

ECS 452: In-Class Exercise # 1 Sol

Instructions

1. Separate into groups of no more than three students each.
2. [ENRE] Explanation is not required for this exercise.
3. **Do not panic.**

Date: 17 / 1 / 2020			
Name			ID <small>(last 3 digits)</small>

1. Consider two codes (for source coding) below. The left column is for Code A. The right column is for Code B. The first row defines these codes via their codebooks.

<p>Codebook for Code A</p> <table border="1" style="margin: 10px auto; border-collapse: collapse; text-align: center;"> <tr> <td>x</td> <td>a</td> <td>e</td> <td>ℓ</td> <td>n</td> <td>r</td> </tr> <tr> <td>$c(x)$</td> <td>1</td> <td>00</td> <td>010</td> <td>0110</td> <td>0111</td> </tr> </table>	x	a	e	ℓ	n	r	$c(x)$	1	00	010	0110	0111	<p>Codebook for Code B</p> <table border="1" style="margin: 10px auto; border-collapse: collapse; text-align: center;"> <tr> <td>x</td> <td>a</td> <td>e</td> <td>ℓ</td> <td>n</td> <td>r</td> </tr> <tr> <td>$c(x)$</td> <td>000</td> <td>100</td> <td>10</td> <td>01</td> <td>11</td> </tr> </table>	x	a	e	ℓ	n	r	$c(x)$	000	100	10	01	11		
x	a	e	ℓ	n	r																						
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<p>The source alphabet for Code A is $\{a, e, \ell, n, r\}$. A codebook shows how each source symbol is mapped into a codeword. The set of all possible source symbols is called the source alphabet. Don't forget that it is a set.</p>	<p>The source alphabet for Code B is $\{a, e, \ell, n, r\}$. The first row in the codebook is the same as the one in Code A. Therefore, the possible source symbols are the same as Code A.</p>																										
<p>The code alphabet for Code A is $\{0,1\}$. Note that 1, 00, 010, 0110, 0111 are codewords. These codewords are constructed from code symbols: 0 or 1. So, the code alphabet, which is the set of all possible code symbols, is $\{0,1\}$.</p>	<p>The code alphabet for Code B is $\{0,1\}$. Although the codewords for Code B are different from Code A, they are still constructed from code symbols: 0 or 1. So, the code alphabet is still $\{0,1\}$.</p>																										
<p>Use code A to encode the source string "real"</p> <table style="margin: 10px auto; border-collapse: collapse; text-align: center;"> <tr> <td>r</td><td>e</td><td>a</td><td>ℓ</td> </tr> <tr> <td style="border-right: 1px solid black;">0111</td> <td style="border-right: 1px solid black;">00</td> <td style="border-right: 1px solid black;">010</td> <td>1010</td> </tr> </table>	r	e	a	ℓ	0111	00	010	1010	<p>Use code B to encode the source string "real"</p> <table style="margin: 10px auto; border-collapse: collapse; text-align: center;"> <tr> <td>r</td><td>e</td><td>a</td><td>ℓ</td> </tr> <tr> <td style="border-right: 1px solid black;">111</td> <td style="border-right: 1px solid black;">000</td> <td style="border-right: 1px solid black;">100</td> <td>10</td> </tr> </table>	r	e	a	ℓ	111	000	100	10										
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<p>Is Code A nonsingular? By definition, a nonsingular code is a code in which every source symbol in the source alphabet is mapped to a unique codeword. Here, the codewords in the codebook are all different. So, yes, Code A is nonsingular.</p>	<p>Is Code B nonsingular? The codewords in the codebook are all different. So, yes, Code B is nonsingular.</p>																										
<p>The string 01000101110110 comes from encoding a source string by Code A. Decode it.</p> <table style="margin: 10px auto; border-collapse: collapse; text-align: center;"> <tr> <td style="border-right: 1px solid black;">010</td> <td style="border-right: 1px solid black;">00</td> <td style="border-right: 1px solid black;">1</td> <td style="border-right: 1px solid black;">0111</td> <td>0110</td> </tr> <tr> <td style="border-right: 1px solid black;">ℓ</td> <td style="border-right: 1px solid black;">e</td> <td style="border-right: 1px solid black;">a</td> <td style="border-right: 1px solid black;">r</td> <td>n</td> </tr> </table> <p>The decoded string is learn.</p>	010	00	1	0111	0110	ℓ	e	a	r	n	<p>The string 0001110001000 comes from encoding a source string by Code B. Decode it.</p> <p>First, we try to decode the beginning part of the encoded string:</p> <table style="margin: 10px auto; border-collapse: collapse; text-align: center;"> <tr> <td style="border-right: 1px solid black;">000</td> <td style="border-right: 1px solid black;">11</td> <td>10001000</td> </tr> <tr> <td style="border-right: 1px solid black;">a</td> <td style="border-right: 1px solid black;">r</td> <td>?</td> </tr> </table> <p>The next step is tricky because the next codeword could be 10 (ℓ) or 100 (e). However, if 10 (ℓ) is used here, no codeword can start the remaining string 001000. Therefore, there is only one interpretation:</p> <table style="margin: 10px auto; border-collapse: collapse; text-align: center;"> <tr> <td style="border-right: 1px solid black;">000</td> <td style="border-right: 1px solid black;">11</td> <td style="border-right: 1px solid black;">100</td> <td style="border-right: 1px solid black;">01</td> <td>000</td> </tr> <tr> <td style="border-right: 1px solid black;">a</td> <td style="border-right: 1px solid black;">r</td> <td style="border-right: 1px solid black;">e</td> <td style="border-right: 1px solid black;">n</td> <td>a</td> </tr> </table> <p>The decoded string is arena.</p>	000	11	10001000	a	r	?	000	11	100	01	000	a	r	e	n	a
010	00	1	0111	0110																							
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