Relational Programming
— A new paradigm

"Functions" in programming aren't all mathematical functions. Functions mean one:one & onto relationship between Domain & Range

Simple example:

```
function stolen(input):
    loop over chars of input
        count += 1
    return count
```

This isn't a function.

Any 6-letter ASCII will return 6. It's a "set" function. ie each output is associated w a set of inputs that give that output

For this ex:

Domain		Range
128 single-letter string	→	1
128^2 double-letter strings	→	2
128^3 triple-letter strings	→	3
⋮		
128^n n-letter strings	→	n

So input space grows by a multiple of 128 (cuz ASCII) for each additional letter in the domain. So viewing this as a set, we could call this relation a set function where domain size grows for each additional element of the range

Another example: Regex + some output

```
func sayHiorBye(input)
    regex_detect("hello",
                 "good morning")
        in input
    if yes: return "hi"
    else: "bye"
```

→ Product idea: students write algo, AI does grunt work. helps understand primitives without language

(mail to: Karpathy) a demo

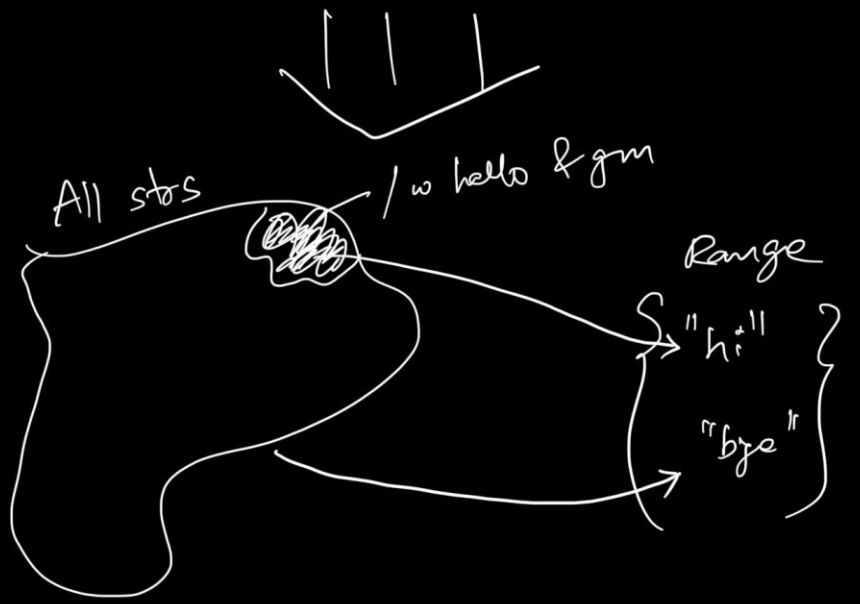
Domain

Range

∞ str + "hello" → "hi"

∞ str + "good morning" → "hi"

∞ str − {"hello", "good morning"} → "bye"



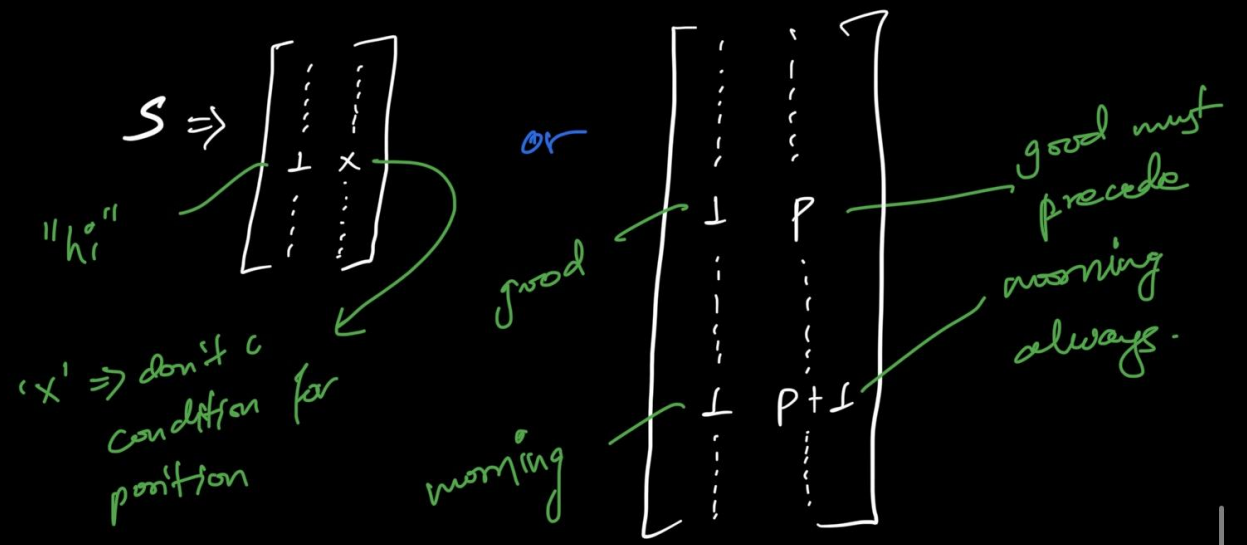
if strings are all encoded by a matrix S

in $\mathbb{R}^{n \times 2}$: $n \times 2$ to encode: ① The string's presence

② The string's position

The matrix should have a very specific

form to give an output of "hi"



$$p \in [\perp, N-\perp]$$

Note: S here represents a very limited/greedy version of our sentence encoder. Any additional occurance of the word will need further columns or the 2nd col needs to be a set.

So our limited space allows only $N-1$ occurances of "good morning" to occur.

Total permutations $\Rightarrow \sum_{i=0}^{N} (N+1-i)$

$\Rightarrow (N+1-0)+(N+1-1)+(N+1-2) \ldots (N+1-N)$

$(N+1)+(N+1)+\ldots+(N+1) - 0-1-2\ldots -N$

$(N+1)^2 - (1+2+3+\ldots N)$

$(N+1)^2 - \frac{N(N+1)}{2}$

$(N+1)\left[N+1-\frac{N}{2}\right] = (N+1)\left(\frac{N}{2}+1\right)$

$= \frac{(N+1)(N+2)}{2}$

So "good morning" is only $\frac{N-1}{\frac{(N+1)(N+2)}{2}}$

As $\lim_{N\to\infty}$ $\frac{N^2\left(1-\frac{1}{N}\right)}{N^2\left(1+\frac{1}{N}\right)\left(1+\frac{2}{N}\right)}$

$$= \frac{1-0}{\infty\,(1+0)(1+0)} = 0\,\% \text{ if } N \to \infty$$

For $N = 10^5$ $\sim \frac{2 \cdot 10^5}{10^{10}} \sim 2 \cdot 10^{-5}$

$\sim 0.002\,\%$

(very small)

So this can be interpreted as a set function too

& "functions" in programming are full of these "set functions"

The way an AI compiler can be used now, is by clearly laying out Domain, Range assertions.

For ex: Algo:

Step 1

Step 2

Step 3

Treat each step as a relation. Compiler should

Define relation_step 1 :

Domain => {X}

Range => {Y}

Write code

assert Y given X

loop until true

proceed to stp 2 w current Y as new X.