Homework 32

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60

a

The following assignment satisfies the equation: $u_1 = 1, u_2 = 0, u_3 = 1$.

$$\begin{aligned}(1)(1) + (1)(0) + (1)(1) &= 1 + 0 + 1 = 0\\ (1)(1) + (0)(0) &= 1 + 0 = 1\\ (1)(1) + (1)(0) &= 1 + 0 = 1\\ (0)(0) + (0)(1) &= 0 + 0 = 0\\ (0)(1) + (1)(1) + (1)(0) &= 0 + 1 + 0 = 1\end{aligned}$$

b

See attached hw32.py file.

c

All 520 bits (80 per row):

01011010010110100101101001011010010110100101101001011010010110100101101001011010100101

10100101101001011010010110100101101001011010010110100101101001011010010110100101101001011010

01011010010110100101101001011010010110101010010110100101101001011010010110100101101001011010

10100101101001011010010110100101101001011010010110100101101001011010010110100101101001011010

10100101010110100101101001011010010110100101101001011010010110100101101001011010100101101001

10100101101001011010010110100101101001011010010110100101101001011010010110100101101001011010

01011010010110100101101001011010010110100101101001011010

d

The first 8 bits represent the Walsh-Hadamard encoding $f := WH(u = 101)$, the next 512 bits represent the Walsh-Hadamard encoding of $g := WH(u \times u)$. When looking up bits in f, the first bit will be $000 \odot u$ and the last bit $111 \odot u$.

When looking up the bits in g, consider $u \times u = (u_1u_1, u_1u_2, u_1u_3, u_2u_1, u_2u_2, u_2u_3, u_3u_1, u_3u_2, u_3u_3)$. To find the value of $u_1u_2 + u_2u_2 + u_3u_3$ consider the binary number formed when making bits $u_1u_2, u_2u_2, u_3u_3 = 1$ and the rest 0 in the tuple $u \times u$. This would give us the binary value $010010001_b = 145_d =: g_{index}$. Finally add $g_{index} + 8 + 1$ to account for the 8 bits in f and the offset of 1 to put it in the range of $[1, 520]$. Thus to find the value of $u_1u_2 + u_2u_2 + u_3u_3$, look at bit 154 (from the left, in range $[1, 520]$) to find the value (in this case it's 0).