EECE 580B
Modern Coding Theory

Information theory

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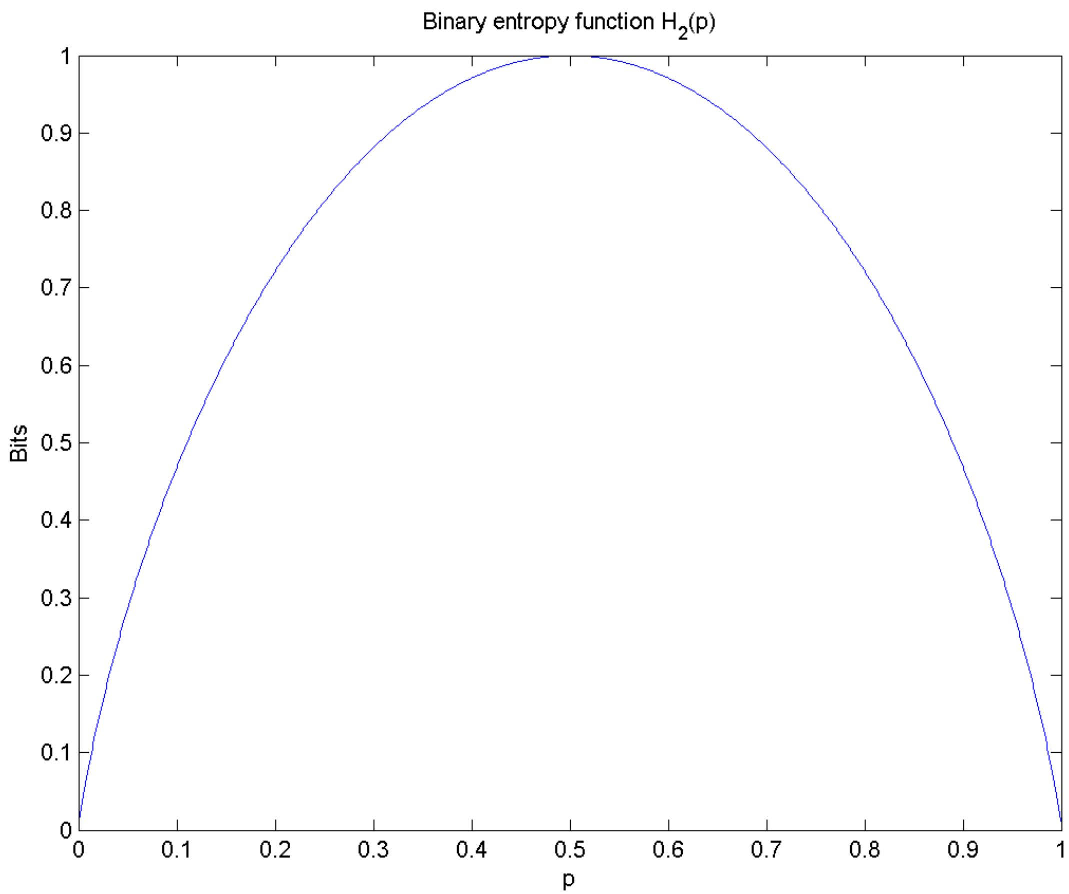
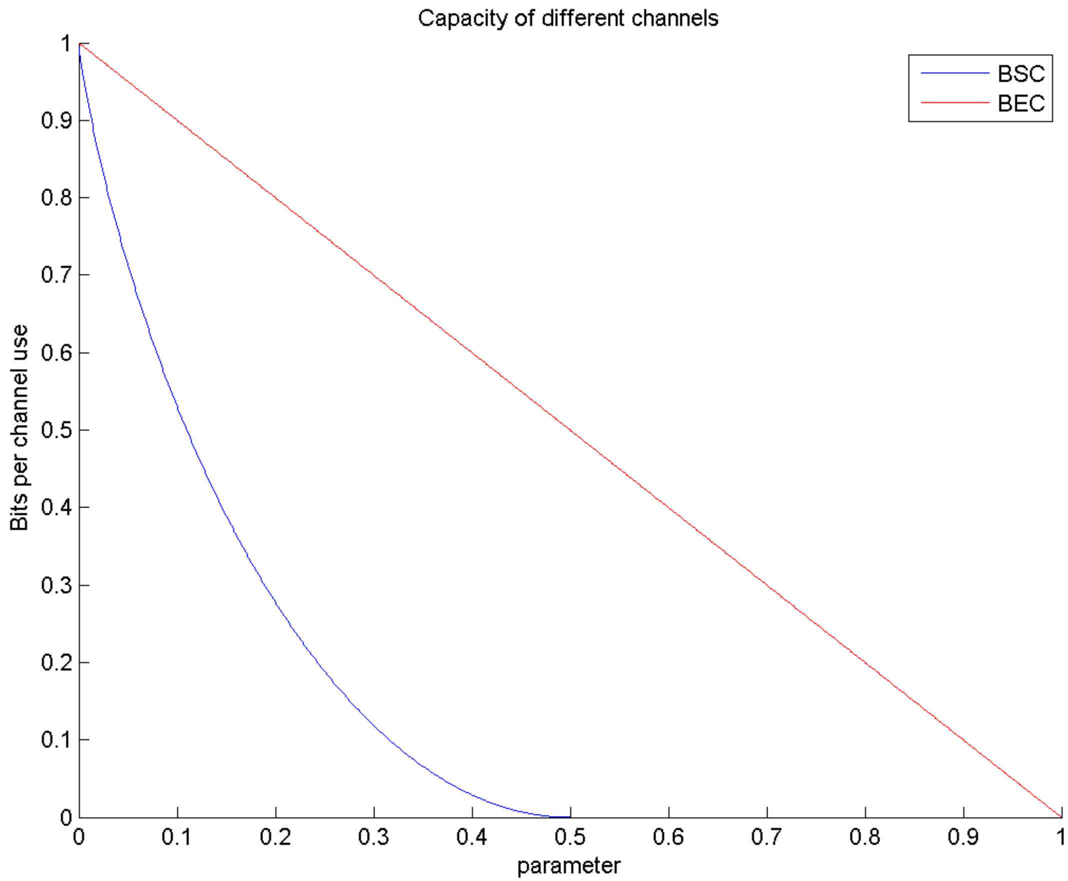
Binary Entropy Function



$$H_2(p) = -p \cdot \log_2(p) - (1-p) \cdot \log_2(1-p)$$

Capacity of BEC and BSC Channel



Point-to-Multipoint Communication

Point-to-Multipoint Communication

Distribute updates of GPS maps to cars using a satellite link.

Cars see the satellite at random times and experience different losses. There is no feedback between car and satellite.

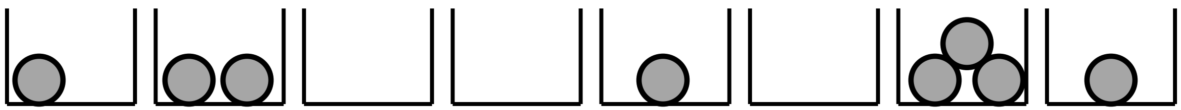
Point-to-Multipoint Communication

Trivial solution:

- Send the original data several times in a carousel manner.
- Original file consists of k packets; cars tune in at a random times, and each time they receive b packets.
- Assume that a complete transmission of k packets takes one day.
- Every car tunes in 2 times per day. How many days d of transmission are needed to ensure that 99.99% of the cars have received all the packets? (minimum is k/2b)

Model:

- throw dk balls at random into k bins. For a given bin, what is the probability that it has received at least one ball?



k bins

Point-to-Multipoint Communication

Each day, every bin receives a ball with probability 2b/k.

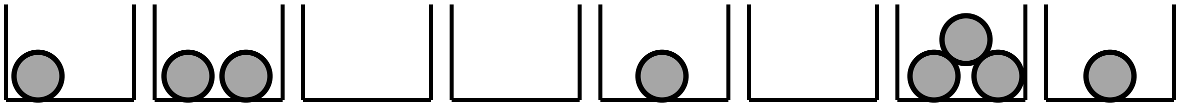
Probability that the bin is empty after d days is

$$(1 - 2b/k)^d \approx \exp(-2bd/k)$$

Want this quantity to be less than 0.0001; so d is roughly 4.6k/2b, that means every car receives 9.4k packets (instead of only k) of which many duplicate.

file = k packets
car receives b packets in one day
d = number of days needed

There is an elegant solution to this problem that needs only little bit more that k packets!



k bins