For a natural number $t \in \mathbb{N}$, a language L is *decidable with lag* t if there exists a Turing machine M with the following properties:

1. M decides L
2. For every input w, M halts on input w in at most $|w| + t$ steps

For this question you are to prove that for every $t \in \mathbb{N}$, there exists a language L_t such that:

1. L_t is decidable
2. L_t is not decidable with lag t

Your proof should use diagonalization.

Hint: Consider a table whose rows are labelled with Turing machines, and whose columns are labelled with Turing machine descriptions, and where the entry $(M_i, \langle M_j \rangle)$ contains a 1 if M_i accepts $\langle M_j \rangle$ in at most $|\langle M_j \rangle| + t$ steps (and contains a 0 otherwise).