Everything Is a Number

Abstractions and Types

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Everything Is a Number

- Key principle: Everything Is a Number
  - Computers only work with numbers
- Hardware: **bits** (0 , 1)
  - Can only do math
- Do not need to worry about bits
  - Abstraction

Abstraction

Interface: What It Does

Implementation: How It Does It

- Abstraction:
  - Separation of **interface** + **implementation**

Abstraction

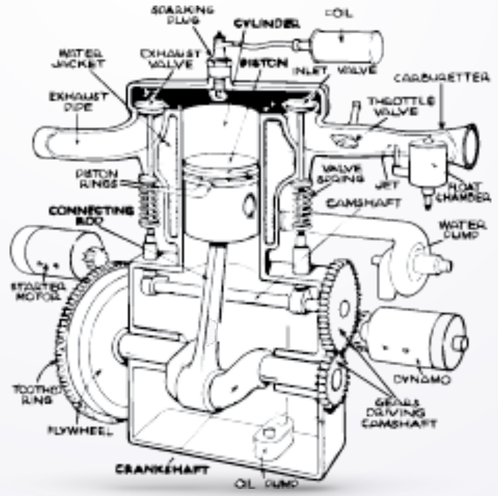
Push Gas Pedal → Car Goes Faster

Complicated Inner Workings of Engine

- Example: Driving a Car

Abstraction: Multiple Layers

Driver



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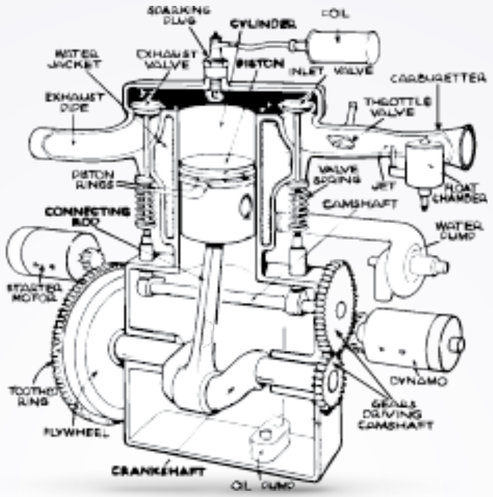
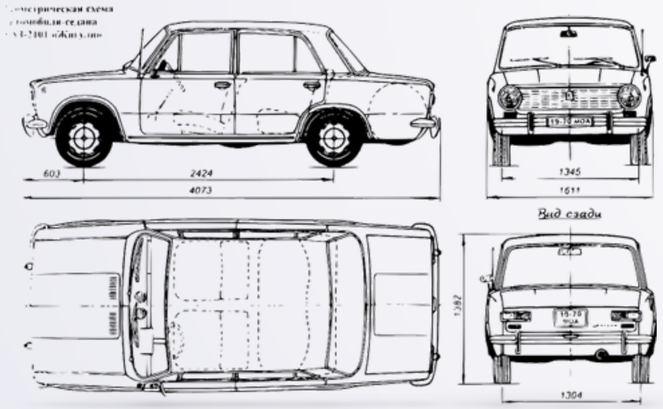
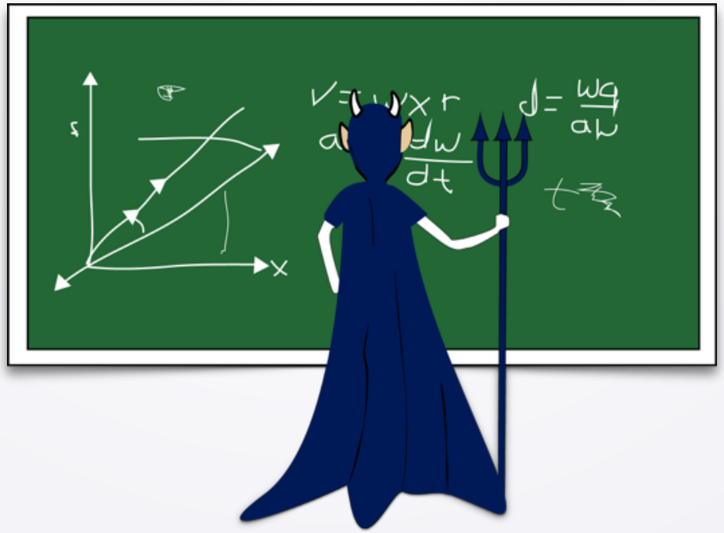
Abstraction: Multiple Layers



Mechanic





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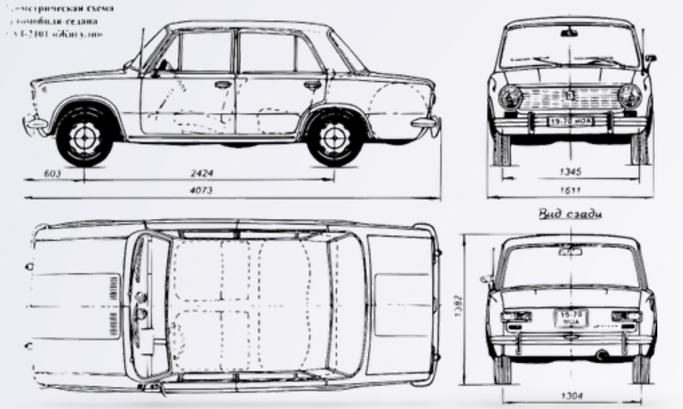
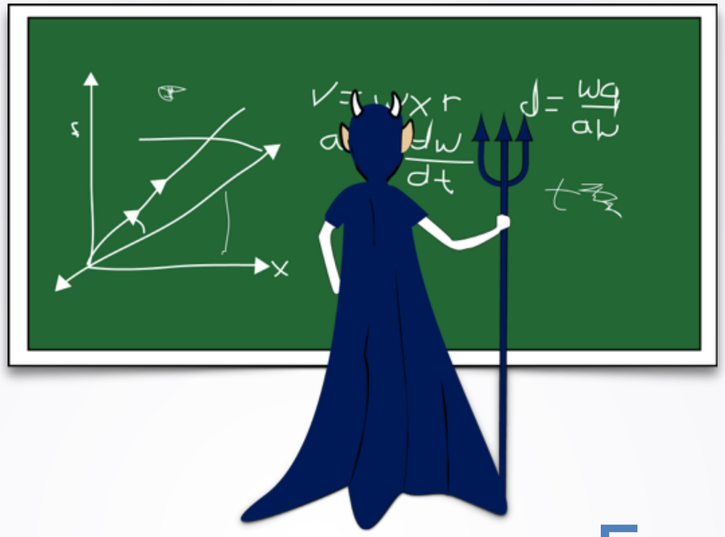
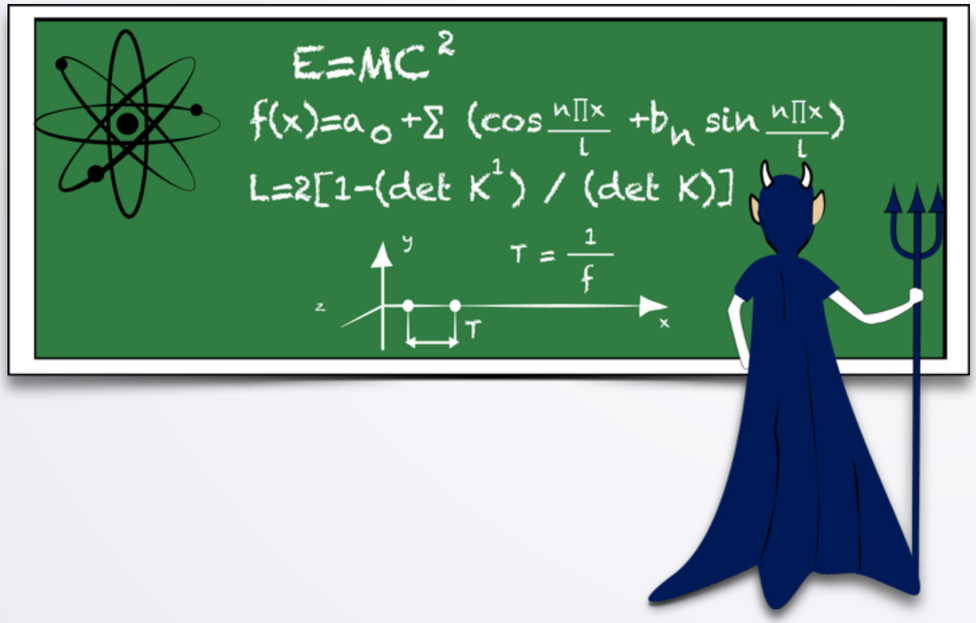
Abstraction: Multiple Layers





Engineer



Everything Is a Number: Characters

- Letters?
  - Could do a=1, b=2,…
- Actually **characters**
  - A= 65, B=66,…
  - a=97, b=98,…
  - !=33

Everything Is a Number: Characters

- Letters?
  - Could do a=1, b=2,…
- Actually **characters**

32	sp	33	!	34	"	35	#	36	$	37	%	38	&	39	'
40	(	41	)	42	*	43	+	44	,	45	-	46	.	47	/
48	0	49	1	50	2	51	3	52	4	53	5	54	6	55	7
56	8	57	9	58	:	59	;	60	<	61	=	62	>	63	?
64	@	65	A	66	B	67	C	68	D	69	E	70	F	71	G
72	H	73	I	74	J	75	K	76	L	77	M	78	N	79	O
80	P	81	Q	82	R	83	S	84	T	85	U	86	V	87	W
88	X	89	Y	90	Z	91	[	92	\	93	]	94	^	95	_
96	`	97	a	98	b	99	c	100	d	101	e	102	f	103	g
104	h	105	i	106	j	107	k	108	l	109	m	110	n	111	o
112	p	113	q	114	r	115	s	116	t	117	u	118	v	119	w
120	x	121	y	122	z	123	{	124	|	125	}	126	~	127	del

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Everything Is a Number: Characters

- Letters?
  - Could do a=1, b=2,…
- Actually **characters**
  - A= 65, B=66,…
  - a=97, b=98,…
  - !=33
- Do not need to know specific numbers!
  - Abstraction

Strings: Sequences of Characters

- String: sequence of characters
  - “Hello!”
- Come up often in CS
  - Have seen in HTML

Abstraction: Strings

“Hello!”

72 101 108 108 111 33

- Write “Hello!”
  - Rarely think about numeric implementation

Importance of Everything Is a Number

- Can expose numeric properties
  - Math with letters? Cryptography
- **Types**: interpretation of numbers
  - How to operate on values?
    - “1” + “1” = “11”
    - 1 + 1 = 2
- Represent data numerically
  - Maybe with existing types

Programs: Also Numbers

- Programs: also numbers
  - Starts out as a string
  - Turned into **instructions**
    - Numerical encoding of what to do
- Importance:
  - Can download, run new programs
  - Security issues (advanced concepts!)
- As always: abstraction!

Everything Is a Number

- Everything Is a Number
  - Computers do math
  - Abstraction: interface vs. implementation
    - May not “see” numeric details