Digital Communications
SSY125, Lecture 1

The Big Picture

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The communication problem

The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have meaning

—Claude Shannon, A Mathematical Theory of Communication (1948)

Digital communications is at the basis of the modern society

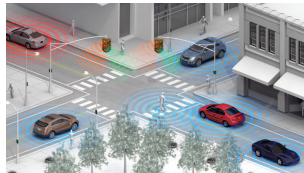# Digital communications is everywhere
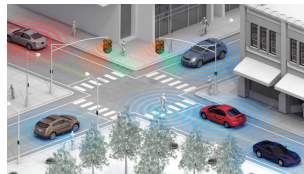
Digital communications is everywhere

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Digital communications is everywhere

The communication problem

audio, video
digital data

The communication problem

audio, video
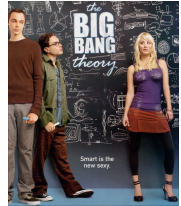digital data

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The communication problem

audio, video
digital data
100110101

channel

satellite link,
fiber, wireless link,
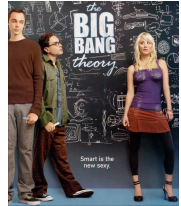hard-disk drive

The communication problem

audio, video
digital data

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channel

satellite link,
fiber, wireless link,
hard-disk drive

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Errors may occur during transmission!

Some fundamental questions...

channel

satellite link,
fiber, wireless link,
hard-disk drive

audio, video
digital data

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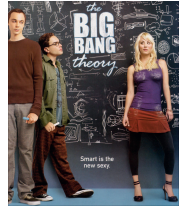100011101

Some fundamental questions...

audio, video
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How do we measure information?

Some fundamental questions...

audio, video
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How do we measure information?

How can we represent the information of the source efficiently?

Some fundamental questions...

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How do we measure information?

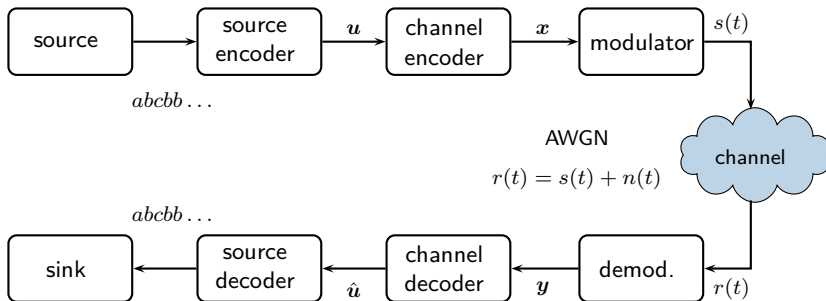How can we represent the information of the source efficiently?

Can we transmit reliably over a non-reliable (noisy) channel?

Some fundamental questions...

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How do we measure information?

How can we represent the information of the source efficiently?

Can we transmit reliably over a non-reliable (noisy) channel?

How much information can we transmit reliably through the channel?
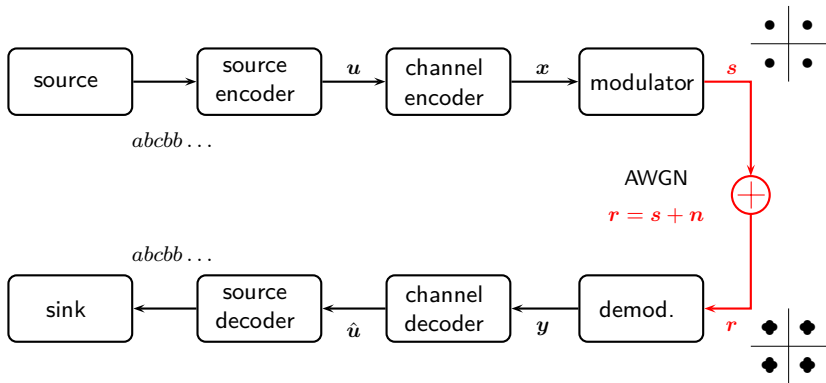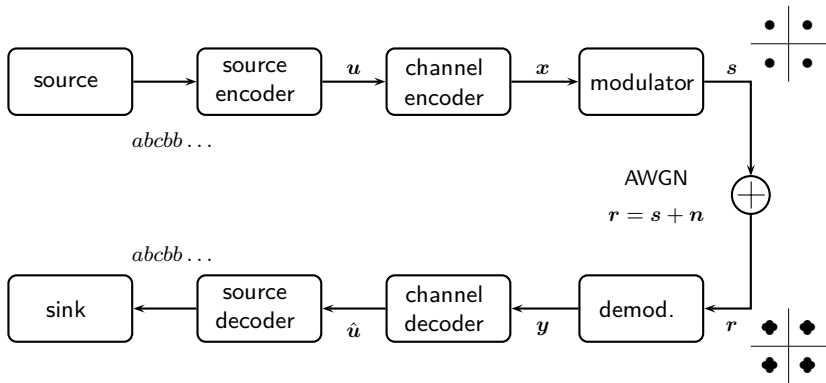
Shannon's communication model
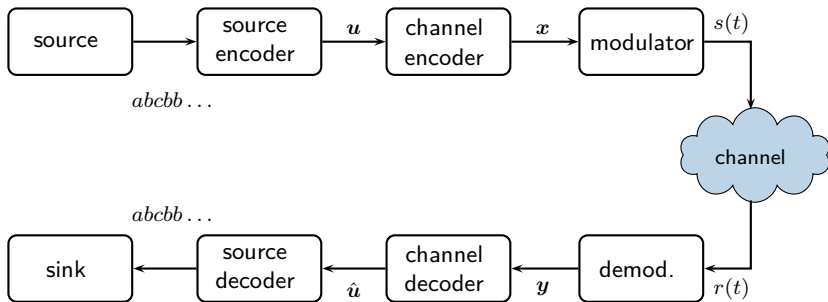
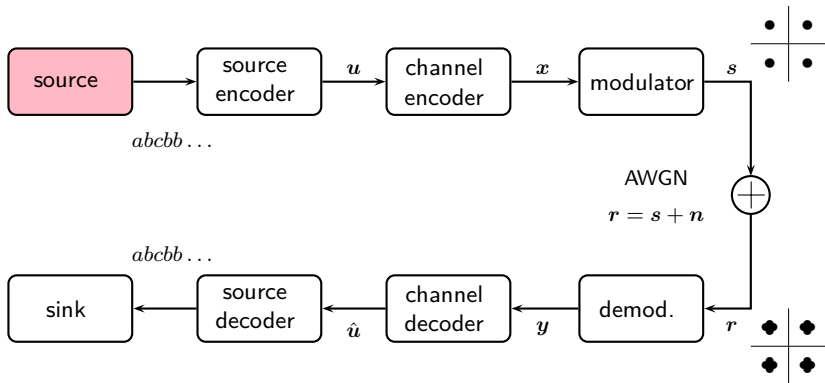# Shannon's communication model

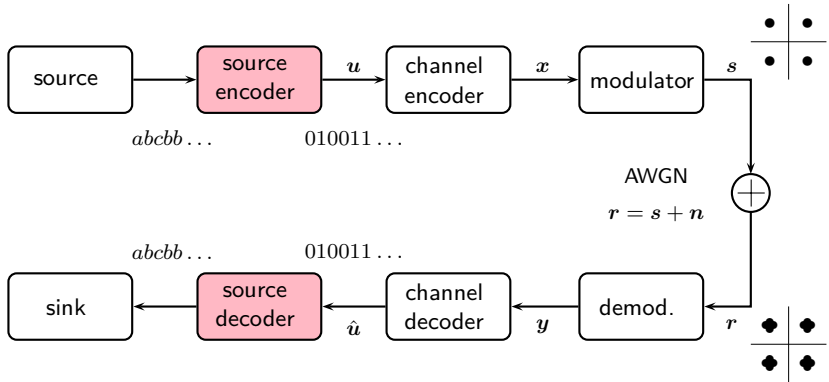# Shannon's communication model

Shannon's communication model

Shannon's communication model

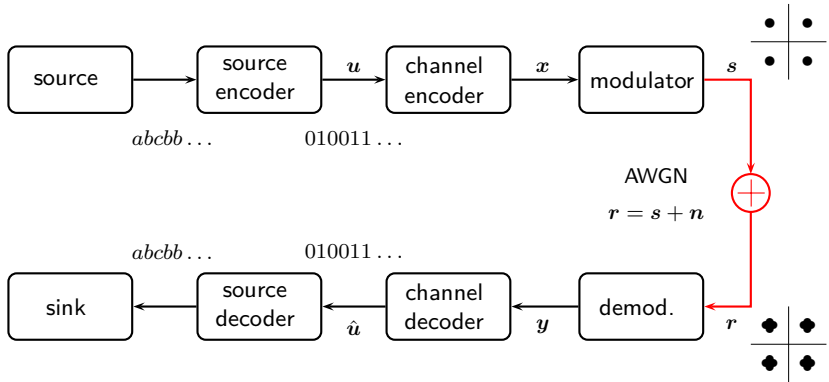How do we measure information? Definition of information (Lecture 2)
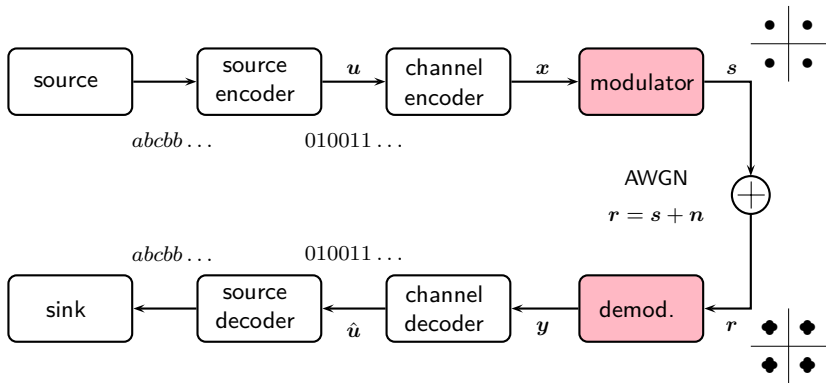
Shannon's communication model

How do we represent the information at the output of the source efficiently? Source compression (Lectures 2, 3, and 4)
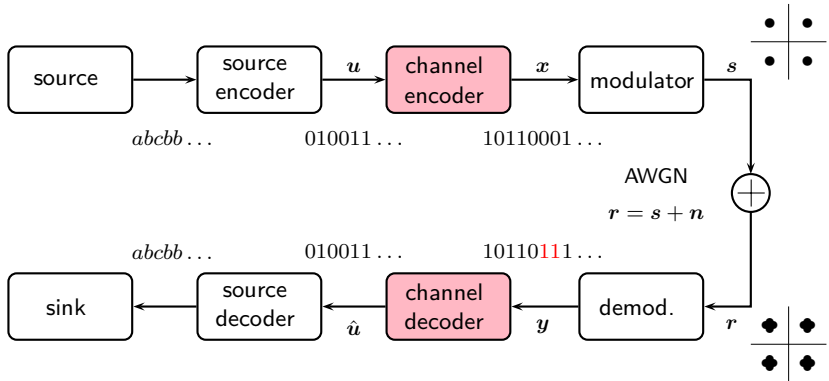
Shannon's communication model

How much information we can communicate reliably through the channel? Channel capacity (Lectures 5 and 6)

Shannon's communication model

Uncoded transmission with linear modulation: a benchmark (Lecture 7)

Shannon's communication model

How do we achieve the channel capacity in practice?

Channel coding (Lectures 8 to 14)

More than communication and storage

> The concepts introduced in this course extend
> beyond communication and storage

Coding plays a key role in:
- Distributed computing
- Decentralized learning
- DNA storage
- Distributed storage and caching
- Quantum key distribution
- Post-quantum cryptography
- Privacy and security
- Uncoordinated multiple access, . . .