Akash Krishna
Comp 590: Data Compression

**Part 3:**

## Question 2: Symbol Probability

| | |
|---|---|
| Symbol: 0  NUL Probability: 0.0 | Symbol: 128 ? Probability: 0.0 |
| Symbol: 1  SOH Probability: 0.0 | Symbol: 129 ? Probability: 0.0 |
| Symbol: 2  STX Probability: 0.0 | Symbol: 130 ? Probability: 0.0 |
| Symbol: 3  ETX Probability: 0.0 | Symbol: 131 ? Probability: 0.0 |
| Symbol: 4  EOT Probability: 0.0 | Symbol: 132 ? Probability: 0.0 |
| Symbol: 5  ENQ Probability: 0.0 | Symbol: 133 ? Probability: 0.0 |
| Symbol: 6  ACK Probability: 0.0 | Symbol: 134 ? Probability: 0.0 |
| Symbol: 7  BEL Probability: 0.0 | Symbol: 135 ? Probability: 0.0 |
| Symbol: 8  BS Probability: 0.0 | Symbol: 136 ? Probability: 0.0 |
| Symbol: 9  TAB Probability: 0.0 | Symbol: 137 ? Probability: 0.0 |
| Symbol: 10 LF Probability: 0.02 | Symbol: 138 ? Probability: 0.0 |
| Symbol: 11 VT Probability: 0.0 | Symbol: 139 ? Probability: 0.0 |
| Symbol: 12 FF Probability: 0.0 | Symbol: 140 ? Probability: 0.0 |
| Symbol: 13 CR Probability: 0.02 | Symbol: 141 ? Probability: 0.0 |
| Symbol: 14 SO Probability: 0.0 | Symbol: 142 ? Probability: 0.0 |
| Symbol: 15 SI Probability: 0.0 | Symbol: 143 ? Probability: 0.0 |
| Symbol: 16 DLE Probability: 0.0 | Symbol: 144 ? Probability: 0.0 |
| Symbol: 17 DC1 Probability: 0.0 | Symbol: 145 ? Probability: 0.0 |
| Symbol: 18 DC2 Probability: 0.0 | Symbol: 146 ? Probability: 0.0 |
| Symbol: 19 DC3 Probability: 0.0 | Symbol: 147 ? Probability: 0.0 |
| Symbol: 20 DC4 Probability: 0.0 | Symbol: 148 ? Probability: 0.0 |
| Symbol: 21 NAK Probability: 0.0 | Symbol: 149 ? Probability: 0.0 |
| Symbol: 22 SYN Probability: 0.0 | Symbol: 150 ? Probability: 0.0 |
| Symbol: 23 ETB Probability: 0.0 | Symbol: 151 ? Probability: 0.0 |
| Symbol: 24 CAN Probability: 0.0 | Symbol: 152 ? Probability: 0.0 |
| Symbol: 25 EM Probability: 0.0 | Symbol: 153 ? Probability: 0.0 |
| Symbol: 26 SUB Probability: 0.0 | Symbol: 154 ? Probability: 0.0 |
| Symbol: 27 ESC Probability: 0.0 | Symbol: 155 ? Probability: 0.0 |
| Symbol: 28 FS Probability: 0.0 | Symbol: 156 ? Probability: 0.0 |
| Symbol: 29 GS Probability: 0.0 | Symbol: 157 ? Probability: 0.0 |
| Symbol: 30 RS Probability: 0.0 | Symbol: 158 ? Probability: 0.0 |
| Symbol: 31 US Probability: 0.0 | Symbol: 159 ? Probability: 0.0 |
| Symbol: 32 Space Probability: 0.16 | Symbol: 160   Probability: 0.0 |
| Symbol: 33 ! Probability: 0.0 | Symbol: 161 ¡ Probability: 0.0 |
| Symbol: 34 " Probability: 0.0 | Symbol: 162 ¢ Probability: 0.0 |
| Symbol: 35 # Probability: 0.0 | Symbol: 163 £ Probability: 0.0 |
| Symbol: 36 $ Probability: 0.0 | Symbol: 164 ¤ Probability: 0.0 |
| Symbol: 37 % Probability: 0.0 | Symbol: 165 ¥ Probability: 0.0 |
| Symbol: 38 & Probability: 0.0 | Symbol: 166 ¦ Probability: 0.0 |
| Symbol: 39 ' Probability: 0.0 | Symbol: 167 § Probability: 0.0 |
| Symbol: 40 ( Probability: 0.0 | Symbol: 168 ¨ Probability: 0.0 |
| Symbol: 41 ) Probability: 0.0 | Symbol: 169 © Probability: 0.0 |
| Symbol: 42 * Probability: 0.0 | Symbol: 170 ª Probability: 0.0 |
| Symbol: 43 + Probability: 0.0 | Symbol: 171 « Probability: 0.0 |
| Symbol: 44 , Probability: 0.01 | Symbol: 172 ¬ Probability: 0.0 |
| Symbol: 45 - Probability: 0.0 | Symbol: 173  Probability: 0.0 |
| Symbol: 46 . Probability: 0.01 | Symbol: 174 ® Probability: 0.0 |
| Symbol: 47 / Probability: 0.0 | Symbol: 175 ¯ Probability: 0.0 |
| Symbol: 48 0 Probability: 0.0 | Symbol: 176 ° Probability: 0.0 |
| Symbol: 49 1 Probability: 0.0 | Symbol: 177 ± Probability: 0.0 |
| Symbol: 50 2 Probability: 0.0 | Symbol: 178 ² Probability: 0.0 |

| | |
|---|---|
| Symbol: 51 3 Probability: 0.0 | Symbol: 179 ³ Probability: 0.0 |
| Symbol: 52 4 Probability: 0.0 | Symbol: 180 ´ Probability: 0.0 |
| Symbol: 53 5 Probability: 0.0 | Symbol: 181 µ Probability: 0.0 |
| Symbol: 54 6 Probability: 0.0 | Symbol: 182 ¶ Probability: 0.0 |
| Symbol: 55 7 Probability: 0.0 | Symbol: 183 · Probability: 0.0 |
| Symbol: 56 8 Probability: 0.0 | Symbol: 184 ¸ Probability: 0.0 |
| Symbol: 57 9 Probability: 0.0 | Symbol: 185 ¹ Probability: 0.0 |
| Symbol: 58 : Probability: 0.0 | Symbol: 186 º Probability: 0.0 |
| Symbol: 59 ; Probability: 0.0 | Symbol: 187 » Probability: 0.0 |
| Symbol: 60 < Probability: 0.0 | Symbol: 188 ¼ Probability: 0.0 |
| Symbol: 61 = Probability: 0.0 | Symbol: 189 ½ Probability: 0.0 |
| Symbol: 62 > Probability: 0.0 | Symbol: 190 ¾ Probability: 0.0 |
| Symbol: 63 ? Probability: 0.0 | Symbol: 191 ¿ Probability: 0.0 |
| Symbol: 64 @ Probability: 0.0 | Symbol: 192 À Probability: 0.0 |
| Symbol: 65 A Probability: 0.0 | Symbol: 193 Á Probability: 0.0 |
| Symbol: 66 B Probability: 0.0 | Symbol: 194 Â Probability: 0.0 |
| Symbol: 67 C Probability: 0.0 | Symbol: 195 Ã Probability: 0.0 |
| Symbol: 68 D Probability: 0.0 | Symbol: 196 Ä Probability: 0.0 |
| Symbol: 69 E Probability: 0.0 | Symbol: 197 Å Probability: 0.0 |
| Symbol: 70 F Probability: 0.0 | Symbol: 198 Æ Probability: 0.0 |
| Symbol: 71 G Probability: 0.0 | Symbol: 199 Ç Probability: 0.0 |
| Symbol: 72 H Probability: 0.0 | Symbol: 200 È Probability: 0.0 |
| Symbol: 73 I Probability: 0.0 | Symbol: 201 É Probability: 0.0 |
| Symbol: 74 J Probability: 0.0 | Symbol: 202 Ê Probability: 0.0 |
| Symbol: 75 K Probability: 0.0 | Symbol: 203 Ë Probability: 0.0 |
| Symbol: 76 L Probability: 0.0 | Symbol: 204 Ì Probability: 0.0 |
| Symbol: 77 M Probability: 0.0 | Symbol: 205 Í Probability: 0.0 |
| Symbol: 78 N Probability: 0.0 | Symbol: 206 Î Probability: 0.0 |
| Symbol: 79 O Probability: 0.0 | Symbol: 207 Ï Probability: 0.0 |
| Symbol: 80 P Probability: 0.0 | Symbol: 208 Ð Probability: 0.0 |
| Symbol: 81 Q Probability: 0.0 | Symbol: 209 Ñ Probability: 0.0 |
| Symbol: 82 R Probability: 0.0 | Symbol: 210 Ò Probability: 0.0 |
| Symbol: 83 S Probability: 0.0 | Symbol: 211 Ó Probability: 0.0 |
| Symbol: 84 T Probability: 0.0 | Symbol: 212 Ô Probability: 0.0 |
| Symbol: 85 U Probability: 0.0 | Symbol: 213 Õ Probability: 0.0 |
| Symbol: 86 V Probability: 0.0 | Symbol: 214 Ö Probability: 0.0 |
| Symbol: 87 W Probability: 0.0 | Symbol: 215 × Probability: 0.0 |
| Symbol: 88 X Probability: 0.0 | Symbol: 216 Ø Probability: 0.0 |
| Symbol: 89 Y Probability: 0.0 | Symbol: 217 Ù Probability: 0.0 |
| Symbol: 90 Z Probability: 0.0 | Symbol: 218 Ú Probability: 0.0 |
| Symbol: 91 [ Probability: 0.0 | Symbol: 219 Û Probability: 0.0 |
| Symbol: 92 \ Probability: 0.0 | Symbol: 220 Ü Probability: 0.0 |
| Symbol: 93 ] Probability: 0.0 | Symbol: 221 Ý Probability: 0.0 |
| Symbol: 94 ^ Probability: 0.0 | Symbol: 222 Þ Probability: 0.0 |
| Symbol: 95 _ Probability: 0.0 | Symbol: 223 ß Probability: 0.0 |
| Symbol: 96 ` Probability: 0.0 | Symbol: 224 à Probability: 0.0 |
| Symbol: 97 a Probability: 0.05 | Symbol: 225 á Probability: 0.0 |
| Symbol: 98 b Probability: 0.01 | Symbol: 226 â Probability: 0.0 |
| Symbol: 99 c Probability: 0.01 | Symbol: 227 ã Probability: 0.0 |
| Symbol: 100 d Probability: 0.03 | Symbol: 228 ä Probability: 0.0 |
| Symbol: 101 e Probability: 0.09 | Symbol: 229 å Probability: 0.0 |
| Symbol: 102 f Probability: 0.01 | Symbol: 230 æ Probability: 0.0 |
| Symbol: 103 g Probability: 0.01 | Symbol: 231 ç Probability: 0.0 |
| Symbol: 104 h Probability: 0.04 | Symbol: 232 è Probability: 0.0 |
| Symbol: 105 i Probability: 0.04 | Symbol: 233 é Probability: 0.0 |

| | |
|---|---|
| Symbol: 106 j Probability: 0.0 | Symbol: 234 ê Probability: 0.0 |
| Symbol: 107 k Probability: 0.0 | Symbol: 235 ë Probability: 0.0 |
| Symbol: 108 l Probability: 0.02 | Symbol: 236 ì Probability: 0.0 |
| Symbol: 109 m Probability: 0.01 | Symbol: 237 í Probability: 0.0 |
| Symbol: 110 n Probability: 0.04 | Symbol: 238 î Probability: 0.0 |
| Symbol: 111 o Probability: 0.05 | Symbol: 239 ï Probability: 0.0 |
| Symbol: 112 p Probability: 0.01 | Symbol: 240 ð Probability: 0.0 |
| Symbol: 113 q Probability: 0.0 | Symbol: 241 ñ Probability: 0.0 |
| Symbol: 114 r Probability: 0.04 | Symbol: 242 ò Probability: 0.0 |
| Symbol: 115 s Probability: 0.04 | Symbol: 243 ó Probability: 0.0 |
| Symbol: 116 t Probability: 0.06 | Symbol: 244 ô Probability: 0.0 |
| Symbol: 117 u Probability: 0.02 | Symbol: 245 õ Probability: 0.0 |
| Symbol: 118 v Probability: 0.0 | Symbol: 246 ö Probability: 0.0 |
| Symbol: 119 w Probability: 0.01 | Symbol: 247 ÷ Probability: 0.0 |
| Symbol: 120 x Probability: 0.0 | Symbol: 248 ø Probability: 0.0 |
| Symbol: 121 y Probability: 0.01 | Symbol: 249 ù Probability: 0.0 |
| Symbol: 122 z Probability: 0.0 | Symbol: 250 ú Probability: 0.0 |
| Symbol: 123 { Probability: 0.0 | Symbol: 251 û Probability: 0.0 |
| Symbol: 124 | Probability: 0.0 | Symbol: 252 ü Probability: 0.0 |
| Symbol: 125 } Probability: 0.0 | Symbol: 253 ý Probability: 0.0 |
| Symbol: 126 ~ Probability: 0.0 | Symbol: 254 þ Probability: 0.0 |
| Symbol: 127 DEL Probability: 0.0 | Symbol: 255 ÿ Probability: 0.0 |

**Question 3:**
The theoretical source entropy for bits per symbol is: 4.532 bits

**Question 4:**
The compressed entropy achieved by provided compressed file is 4.859 bits per symbol

**Question 6:**
Compressed entropy achieved by my encoder is 4.573 bits per symbol

**Question 7:**
Calculations indicates my encoder achieved better compression than the provided compressed file.