Opportunity Title: Anticipating Complexity in a Modern World Fellowship
Opportunity Reference Code: ICPD-2024-41

Organization	Office of the Director of National Intelligence (ODNI)
Reference Code	ICPD-2024-41
How to Apply	**Create and release your Profile on Zintellect** – Postdoctoral applicants must create an account and complete a profile in the on-line application system. **Please note: your resume/CV may not exceed 3 pages.** **Complete your application** – Enter the rest of the information required for the IC Postdoc Program Research Opportunity. The application itself contains detailed instructions for each one of these components: availability, citizenship, transcripts, dissertation abstract, publication and presentation plan, and information about your Research Advisor co-applicant. Additional information about the IC Postdoctoral Research Fellowship Program is available on the program website located at: https://orise.orau.gov/icpostdoc/index.html. If you have questions, send an email to ICPostdoc@orau.org. Please include the reference code for this opportunity in your email.
Application Deadline	2/28/2024 6:00:00 PM Eastern Time Zone
Description	**Research Topic Description, including Problem Statement:** The world is becoming ever more complex as physical reality is combined with the virtual world of cyber through the cyber-physical. Interdependencies of cyber-physical system components, either directly or via the virtual world of computing, are growing in intensity. At some point in the future, the technologies we increasingly rely on to live safe and fruitful lives will become complex systems with emergent properties in their own right. Soon, our relationship with the cyber-physical systems that surround us will be determined by the emergent properties of the collective and will not merely be the sum of what the developers of the individual devices intended. This affects the availability and reliability of smart cities, intelligent transport systems, supply chain logistics, smart buildings, industry 4.0, advanced military conflict, and wherever large collectives of disparate technologies sustain our lives. How do we predict the technological tipping point to complexity? How do we prepare ourselves so that we understand the security implications of technologies with properties no one intentionally designed? How stable will the environment we live in be, and how vulnerable to attack? These are just some of the questions we are likely to face in the next few years. This topic is to explore the representation of complexity in highly interdependent collectives of cyber-physical systems. We can assume that each member of the collective is a heterogenous

intelligent agent, or a member of a guild, with a model of its situation (and potentially those around it), but without visibility of the collective as a whole. Individual mission goals drive behavior (which may be prosocial or antisocial) with no guarantee of synergy or collaboration. The research is to define fundamental approaches to modelling complex systems. This may include (but is not limited to) the evolutionary dynamics: coherence in time (synchronization and coordinated dynamics), adaptation, levers and lever points; thresholds; critical behaviors; tipping points; stability; turbulence; sustainability; susceptibility; and resilience. The emphasis is on the connected technologies of tomorrow and their behaviors from a cybersecurity perspective. The aim is to create a mathematical model of complexity in collectives of cyber-physical systems that will lead to better understanding of security vulnerabilities, the corresponding defenses, and the potential impact of cyber-attack.

Example Approaches:

- Models of complexity in intelligent agency (e.g., emergent properties of Popperian intelligent agents, antifragile systems).
- Agent-based modelling of multi-agent systems (e.g., stochastic modelling of multi-agent behavior and interactions; swam intelligence models).
- Generative self-organization (and Finitely Generated Systems).
- Measures of complexity, such as entropy; intensive or extensive measures (of how the properties changes when the size or extent of the system changes); behavior (such as measures based on the law of requisite variety).
- Revealed Dynamics Markov Model (Bramson, 2019 in Carmichael et. al. pp79-128).
- Other mathematical tools of complexity science: branching processes (and generator functions), statistical mechanics, network theory (and graphs), information theory and entropy, stochastic dynamics (and probability), intermittent dynamics (and differences in dynamics at the individual and aggregated scales), and co-evolutionary dynamics.

Ted Carmichael (Editor), Andrew J. Collins (Editor), Mirsad Hadžikadic (Editor), Complex Adaptive Systems: Views from the Physical, Natural, and Social Sciences (Understanding Complex Systems), Springer; 1st ed. 2019 edition (27 Jun. 2019), ISBN-13: 978-3030203078

Key Words: Microbiome; Biosecurity; Detection; Attribution; Disease; Engineering Biology; Synthetic Biology.

Qualifications

Postdoc Eligibility

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- U.S. citizens only
- Ph.D. in a relevant field must be completed before beginning the appointment and within five years of the appointment start date
- Proposal must be associated with an accredited U.S. university, college, or U.S. government laboratory
- Eligible candidates may only receive one award from the IC Postdoctoral Research Fellowship Program

Research Advisor Eligibility

- Must be an employee of an accredited U.S. university, college or U.S. government laboratory
- Are not required to be U.S. citizens

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12 👁)
  - **Communications and Graphics Design** (3 👁)
  - **Computer, Information, and Data Sciences** (16 👁)
  - **Earth and Geosciences** (21 👁)
  - **Engineering** (27 👁)
  - **Environmental and Marine Sciences** (14 👁)
  - **Life Health and Medical Sciences** (45 👁)
  - **Mathematics and Statistics** (11 👁)
  - **Other Non-Science & Engineering** (2 👁)
  - **Physics** (16 👁)
  - **Science & Engineering-related** (1 👁)
  - **Social and Behavioral Sciences** (30 👁)