## KOLIČINA INFORMACIJE

$$I(x_i) = -\log_2 p(x_i) \left[\frac{\text{bit}}{\text{simbol}}\right]$$

$$I(x_1 x_2 \dots x_k) = -\log_2[p(x_1)\cdot p(x_2)\cdot \dots \cdot p(x_k)] \left[\frac{\text{bit}}{\text{poruka}}\right]$$

## VJEROJATNOSTI U KOMUNIKACIJSKOM SUSTAVU

$$[p(y_j|x_i)] = \begin{bmatrix} p(y_1|x_1) & p(y_2|x_1) & \dots & p(y_m|x_1) \\ p(y_1|x_2) & p(y_2|x_2) & \dots & p(y_m|x_2) \\ \dots & \dots & \dots & \dots \\ p(y_1|x_n) & p(y_2|x_n) & \dots & p(y_m|x_n) \end{bmatrix} \begin{matrix} \}\,\Sigma = 1 \\ \}\,\Sigma = 1 \\ \dots \\ \}\,\Sigma = 1 \end{matrix}$$

$$[p(y_j)] = [p(x_i)][p(y_j|x_i)] \quad [p(x_j)]^T = [p(x_i|y_j)][p(y_j)]^T$$

$$[p(x_i, y_j)] = [p(x_i)p(y_j|x_i)] = [p(x_i|y_j)p(y_j)]$$

$$p(x_i|y_j) = \frac{p(x_i, y_j)}{p(y_j)} = \frac{p(x_i, y_j)}{\sum_{i=1}^{n} p(x_i, y_j)} = \frac{p(x_i)p(y_j|x_i)}{\sum_{i=1}^{n} p(x_i)p(y_j|x_i)}$$

$$[p(x_i, y_j)] = \begin{bmatrix} p(x_1, y_1) & p(x_1, y_2) & \dots & p(x_1, y_m) \\ p(x_2, y_1) & p(x_2, y_2) & \dots & p(x_2, y_m) \\ \dots & \dots & \dots & \dots \\ \underbrace{p(x_n, y_1)} & \underbrace{p(x_n, y_2)} & \dots & \underbrace{p(x_n, y_m)} \end{bmatrix} \begin{matrix} \}\,\Sigma = p(x_1) \\ \}\,\Sigma = p(x_2) \\ \dots \\ \}\,\Sigma = p(x_n) \end{matrix}$$
$$\Sigma = p(y_1) \quad \Sigma = p(y_2) \quad \dots \quad \Sigma = p(y_m)$$

## ENTROPIJA

$$H(X) = -\sum_{i=1}^{n} p(x_i)\log_2 p(x_i) \left[\frac{\text{bit}}{\text{simbol}}\right]$$

$$H(Y) = -\sum_{j=1}^{m} p(y_j)\log_2 p(y_j) \left[\frac{\text{bit}}{\text{simbol}}\right]$$

$$H(X,Y) = -\sum_{i=1}^{n}\sum_{j=1}^{m} p(x_i, y_j)\log_2 p(x_i, y_j) \left[\frac{\text{bit}}{\text{simbol}}\right]$$

### *ENTROPIJA ŠUMA (IRELEVANTNOST)*

$$H(Y|X) = -\sum_{i=1}^{n}\sum_{j=1}^{m} p(x_i, y_j)\log_2 p(y_j|x_i) \left[\frac{\text{bit}}{\text{simbol}}\right]$$

### *EKVIVOKACIJA (MNOGOZNAČNOST)*

$$H(X|Y) = -\sum_{i=1}^{n}\sum_{j=1}^{m} p(x_i, y_j)\log_2 p(x_i|y_j) \left[\frac{\text{bit}}{\text{simbol}}\right]$$

### *SREDNJI SADRŽAJ INFORMACIJE (TRANSINFORMACIJA)*

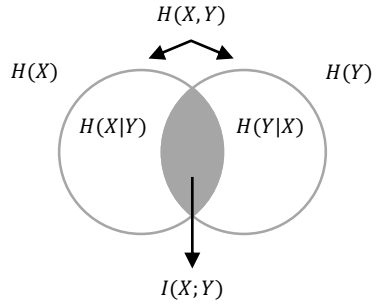
$$I(X;Y) = \sum_{i=1}^{n}\sum_{j=1}^{m} p(x_i, y_j)\log_2 \frac{p(x_i, y_j)}{p(x_i)p(y_j)} \left[\frac{\text{bit}}{\text{simbol}}\right]$$

$$I(X;Y) = H(X) - H(X|Y) \quad I(X;Y) = H(Y) - H(Y|X) \quad I(X;X) = H(X)$$

$$I(X;Y) = H(X) + H(Y) - H(X,Y)$$

$$H(X,Y) = H(X) + H(Y|X) \quad H(X,Y) = H(Y) + H(X|Y)$$

$$X \text{ i } Y \text{ nezavisni} \rightarrow H(X,Y) = H(X) + H(Y)$$




### *RELATIVNA ENTROPIJA*

$$D(p\|q) = \sum_{i=1}^{n} p(x_i)\log\frac{p(x_i)}{q(x_i)}$$

### *KAPACITET DISKRETNOG KOMUNIKACIJSKOG KANALA*

$$C = \max_{\{p(x_i)\}} I(X;Y) = \max_{\{p(x_i)\}} \big(H(Y) - H(Y|X)\big) \left[\frac{\text{bit}}{\text{simbol}}\right]$$

### *INFORMACIJSKA BRZINA IZVORIŠTA*

$$R = \frac{H(X)}{T_s} \left[\frac{\text{bit}}{\text{s}}\right] \quad (T_s - \textit{prosječno trajanje simbola})$$

## ENTROPIJSKO KODIRANJE

### *SREDNJA DULJINA KODNE RIJEČI*

$$L(X) = \sum_{i=1}^{n} p(x_i) l_i \left[\frac{\text{bit}}{\text{simbol}}\right]$$

### *EFIKASNOST KODA*

$$\varepsilon = \frac{H(X)}{L(X)}$$

### *KRAFTOVA NEJEDNAKOST* *(nužan i dovoljan uvjet za prefiksni kod)*

$$\sum d^{-L_i} \leq 1$$

### *OPTIMALNOST KODA* *(nužan i dovoljan optimalnosti koda)*

$$H(X) \leq L(X) < H(X) + 1$$

$$\min\left[L(X) = \sum_{i=1}^{n} p(x_i) l_i\right] \textit{ uz uvjet } \sum_{i=1}^{n} d^{-L_i} \leq 1$$

### *SARDINAS-PATTERSONOV TEST*

$C(y)$ *se dodaje u skup* $S_{i+1}$ *ako i samo ako*:
$\exists\, C(x) \in S_0$ *tako da* $C(x)C(y) \in S_i$
*ili*
$\exists\, C(z) \in S_i$ *tako da* $C(z)C(y) \in S_0$

■ *Kod je JDK ako niti jedan* $S_i$ $(i \geq 1)$ *ne sadrži kodne riječi iz* $S_0$ ■

### *HUFFMANNOVO KODIRANJE*

$N - \textit{broj simbola}; \quad B - \textit{baza kodiranja}; \quad k = \left\lceil\frac{N-1}{B-1}\right\rceil$
$N' = (B-1)k + 1; \quad N' \neq N \Rightarrow \textit{dodaj } N' - N \textit{ simbola s } \boldsymbol{p} = 0$

### *ARITMETIČKO KODIRANJE*

$$D' = D + (G - D)\cdot D_s$$

$$G' = D + (G - D)\cdot G_s$$

$$\left\lceil\log_2\left(\frac{1}{G' - D'}\right)\right\rceil + 1 \textit{ znamenki} \rightarrow \textit{kod koji se može JDK}$$

$$L_{a(d=10)} = \sum_{i=1}^{N} L_{a(d=2)}(i)\cdot 2^{-i}$$

### *SREDNJA DULJINA KODNE RIJEČI*

$$L(X) = \frac{\sum_{i=1}^{n} p(x_i)\cdot l(x_i)}{\sum_{i=1}^{n} p(x_i)\cdot n(x_i)} \left[\frac{\text{bit}}{\text{simbol}}\right] \quad \begin{matrix} l(x_i) \rightarrow \textit{duljina kodne riječi} \\ n(x_i) \rightarrow \textit{broj simbola} \end{matrix}$$

### *VJEROJATNOST POJAVE POJEDINOG SIMBOLA*

$$p(\text{pojave\_simbola}) = \frac{p(x_i)\cdot n(x_i)}{L(X)}$$

$n(x_i) \rightarrow$ *duljina* simbola

### *VJEROJATNOST ISPRAVNOG PRIJENOSA BINARNOG SIMETRIČNOG KANALA*

$$P_{BSK} = \frac{1}{2}(1 + (1 - 2\cdot p)^k) \quad p \rightarrow \textit{vjerojatnost pogreške}$$

### *VJEROJATNOST POGREŠNOG PRIJENOSA BINARNOG SIMETRIČNOG KANALA*

$$P_{BSK} = \frac{1}{2}(1 - (1 - 2\cdot p)^k) \quad p \rightarrow \textit{vjerojatnost pogreške}$$

## OSTALO

***VJEROJATNOST PRIJELAZA***

$$[p(y_j)] = [p(z_k)][p(y_j|z_k)]$$
$$[p(y_j)] = [p(x_i)][p(y_j|x_i)] \rightarrow [p(y_j|x_i)] = [p(z_k|x_i)][p(y_j|z_k)]$$
$$[p(z_k)] = [p(x_i)][p(z_k|x_i)]$$

***HUFFMANOVO KODIRANJE (m simbola)***

$$p(x_i) = \frac{1}{m}$$

$$2^n \leq m < 2^{n+1} \rightarrow k = m - 2^n$$

$$kodnih\ riječi\ duljine\ \boldsymbol{n}\ ima \rightarrow 2^n - k$$

$$kodnih\ riječi\ duljine\ \boldsymbol{n+1}\ ima \rightarrow 2k$$

***NAJMANJI BROJ ELEMENATA SKUPA***

$$\min(\mathrm{card}(X)) \rightarrow \max(H(X))$$

$$\mathrm{card}(X) \geq \log_2(H(X))$$

***NAJMANJA DULJINA KODNE RIJEČI (Aritmetički algoritam)***

$$l(x) = \left\lceil \log_2\left(\frac{1}{P(X)}\right)\right\rceil + 1\ [\mathrm{bit}]$$

$$P_i(x) = \prod_{i=1}^{n} p(x_i)$$

$$ako\ tražimo\ minimalnu\ duljinu \rightarrow tražimo\ \max(P_i(x))$$