1. Given a supported model $M$ of a normal logic program $P$, prove that

   (a) if $P$ is tight on $M$, then there is a level numbering $\lambda : M \to \mathbb{N}$, and

   (b) the converse does not hold in general.

2. Recall the primitive operations on binary counters $c[1\ldots n]$ and $d[1\ldots n]$ involved in the translation $\text{Tr}_{\text{AT}}(P)$:

   (a) The program $\text{NXT}(c[1\ldots n], d[1\ldots n])$ sets the value of $d[1\ldots n]$ as the successor of the value of $c[1\ldots n]$ in binary representation.

   (b) The program $\text{FIX}(c[1\ldots n], v)$ sets a fixed value $v$ for $c[1\ldots n]$.

   (c) The program $\text{LT}(c[1\ldots n], d[1\ldots n])$ checks whether the value of the counter $c[1\ldots n]$ is lower than that of $d[1\ldots n]$.

   (d) The program $\text{EQ}(c[1\ldots n], d[1\ldots n])$ tests whether the values of the counters $c[1\ldots n]$ and $d[1\ldots n]$ are the same.

   Encode these programs using only atomic rules of the form $a \leftarrow \sim C$.

3. The correctness proof of $\text{Tr}_{\text{AT}}(P)$ treats the translation in the respective parts $\text{Tr}_{\text{SUPP}}(P)$, $\text{Tr}_{\text{CTR}}(P)$, $\text{Tr}_{\text{MAX}}(P)$, and $\text{Tr}_{\text{MIN}}(P)$, which can be viewed as program modules.

   (a) Define the module interfaces for these four parts of $\text{Tr}_{\text{AT}}(P)$.

   (b) Is the join of the respective modules defined?

   (c) Explain in which way the module theorem can alleviate the proof of $P \equiv_v \text{Tr}_{\text{AT}}(P)$. 