

Topic:

- Sustainability

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- **Sustainability** is the ability to maintain the balance of a process in a system over the long term.
- **Ecological sustainability** is the ability of an ecosystem to maintain ecological processes, functions, biodiversity, and productivity into the future.

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- **Sustainable development** is the ability to recognize and meet the needs of the present without compromising the ability of future generations to meet their own needs. [Brundtland, *Our Common Future*, 1987].

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This natural inequality of the two powers, of population, and of production of the earth, and that great law of our nature which must constantly keep their effects equal, form the great difficulty.
- The global planetary system must satisfy the constraint that the consumption by the growing population is limited by the food production of the Earth.
- That is just one of many constraints that must be satisfied for our planetary system to be sustainable and resilient.

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- But many resources are consumed and wasted.
- Mining for the materials needed for computers, devices, and batteries can have serious environmental effects.

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- Mining of some **cryptocurrency** coins, such as Bitcoin, and the verification of cryptocurrency transactions are also major resource sinks.
- Countering these trends is the **green information technology** movement, which aims to design, manufacture, use, repair, and dispose of computers, servers, and other devices with minimal energy use and impact on the environment.

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- Two main themes:
 - ▶ Developing computational models and methods for **offline** decision making for the management and allocation of ecosystem resources
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- AI plays a key role in both themes.

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- The boundaries are **goal constraints** on:
 - ▶ climate change
 - ▶ rate of biodiversity loss (terrestrial and marine)
 - ▶ interference with the nitrogen and phosphorus cycles
 - ▶ stratospheric ozone depletion
 - ▶ ocean acidification
 - ▶ global freshwater use
 - ▶ change in land use
 - ▶ chemical pollution
 - ▶ atmospheric aerosol loading.

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- **Constraint satisfaction** is at the core of computational sustainability.

- The United Nations specified 17 **Sustainable Development Goals (SDGs)** [UN, 2015].
- The SDGs cover the nine biophysical planetary boundary constraints and extend them to cover human social and economic goals such as reducing poverty, hunger, and inequality, while improving health, education, and access to justice.

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- Multiagent techniques based on **Stacklberg security games** can enhance public health, security, and social justice. [Perrault, 2020]
- Multiagent methods also address the so-called **tragedy of the commons** which is at the heart of sustainability concerns [Hardin, 1968]. Ostrom [1990] showed that institutions for collective action can evolve to govern the commons.

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- Some of the positive environmental impacts of intelligent vehicles and smart traffic control were presented in Lecture 18.3.

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- Determining the winner is difficult because preferences are usually not **additive**, but items are typically **complements** or **substitutes**.
- Work on combinatorial auctions, already applied to spectrum allocation (allocation of radio frequencies to companies for television or cell phones), logistics (planning for transporting goods), and supply chain configuration, could further be applied to support carbon markets, to optimize energy supply and demand, and to mitigate climate change.