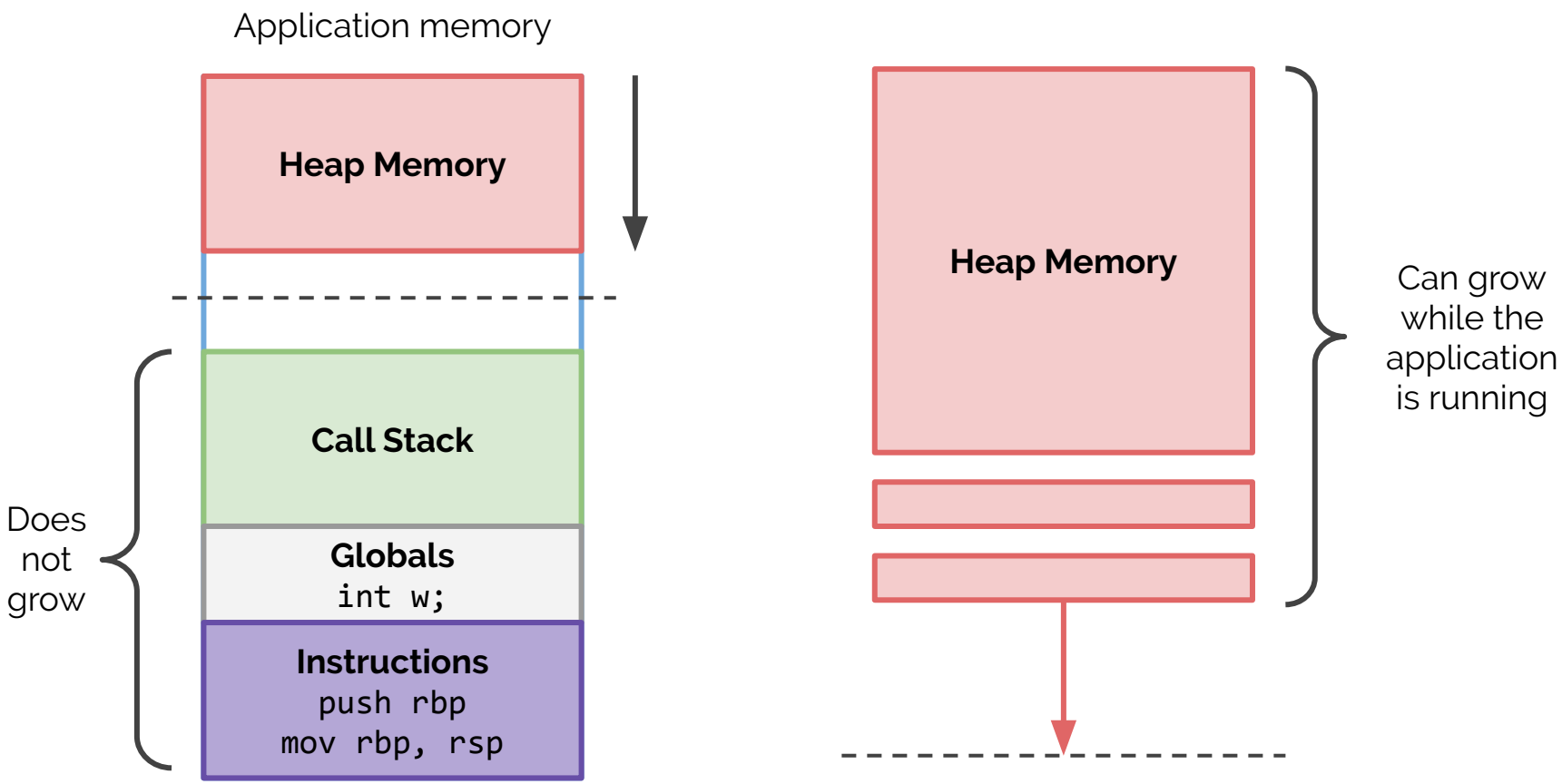
Cyber Security

Software Security: Exploits and Mitigations

Dr Chris Willcocks

Recap


Application memory
Heap Memory
Call Stack
Globals
int w;
Instructions
push rbp
mov rbp, rsp
Does not grow
Heap Memory
Can grow while the application is running

Buffer Overflows

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- When writing data to a buffer, you overrun into adjacent memory locations
- Often results in a crash, but sometimes can be exploited for other malicious behaviour, such as gaining elevated privileges
- Can occur on the stack:
  - **Stack smashing**
- Can occur on the heap:
  - **Heap overflow**

Buffer Overflows

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```c
#include <stdio.h>

int main ()
{
   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: L2udm71vYECrgBcgZLA6JpUfUwDYHqcBA89Db9QazRYKGhg1EbCZ\n");

   return 0;
}
```

Buffer Overflows

```
 chris@chris-lab ❯ ~/security ⎇ master ● ❯ ls
main.c
 chris@chris-lab ❯ ~/security ⎇ master ● ❯ gcc -fno-stack-check -fno-stack-protector -std=
c89 -O0 -pedantic main.c -o main.o
main.c: In function 'main':
main.c:11:5: warning: 'gets' is deprecated [-Wdeprecated-declarations]
     gets(username);
     ^~~~
In file included from main.c:1:0:
/usr/include/stdio.h:577:14: note: declared here
 extern char *gets (char *__s) __wur __attribute_deprecated__;
              ^~~~
/tmp/ccL18cJ6.o: In function `main':
main.c:(.text+0x28): warning: the `gets' function is dangerous and should not be used.
 chris@chris-lab ❯ ~/security ⎇ master ● ❯ objdump -S -M intel main.o > main.asm
 chris@chris-lab ❯ ~/security ⎇ master ● ❯ ./main.o
Enter your username, please: jess
 chris@chris-lab ❯ ~/security ⎇ master ● ❯ ./main.o
Enter your username, please: chris
Here is your private Bitcoin wallet: L2udm71vYECrgBcgZLA6JpUfUwDYHqcBA89Db9QazRYKGhg1EbCZ
 chris@chris-lab ❯ ~/security ⎇ master ● ❯ ./main.o
Enter your username, please: alice
 chris@chris-lab ❯ ~/security ⎇ master ● ❯ ./main.o
Enter your username, please: bbbbbbbbb
Here is your private Bitcoin wallet: L2udm71vYECrgBcgZLA6JpUfUwDYHqcBA89Db9QazRYKGhg1EbCZ
 chris@chris-lab ❯ ~/security ⎇ master ● ❯
```

Lots of modern checks

- Using a patched gcc which forces stack protection by default
- Deprecated APIs
- Helpful warnings

- `jess` can't login
- `chris` can login
- .. but so can `bbbbbbbbb`

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Buffer Overflows

```
000000000000072a <main>:
72a:   55                      push   rbp
72b:   48 89 e5                mov    rbp,rsp
72e:   48 83 ec 10             sub    rsp,0x10
732:   c7 45 fc 00 00 00 00    mov    DWORD PTR [rbp-0x4],0x0
739:   48 8d 3d d8 00 00 00    lea    rdi,[rip+0xd8]
740:   b8 00 00 00 00          mov    eax,0x0
745:   e8 a6 fe ff ff          call   5f0 <printf@plt>
74a:   48 8d 45 f4             lea    rax,[rbp-0xc]
74e:   48 89 c7                mov    rdi,rax
751:   e8 ba fe ff ff          call   610 <gets@plt>
756:   48 8d 45 f4             lea    rax,[rbp-0xc]
75a:   48 8d 35 d5 00 00 00    lea    rsi,[rip+0xd5]
761:   48 89 c7                mov    rdi,rax
764:   e8 97 fe ff ff          call   600 <strcmp@plt>
769:   85 c0                   test   eax,eax
76b:   75 07                   jne    774 <main+0x4a>
76d:   c7 45 fc 01 00 00 00    mov    DWORD PTR [rbp-0x4],0x1
774:   83 7d fc 00             cmp    DWORD PTR [rbp-0x4],0x0
778:   74 0c                   je     786 <main+0x5c>
77a:   48 8d 3d bf 00 00 00    lea    rdi,[rip+0xbf]
781:   e8 5a fe ff ff          call   5e0 <puts@plt>
786:   b8 00 00 00 00          mov    eax,0x0
78b:   c9                      leave
78c:   c3                      ret
78d:   0f 1f 00                nop    DWORD PTR [rax]
```

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}
```

Buffer Overflows

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774:   83 7d fc 00             cmp    DWORD PTR [rbp-0x4],0x0
778:   74 0c                   je     786 <main+0x5c>
77a:   48 8d 3d bf 00 00 00    lea    rdi,[rip+0xbf]
781:   e8 5a fe ff ff          call   5e0 <puts@plt>
786:   b8 00 00 00 00          mov    eax,0x0
78b:   c9                      leave
78c:   c3                      ret
78d:   0f 1f 00                nop    DWORD PTR [rax]
```

16 byte stack frame

```c
#include <stdio.h>

int main ()
{
   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```

Buffer Overflows

```
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740:   b8 00 00 00 00          mov    eax,0x0
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75a:   48 8d 35 d5 00 00 00    lea    rsi,[rip+0xd5]
761:   48 89 c7                mov    rdi,rax
764:   e8 97 fe ff ff          call   600 <strcmp@plt>
769:   85 c0                   test   eax,eax
76b:   75 07                   jne    774 <main+0x4a>
76d:   c7 45 fc 01 00 00 00    mov    DWORD PTR [rbp-0x4],0x1
774:   83 7d fc 00             cmp    DWORD PTR [rbp-0x4],0x0
778:   74 0c                   je     786 <main+0x5c>
77a:   48 8d 3d bf 00 00 00    lea    rdi,[rip+0xbf]
781:   e8 5a fe ff ff          call   5e0 <puts@plt>
786:   b8 00 00 00 00          mov    eax,0x0
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78d:   0f 1f 00                nop    DWORD PTR [rax]
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#include <stdio.h>

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{
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   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
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}
```

Buffer Overflows

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732:   c7 45 fc 00 00 00 00    mov    DWORD PTR [rbp-0x4],0x0
739:   48 8d 3d d8 00 00 00    lea    rdi,[rip+0xd8] # 818
740:   b8 00 00 00 00          mov    eax,0x0
745:   e8 a6 fe ff ff          call   5f0 <printf@plt>
74a:   48 8d 45 f4             lea    rax,[rbp-0xc]
74e:   48 89 c7                mov    rdi,rax
751:   e8 ba fe ff ff          call   610 <gets@plt>
756:   48 8d 45 f4             lea    rax,[rbp-0xc]
75a:   48 8d 35 d5 00 00 00    lea    rsi,[rip+0xd5] # 836
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774:   83 7d fc 00             cmp    DWORD PTR [rbp-0x4],0x0
778:   74 0c                   je     786 <main+0x5c>
77a:   48 8d 3d bf 00 00 00    lea    rdi,[rip+0xbf] # 840
781:   e8 5a fe ff ff          call   5e0 <puts@plt>
786:   b8 00 00 00 00          mov    eax,0x0
78b:   c9                      leave
78c:   c3                      ret
78d:   0f 1f 00                nop    DWORD PTR [rax]
```

Pointers to string data

```c
#include <stdio.h>

int main ()
{
   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```

Buffer Overflows

```
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```

`.text` (code segment) stores program instructions
`.data` segment stores global variables, static local variables
`.rodata` read-only data segment stores static constants

```
chris@chris-lab  ~/security  master •  objdump -s -j .rodata main.o

main.o:     file format elf64-x86-64

Contents of section .rodata:
 0810 01000200 00000000 456e7465 7220796f  ........Enter yo
 0820 75722075 7365726e 616d652c 20706c65  ur username, ple
 0830 6173653a 20006368 72697300 00000000  ase: .chris.....
 0840 48657265 20697320 796f7572 20707269  Here is your pri
 0850 76617465 20426974 636f696e 2077616c  vate Bitcoin wal
 0860 6c65743a 204c3275 646d3731 76594543  let: L2udm71vYEC
 0870 72674263 675a4c41 364a7055 66557744  rgBcgZLA6JpUfUwD
 0880 59487163 42413839 44623951 617a5259  YHqcBA89Db9QazRY
 0890 4b476867 31456243 5a00               KGhg1EbCZ.
chris@chris-lab  ~/security  master •
```

There are a few other segments try **`objdump -s main.o`**

Buffer Overflows

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781:   e8 5a fe ff ff          call   5e0 <puts@plt>
786:   b8 00 00 00 00          mov    eax,0x0
78b:   c9                      leave
78c:   c3                      ret
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#include <stdio.h>

int main ()
{
    int allow;
    char username[8];

    allow = 0;

    printf("Enter your username, please: ");
    gets(username);

    if (strcmp(username, "chris") == 0)
        allow = 1;

    if (allow)
        printf("Here is your private Bitcoin wallet: ...");

    return 0;
}
```

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78d:   0f 1f 00                nop    DWORD PTR [rax]
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int main ()
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   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```

Buffer Overflows

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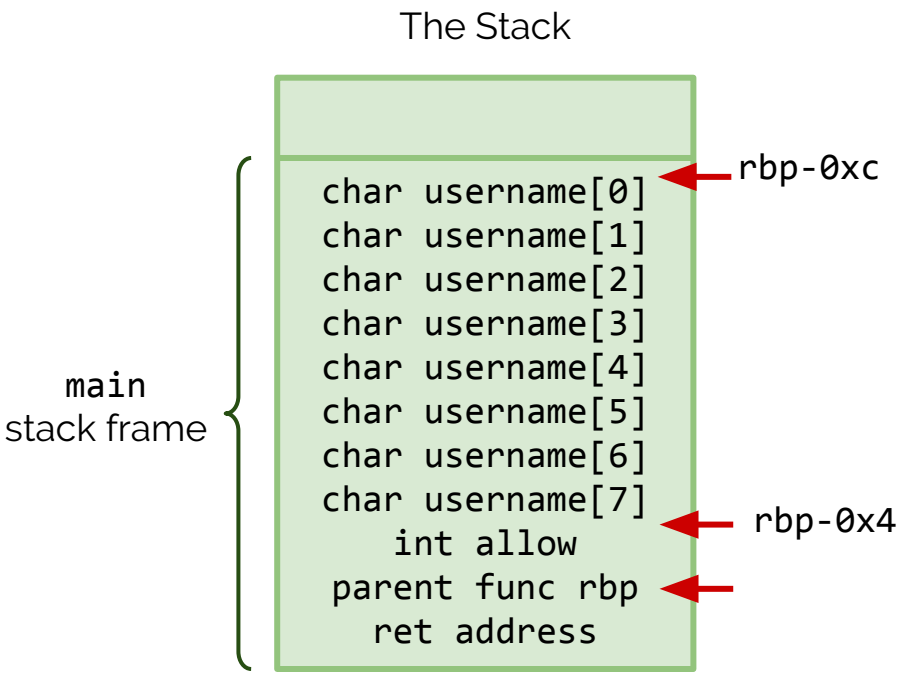
Before calling **gets**, this is what the stack looks like:

```c
#include <stdio.h>

int main ()
{
   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```



Buffer Overflows

gets then fetches data into the address specified by **rax** without considering the bounds of the buffer it is putting it into...

```c
#include <stdio.h>

int main ()
{
   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
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```

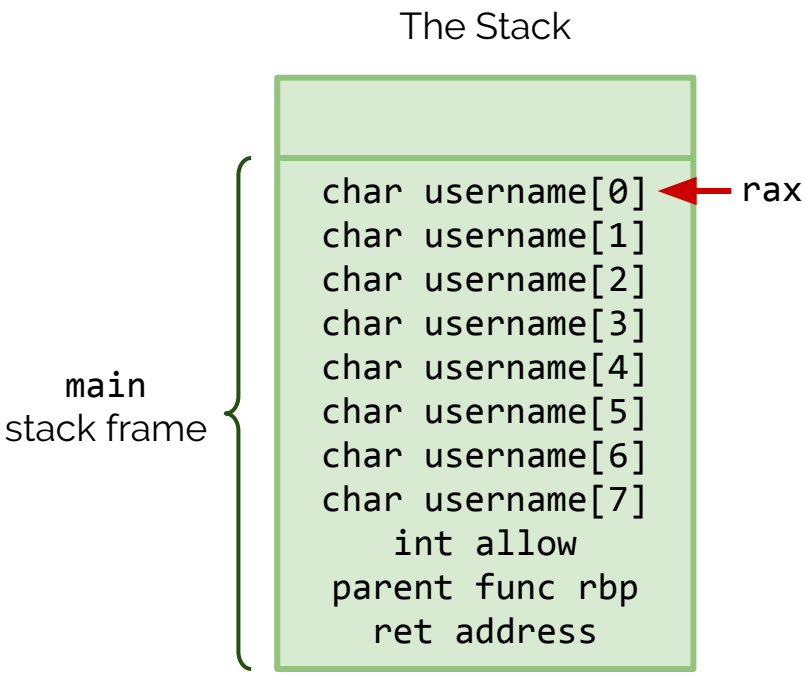

Buffer Overflows

Durham University

For example: "**jess**"

```c
#include <stdio.h>

int main ()
{
   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```

main stack frame

The Stack	ASCII	Decimal
char username[0]	j	106
char username[1]	e	101
char username[2]	s	115
char username[3]	s	115
char username[4]	?	0
char username[5]	?	0
char username[6]	?	0
char username[7]	?	0
int allow	0	0
parent func rbp		-231
ret address		-532

Buffer Overflows

What about the string: "**abcd1234f**"

```c
#include <stdio.h>

int main ()
{
   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```

main stack frame

The Stack	ASCII	Decimal
char username[0]	?	0
char username[1]	?	0
char username[2]	?	0
char username[3]	?	0
char username[4]	?	0
char username[5]	?	0
char username[6]	?	0
char username[7]	?	0
int allow	0	0
parent func rbp		-231
ret address		-532

Buffer Overflows

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What about the string: "**abcd1234f**"

```c
#include <stdio.h>

int main ()
{
   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```

main stack frame

The Stack	ASCII	Decimal
char username[0]	a	97
char username[1]	?	0
char username[2]	?	0
char username[3]	?	0
char username[4]	?	0
char username[5]	?	0
char username[6]	?	0
char username[7]	?	0
int allow	0	0
parent func rbp		-231
ret address		-532

Buffer Overflows

Durham University

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```

main stack frame

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char username[2]	?	0
char username[3]	?	0
char username[4]	?	0
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   return 0;
}
```

main stack frame

The Stack	ASCII	Decimal
char username[0]	a	97
char username[1]	b	98
char username[2]	c	99
char username[3]	d	100
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char username[6]	?	0
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}
```

main stack frame

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char username[3]	d	100
char username[4]	1	49
char username[5]	2	50
char username[6]	?	0
char username[7]	?	0
int allow	0	0
parent func rbp		-231
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Durham University

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   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```

main stack frame

The Stack	ASCII	Decimal
char username[0]	a	97
char username[1]	b	98
char username[2]	c	99
char username[3]	d	100
char username[4]	1	49
char username[5]	2	50
char username[6]	3	51
char username[7]	⬩	0
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Buffer Overflows

Durham University

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       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```

main stack frame

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char username[2]	c	99
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char username[6]	3	51
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Buffer Overflows

Durham University

What about the string: "**abcd1234f**"

```c
#include <stdio.h>

int main ()
{
   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```

	The Stack	ASCII	Decimal
main stack frame	char username[0]	a	97
	char username[1]	b	98
	char username[2]	c	99
	char username[3]	d	100
	char username[4]	1	49
	char username[5]	2	50
	char username[6]	3	51
	char username[7]	4	52
	int allow	f	102
	parent func rbp		-231
	ret address		-532

Buffer Overflows

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What about the string: "**abcd1234f**"

We can write over the **allow** variable data

```
#include <stdio.h>

int main ()
{
   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```

main stack frame

The Stack	ASCII	Decimal
char username[0]	a	97
char username[1]	b	98
char username[2]	c	99
char username[3]	d	100
char username[4]	1	49
char username[5]	2	50
char username[6]	3	51
char username[7]	4	52
int allow	f	102
parent func rbp		-231
ret address		-532

Buffer Overflows

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At this point, allow is now: **102**

```c
#include <stdio.h>

int main ()
{
   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```

main stack frame

The Stack	ASCII	Decimal
char username[0]	a	97
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char username[7]	4	52
int allow	f	102
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Buffer Overflows

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String check fails, allow is still: **102**

```c
#include <stdio.h>

int main ()
{
   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```

main stack frame

The Stack	ASCII	Decimal
char username[0]	a	97
char username[1]	b	98
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Buffer Overflows

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`if` statement passes (anything that is not zero is a true value in an **`if`**)

```c
#include <stdio.h>

int main ()
{
   int allow;
   char username[8];

   allow = 0;

   printf("Enter your username, please: ");
   gets(username);

   if (strcmp(username, "chris") == 0)
       allow = 1;

   if (allow)
       printf("Here is your private Bitcoin wallet: ...");

   return 0;
}
```

	The Stack	ASCII	Decimal
main stack frame	char username[0]	a	97
	char username[1]	b	98
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	int allow	f	102
	parent func rbp		-231
	ret address		-532

Protection against Buffer Overflows

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- Detect and abort before malicious behaviour occurs:

```
 chris@chris-lab  ~/security  master ●  gcc -fstack-protector -std=c89 -O0 -pedantic main.c -o m
n.o
main.c: In function ‘main’:
main.c:11:5: warning: ‘gets’ is deprecated [-Wdeprecated-declarations]
     gets(username);
     ^~~~
In file included from main.c:1:0:
/usr/include/stdio.h:577:14: note: declared here
 extern char *gets (char *__s) __wur __attribute_deprecated__;
              ^~~~
/tmp/ccyFWBuE.o: In function `main':
main.c:(.text+0x48): warning: the `gets' function is dangerous and should not be used.
 chris@chris-lab  ~/security  master ●  ./main.o
Enter your username, please: abcd1234f
*** stack smashing detected ***: <unknown> terminated
[1]    4063 abort (core dumped)  ./main.o
 ✘ chris@chris-lab  ~/security  master ●
```

Nice!

Protection against Buffer Overflows

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```c
#include <stdio.h>
#include <stdlib.h>

int main ()
{
   int allow;
   char* username;
   allow = 0;
   username = malloc(8 * sizeof(*username));
   if (!username)
       return 1;

   printf("Enter your username, please: ");

   fgets(username, 8, stdin);
   strtok(username, "\n");

   if (strcmp(username, "chris") == 0)
       allow = 1;

   free(username);
   if (allow)
       printf("Here is your private Bitcoin wallet: L2udm71vYECrgBcgZLA6JpUfUwDYHqcBA89Db9QazRYKGhg1EbCZ\n");
   return 0;
}
```

Use heap memory

Do proper bounds checking (no more than 8 characters)

Protection against Buffer Overflows

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- Using heap memory and **`fgets`**

```
 chris@chris-lab  ~/security  master ●  ls
main.c
 chris@chris-lab  ~/security  master ●  gcc -std=c89 -O0 -pedantic main.c -o main.o
 chris@chris-lab  ~/security  master ●  ./main.o
Enter your username, please: jess
 chris@chris-lab  ~/security  master ●  ./main.o
Enter your username, please: this-is-a-really-long-username-example
 chris@chris-lab  ~/security  master ●  ./main.o
Enter your username, please: chris
Here is your private Bitcoin wallet: L2thi71sYEConBeiZLA6JsU0UcDYHhrBA89Do9QnoRYtGri1ggCeZr
 chris@chris-lab  ~/security  master ●
```

No warnings

No overflow

Other common functions vulnerable to overflow (and their mitigations)

not examined

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Some more potentially dangerous system calls...

- **`gets`** - read line from stdin
- **`strcpy`** - copies string src dst
- **`strcat`** - appends string src dst
- **`sprintf`** - write data to string buffer
- **`scanf`** - read data from stdin
- **`sscanf`** - read data from string
- **`fscanf`** - read data from stream
- **`vfscanf`** - read from stream to args
- **`realpath`** - returns absolute path
- **`getenv`** - get environment string
- **`getpass`** - gets a password

... and lots more in many languages...

Heartbleed: A Buffer Over-read

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Buffer over-read vulnerability in OpenSSL

- Open source code that handles a large proportion of the world's secured web traffic
  - Traffic between you and banks
  - Private emails
  - Social networks
- Clients send heartbeats to servers (are you alive?)
- Server responds with data
- A particular version of OpenSSL didn't check for over-read
- Each heartbeat could reveal 64k of application memory
  - Lots of sensitive data leaked
  - Big websites request password resets following heartbleed
    - Reddit, Github, Bitbucket, Mojang, Amazon AWS, Pinterest, Tumblr, ...

Stack Smashing

- So we can overwrite memory. What else can we do?

The Stack	ASCII	Decimal
`char username[0]`	a	97
`char username[1]`	b	98
`char username[2]`	c	99
`char username[3]`	d	100
`char username[4]`	1	49
`char username[5]`	2	50
`char username[6]`	3	51
`char username[7]`	4	52
`int allow`	f	102
`parent func rbp`		-231
`ret address`		-532

`main` stack frame

What if we kept going until we reached here?

Choose where we want to jump to...

Stack Smashing

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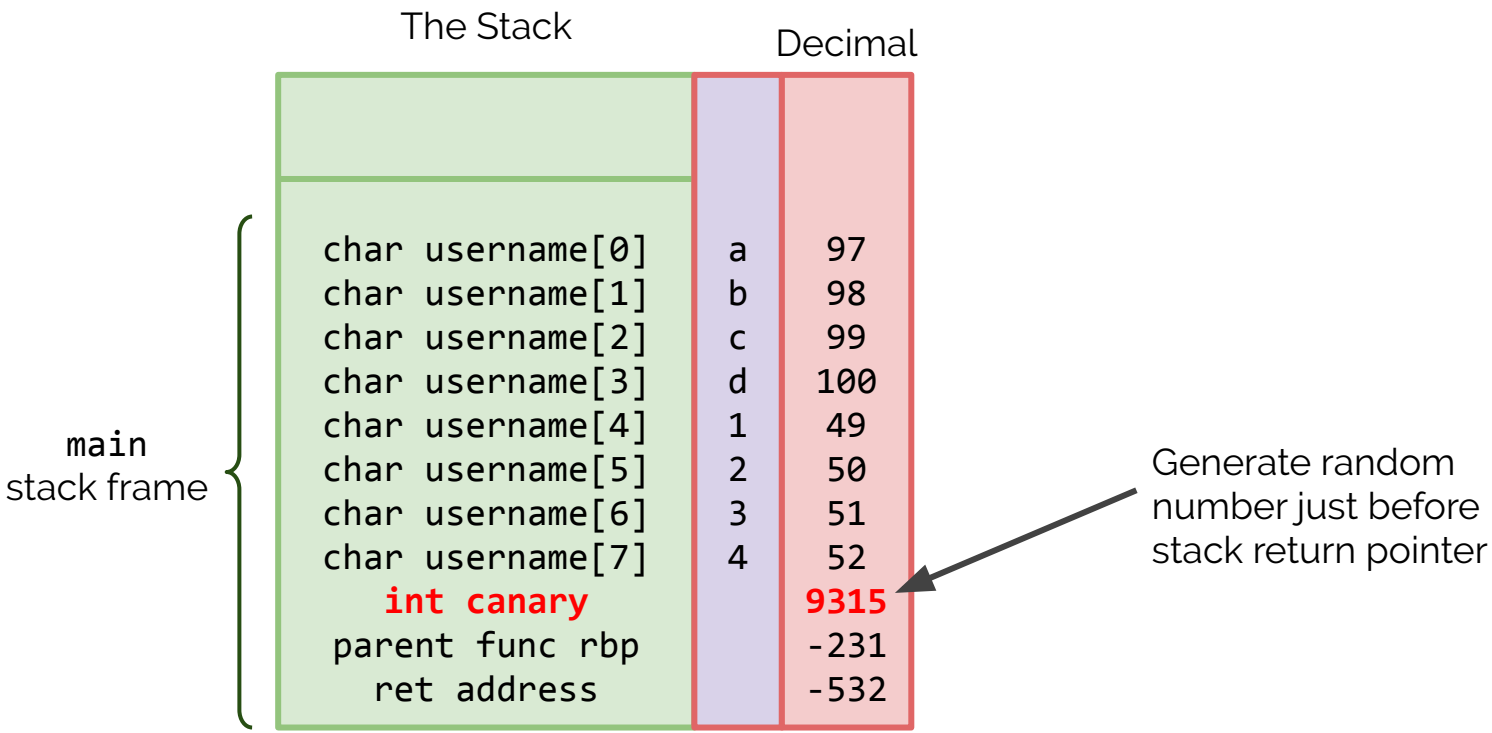
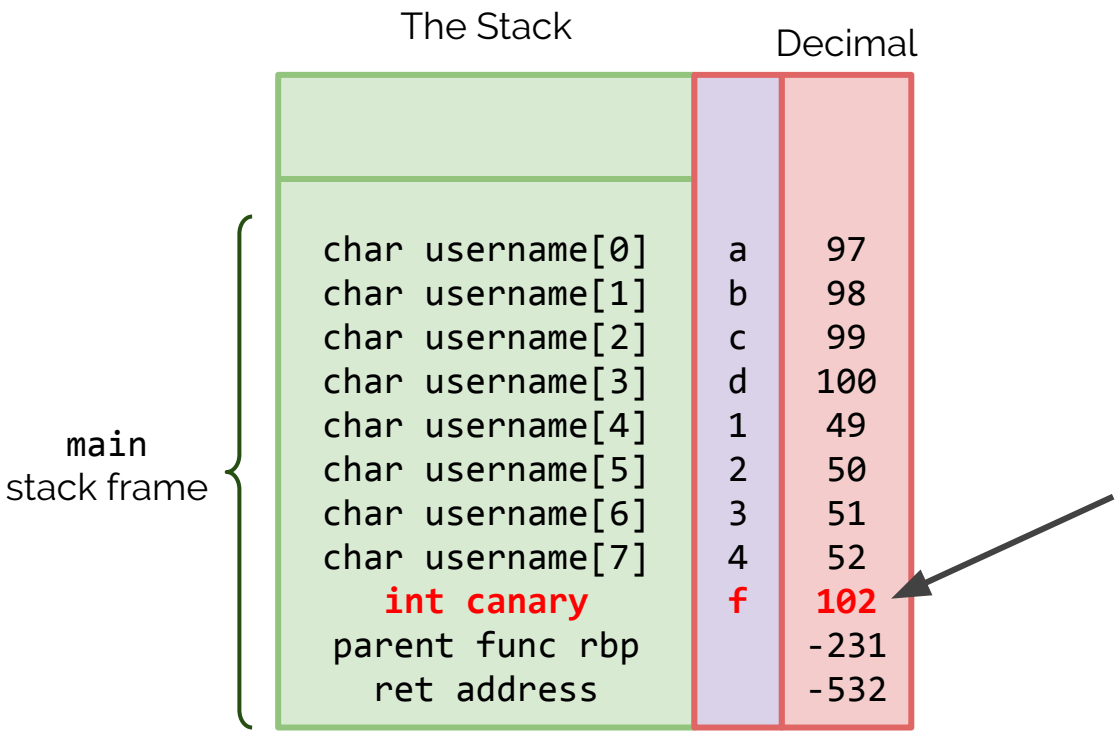
- What if we jumped to somewhere else where we had malicious code?
  - If we can use this on a program that has higher privilege than ourself, we can jump to **deployed shellcode** for that **level of privilege**.
  - Shell code is executable code inserted as a payload for insertion attacks.
- Countermeasures:
  - Check buffer lengths
  - Use heap memory
  - Use ASLR, on the fly randomization of memory to make buffer flow attacks more difficult to implement.
    - Similar concept of making the operating system less predictable and much harder to do these kinds of attacks.
    - Has been bypassed using side-channel attacks (2017)
  - Use a canary
- We can do *similar* things on the heap

Canary Value



Canary Value



After writing to buffer, check if value is same as randomly generated value:

102 != 9315

...this has been tampered with, exit!

Heap Smashing and NOP slides

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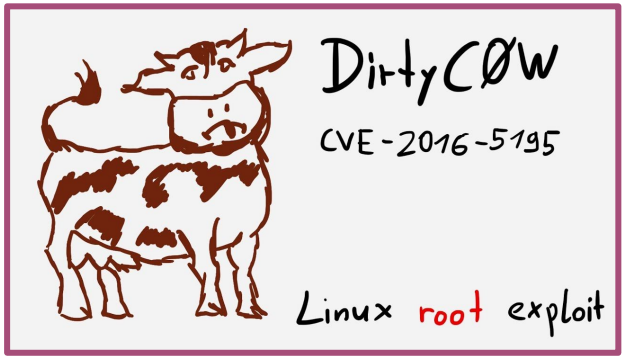
- Heap memory rarely contains pointers that influence control flow
  - Needs to be combined as part of larger attack
  - Has been used in practice in some popular software
    - Internet Explorer
    - VLC multimedia player
    - Adobe Acrobat
    - Adobe Flash
- Heap sprays
  - Attempts to put a certain sequence of bytes at a predetermined location in the memory by allocating large blocks on the process's heap and filling the bytes in these blocks with specific values.
  - NOP slides (NOP sleds)
    - “Move onto next instruction” - put loads of x90’s followed by your shell code. Then your return address is likely to hit one and slide to the malicious code.

Race Condition Attacks

not examined

- Occur when multiple processes or threads operate on shared data.
- Attacks occur in many different situations:
  - Typically developers perform two or more steps but forget that hackers can **do something malicious in the gap** between the steps
- Popular example, **Dirty Cow**



Exploits copy-on-write (CoW) functionality in OS to gain root (quite easy to do).

- Two processes may read same physical memory.
- If one tries to write, the OS makes a copy.
- Dirty cow map sensitive files that you want to modify, invokes CoW, opens two threads which interfere and allow you to write over sensitive file.

Timing Attacks

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```
bool check_password(string real, string guess)
{
    for (int i=0; i<16; ++i)
        if (real[i] != guess[i])
            return false;
    return true;
}
```

You would typically need 96^{16} guesses to bruteforce

= 52,040,292,466,647,269,602,037,015,248,896

However if you accurately time application, it finishes at different times

Timing attack:

1. Try each of 96 chars for first letter in a random 16-length string.
   - Find which character takes longest to return false.
2. Move on to next character, and repeat

Would only take 96 * 16 guesses = maximum of **1,536** attempts to brute force

Impact of AI on Cyber Security

Durham University

- Gaining recent research traction (especially in 2019)
- Lots of unethical research taking place in this field
  - Shown to accurately predict sensitive information about people
  - Why are you researching that? "It doesn't matter, it's not personally identifiable." Yes it does!
  - "When a model is trained, you can't reverse engineer it to recover source data, so its ok!"
- Will it advance faster than we can keep up with?

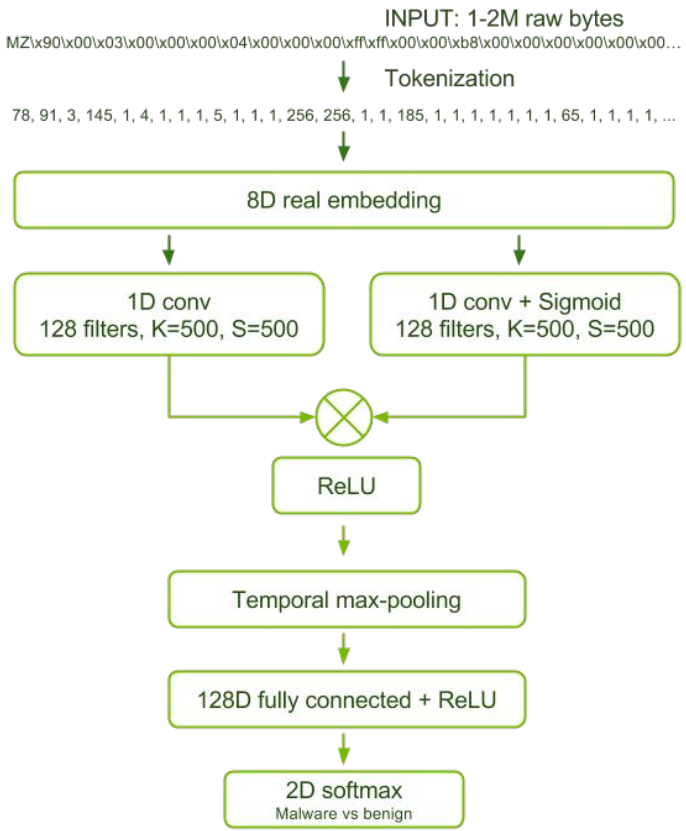
More/bigger datasets becoming available:

https://www.secrepo.com/

Questions:

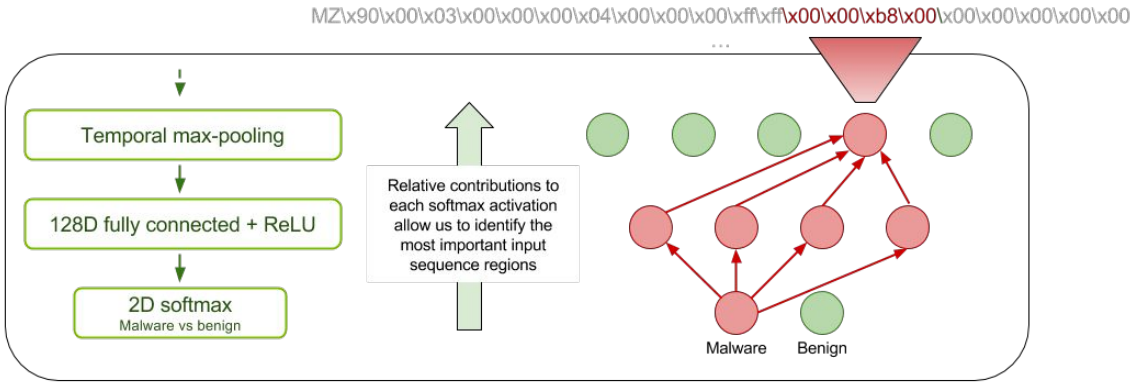
- Will AI **help us write more secure software?**
- ...or will AI discover more vulnerabilities faster than we can patch?

Impact of AI on Cyber Security



- Better anti-virus or…
- Better virus?

Good at analysis of complex ill-defined problems - large systems/datasets



Impact of AI on Cyber Security

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Adversarial against Humans:

- Chatbots
  - New types of spear phishing?
- Can't distinguish human from AI voice
- Reinforcement learning (Alpha Go, Starcraft)?
  - Real-world game?
- Deep Learning fools CAPTCHA

Fraudster chatbots & protecting from various nasty bots

Currently mostly focusing on detecting malware and intrusions

Collection of AI cyber security research papers & datasets

Better Defense Example:

Malware prediction & intrusion detection

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Kaggle competitions:

https://www.kaggle.com/c/microsoft-malware-prediction

- ProductName - Defender state information e.g. win8defender
- EngineVersion - Defender state information e.g. 1.1.12603.0
- AppVersion - Defender state information e.g. 4.9.10586.0
- AvSigVersion - Defender state information e.g. 1.217.1014.0
- IsBeta - Defender state information e.g. false
- AVProductsInstalled - NA
- AVProductsEnabled - NA
- CountryIdentifier - ID for the country the machine is located in
- CityIdentifier - ID for the city the machine is located in
- OrganizationIdentifier - ID for the organization the machine belongs in, organization ID is mapped to both specific companies and broad industries
- GeoNameIdentifier - ID for the geographic region a machine is located in

Better Offense Example:

PassGAN: A Deep Learning Approach for Password Guessing

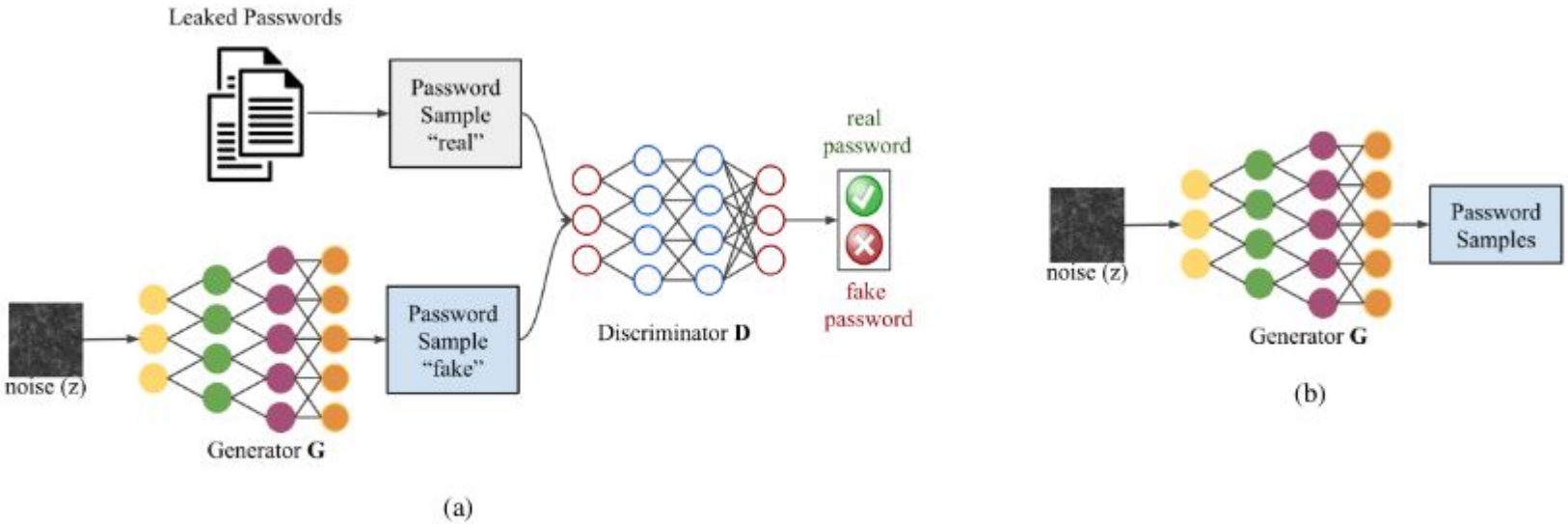


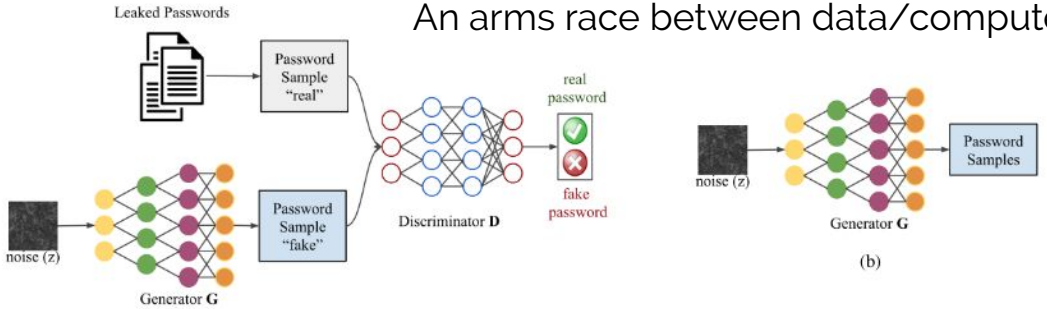
Fig. 1: Summary of PassGAN's Architecture. In the training procedure, shown in (a), the discriminator (D) processes passwords from the training dataset, as well as password samples produced by the generator (G). Based on the feedback from D, G fine-tunes its network to produce password samples that are close to the training set (G has no direct access to the training set). The password generation procedure is shown in (b).

PassGAN: https://arxiv.org/pdf/1709.00440.pdf

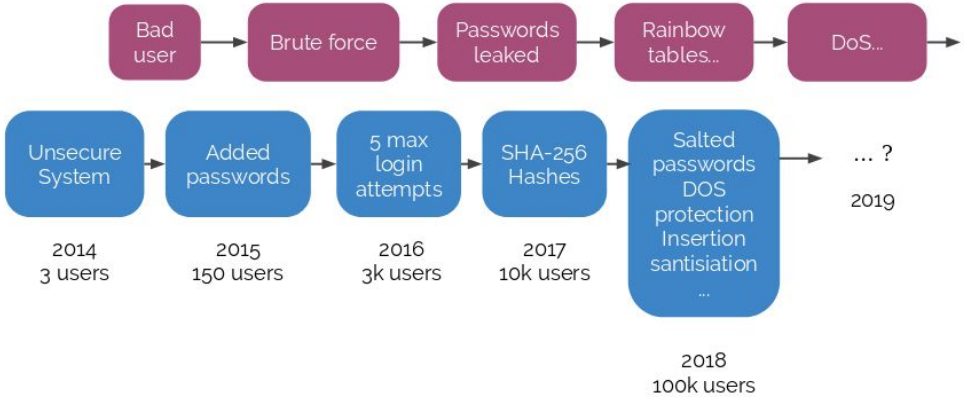
Recall from Lecture 1

image from https://mile2.com

An arms race between data/compute?



An arms race between humans...



Questions?

- What to revise
- Research themes
- Any concepts discussed which were challenging to understand?

Romantic Takeaways

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- **Just remember how easy it is to break in with a little time and effort**
- Security covers all levels and infrastructure of a system
  - The weakest link
- Hierarchically assess the situation
  - Assess the assets, vulnerabilities, threat, risk
- Understand **the enemy**
  - The landscape, the economy, the war
- Understand **the platform**
- Understand **the people**
- Don't be careless or manage in a way that promotes carelessness
- Don't trust people
- KISS!

cwkx @cwkx

Thank you

Durham University

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cwkx @cwkx