Communication amid Uncertainty

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Based on:

- Universal Semantic Communication – Juba & S. (STOC 2008)
- Goal-Oriented Communication – Goldreich, Juba & S. (JACM 2012)
- Compression without a common prior … – Kalai, Khanna, Juba & S. (ICS 2011)
- Efficient Semantic Communication with Compatible Beliefs – Juba & S. (ICS 2011)

Uncertainty in Communication?

- Always has been a central problem:
  - But usually focusses on uncertainty introduced by the channel
  - Standard Solution:
    - Use error-correcting codes
    - Significantly:
      - Design Encoder/Decoder jointly
      - Deploy Encoder at Sender, Decoder at Receiver

New Era, New Challenges:

- Interacting entities not jointly designed.
  - Can't design encoder+decoder jointly.
  - Can they be build independently?
  - Can we have a theory about such?
    - Where we prove that they will work?
    - Hopefully:
      - YES
      - And the world of practice will adopt principles.

Example 1

- Intersystem communication?
  - Google+ ↔ Facebook friendship ?
  - Skype ↔ Facetime chat?

- Problem:
  - When designing one system, it is uncertain what the other's design is (or will be in the future)!

Example 2

- Heterogenous data?
  - Amazon-marketplace spends N programmer hours converting data from mom-n-pop store catalogs to uniform searchable format.
  - Healthcare analysts spend enormous #hours unifying data from multiple sources.
- Problem: Interface of software with data:
  - Challenge:
    - Software designer uncertain of data format.
    - Data designer uncertain of software.

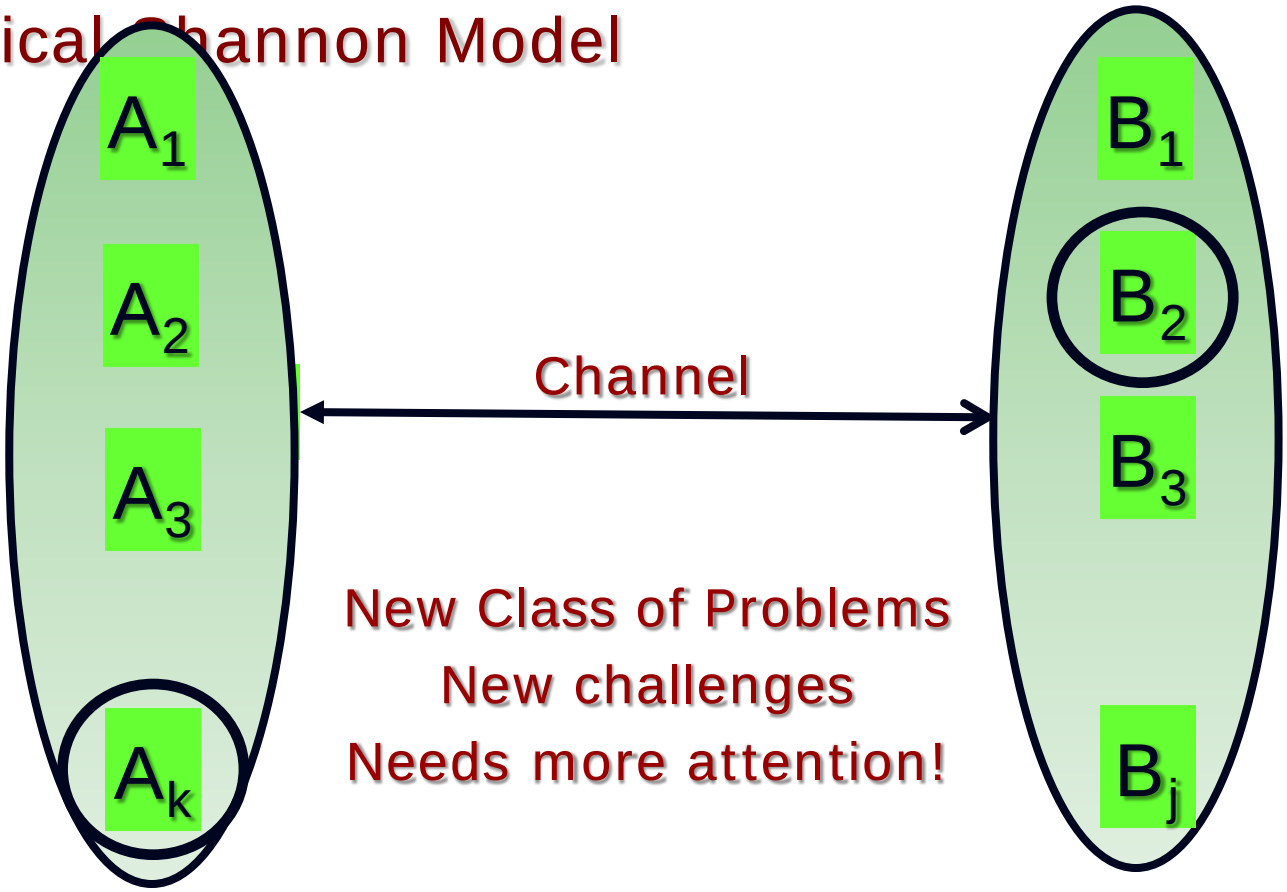
Example 3

- Archiving data
  - Physical libraries have survived for 100s of years.
  - Digital books have survived for five years.
  - Can we be sure they will survive for the next five hundred?

- Problem: Uncertainty of the future.
  - What systems will prevail?
  - Why aren't software systems ever constant?

Modelling uncertainty

Semantic Communication Model
Classical Shannon Model



New Class of Problems
New challenges
Needs more attention!

Nature of uncertainty

- A_i's, B_j's differ in beliefs, but can be centrally programmed/designed.
  - [Juba,Kalai,Khanna,S.'11] : Compression in this context has graceful degradation as beliefs diverge.
- A_i's, B_j's differ in behavior:
  - Nothing to design any more.
  - Best hope: Can highlight certain A_i's (universalists) that can interact successfully with many B_j's
  - [Juba,S'08; Goldreich,J,S'12; J,S'11]: "All is not lost, if we keep goal of communication in mind"
  - Details don't fit in margin …

Future?

- Understand human communication?
  - How does it evolve
  - What are influencing factors?
    - (My guesses): Compression, Computation, Survival of fittest.
- Extend to other “distributed design” settings.
- Architecture/Program for preserving Data?
  - Blend safe assumptions, with “likely-to-be-fast” performance.

Thank You!