IN2: Trusting Trust

Introduction to Compilers

CMPT 379: Compilers

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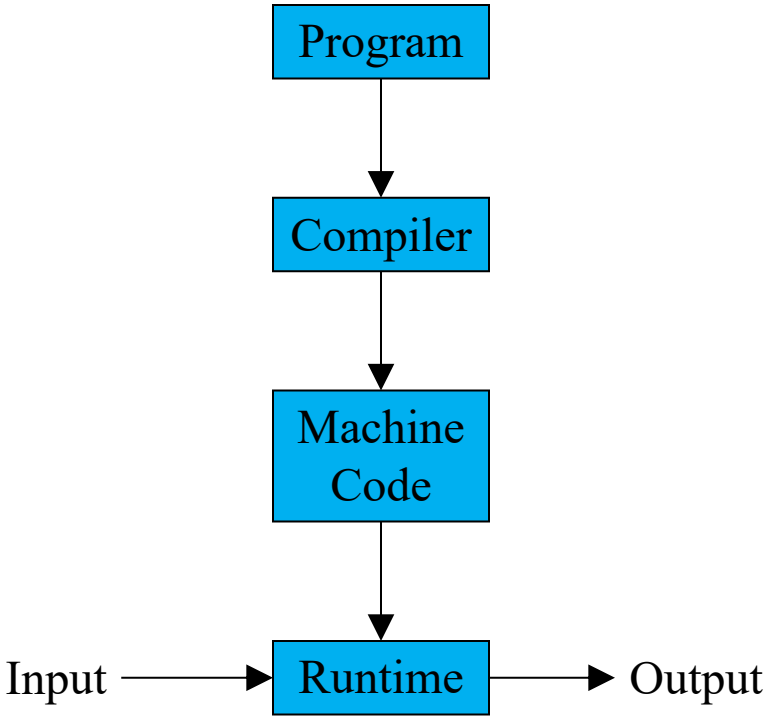
anoopsarkar.github.io/compilers-class


Program
Compiler
Machine Code
Input
Runtime
Output

Program

What is a program?

hello.c

```
#include <stdio.h>
int main() {
    printf("hello world!\n");
}
```

```
$ file hello.c
hello.c: c program text, ASCII text
```

ASCII character set

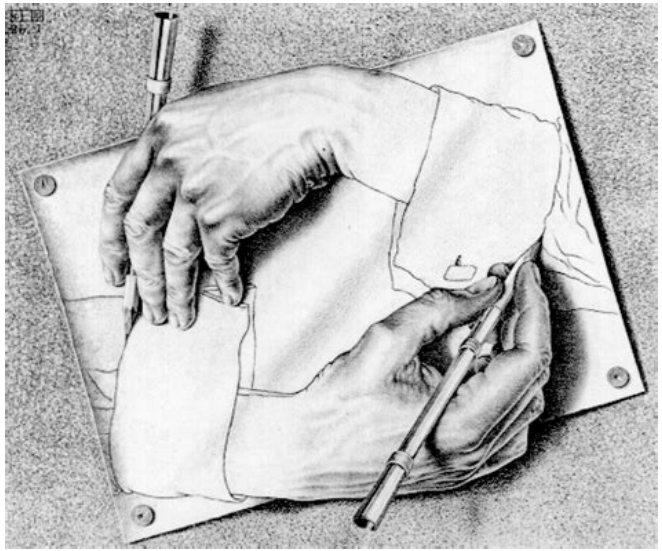
0	nul	1	soh	2	stx	3	etx	4	eot	5	enq	6	ack	7	bel
8	bs	9	ht	10	nl	11	vt	12	np	13	cr	14	so	15	si
16	dle	17	dc1	18	dc2	19	dc3	20	dc4	21	nak	22	syn	23	etb
24	can	25	em	26	sub	27	esc	28	fs	29	gs	30	rs	31	us
32	sp	33	!	34	"	35	#	36	$	37	%	38	&	39	'
40	(	41	)	42	*	43	+	44	,	45	-	46	.	47	/
48	0	49	1	50	2	51	3	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

Q: Why 128?

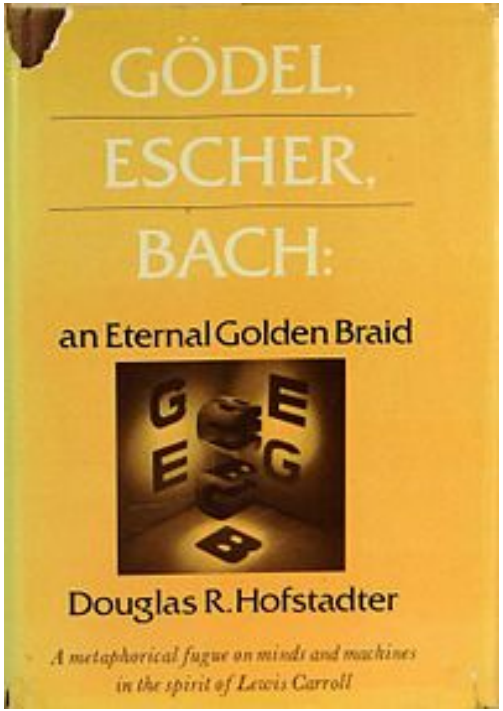
A Quine is a program that generates its own code

- A program is just a text ASCII file
- `printf` prints out ASCII text
- There must be a program that can print out ASCII text that is itself source code for a program
- This would be a program that is a program generator
- A program generator that generates itself is called a Quine

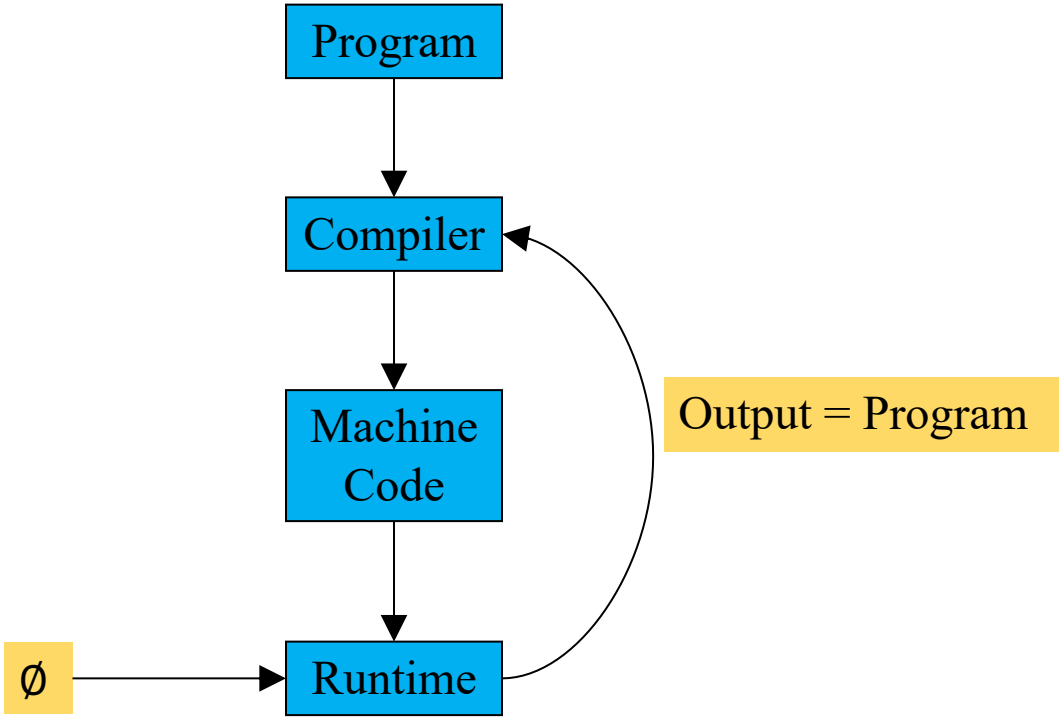
A Quine is a program that generates its own code



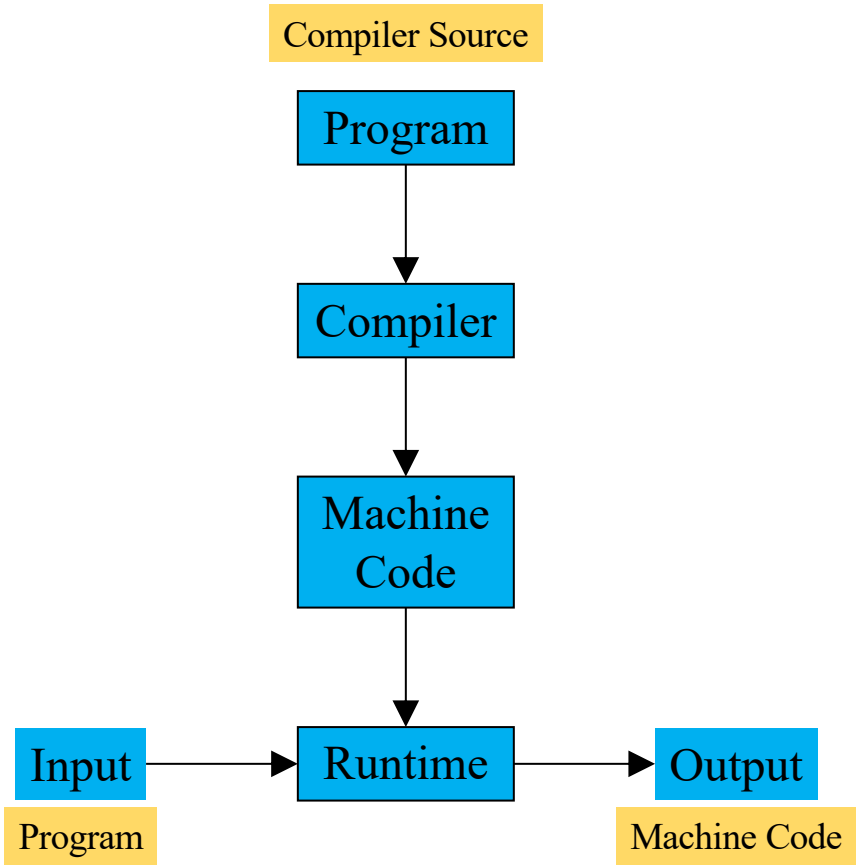
M.C. Escher. “Drawing Hands”



```c
#include <stdio.h>
int main(){char *c="#include <stdio.h>%cint main(){char
*c=%c%s%c;printf(c,10,34,c,34,10);}%c";printf(c,10,34,c,34,10);}
```

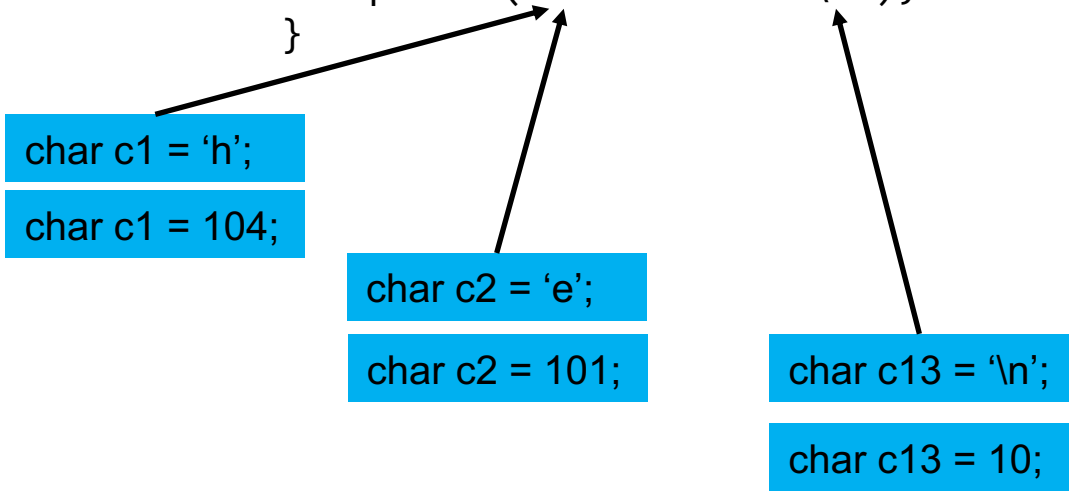


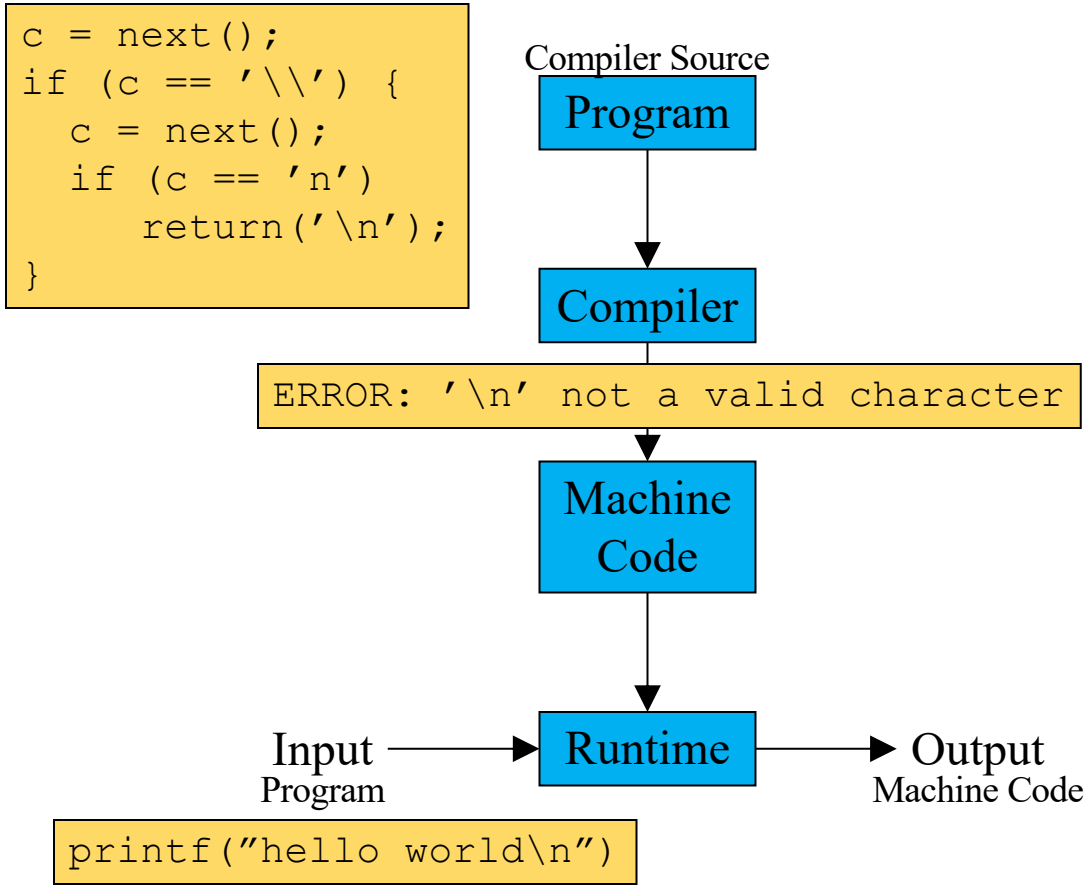
The compiler has source code – must be compiled


Compiler Source
Program
Compiler
Machine Code
Input
Runtime
Output
Program
Machine Code

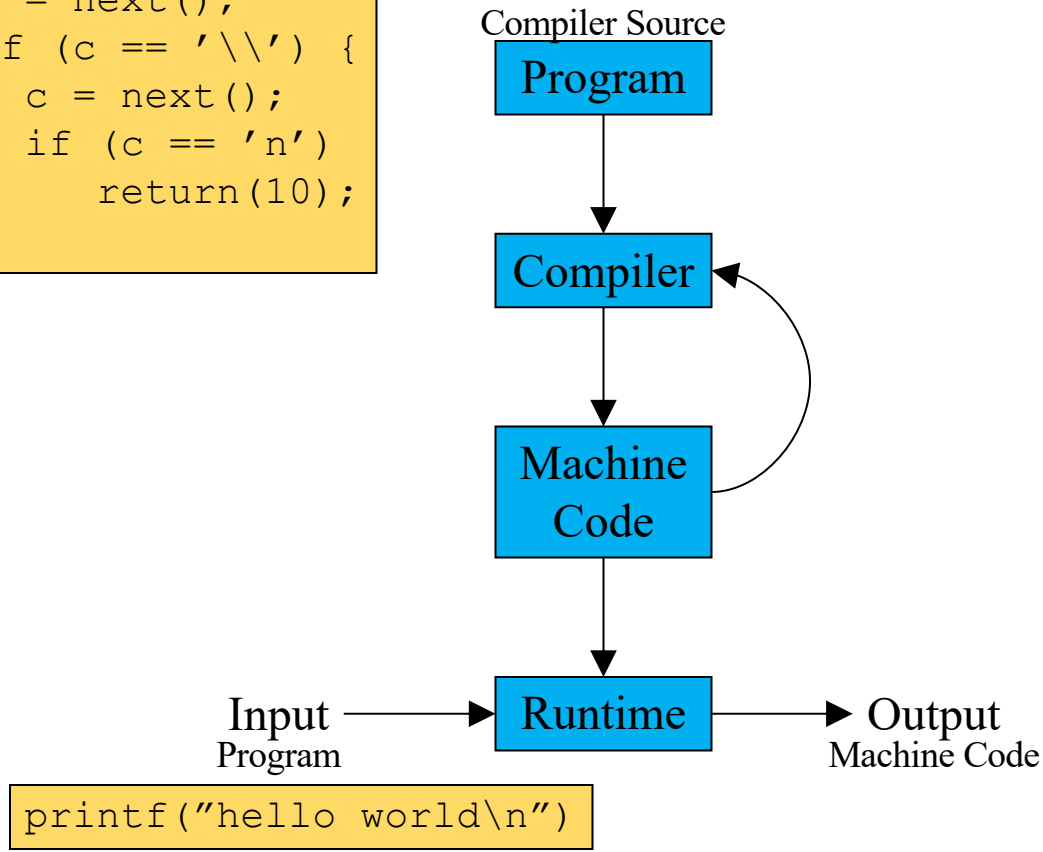
Character constants in programming languages

```
#include <stdio.h>
int main() {
    printf("hello world!\n");
}
```

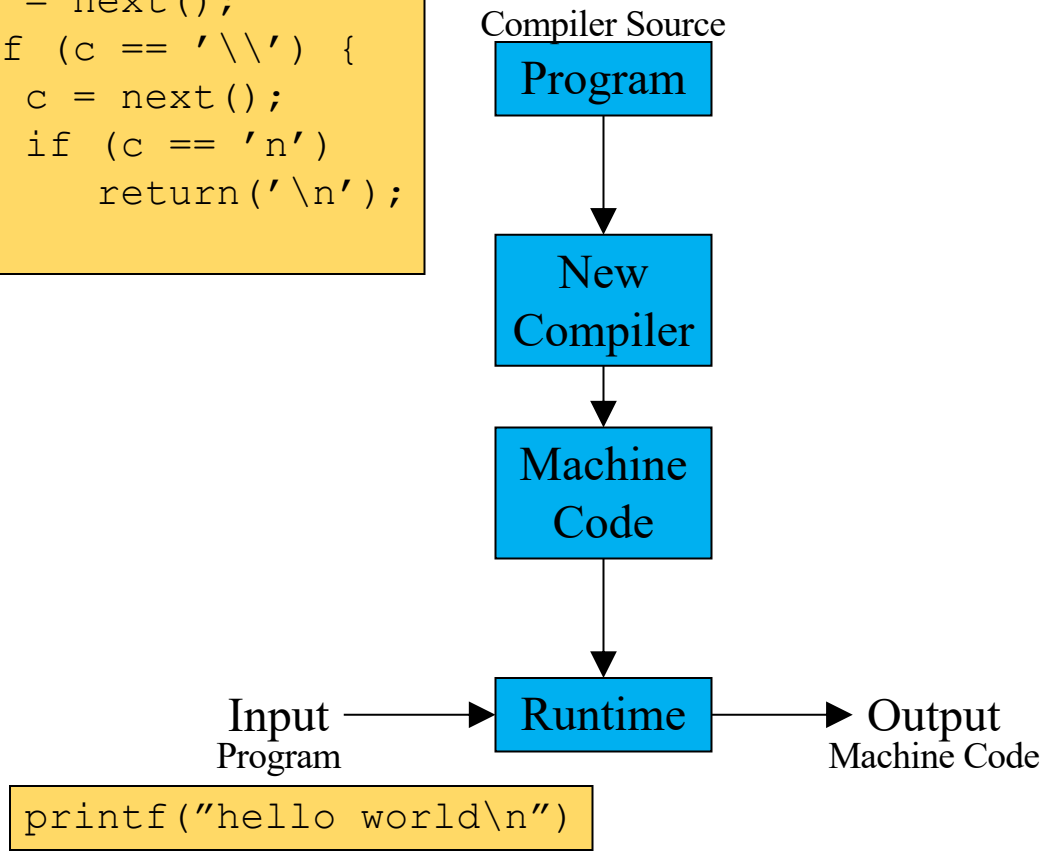



c = next();
if (c == '\\') {
c = next();
if (c == 'n')
return('\n');
}
Compiler Source
Program
Compiler
ERROR: '\n' not a valid character
Machine Code
Input
Program
Runtime
Output
Machine Code
printf("hello world\n")

```
c = next();
if (c == '\\') {
  c = next();
  if (c == 'n')
     return(10);
}
```



```
c = next();
if (c == '\\') {
  c = next();
  if (c == 'n')
     return('\n');
}
```



login is just another program

login code from the freebsd GitHub repository:
https://github.com/freebsd/freebsd

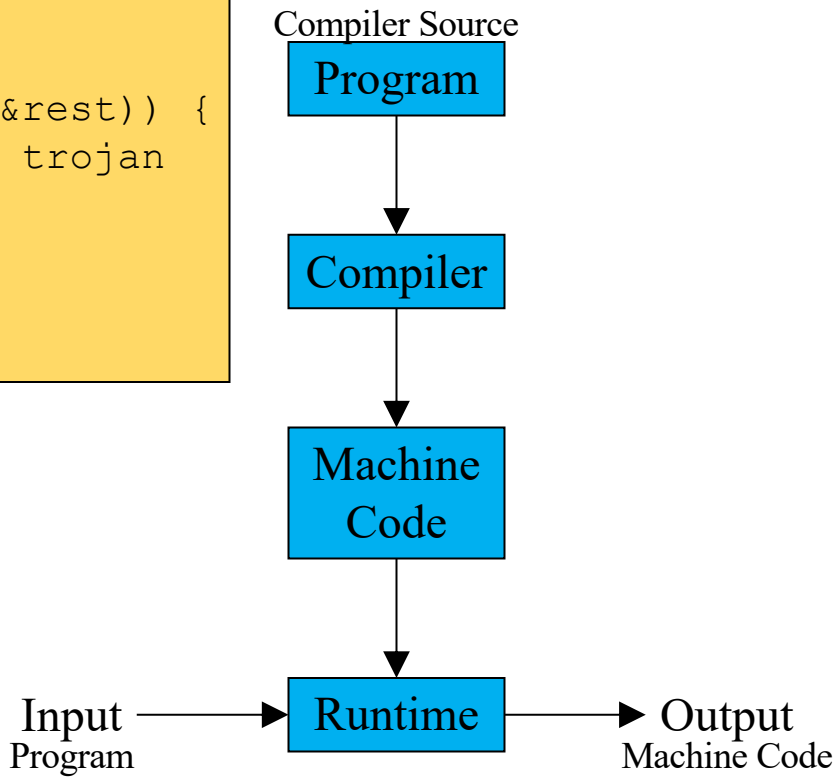
```
static void
do_login(const struct passwd *pwd, char *tty, char *ttyn)
{
  …
  struct spwd *sp = getspnam(pwd->pw_name);
  check_shadow(pwd, sp);
  …

}
```

Get password from system

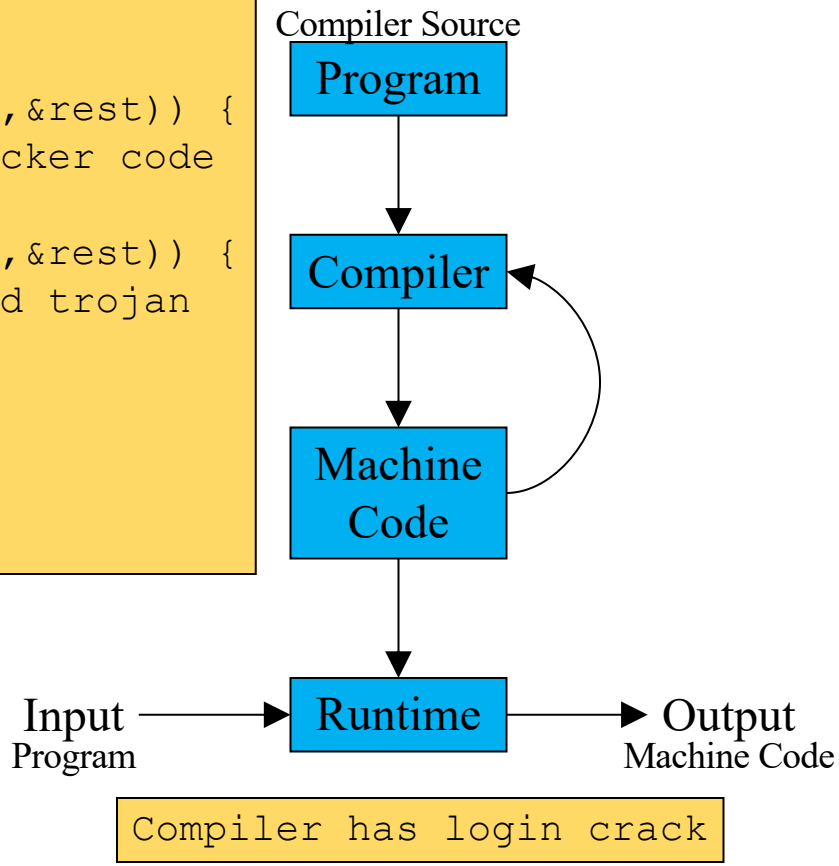
Check entered password against system password

```
compile(char *s)
{
  if(match(s,"login(",&rest)) {
    // add root passwd trojan
    compile(rest);
  }
  …
}
```



Compiler has login crack

```
compile(char *s)
{
  if(match(s,"compile(",&rest)) {
    // insert login cracker code
    compile("
    if(match(s,"login(",&rest)) {
      // add root passwd trojan
      compile(rest);");
  }
  compile(rest);
  …
}
```



```
compile(char *s)
{
  // standard compiler code
  // no login crack
  …
}
```

[Reflections on Trusting Trust](), Ken Thompson. CACM 27(8), pp. 761-763, 1984.