DIAGONALISATION

Consider a collection of strings arranged in square grid of symbols.
For example

```
SHARK
CHERI
NIFTY
PANDA
QQQQQ
```

The idea: create a string by
incrementing 1st letter of 1st word
incrementing 2nd lettr of 2nd word
...
incrementing last lettr of last word

```
SHARK
CHERI
NIFTY
PANDA
QQQQQ
```

T I G E R

TIGER

Yield string NOT in the original collection
Because it's different to each one.

DIAGONALISATION WITH TMS

Consider a list of all TMs. Each can bre represented by string. So for example we might list in increasing length. Whatever. We get $M_1, M_2, M_3, \ldots$

Create a table that says:

Is string $\langle M_j \rangle$ in language of M_i?

	$\langle M_1 \rangle$	$\langle M_2 \rangle$	$\langle M_3 \rangle$	$\langle M_4 \rangle$	$\cdots$
M_1	✓ NO	✓	✓	✓	
M_2	×	× YES	×	×	
M_3	✓	×	× YES	✓	
M_4	✓	×	✓	✓ NO	

Table is infinite. Now do diagonalization to create language. Take $\langle M_1 \rangle$ if first row first column is ×. Take $\langle M_2 \rangle$ if second row second column is ×. And so on. That is, take diagonal and invert it.

Let X be the new language.
It is not the language of M_1, because
they differ on $\langle M_1 \rangle$.
It is not the language of M_2, because
they differ on $\langle M_2 \rangle$
And so on.

Drum Roll please

$\boxed{X \text{ is not a language accepted by any TM}}$

But we've seen X before.
It's, wait for it,
wait for it, S_{TM}.
That is, we've shown that S_{TM} is
not r.e.