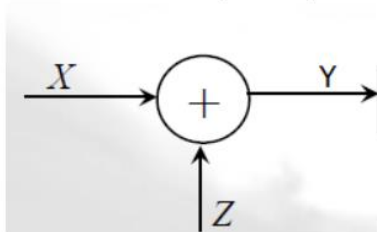


一、判断题：3\*10=30分

二、简答题：4\*5=20分

- 1.等长编码和不等长编码的优缺点
- 2.比较极大似然 (ML) 和极大后验 (MAP) 的异同
- 3.如何理解Kolmogorov复杂度，并比较它和熵的关系
- 4.设计一个两层感知器来表示异或布尔函数
- 5.一个吸尘器，装有红外传感器和微芯片，没电了会自动往回充电，设计其碰到障碍物自动避开的闭环反馈控制系统

三、 $x = \{0,1\}$   $Z = [0 \quad a]$   $Y = X+Z$ ,求 $a$ 取不同值时的信道容量 10分  
[0.5 0.5]



四、给定总功率为24mW，5个独立同分布的高斯信道，噪声功率分别为1,2,4,9,16。 15分

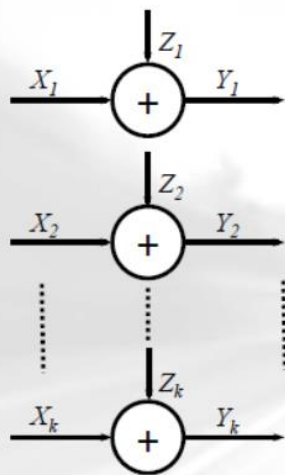
(1) 平行时信道容量

答：用注水法则

(2) 级联时信道容量

相关知识

## 高斯平行信道



$$Y_j = X_j + Z_j, \quad j = 1, 2, \dots, k$$

$$Z_j \sim \mathcal{N}(0, N_j), \quad j = 1, 2, \dots, k$$

$$E \left\{ \sum_{j=1}^k X_j^2 \right\} \leq P$$

$$I(X_1, X_2, \dots, X_k; Y_1, Y_2, \dots, Y_k)$$

$$= h(Y_1, Y_2, \dots, Y_k) - h(Y_1, Y_2, \dots, Y_k | X_1, X_2, \dots, X_k)$$

$$= h(Y_1, Y_2, \dots, Y_k) - h(Z_1, Z_2, \dots, Z_k)$$

$$= h(Y_1, Y_2, \dots, Y_k) - \sum_{i=1}^k h(Z_i)$$

$$\leq \sum_{i=1}^k h(Y_i) - \sum_{i=1}^k h(Z_i)$$

$$\leq \frac{1}{2} \sum_{i=1}^k \log \left( 1 + \frac{P_i}{N_i} \right)$$

$$\text{其中 } P_i = EX_i^2, \quad \sum_{i=1}^k P_i \leq P$$

## 高斯平行信道

$$J(P_1, P_2, \dots, P_k) = \sum_{i=1}^k \frac{1}{2} \log \left( 1 + \frac{P_i}{N_i} \right) + \lambda \sum_{i=1}^k P_i$$

$$\frac{\partial J}{\partial P_i} = \frac{1}{2} \frac{1}{P_i + N_i} + \lambda = 0$$

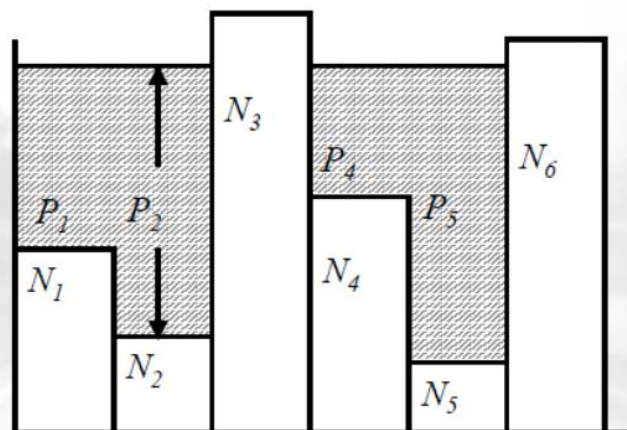
$$P_i = \nu - N_i, i = 1, 2, \dots, k$$

$$P_i = (\nu - N_i)^+ \quad \text{这里 } (x)^+ = \begin{cases} x & \text{如 } x \geq 0 \\ 0 & \text{如 } x < 0 \end{cases}$$

再由  $\sum_{i=1}^k (\nu - N_i)^+ = P$  求出  $\nu$

$$C = \frac{1}{2} \sum_{i=1}^k \log \left( 1 + \frac{(\nu - N_i)^+}{N_i} \right)$$

## 注水法则



## 例子：Play Tennis

- ✧ 每一天属性由：Outlook、Temperature、Humidity和Wind来描述
- ✧ 判断周六是否适合打网球（Yes or No）
- ✧ 周六天气属性：
  - Outlook = Sunny
  - Temperature = Hot
  - Humidity = High
  - Wind = Strong

## 例子：Play Tennis

Day	Outlook	Temp.	Humidity	Wind	Play Tennis
D1	Sunny	Hot	High	Weak	No
D2	Sunny	Hot	High	Strong	No
D3	Overcast	Hot	High	Weak	Yes
D4	Rain	Mild	High	Weak	Yes
D5	Rain	Cool	Normal	Weak	Yes
D6	Rain	Cool	Normal	Strong	No
D7	Overcast	Cool	Normal	Strong	Yes
D8	Sunny	Mild	High	Weak	No
D9	Sunny	Cool	Normal	Weak	Yes
D10	Rain	Mild	Normal	Weak	Yes
D11	Sunny	Mild	Normal	Strong	Yes
D12	Overcast	Mild	High	Strong	Yes
D13	Overcast	Hot	Normal	Weak	Yes
D14	Rain	Mild	High	Strong	No

## 例子：Play Tennis

$$v_{NB} = \arg \max_{v_j \in V} P(v_j)$$

$$* P(\text{Outlook} = \text{Sunny} | v_j) P(\text{Temperature} = \text{Cool} | v_j)$$

$$* P(\text{Humidity} = \text{High} | v_j) P(\text{Wind} = \text{Strong} | v_j)$$

计算结果：

$$P(\text{PlayTennis} = \text{Yes}) = 9/14 = 0.64;$$

$$P(\text{PlayTennis} = \text{No}) = 5/14 = 0.36$$

$$P(\text{Wind} = \text{Strong} | \text{PlayTennis} = \text{Yes}) = 3/9 = 0.33$$

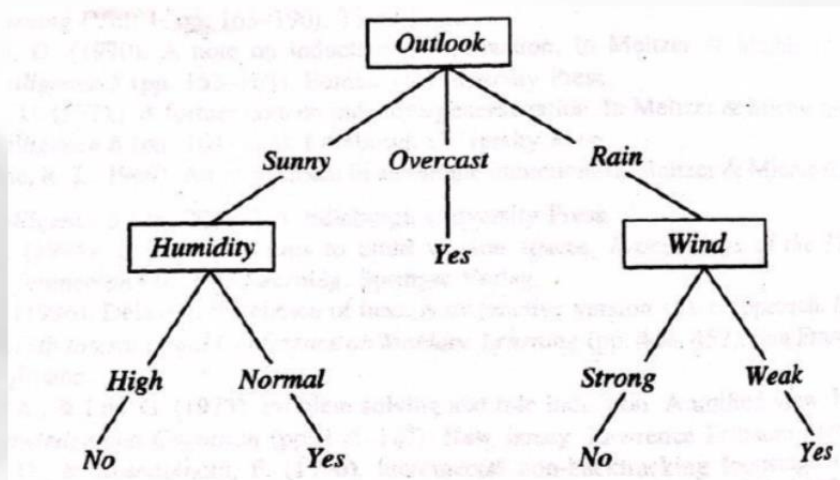
$$P(\text{Wind} = \text{Strong} | \text{PlayTennis} = \text{No}) = 3/5 = 0.60$$

$$P(\text{Yes})P(\text{Sunny} | \text{Yes})P(\text{Cool} | \text{Yes})P(\text{High} | \text{Yes})P(\text{Strong} | \text{Yes}) = 0.0053$$

$$P(\text{No})P(\text{Sunny} | \text{No})P(\text{Cool} | \text{No})P(\text{High} | \text{No})P(\text{Strong} | \text{No}) = 0.02$$

1158482\_road\_blur

## 决策树示例



周六上午是否适合打网球

1158482\_road\_blur

⟨Outlook = Sunny, Temperature = Hot, Humidity = High, Wind = Strong⟩

- (1) 根据信息增益构造决策树，并判断改天的情况是否适合打网球
- (2) 根据朴素贝叶斯判定，对 (1) 中情况进行重新分类

六、10分

$$x' = \begin{bmatrix} -1 & 0 & 0 \end{bmatrix} \quad [1]$$

$$\begin{bmatrix} 0 & -2 & 0 \end{bmatrix} x + \begin{bmatrix} 1 \end{bmatrix} u(t) \quad y = \begin{bmatrix} 2 & 0 & -1 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 & -3 \end{bmatrix} \quad [1]$$

- (1) 求传输函数  $G(s) = Y(s)/X(s)$
- (2) 判断是否是能控的
- (3) 判断是否是能观的