Digital Communication Systems
EES 452

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4. Mutual Information and Channel Capacity

4.4 Special Cases for Calculation of Channel Capacity

Calculating channel capacity

1. Use (multi-variable) calculus
   - standard nonlinear optimization techniques
2. Use Blahut-Arimoto algorithm (MATLAB)
3. Check whether we can match the **Q** matrix with any known special cases.

Remark: Do not assume that the input probabilities will have to be uniform to obtain C.

- See BAC in Ex. 4.25.

Channel Capacity: Special Cases

- **Channel with Nonoverlapping Outputs (NO^2)**
  - There is only one non-zero element in each column of its $\mathbf{Q}$ matrix.
  - $C = \log_2 |\mathcal{X}|$ [4.30]
    is achieved by uniform input probabilities.
  - Ex. Noiseless Binary Channel: $C = 1$ [bpcu] [Ex. 4.27]
- **Weakly Symmetric Channel**
  - (1) all the rows of $\mathbf{Q}$ are permutations of each other and [Defn 4.36]
    (2) all the column sums are equal.
  - $C = \log_2 |\mathcal{Y}| - H(\underline{\mathbf{r}})$ where $\underline{\mathbf{r}}$ is any row from the $\mathbf{Q}$ matrix. [4.37]
    is achieved by uniform input probabilities.
  - Ex. Binary Symmetric Channel: $C = 1 - H(p)$ [bpcu]