
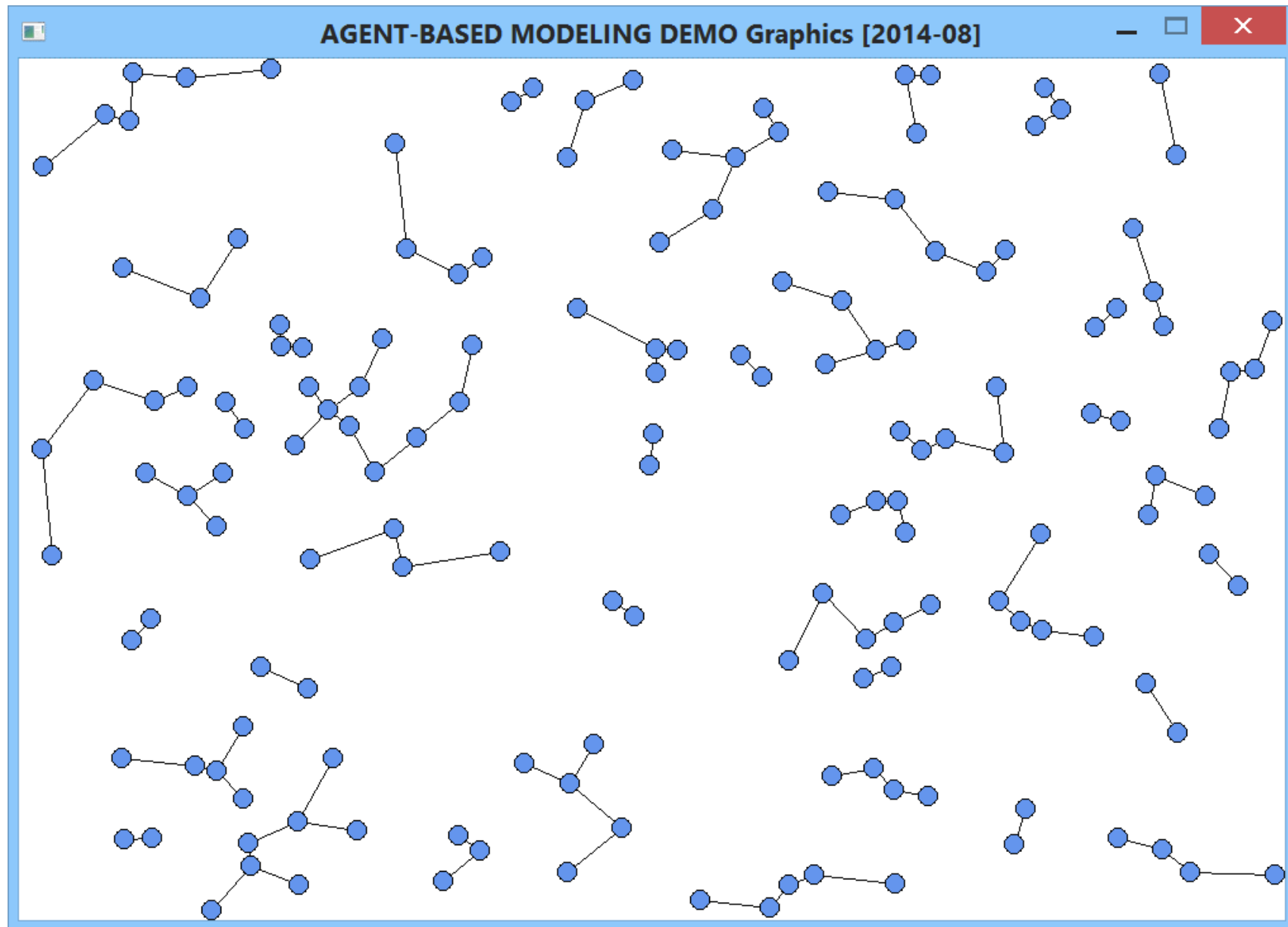
160 agents moving randomly
(distance to nearest agent displayed as solid line)

• 78 out of 92 •

160 agents moving away from nearest agent
(plus a small random jitter)

• 79 out of 92 •

The students are impressed to see how quickly (instantaneously in fact) the agents disperse in a perfectly homogeneous manner just by moving away from their closest neighbor.

It is explained to the students that
* the homogeneous dispersion of the agents is an **emergent** phenomenon of this complex system
* it is stressed to them that it is simple rules like this that oftentimes effect unexpected system-wide patterns such as **self-organization**.

Let's examine **Schelling's segregation model**, borrowing MIT's description:

✴ **Thomas Schelling**, in 1971, showed that a small preference for one's neighbors to be of the same color could lead to total segregation.

　　※　He used coins on graph paper to demonstrate his theory by placing pennies and nickels in different patterns on the "board" and then moving them one by one if they were in an "unhappy" situation.
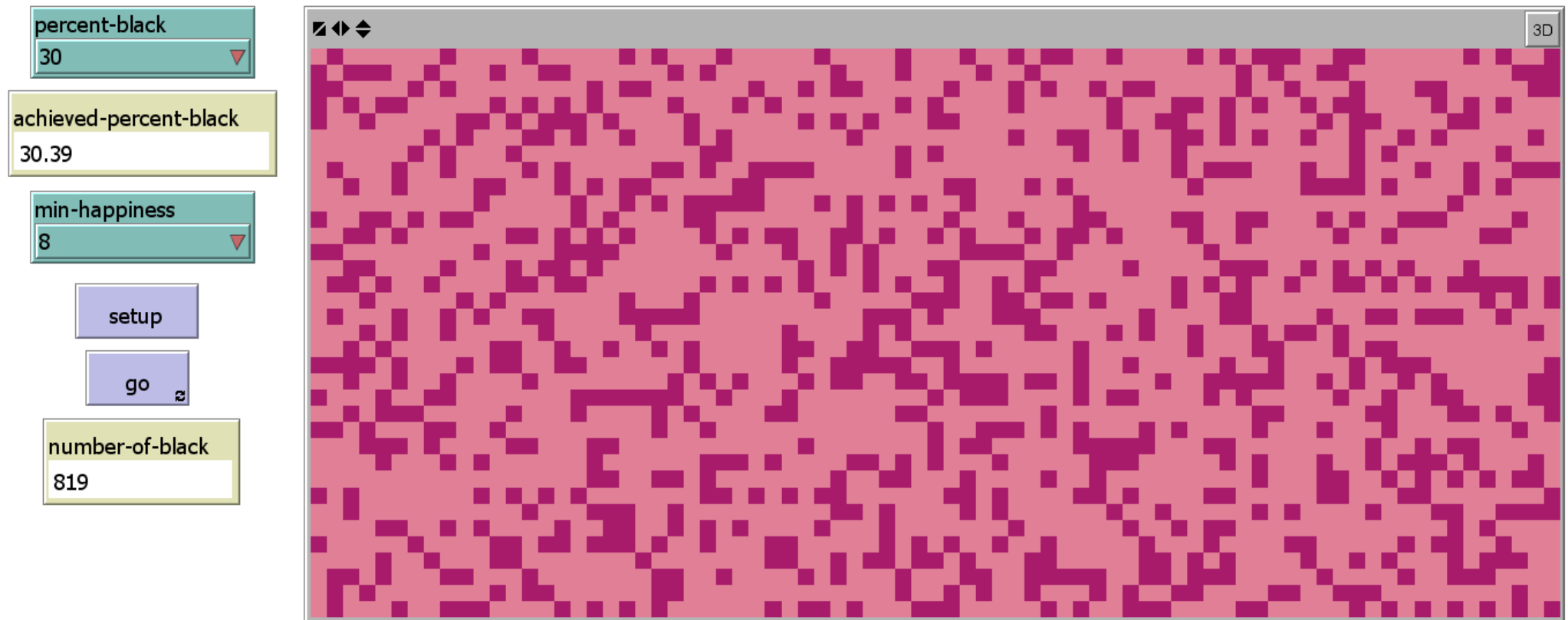
Includes the
NOBEL PRIZE
*ACCEPTANCE
LECTURE*
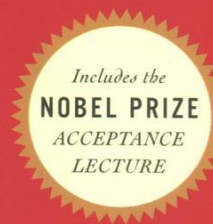
micro**MOTIVES** and **MACRO**behavior

THOMAS C. SCHELLING

"Before *Freakonomics* and *The Tipping Point,* there was *Micromotives and Macrobehavior.*" —BARRY NALEBUFF, coauthor of *Thinking Strategically*
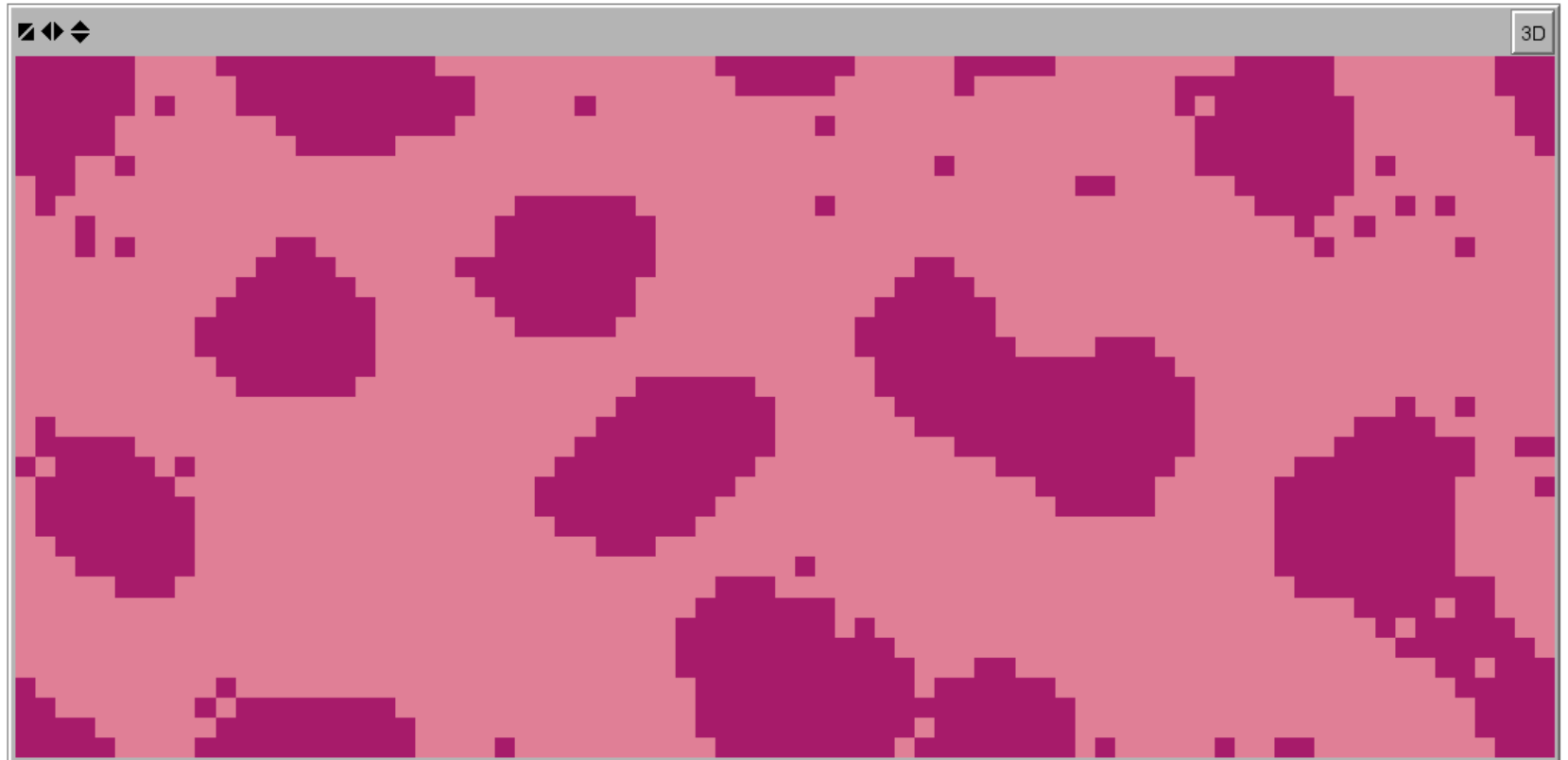
percent-black

30 ▽

achieved-percent-black

30.39

min-happiness

8 ▽

setup

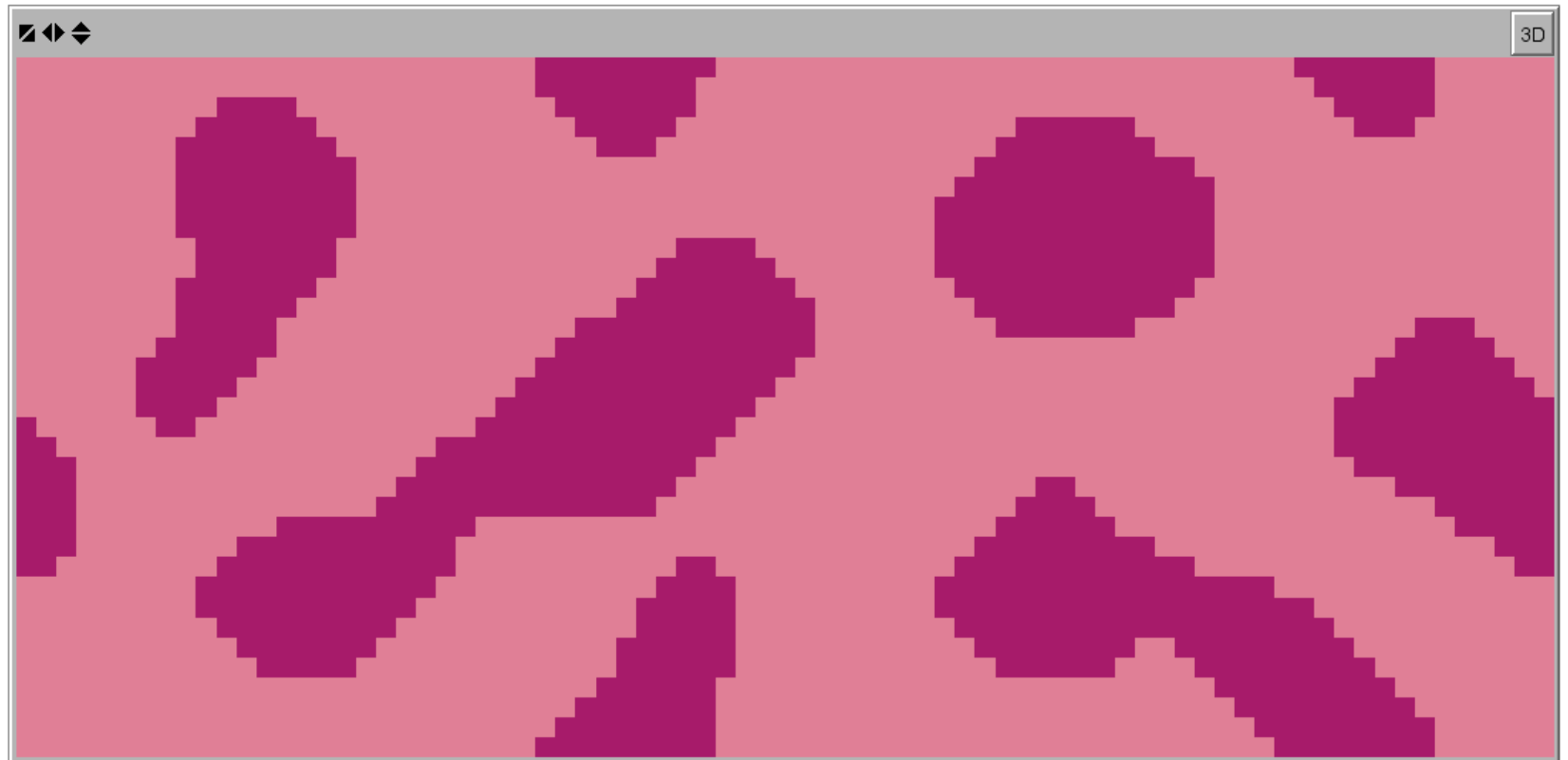go ⟳

number-of-black

819

percent-black
30

achieved-percent-black
30.39

min-happiness
8

setup

go

number-of-black
819

[NetLogo SEGREGATION model](#)

Schelling Model with 2 colors: Final State with Happiness Threshold 80%
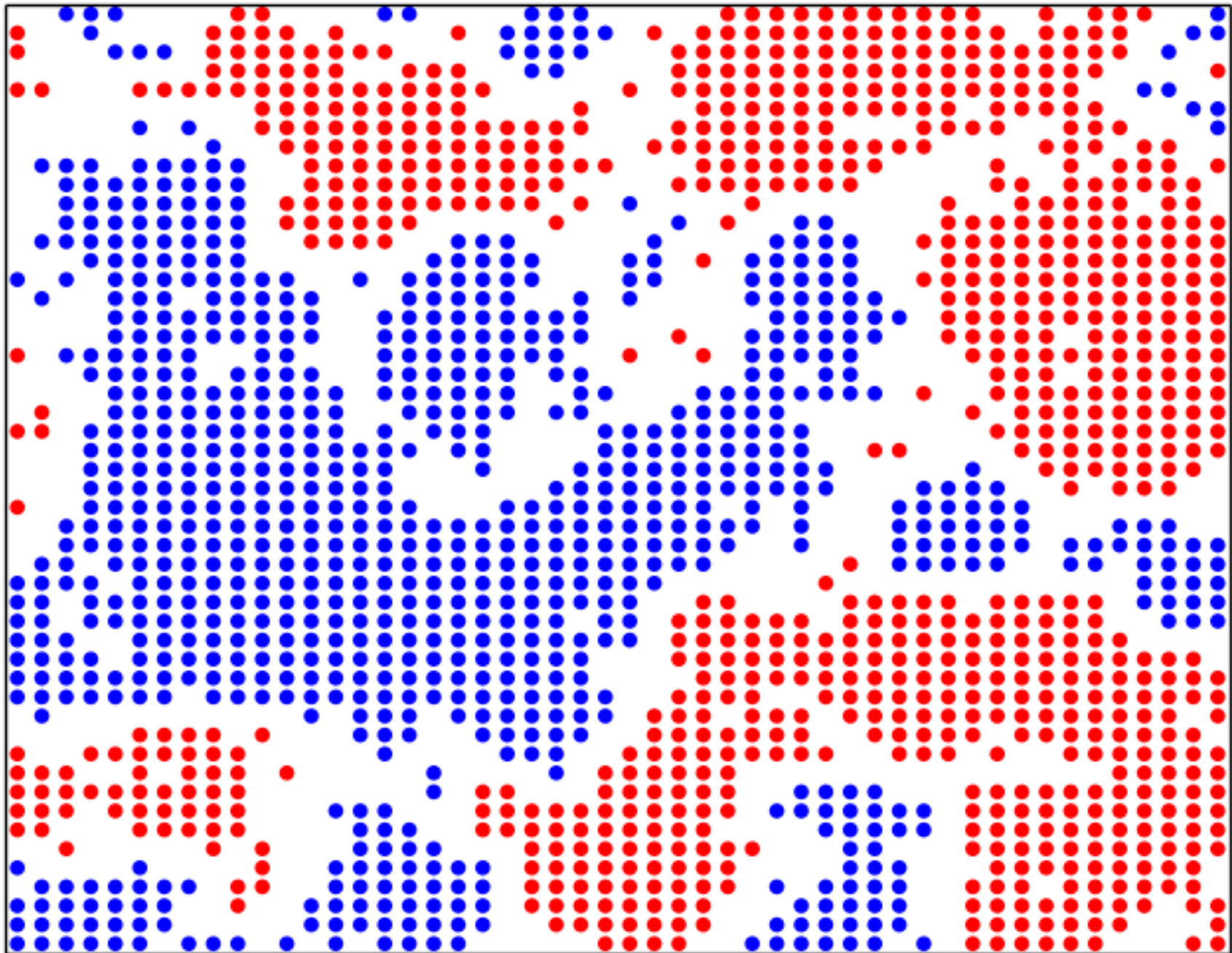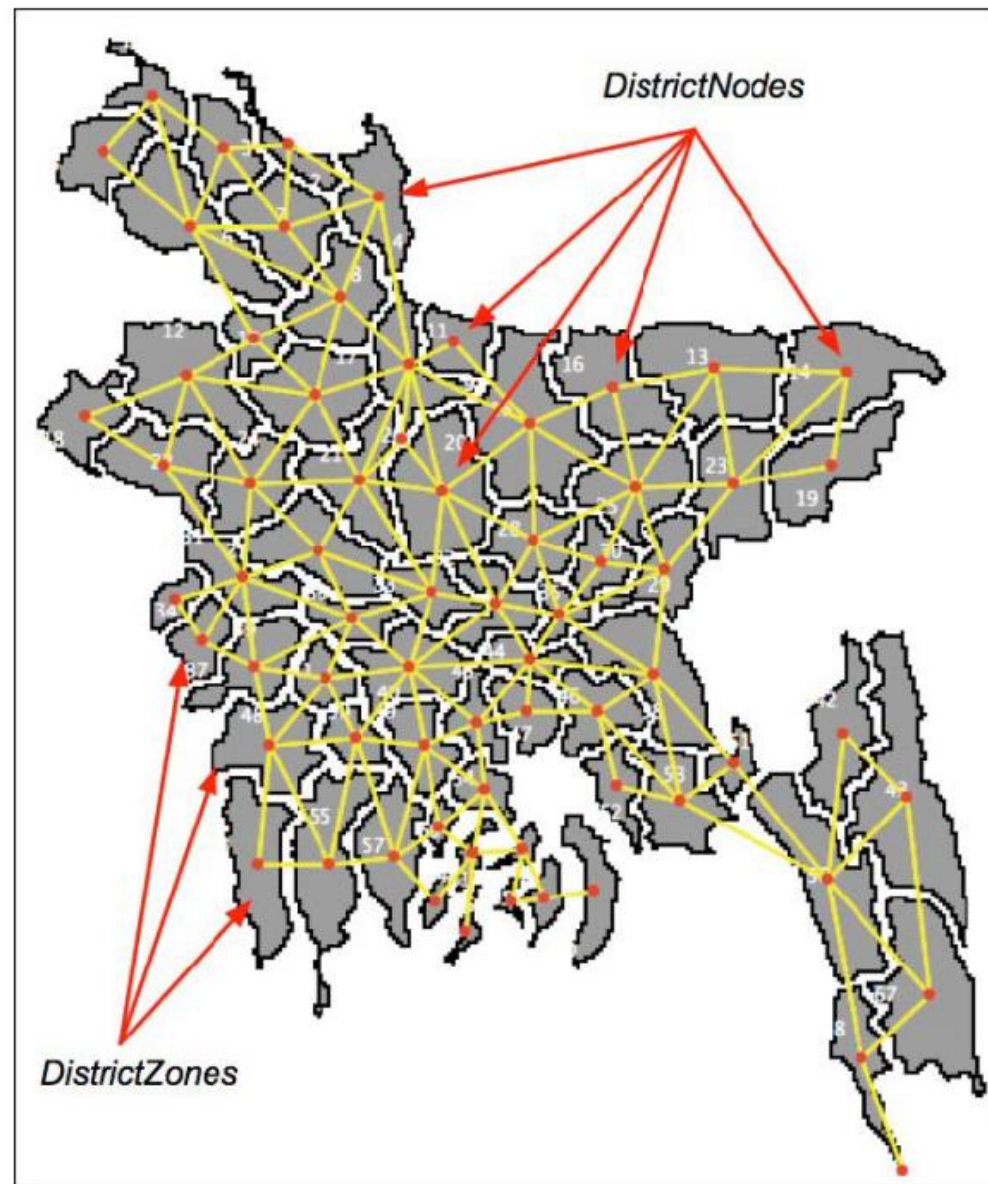
Figure 1: The resultant combined GIS layer and DistrictAgents/ModelZone network layer representation of the spatial model environment.
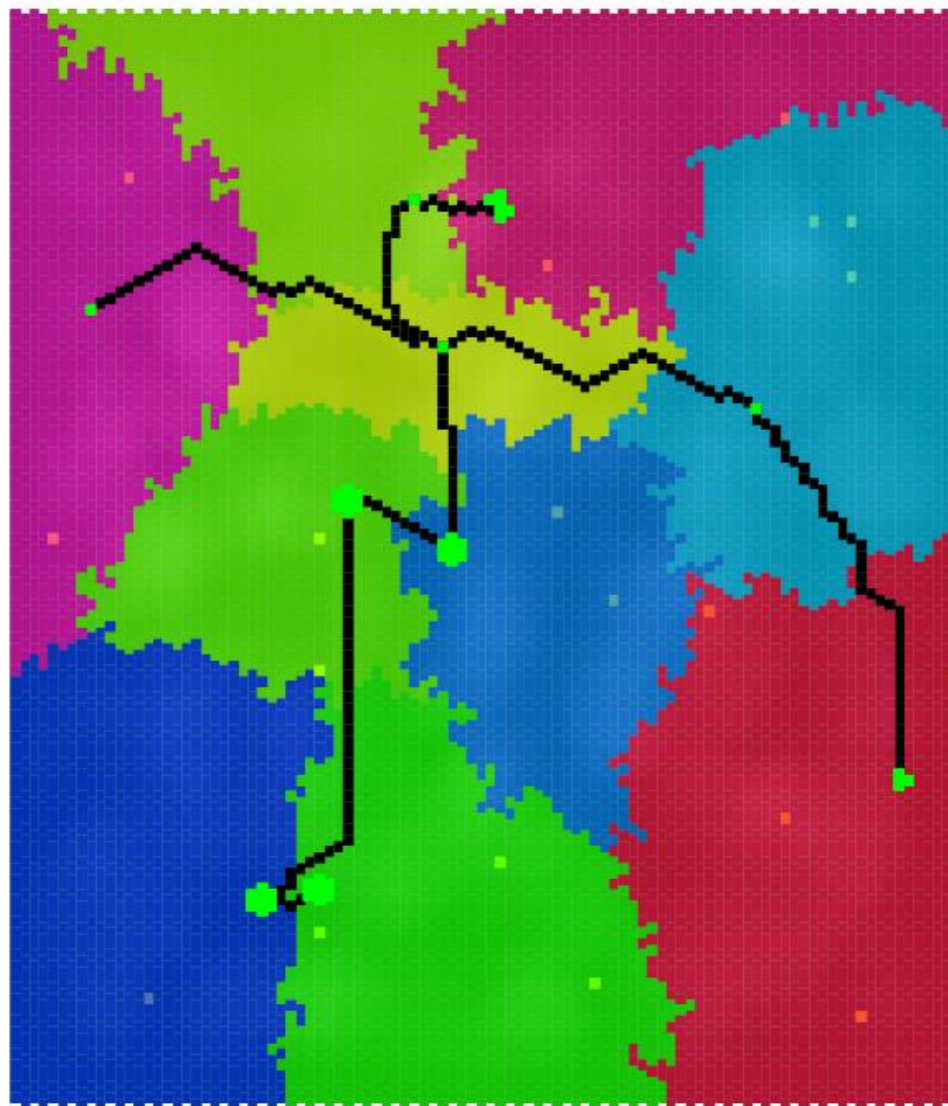
Fig. 1. Map of the AfriLand Region showing its main natural and social features, including countries, borders, cities (green), roads (black), and resources (dots). Physical topography is shown on a green-tone scale. *Source:* Prepared by the authors.

RECAPPING AND CONCLUSIONS

This tutorial suggested that
* the complexity of world politics, taking place on a highly interconnected global network of actors organized as agents and meta-agents
* is a multiplayer extension of game theory that may be regarded as a relatively novel research tool to aid with understanding and anticipating global events.

Thanks to the work of Nobel laureates that worked at the **Santa Fe Institute** such as **Murray Gell-Man** and other celebrated scientists such as **John H. Holland** and **Robert Axelrod**
* complexity science has emerged as an umbrella science
* in the case of world politics, it could be useful as a tool auxiliary to the realist worldview in modeling, understanding and perhaps anticipating the behavior of state and nonstate actors.

Eminent characteristics of the global political system such as the international anarchy or the bipolar structure of the Cold War may well be regarded as **emergent** properties of the complex global system.

The main aim of this tutorial was to
* propose that world politics be considered a CAS with
  ※ states modelled as **agents** and
  ※ international organizations such as the United Nations or the EU as **meta-agents**
* show that the simulation of the complex adaptive world with ABM may help gain a better understanding of the **system rules**
  ※ that would be an important research achievement in global politics.

Are there more? How are they generated?
How they can best be anticipated?

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Thank you for being my captive audience!