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PYTHON:
SCALABLE FROM MICROCONTROLLER
TO SUPERCOMPUTER

HELLO!



THE MISSION OF THE PYTHON SOFTWARE FOUNDATION

To promote, protect, and advance the Python programming language, and to support and facilitate the growth of a diverse and international community of Python programmers

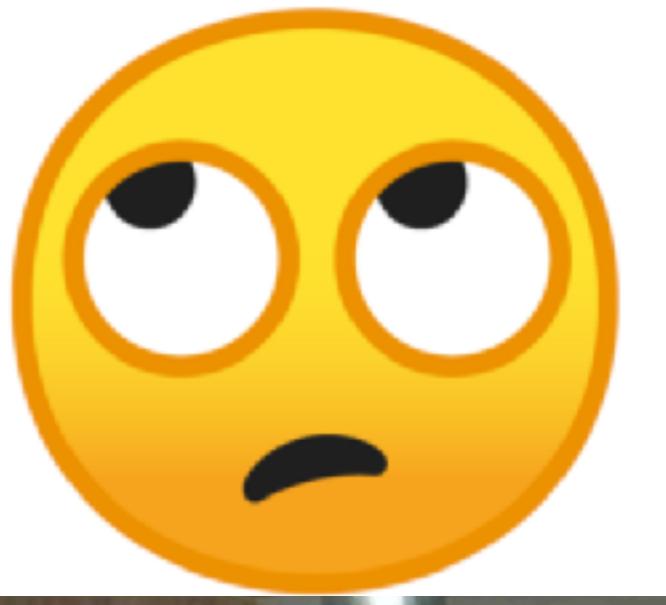
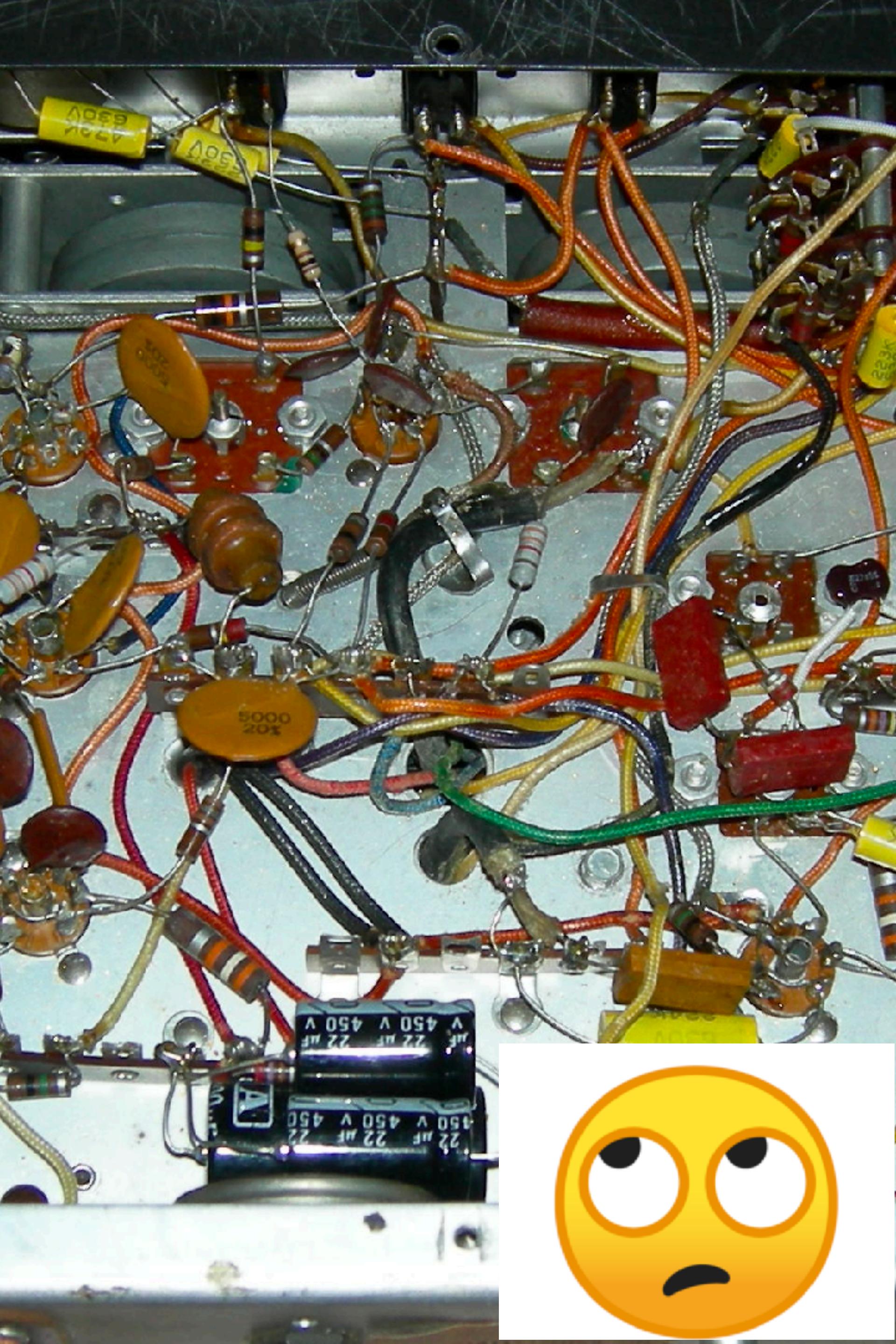
<https://www.python.org/psf/mission/>



I AM OLD



NO, REALLY OLD



YOU CAN'T ALWAYS
GET WHAT YOU WANT
BUT IF YOU TRY
SOMETIMES
YOU JUST MIGHT FIND
YOU GET WHAT YOU
NEED

THE ROLLING STONES

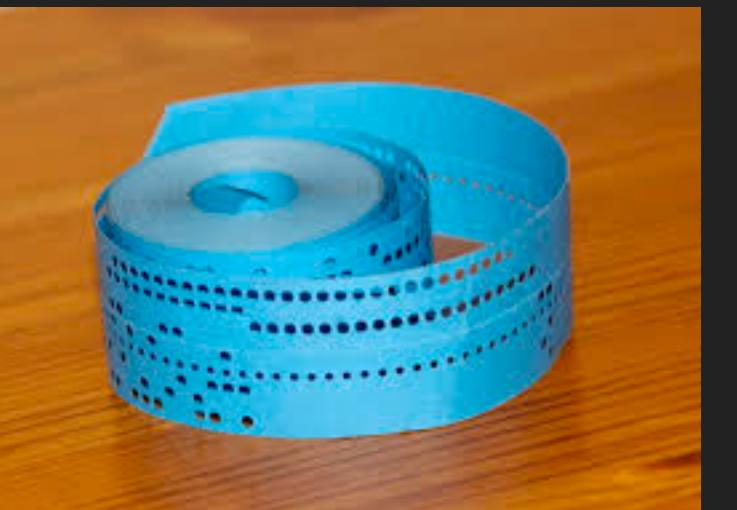
"JOBS FOR THE BOYS"

I HAD TO TRAIN AS A
MECHANICAL ENGINEER?



MY FIRST PROGRAM, IN ALGOL 60:
PRINT THE SQUARES AND CUBES
OF THE INTEGERS FROM 1 TO 10

MARCH, 1967

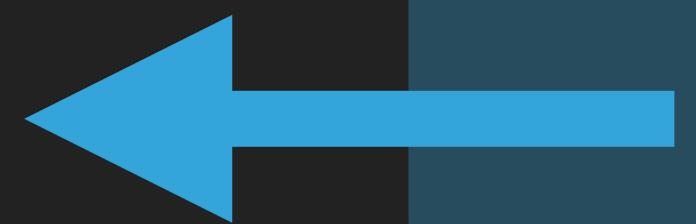
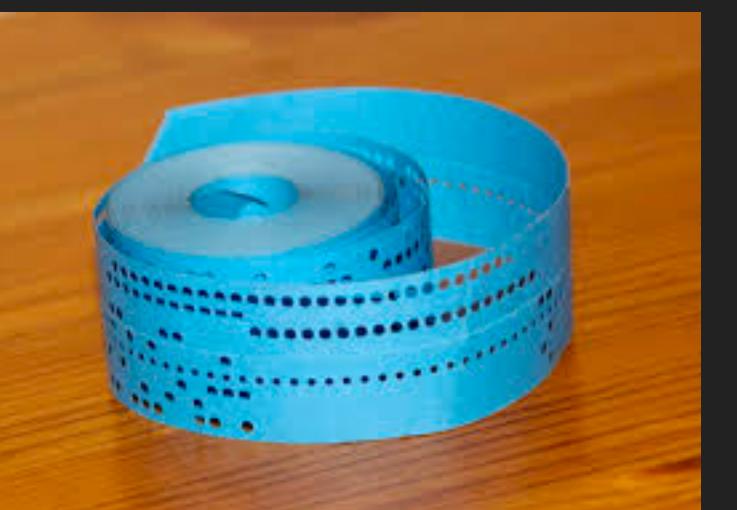


Punch program
on paper tape

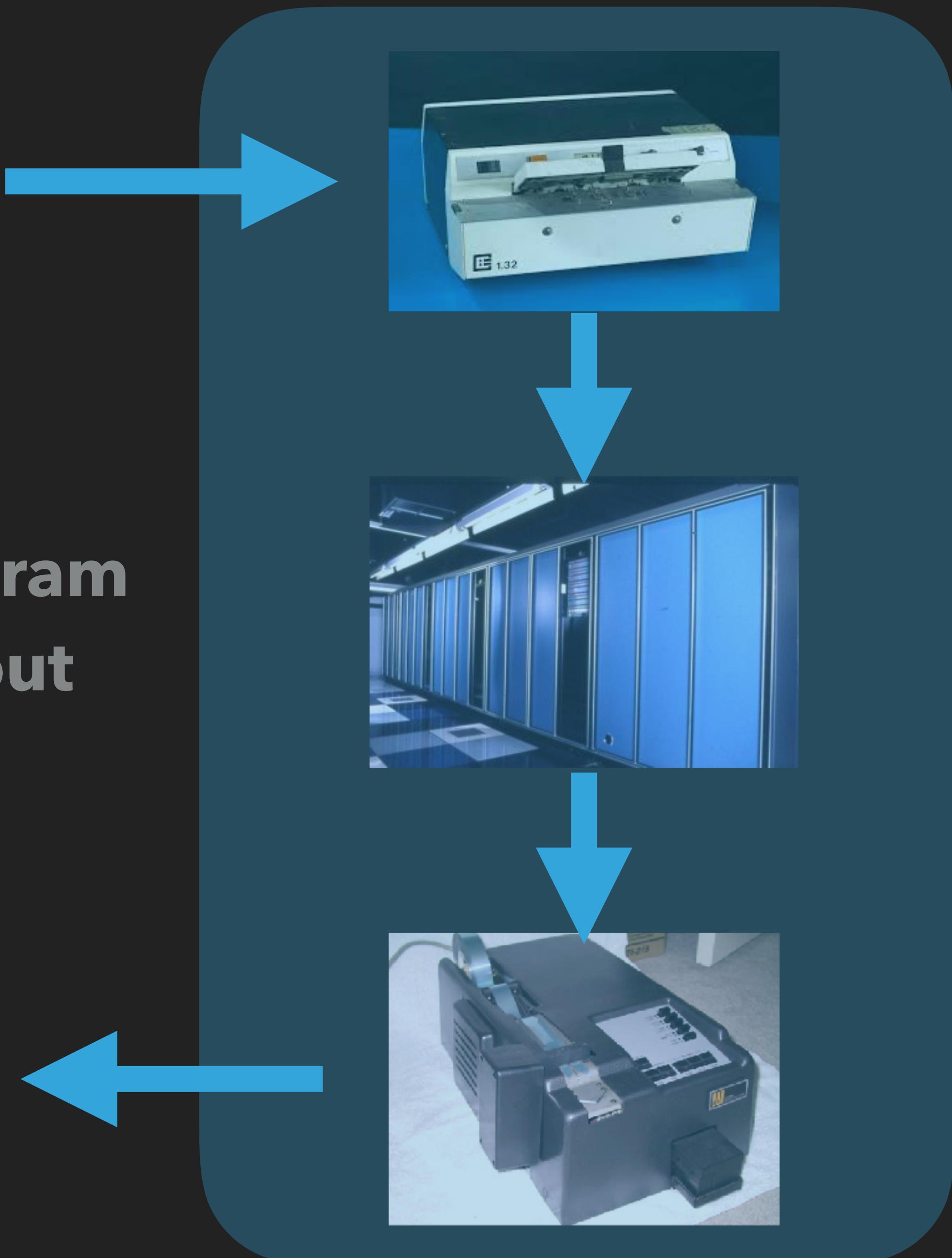
**First you had to load and run
the Algol compiler – two reels
of tape about 20cm in
diameter!**

**It read Algol programs,
and wrote executable
binaries.**

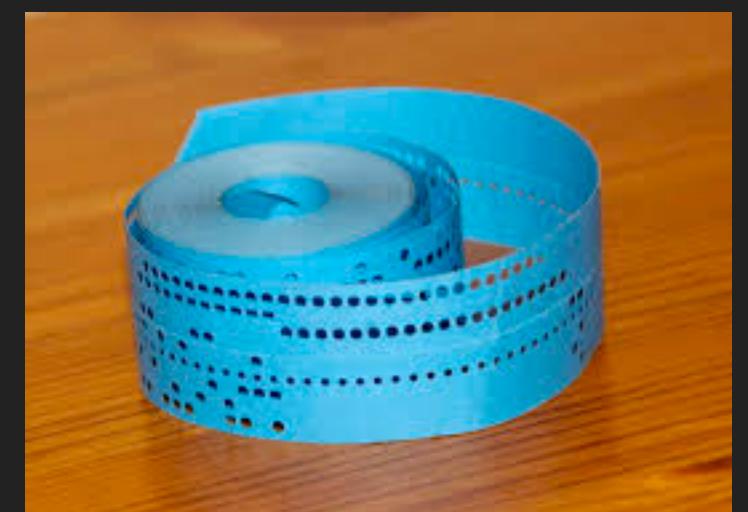
**Compiler output:
binary executable**



**Compiler output:
binary executable**



**Run output through
Flexowriter for hard copy**



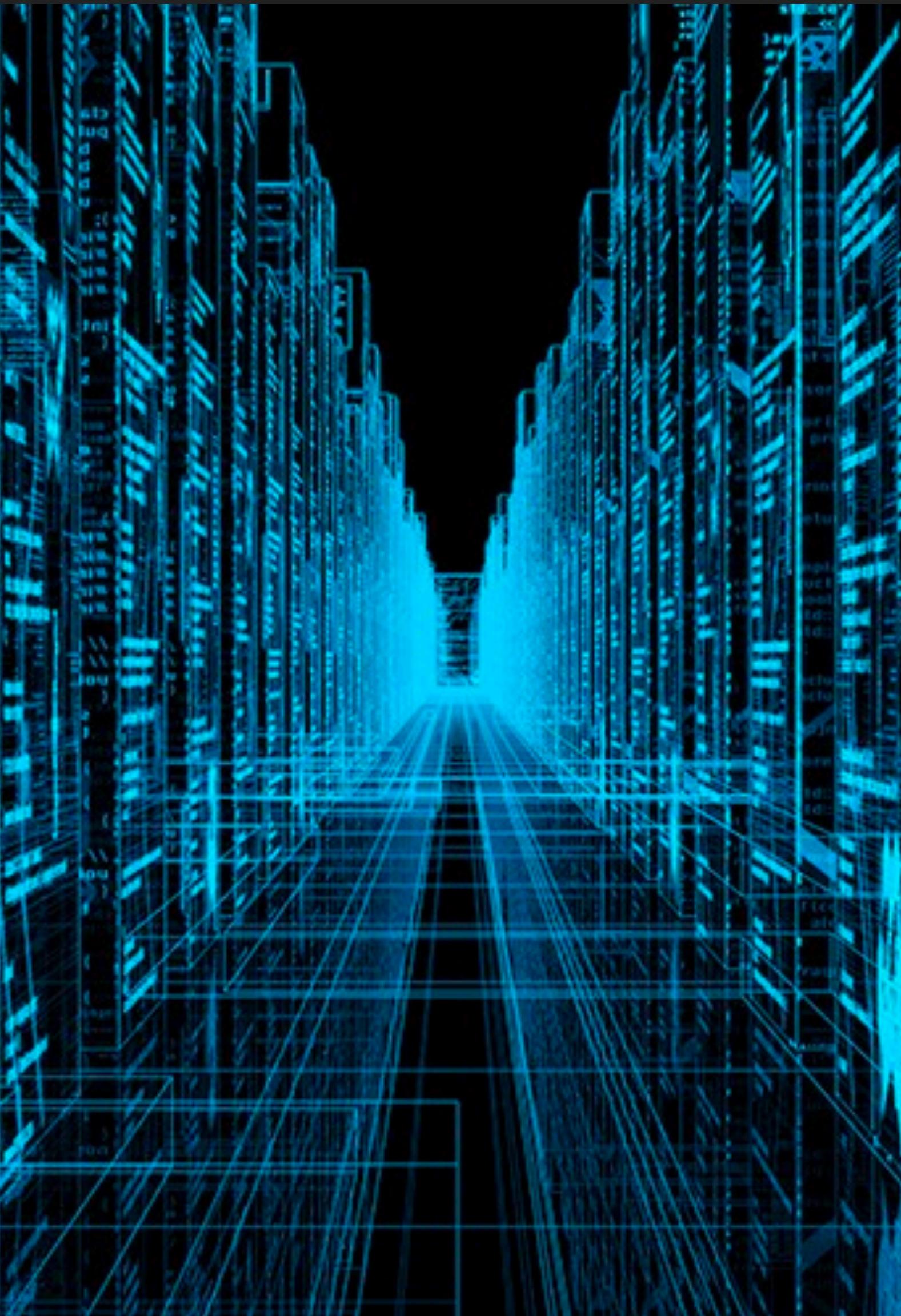
Dec	Hex	Oct	Chr	Dec	Hex	Oct	HTML	Chr	Dec	Hex	Oct	HTML	Chr
0	0	000	NULL	32	20	040	 	Space	64	40	100	@	@
1	1	001	Start of Header	33	21	041	!	!	65	41	101	A	A
2	2	002	Start of Text	34	22	042	"	"	66	42	102	B	B
3	3	003	End of Text	35	23	043	#	#	67	43	103	C	C
4	4	004	End of Transmission	36	24	044	$	\$	68	44	104	D	D
5	5	005	Enquiry	37	25	045	%	%	69	45	105	E	E
6	6	006	Acknowledgment	38	26	046	&	&	70	46	106	F	F
7	7	007	Bell	39	27	047	'	'	71	47	107	G	G
8	8	010	Backspace	40	28	050	((72	48	108	H	H
9	9	011	Horizontal Tab	41	29	051))	73	49	109	I	I
10	A	012	Line feed	42	2A	052	*	*	74	4A	110	J	J
11	B	013	Vertical Tab	43	2B	053	+	+	75	4B	111	K	K
12	C	014	Form feed	44	2C	054	,	,	76	4C	112	L	L
13	D	015	Carriage return	45	2D	055	-	-	77	4D	113	M	M
14	E	016	Shift Out	46	2E	056	.	.	78	4E	114	N	N
15	F	017	Shift In	47	2F	057	/	/	79	4F	115	O	O
16	10	020	Data Link Escape	48	30	060	0	0	80	50	120	P	P
17	11	021	Device Control 1	49	31	061	1	1	81	51	121	Q	Q
18	12	022	Device Control 2	50	32	062	2	2	82	52	122	R	R
19	13	023	Device Control 3	51	33	063	3	3	83	53	123	S	S
20	14	024	Device Control 4	52	34	064	4	4	84	54	124	T	T
21	15	025	Negative Ack.	53	35	065	5	5	85	55	125	U	U
22	16	026	Synchronous idle	54	36	066	6	6	86	56	126	V	V

NUMBERS ARE BITS!
CHARACTERS ARE NUMBERS!

INFORMATION IS
NUMBERS!

DATA STRUCTURES!

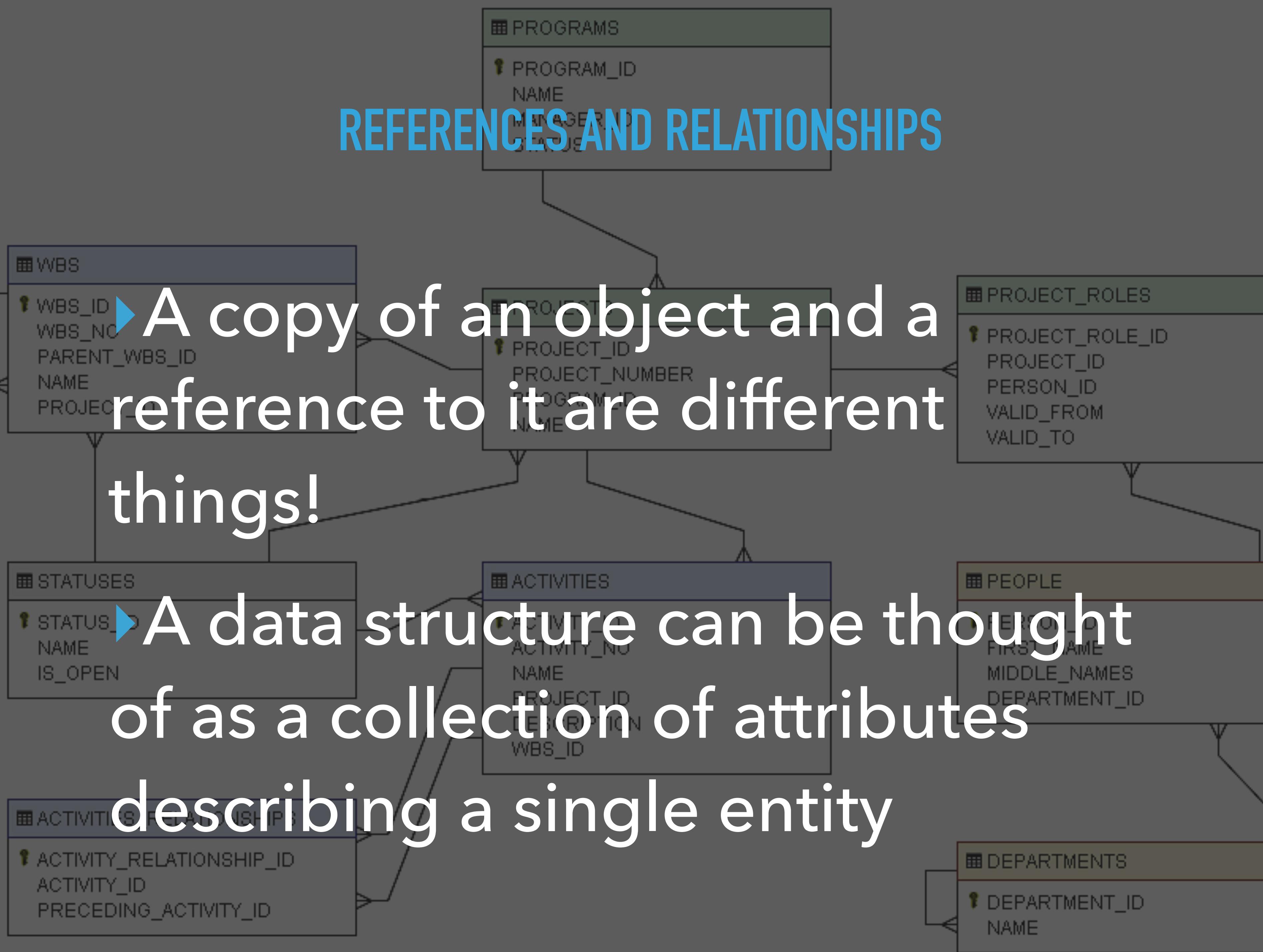
- ▶ Create complex structures composed of simpler ones
- ▶ **(name, address, postcode)**
- ▶ **(billing_address,
delivery_address,
credit_limit, balance)**
- ▶ To multiple levels,
recursively!



REFERENCES AND RELATIONSHIPS

► A copy of an object and a reference to it are different things!

► A data structure can be thought of as a collection of attributes describing a single entity



OBJECT-ORIENTED SYSTEMS

- ▶ Classes define the behaviours of sets of similar objects
- ▶ Each instance of a class has the class's behaviours but its own individual state

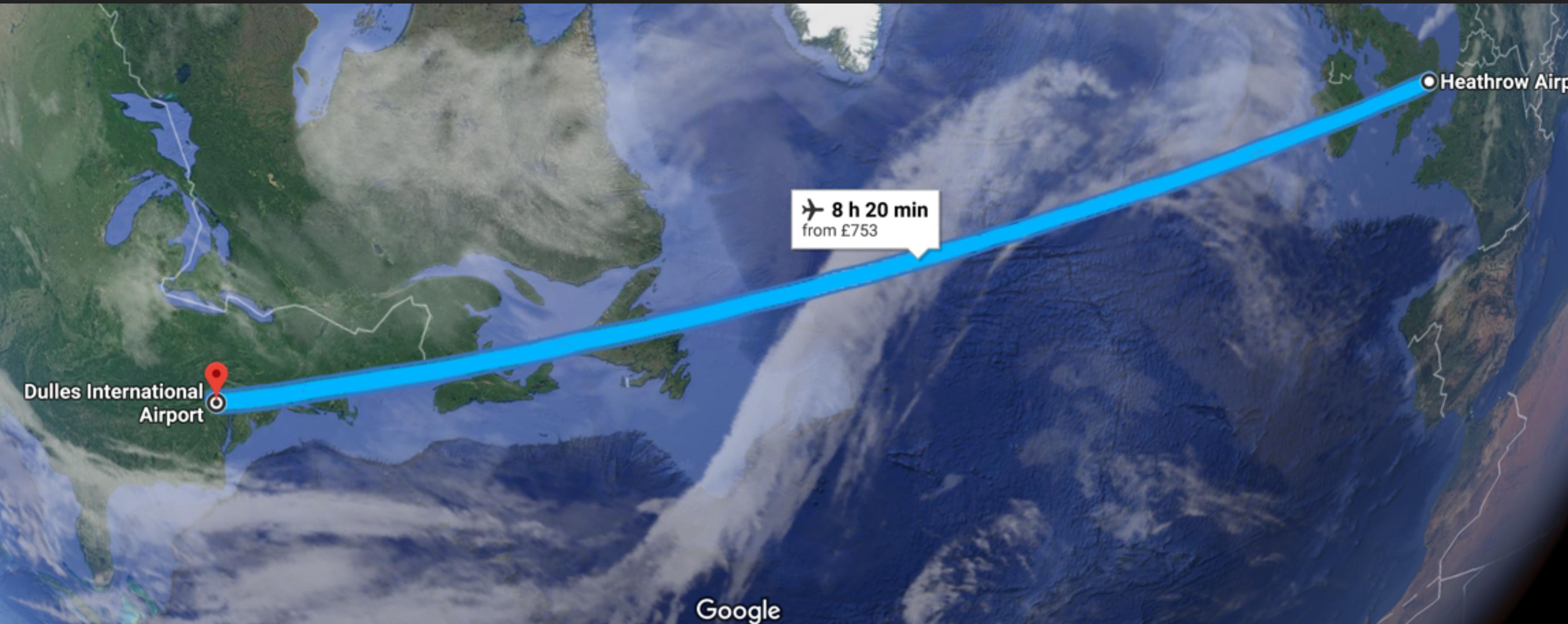
To Get	You Type	We Call It
!	LF <shift> '	do it
☞	<shift> 5 <ctrl><shift>;	hand
⌚	<ctrl> k <shift> /	eyeball
⇒	<shift> 1 <shift> 2	keyhole
↑	<shift> 7 <shift> 8	if ... then
😊	<ctrl> ? <ctrl> s	return
□	<ctrl> d <ctrl> -	smiley
?	<ctrl> -	
's	<ctrl> <	
done!	<ctrl> >	
-	<ctrl> =	
≤	<ctrl> v	unary
≥	<ctrl> 2	less than
≠	<ctrl> 1	greater
%	<ctrl> o	not equal
@	<ctrl> 4	percent
!		"at" sign
"		explain
\$		double dollar

OBJECT-ORIENTATION!

- ▶ 1974: Discovered Alan Kay's PARC papers on SmallTalk
- ▶ 1975: Using Simula-2 (object-oriented simulations)
- ▶ 1980: Joined Computer Science Dept, Manchester University
- ▶ 1981: Visited SmallTalk group at PARC
- ▶ 1983: First UK SmallTalk-80 implementation
- ▶ 1984: Decided SmallTalk was not the answer

A close-up photograph of a man's face. He has a shocked or surprised expression, with wide blue eyes and his mouth slightly open. His hair is dark and receding. The background is plain white.

**SMALLTALK DOES NOT
FIT MY BRAIN!**



SHORT INTERLUDE

TEN YEARS PASS. . .

A FLOWER CANNOT BLOSSOM
WITHOUT SUNSHINE, AND MAN
CANNOT LIVE WITHOUT LOVE.

Max Muller



WHY PYTHON?

**THE LANGUAGE'S
DESIGN**

WHAT'S IN A NAME? THAT WHICH
WE CALL A ROSE BY ANY OTHER
NAME WOULD SMELL AS SWEET.

William Shakespeare, Romeo and Juliet

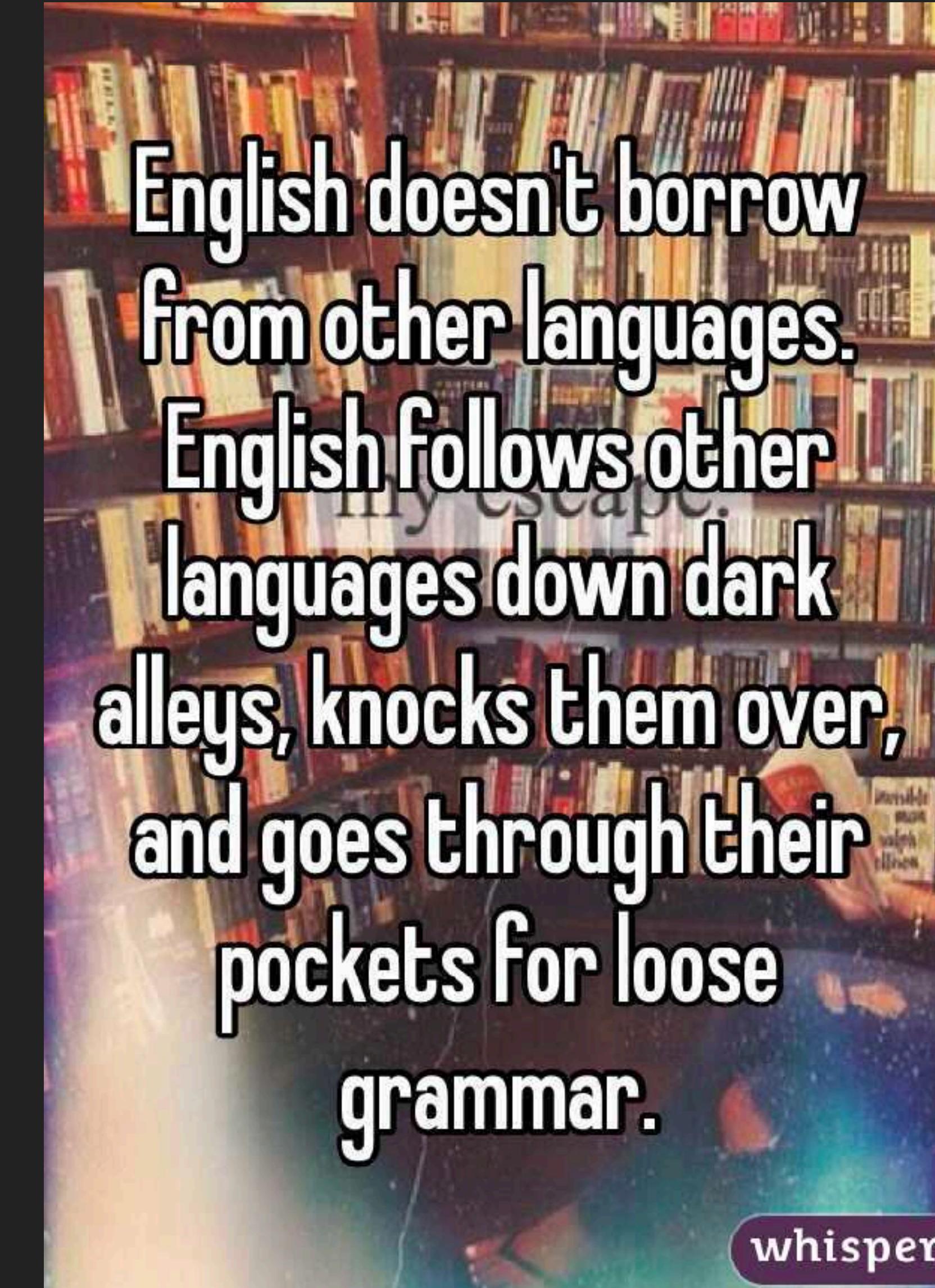
READABILITY COUNTS

- ▶ Code is primarily for people, not computers
- ▶ We created programming languages in an attempt to make it easier to communicate with computers on our own terms



BORROW FROM ELSEWHERE ...

- ▶ ... whenever it makes sense
- ▶ Good ideas are good wherever they come from!



BE AS SIMPLE AS POSSIBLE ...

- ▶ C

```
#include <stdio.h>
int main()
{
    printf("Hello, World!");
    return 0;
}
```

- ▶ Python

```
print("Hello, world!")
```



... BUT NO SIMPLER

▶ C

```
#include <stdio.h>
int main()
{
    int i;
    for ( i=0 ; i < 10 ; i++ )
        printf("%d ",i*i);
    return 0;
}
```

▶ Python

```
for i in range(10):
    print(i*i)
```

▶ C

```
#include <stdio.h>
int main()
{
    int array[8] = {1, 2, 3, 4, 5, 6, 7, 8}
    int loop;
    for ( loop=0 ; loop < 8; loop++ )
        printf("%d ", array[loop]);
    return 0;
}
```

▶ Python

```
numbers = [1, 2, 3, 4, 5, 6, 7, 8]
for number in numbers:
    print(number)
```

ERRORS SHOULD NOT BE FATAL

- ▶ No cored dumps, ever!
- ▶ Whatever buggy code the user writes, errors should not crash the interpreter
- ▶ Libraries in other languages may violate this principle
- ▶ Programs should be able to handle their own errors if necessary
- ▶ Even things like uncontrolled recursion!

```
03-2000: 4083 130D 1311 1314 021F 2023 4C49 5354 0..... #LIST
03-2008: 204B 4559 A807 6C0F 0000 0828 47D1 443A KEY..1...<G.D:
03-2010: 44E0 0360 F187 607C 2034 321D 07EC 0A1D D...1;42.....
03-2018: 47D7 F082 44F6 6C05 6D2D 4526 E8C6 F081 G...D.1.m-E&.....
03-2020: 4523 F081 F081 2060 4C49 5354 A805 6C2C E#...`LIST..1.
03-2028: 0000 0034 C12C 082A 47B3 441C 7171 834B ...4...*G.D.qq.K
03-2030: 2025 B800 7171 834B 2026 321D 0001 B21D z...qq.K &2.....
03-2038: 834B 2025 8000 F020 2001 F403 47B8 6FBC K%...`...G.o.
03-2040: 0360 F187 607C 2038 321D 07BB 0A1D 47A8 ...1;82....G.
03-2048: F082 7170 3360 7171 834B 2023 B800 7171 ..qp3`qq.K #..qq
03-2050: 2021 B800 F081 44BD 6C09 6D03 C103 E8C6 !...D.1.m...
03-2058: 4504 6D01 C103 E8C6 F081 C103 6CFA 6FF9 E.m...`...1.o.
03-2060: 2077 5255 4E20 A805 6C0F 0000 4406 F081 wRUN ..1..D...
03-2068: 0796 086C 4785 F082 0824 4772 7171 834B ..1G...$Grqq.K
03-2070: 2023 B800 F082 C0CE C103 6CE3 F081 208A #...`...1...~.
03-2078: 434F 4E54 A805 6C08 0000 47EF F081 077E CONT..1...G...~.
03-2080: 086C 476E F082 C0CE C103 6C02 F081 0887 .1Gn...`...1...
03-2088: C0D3 F081 2097 5343 5241 5443 4820 4120 ....SCRATCH A
03-2090: A808 E8CE 0000 C168 0000 0087 6C3E 20AA .....h...1> .
03-2098: 5343 5241 5443 4820 4B45 5920 A809 6C07 SCRATCH KEY ..1.
03-20A0: 0000 444D 0761 0834 474B F082 C0CE 449C ..DM.a.4GK...D.
03-20A8: F081 F081 20B5 5343 5241 5443 4820 5020 ....SCRATCH P
03-20B0: A808 E8CE 0000 0022 6C20 20C0 5343 5241 ....."1 ..SCRA
```

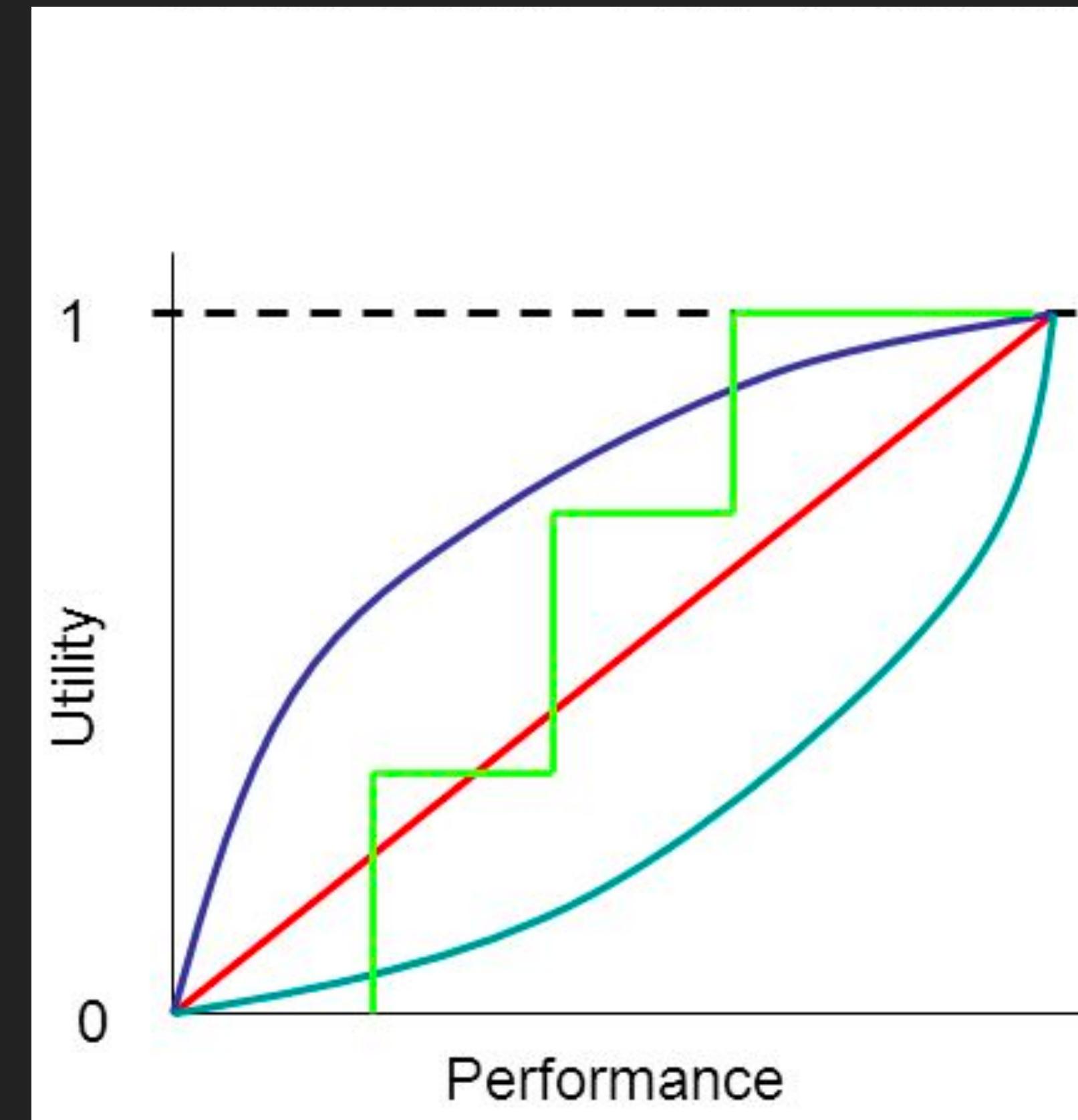
```
def recurse_indefinitely():
    return recurse_indefinitely()

try:
    recurse_indefinitely()
except RecursionError:
    print("Definitely recursive")
```

Definitely recursive

PERFORMANCE ISN'T KEY

- ▶ Plan to optimise later
- ▶ But only if needed!
- ▶ Utility to the programmer is what attracted early adopters



PLAY WELL WITH OTHERS

- ▶ Python is not perfect
 - ▶ Other languages will be better at some tasks
- ▶ Incorporating other languages gives Python more power!
- ▶ e.g., Numpy, a widely used numerical package
- ▶ Uses code written in Python, C++, C and Fortran!



DON'T FIGHT THE ENVIRONMENT

- ▶ Go with the flow
- ▶ Offer a consistent interface across platforms
- ▶ Platform-specific features are OK
 - ▶ But don't use them in programs you want to be portable!



DON'T STRIVE FOR PERFECTION

- ▶ "Good enough" is often just that
- ▶ Optimise for low development times rather than fast execution



GOOD
ENOUGH
IS THE NEW
PERFECT

IT'S OK TO CUT CORNERS ...

- ▶ ... sometimes
- ▶ Especially if you can do it right later
- ▶ But try to avoid abhorrences like

try:

True

except NameError:

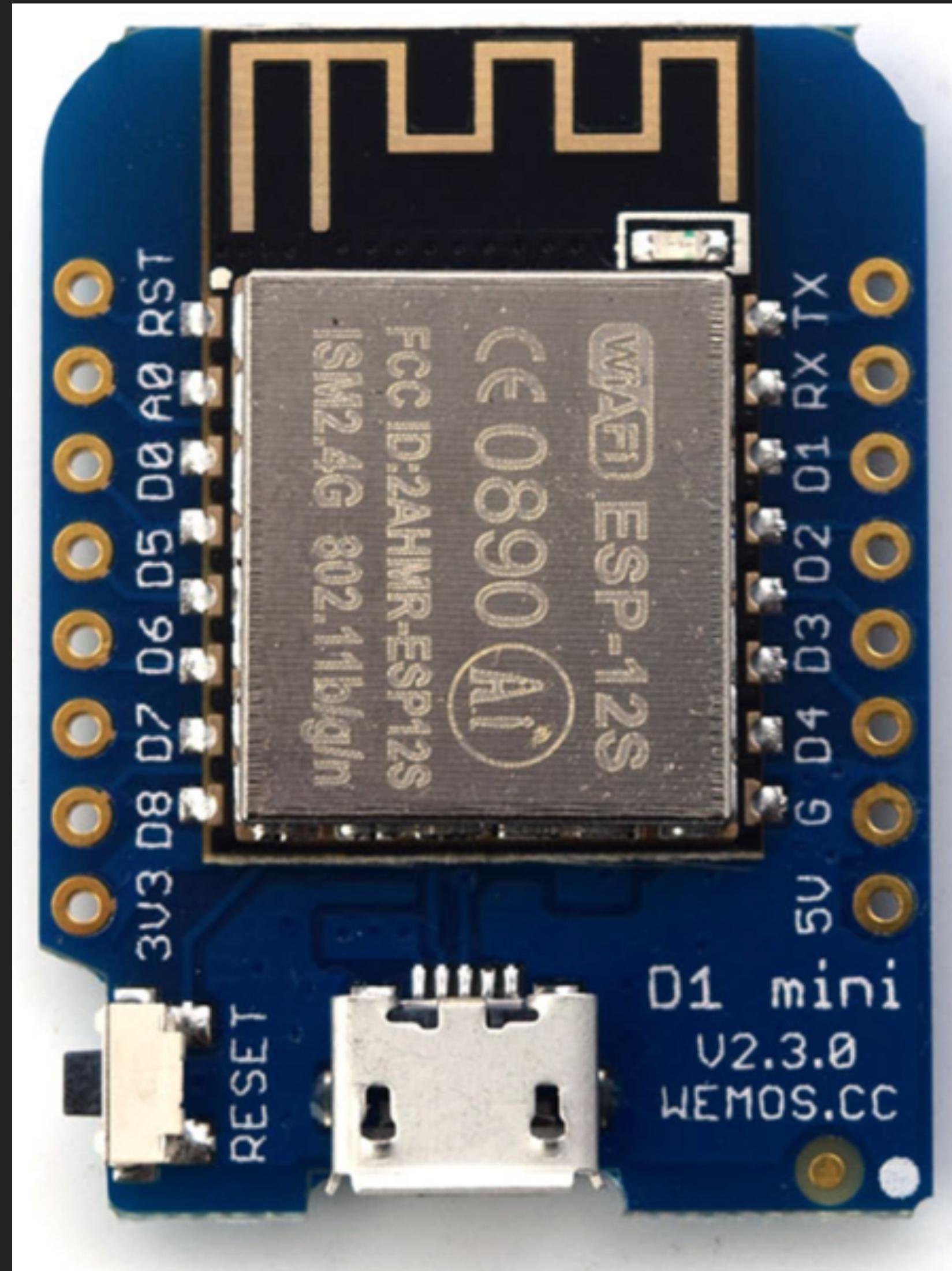
True = 1

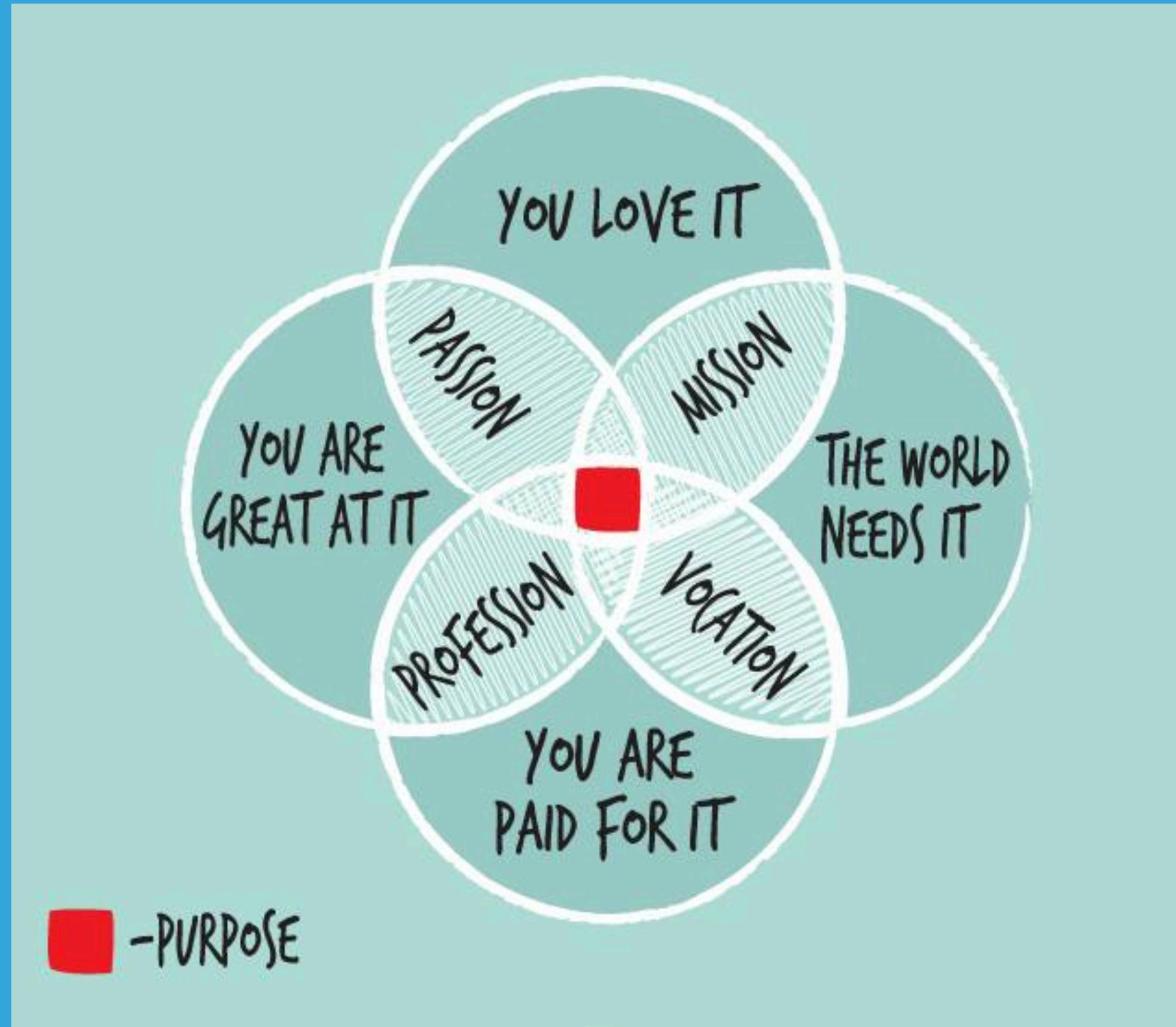


BUT . . . WHAT'S IN THE FUTURE?

- ▶ Nowadays major features appear first in the `__future__` module
- ▶ Standard Python 2.7:
print "Hello, World!"
- ▶ This import *changes Python's syntax!*
`from __future__ import print_function
print("Hello, World!")`







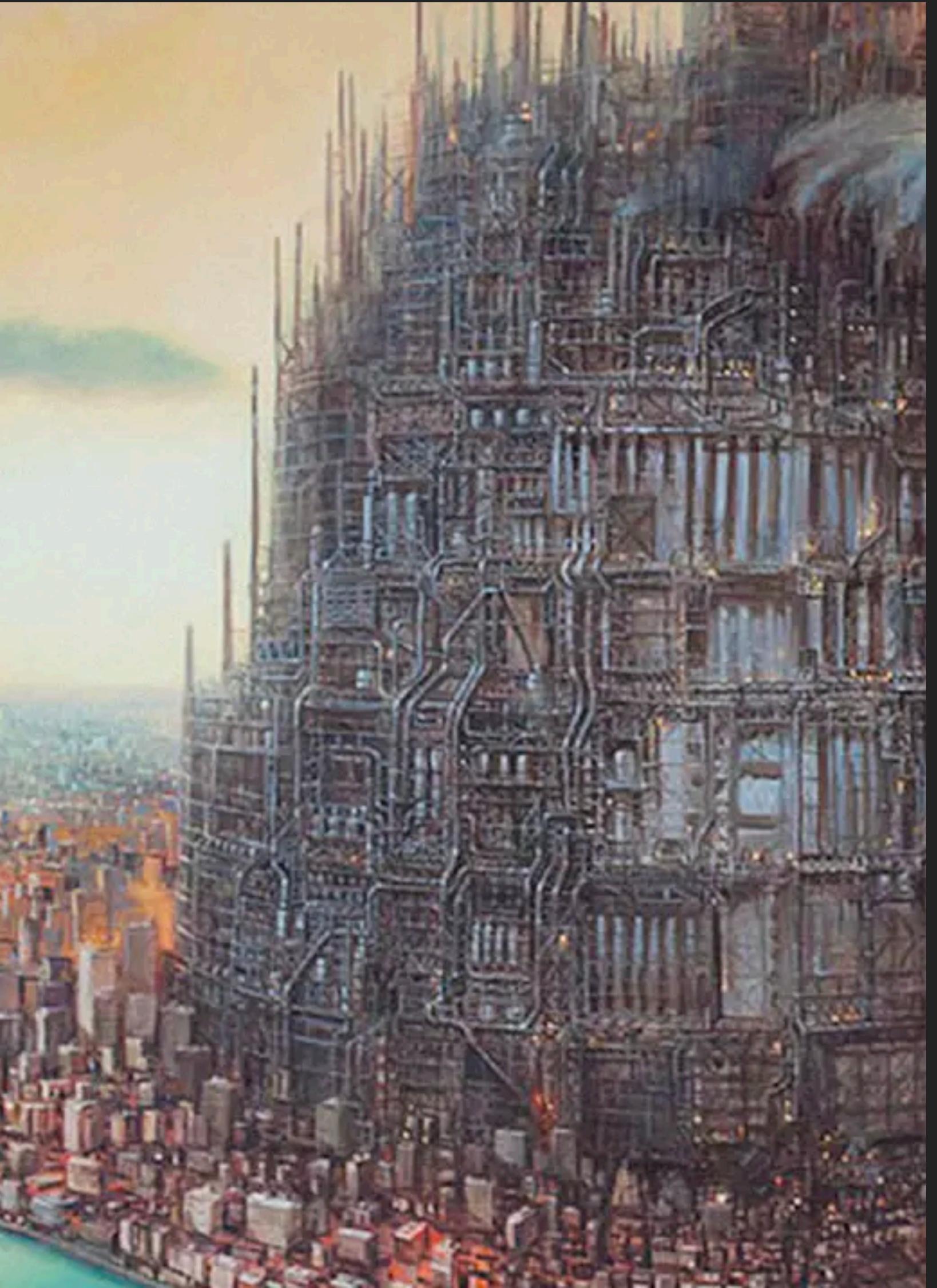
HINDSIGHT IS GAINED THROUGH EXPERIENCE

Ellen Hopkins

WHY I LOVE SOFTWARE DEVELOPMENT

- ▶ “Tell me what the rules are, I can build it for you!”
- ▶ You can (almost) build castles in the sky





WHY I FEAR SOFTWARE DEVELOPMENT

- ▶ “Tell me what the rules are, I can build it for you!”
- ▶ You can enforce and monitor *any* system of rules

Questions?

Slides and Notes at

github.com/holdenweb/open19

Thank you!