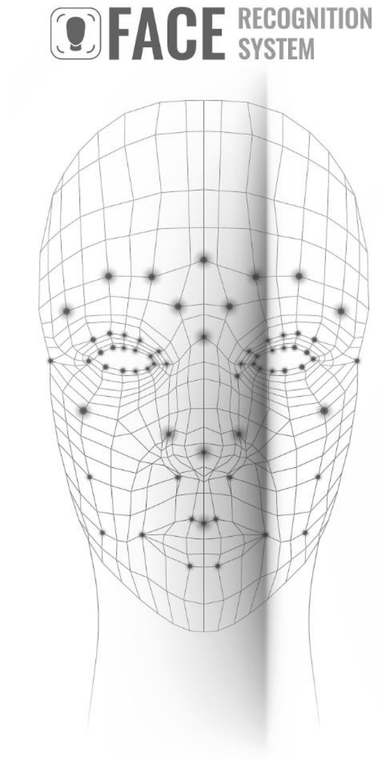
o-glassesX: Compiler Provenance Recovery with Attention Mechanism from a Short Code Fragment

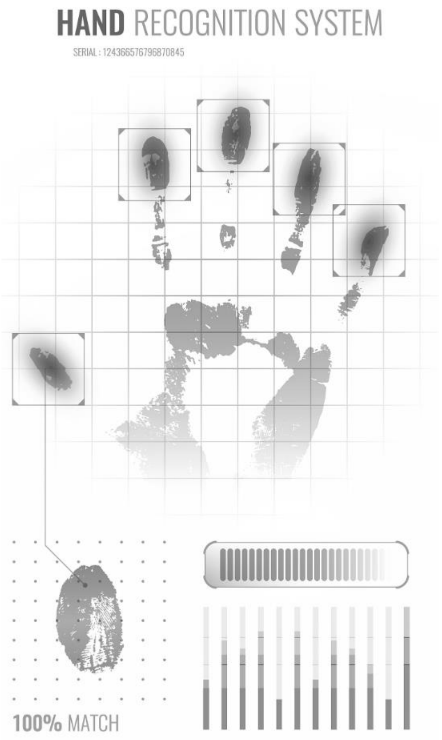
Yuhei Otsubo*†, Akira Otsuka†, Mamoru Mimura‡ †,
Takeshi Sakaki§, and Hiroshi Ukegawa*

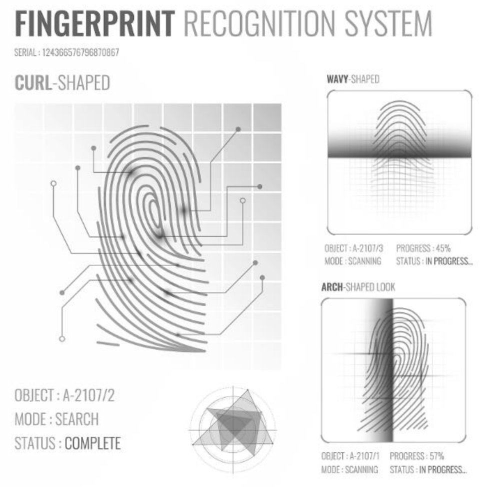
*National Police Agency, Tokyo, Japan
†Institute of information Security, Kanagawa, Japan
‡National Defense Academy, Kanagawa, Japan
§The University of Tokyo, Tokyo, Japan

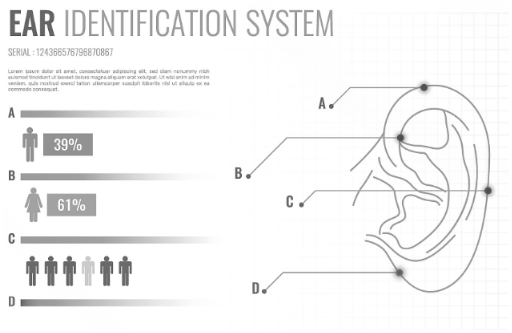
Introduction

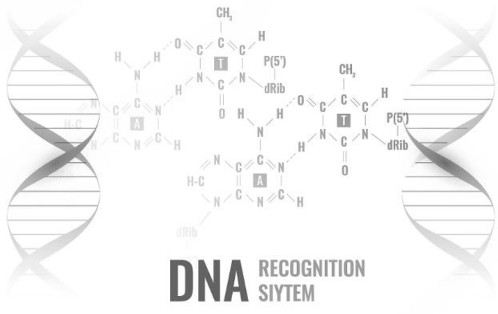
Forensic Scientists

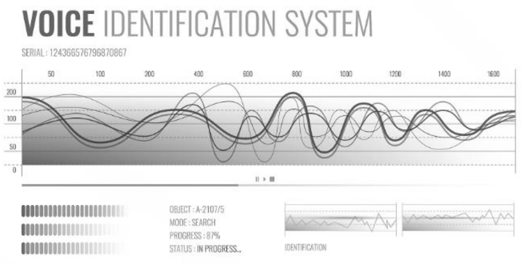




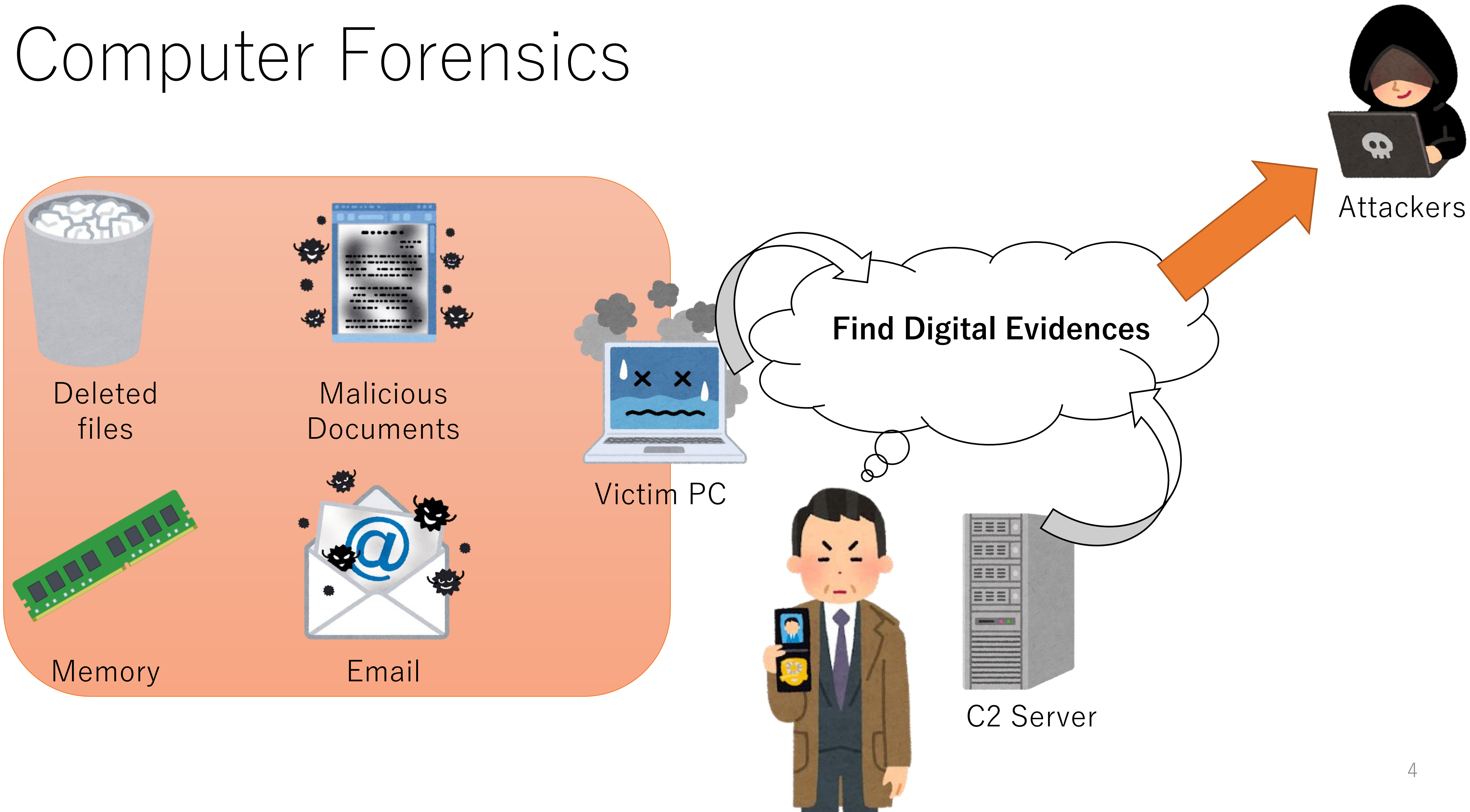








Computer Forensics



Author Identification

Compiler Provenance

Compiler
Family
Version
Optimization level

Malicious EXE

MZ

This Program is …

abc123

JFIF

Specific Strings

Secret key

Resources

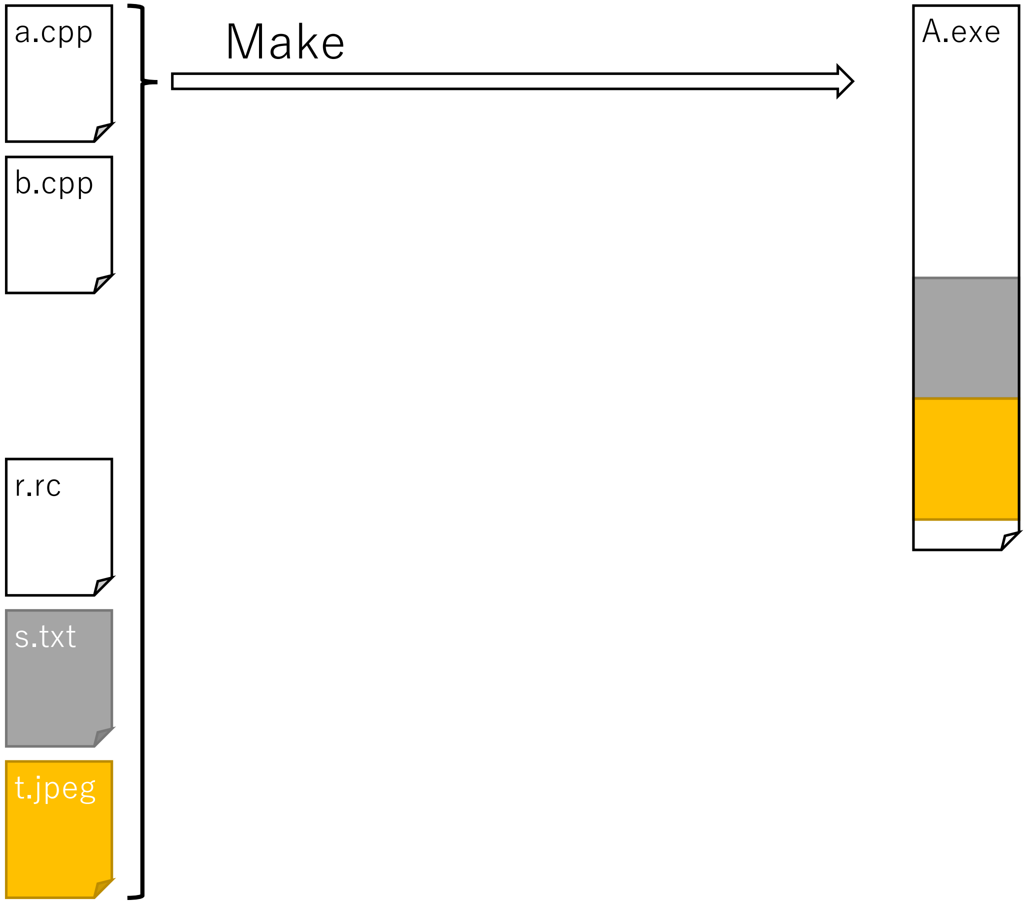
Language

API name

Compile time

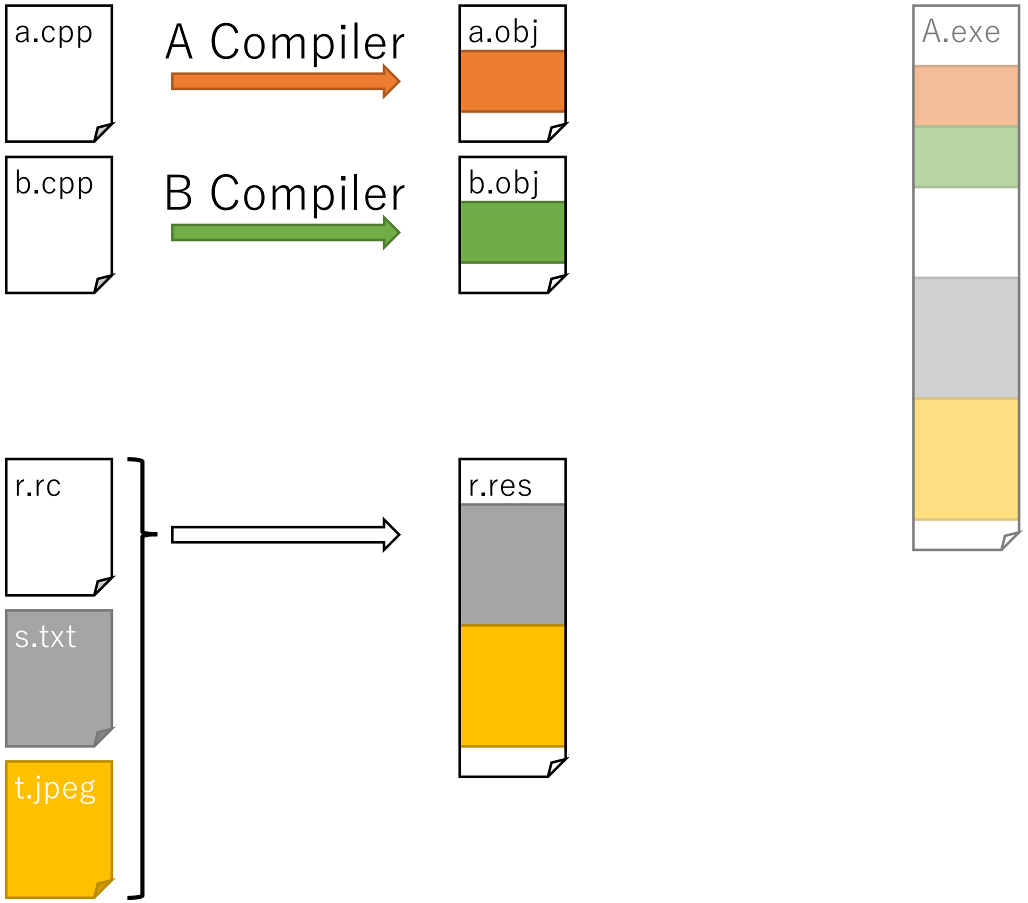
Static Link Libraries

Multiple Compiler Binary



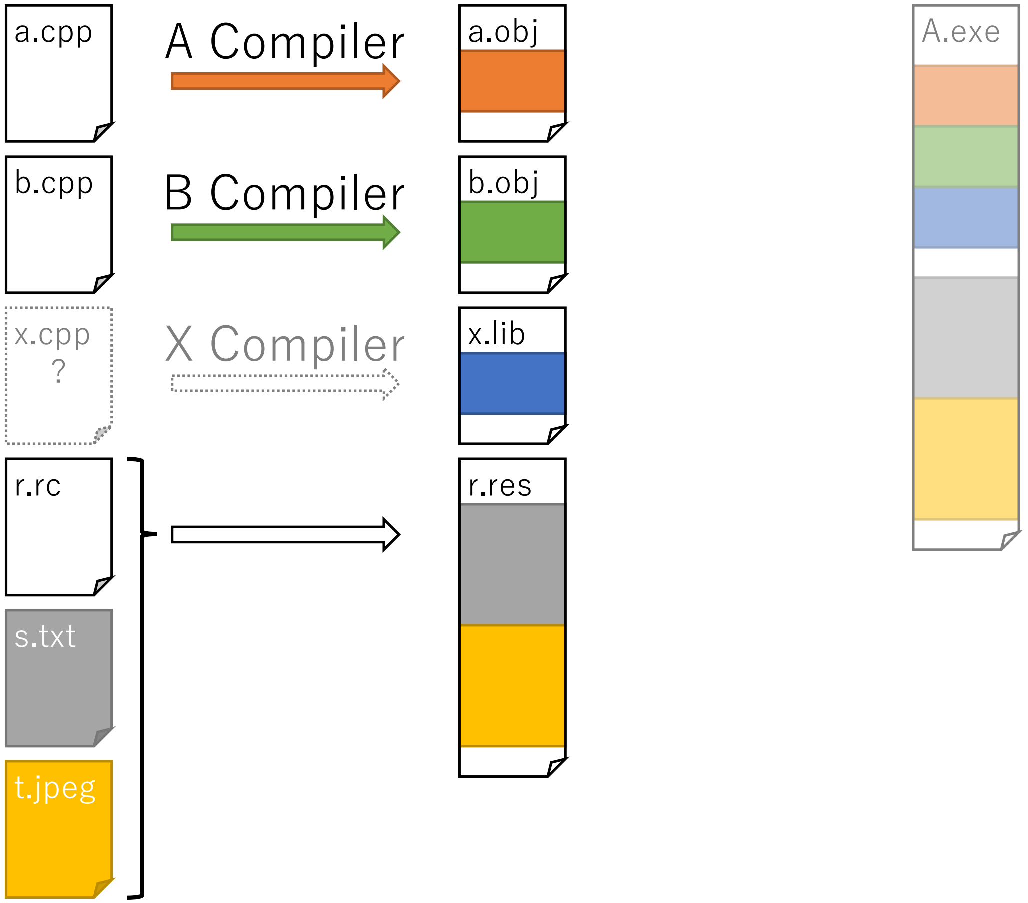
What is the truth label of A.exe?

Multiple Compiler Binary



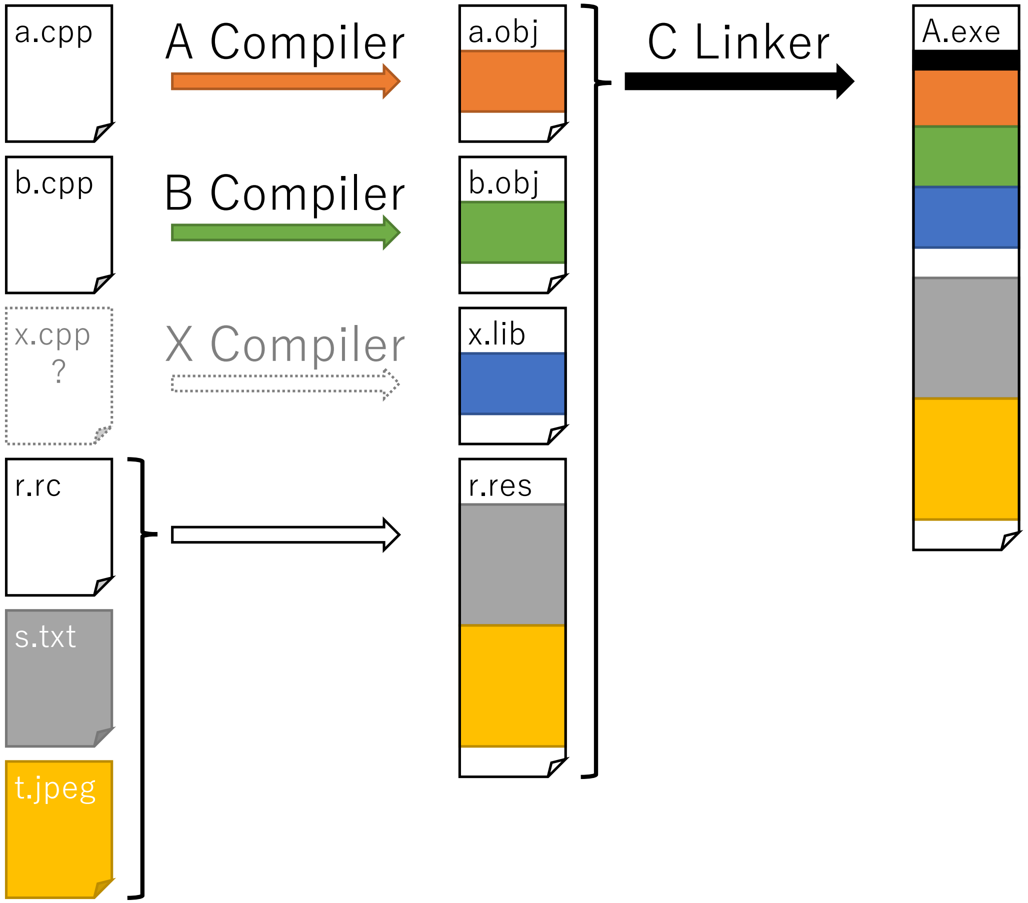
What is the truth label of A.exe?
- **A Compiler?**
- **B Compiler?**

Multiple Compiler Binary



What is the truth label of A.exe?
- **A Compiler?**
- **B Compiler?**
- **X Compiler?**

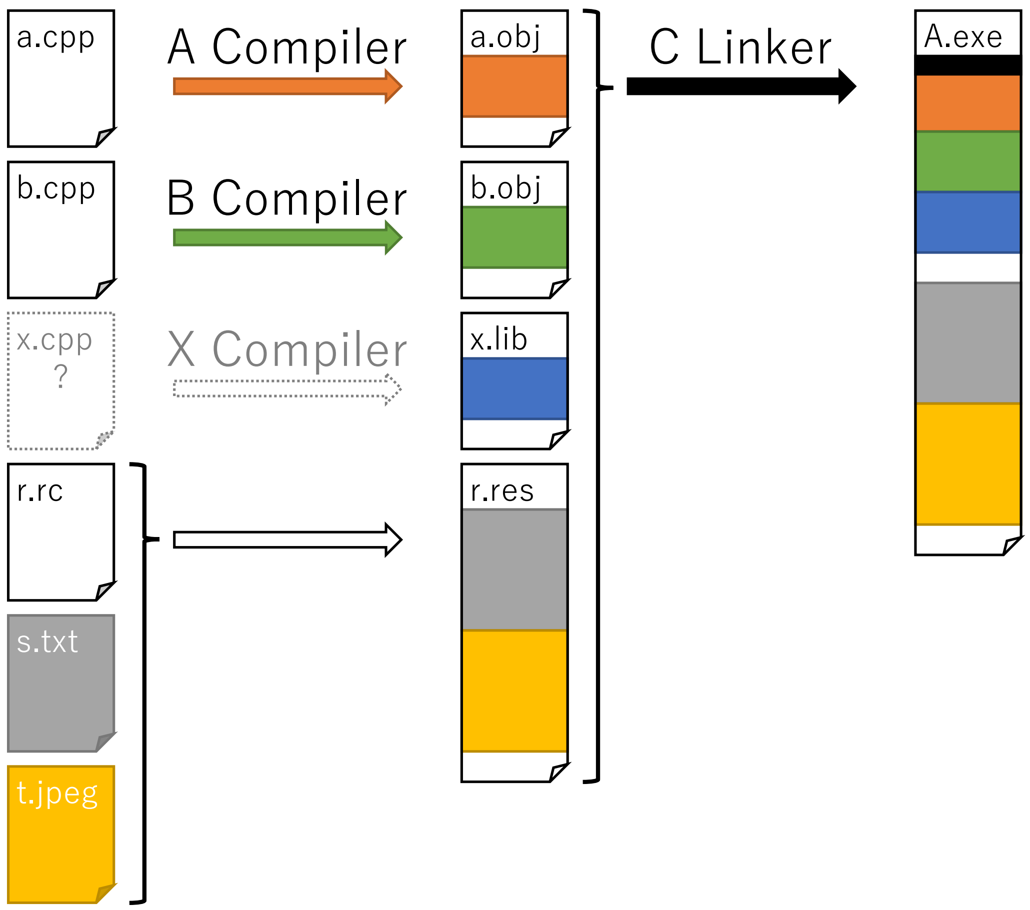
Multiple Compiler Binary



What is the truth label of A.exe?

- **A Compiler?**
- **B Compiler?**
- **X Compiler?**
- **C Linker?**

Multiple Compiler Binary



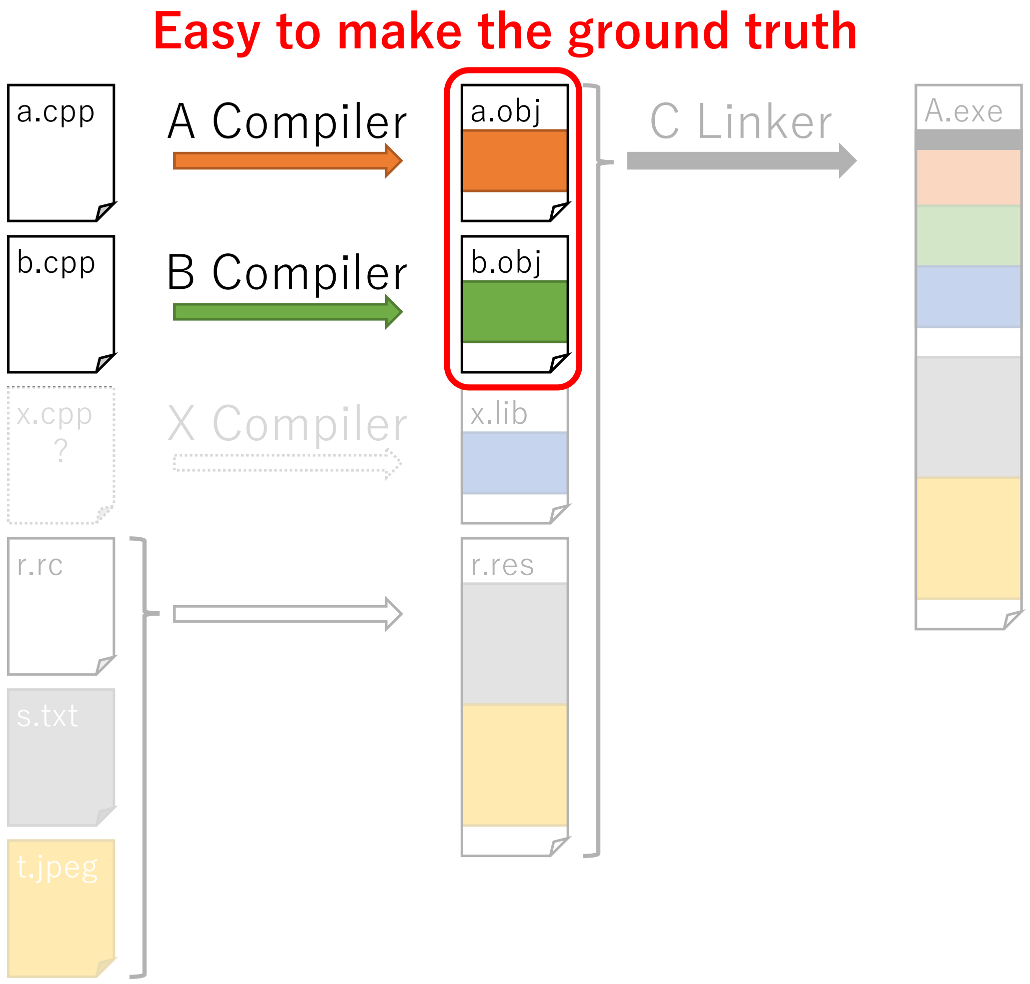
What is the truth label of A.exe?
- **A Compiler?**
- **B Compiler?**
- **X Compiler?**
- **C Linker?**

What is the truth label of a.obj?
- **A Compiler**

What is the truth label of b.obj?
- **B Compiler**

What is the truth label of x.lib?
- **Hmm… I think VC, because MS provide it!**

Multiple Compiler Binary



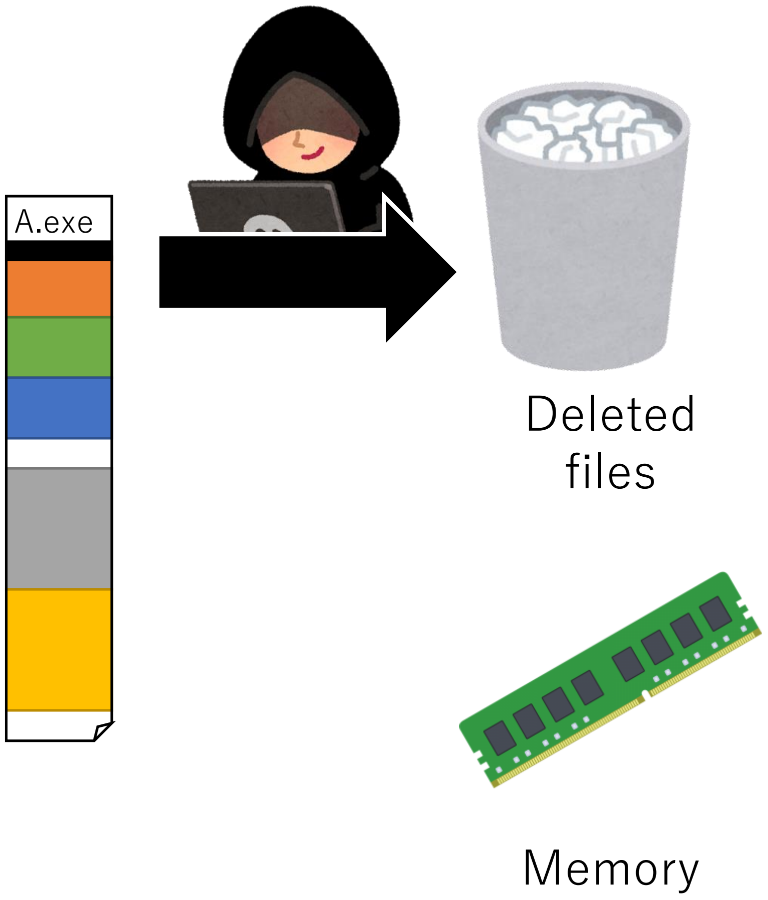
What is the truth label of A.exe?
- A Compiler?
- B Compiler?
- X Compiler?
- C Linker?

What is the truth label of a.obj?
- **A Compiler**

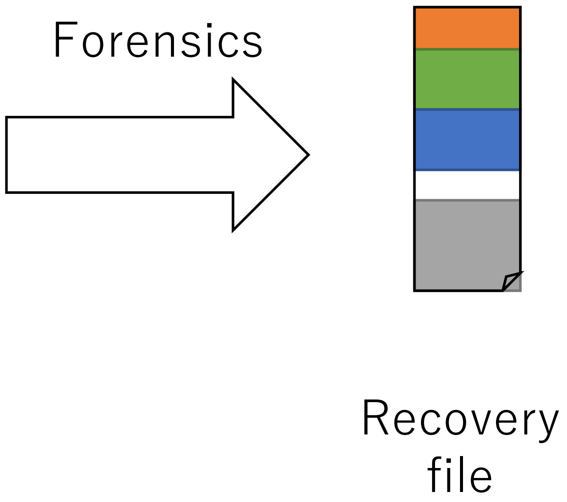
What is the truth label of b.obj?
- **B Compiler**

What is the truth label of x.lib?
- Hmm… I think VC, because MS provide it!

Fragmented Files



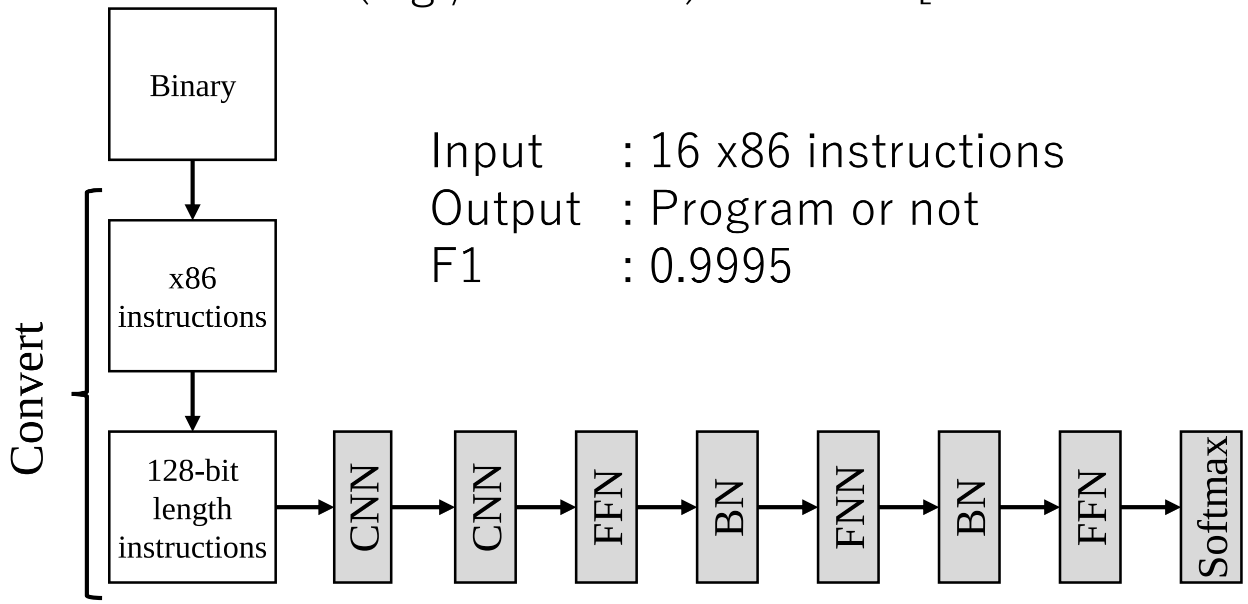
Collect as much of the attacker's trace as possible even from fragmented files.



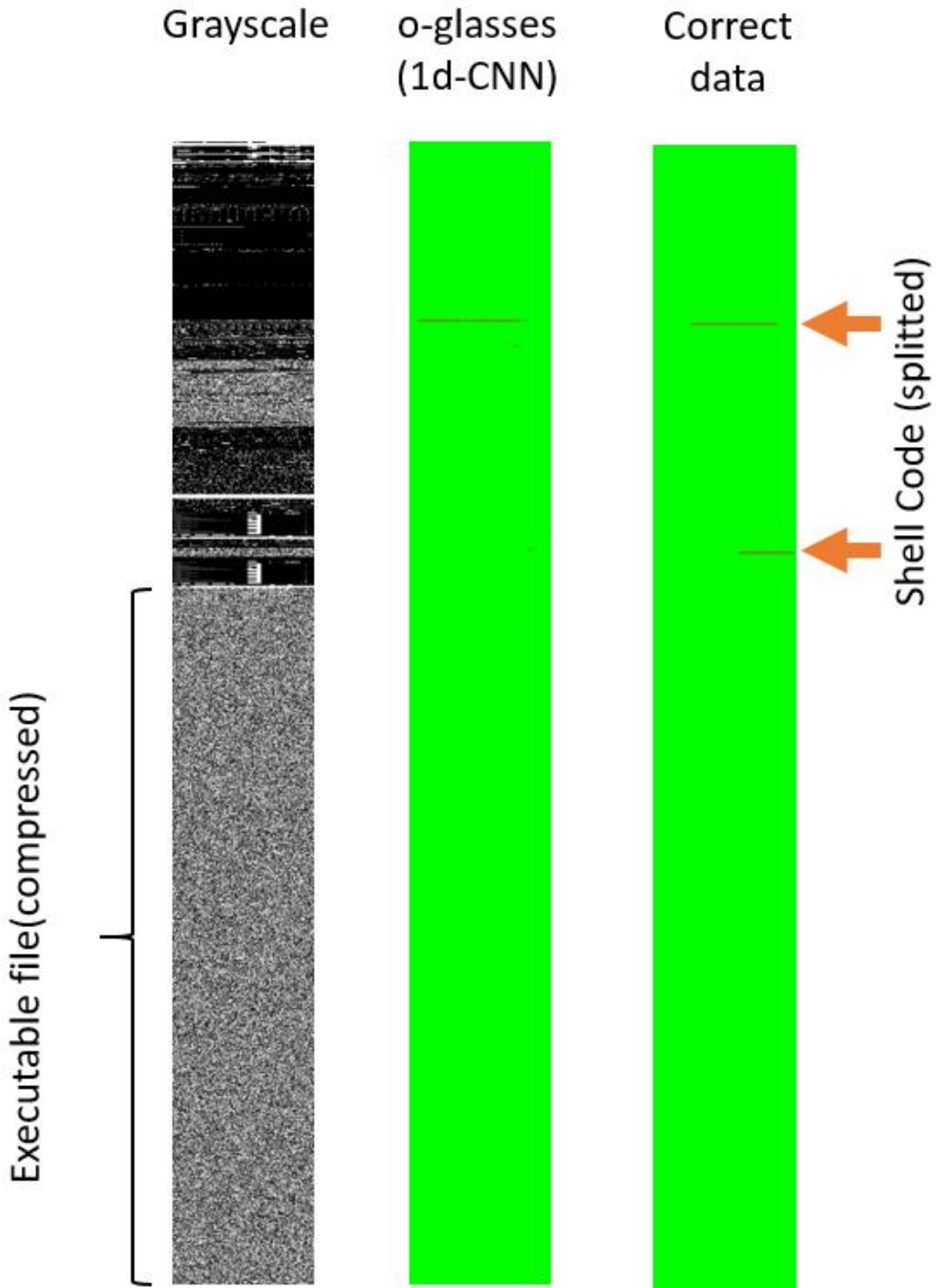
Preliminaries

o-glasses

x86 code (e.g., shellcode) detector [arXive.1806.05328]

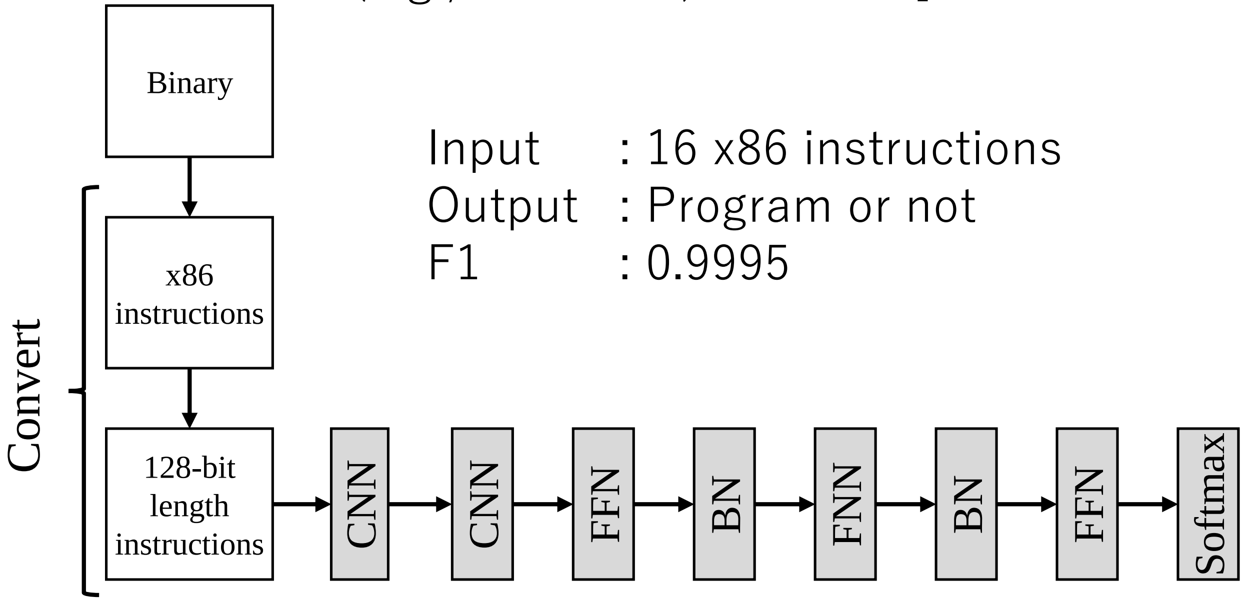


Input : 16 x86 instructions
Output : Program or not
F1 : 0.9995



o-glasses

x86 code (e.g., shellcode) detector [arXive.1806.05328]



Input : 16 x86 instructions
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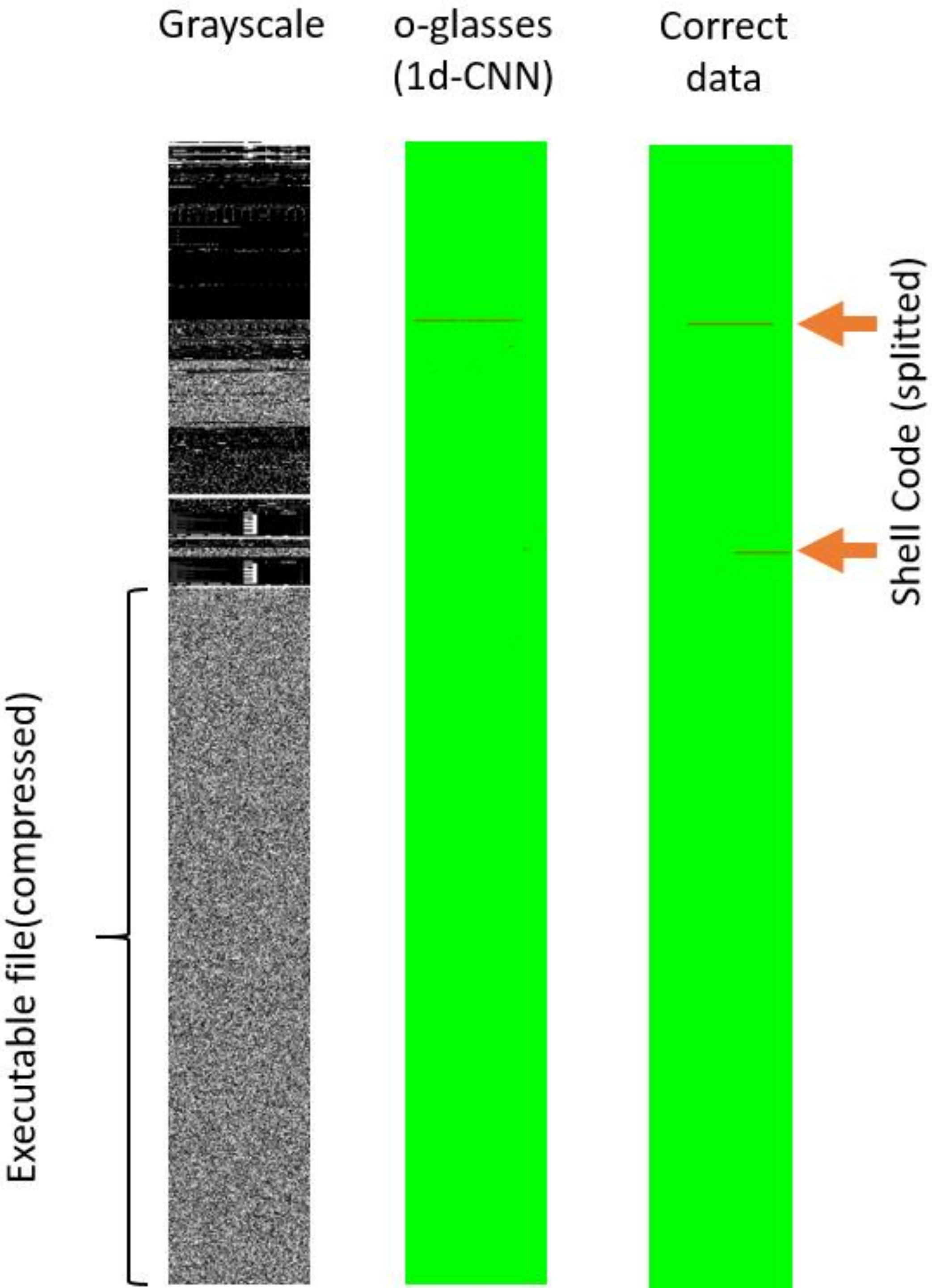


- **Applying to compiler identification**
- **Black Box Problem**

Attention Is All You Need

[Łukasz Kaiser et al., NIPS, 2017]

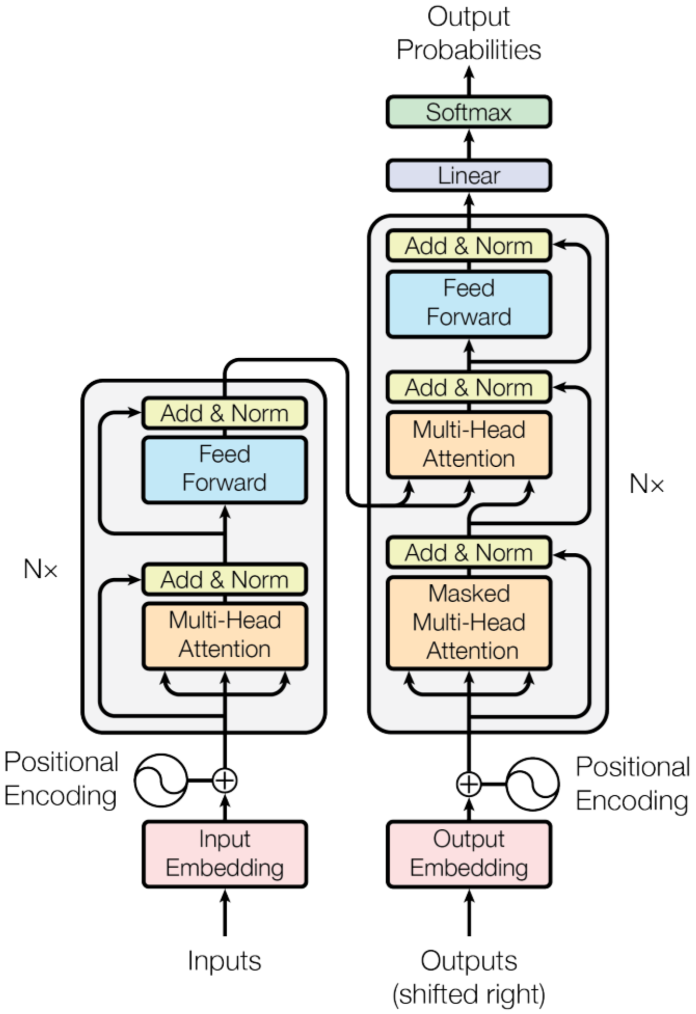


Figure 1: The Transformer - model architecture.

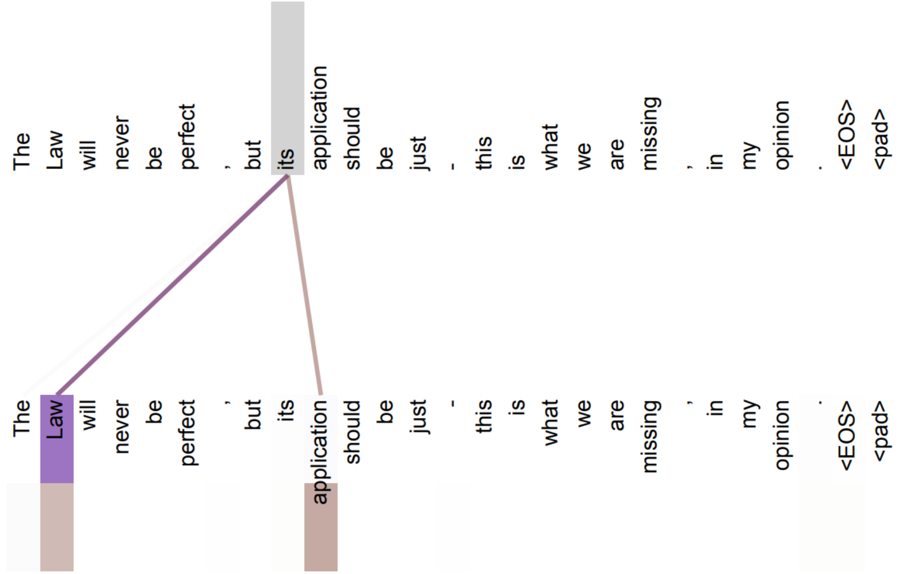
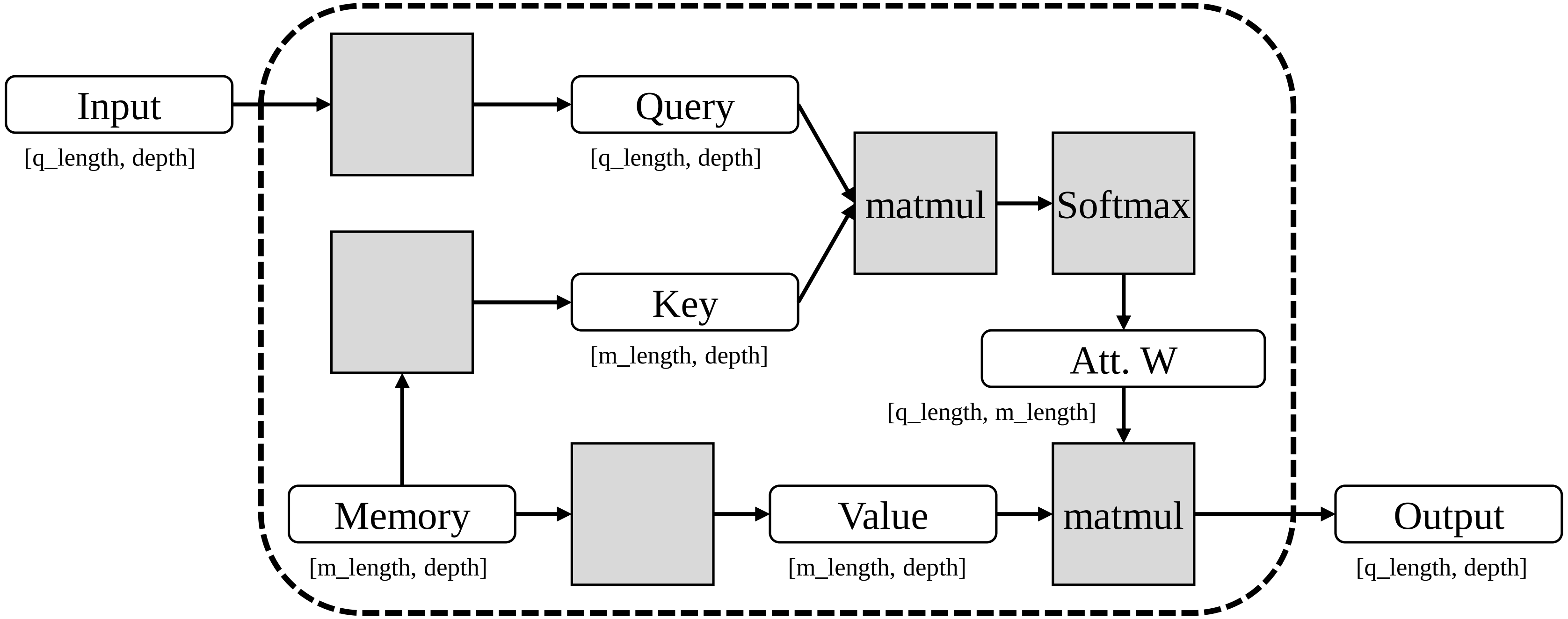


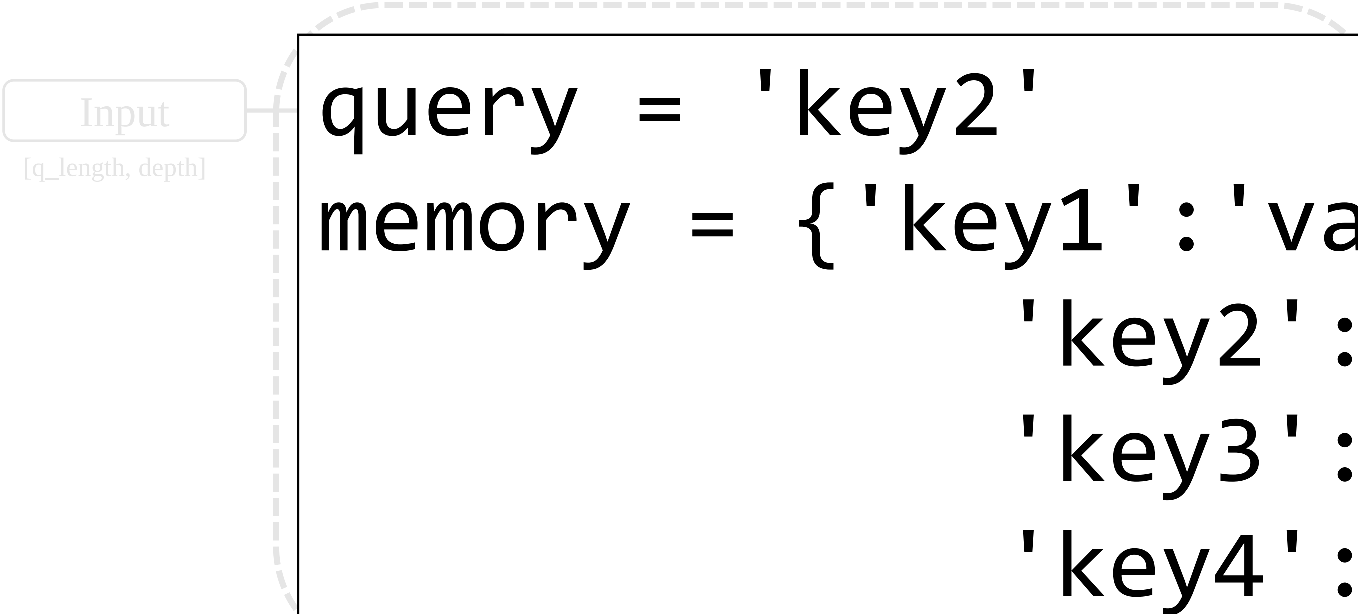
Table 2: The Transformer achieves better BLEU scores than previous state-of-the-art models on the English-to-German and English-to-French newstest2014 tests at a fraction of the training cost.

Model	BLEU		Training Cost (FLOPs)	
	EN-DE	EN-FR	EN-DE	EN-FR
ByteNet [15]	23.75			
Deep-Att + PosUnk [32]		39.2		$1.0 \cdot 10^{20}$
GNMT + RL [31]	24.6	39.92	$2.3 \cdot 10^{19}$	$1.4 \cdot 10^{20}$
ConvS2S [8]	25.16	40.46	$9.6 \cdot 10^{18}$	$1.5 \cdot 10^{20}$
MoE [26]	26.03	40.56	$2.0 \cdot 10^{19}$	$1.2 \cdot 10^{20}$
Deep-Att + PosUnk Ensemble [32]		40.4		$8.0 \cdot 10^{20}$
GNMT + RL Ensemble [31]	26.30	41.16	$1.8 \cdot 10^{20}$	$1.1 \cdot 10^{21}$
ConvS2S Ensemble [8]	26.36	**41.29**	$7.7 \cdot 10^{19}$	$1.2 \cdot 10^{21}$
Transformer (base model)	27.3	38.1	$\mathbf{3.3 \cdot 10^{18}}$	
Transformer (big)	**28.4**	**41.0**	$2.3 \cdot 10^{19}$	

Basic of Attention

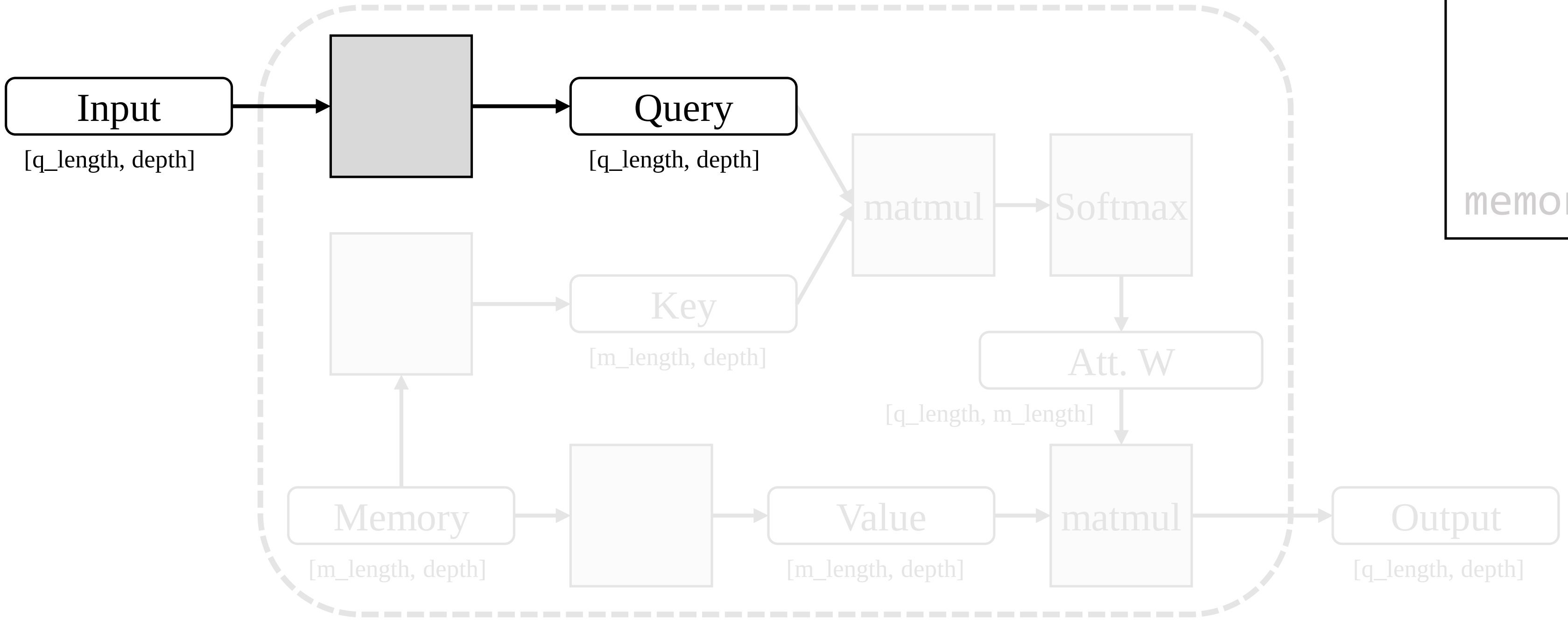


Basic of Attention




```
query = 'key2'
memory = {'key1':'value2',
             'key2':'value2',
             'key3':'value3',
             'key4':'value4'}
memory[query] = 'value2'
```

Basic of Attention

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query = 'key2'
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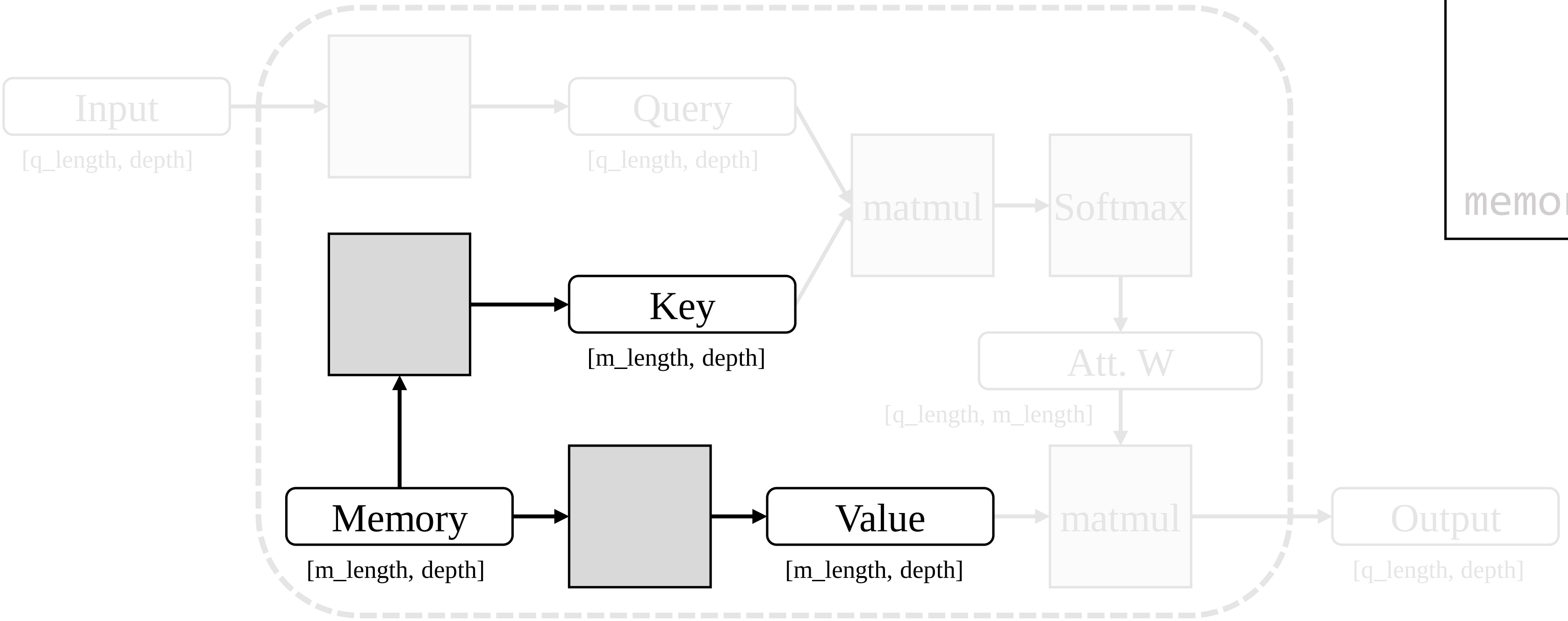
```

Basic of Attention




```
query = 'key2'
memory = {'key1':'value2',
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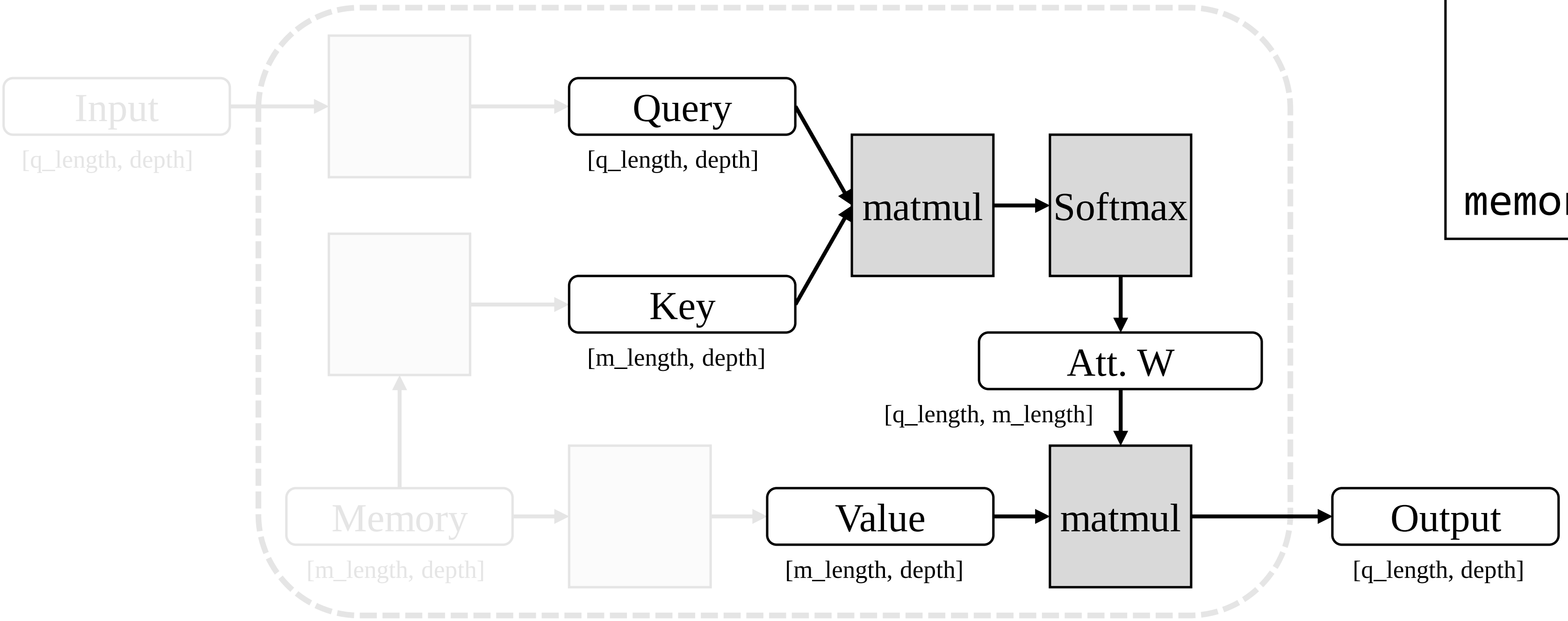
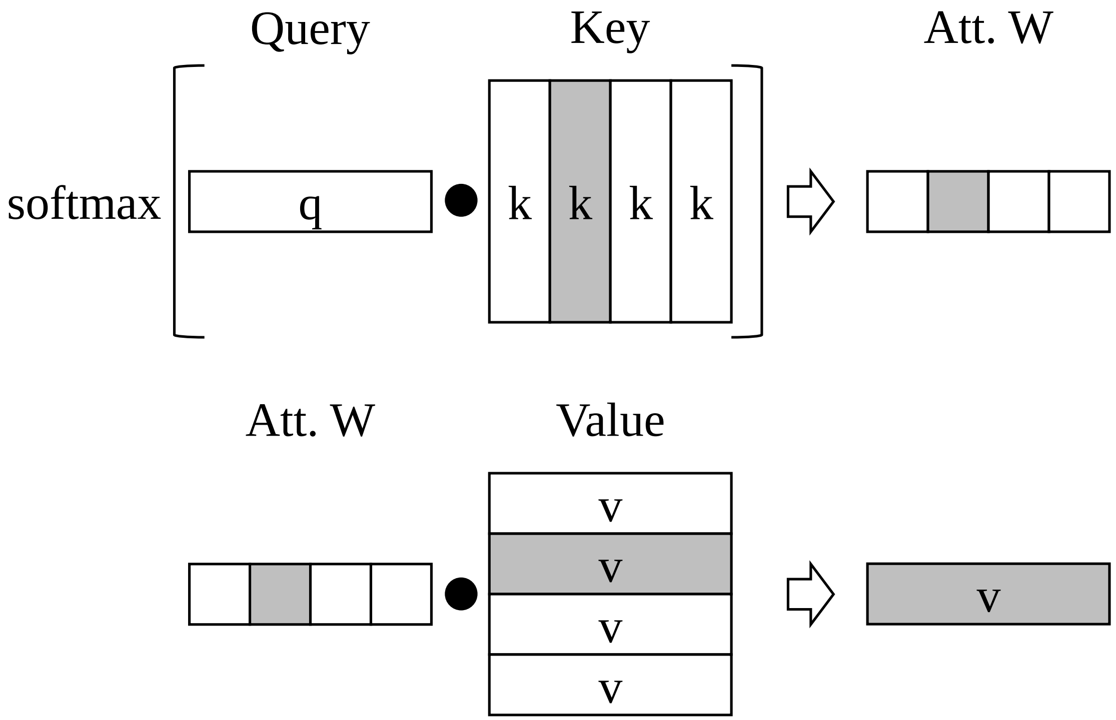
memory[query] = 'value2'
```

Basic of Attention

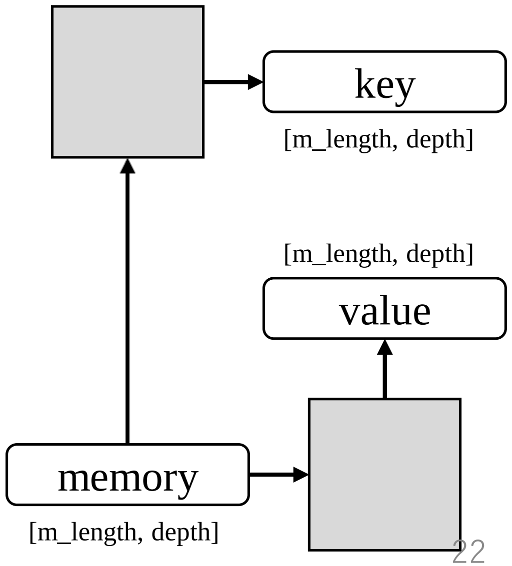



```
query = 'key2'
memory = {'key1':'value2',
          'key2':'value2',
          'key3':'value3',
          'key4':'value4'}
memory[query] = 'value2'
```

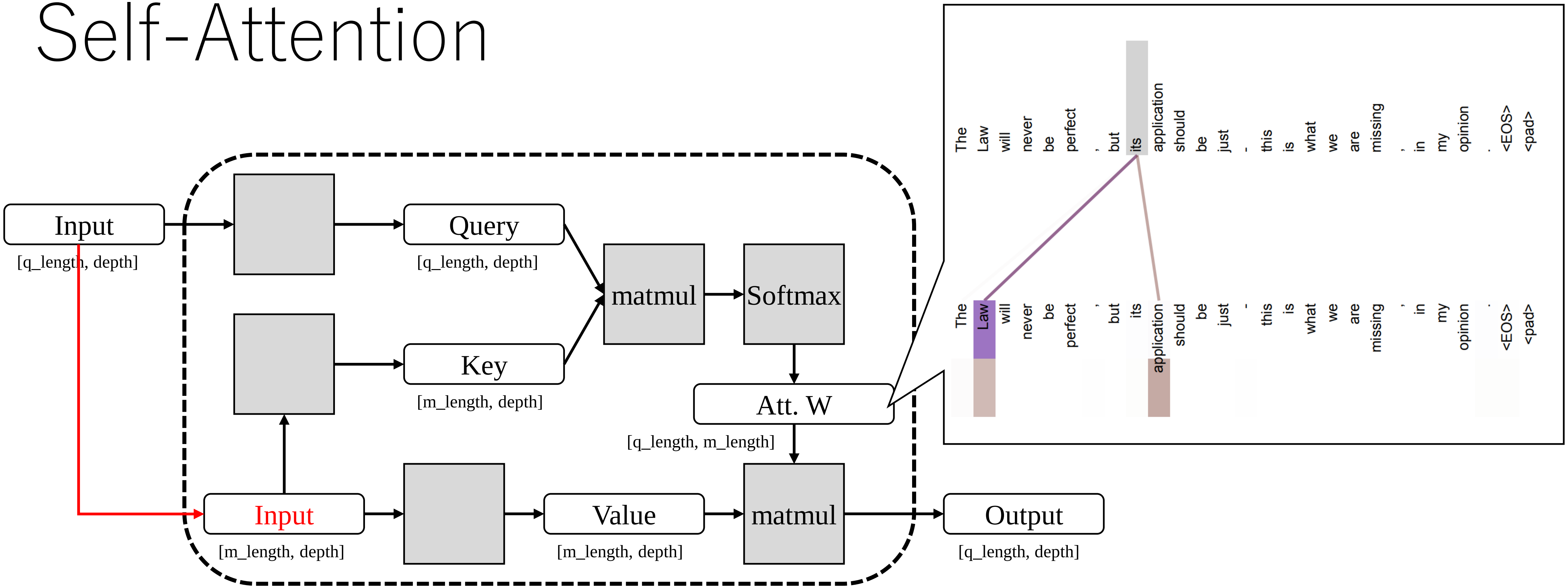
Dot-Product Attention vs. Dictionary Object




```
query = 'key2'
memory = {'key1':'value2',
          'key2':'value2',
          'key3':'value3',
          'key4':'value4'}
memory[query] = 'value2'
```



Self-Attention



Positional Encoding (PE)

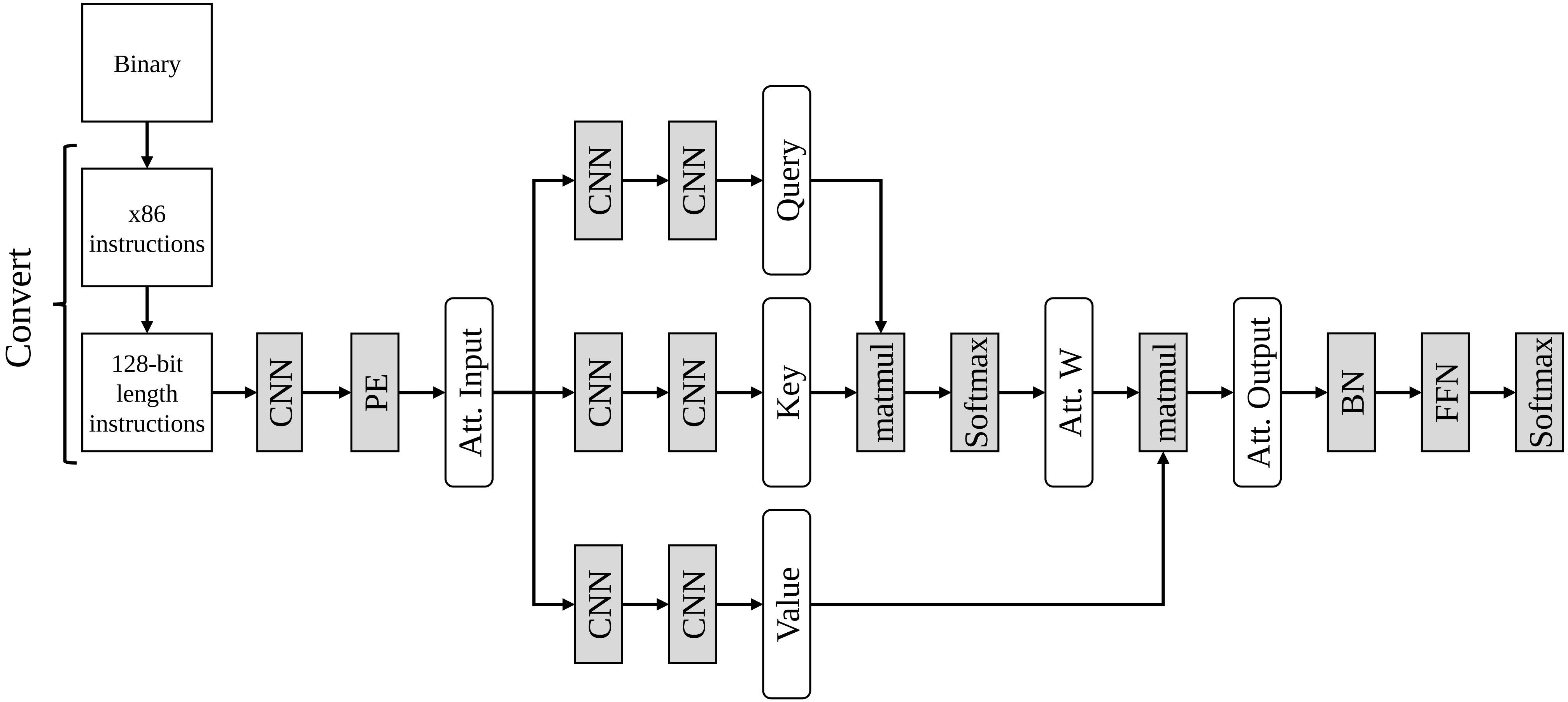
PE (Positional Encoding) adds information about the word position to the input word vectors for learning the context of words.

$$Y(X) = X + \alpha PE$$

$$PE_{(pos,2i)} = \sin\left(pos/10000^{2i/d_{model}}\right)$$
$$PE_{(pos,2i+1)} = \cos\left(pos/10000^{2i/d_{model}}\right)$$

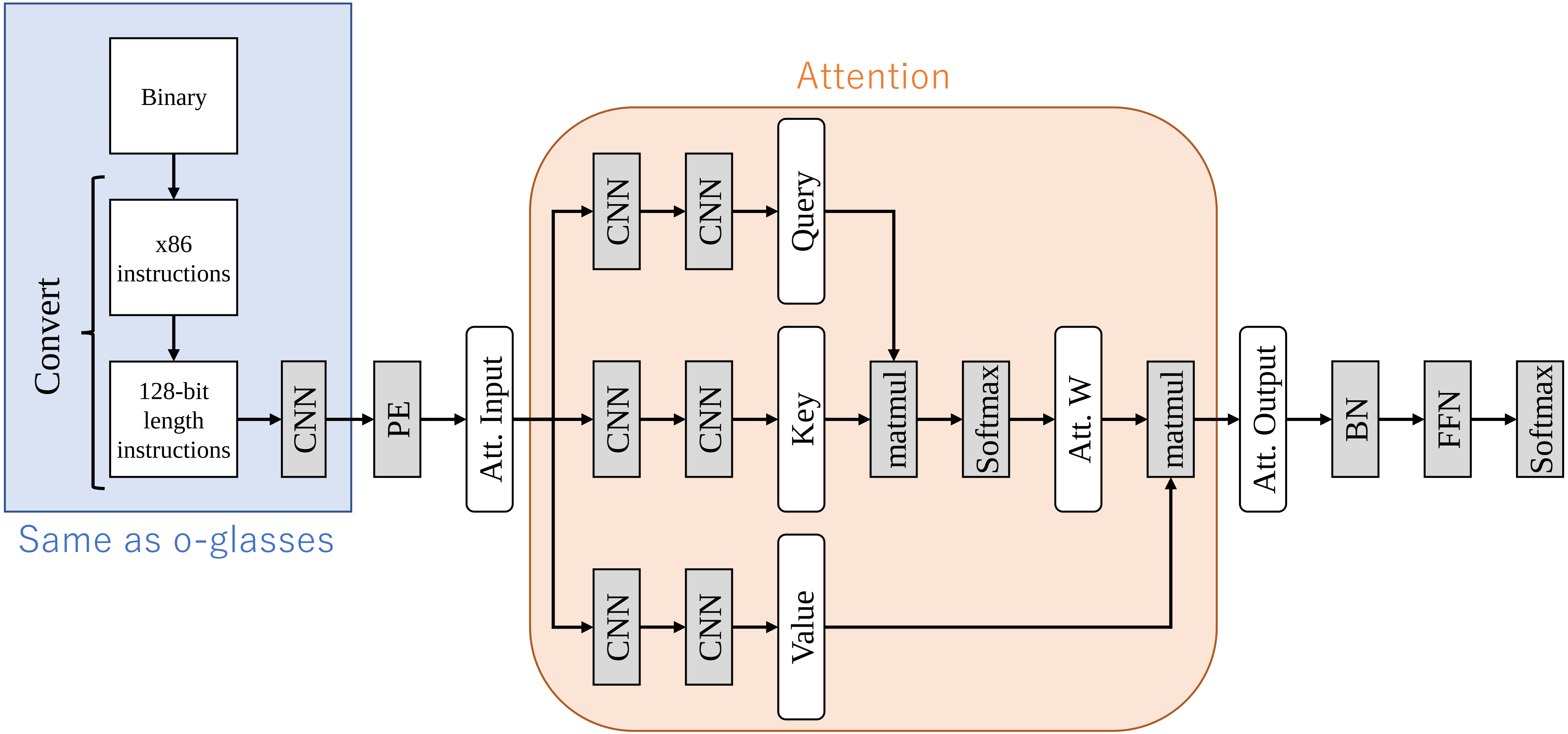
Proposed Method

o-glassesX



Binary
x86 instructions
128-bit length instructions
Convert
CNN
PE
Att. Input
CNN
CNN
Query
CNN
CNN
Key
CNN
CNN
Value
matmul
Softmax
Att. W
matmul
Att. Output
BN
FFN
Softmax

o-glassesX



Binary
x86 instructions
128-bit length instructions
Convert
CNN
Same as o-glasses
PE
Att. Input
Attention
CNN
CNN
Query
CNN
CNN
Key
CNN
CNN
Value
matmul
Softmax
Att. W
matmul
Att. Output
BN
FFN
Softmax

Preprocessing details

Binary

60	B9	67	01	00	00	EB	0F

x86 instructions

60					PUSHA
B9	67	01	00	00	MOV ECX,0x167
EB	0F				JMP loc_17

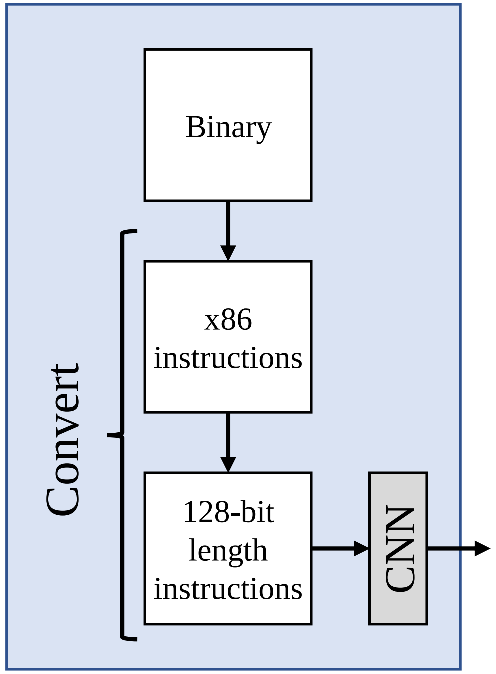
128-bit length instructions

16 bytes

60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
B9	67	01	00	00	00	00	00	00	00	00	00	00	00	00	00
EB	0F	00	00	00	00	00	00	00	00	00	00	00	00	00	00

128 bits

0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	… … … … …	0	0	0	0	0	0	0	0
1	0	0	1	1	1	0	1	1	1	1	0	0	1	1	0	… … … … …	0	0	0	0	0	0	0	0
1	1	0	1	0	1	1	1	1	1	1	1	0	0	0	0	… … … … …	0	0	0	0	0	0	0	0

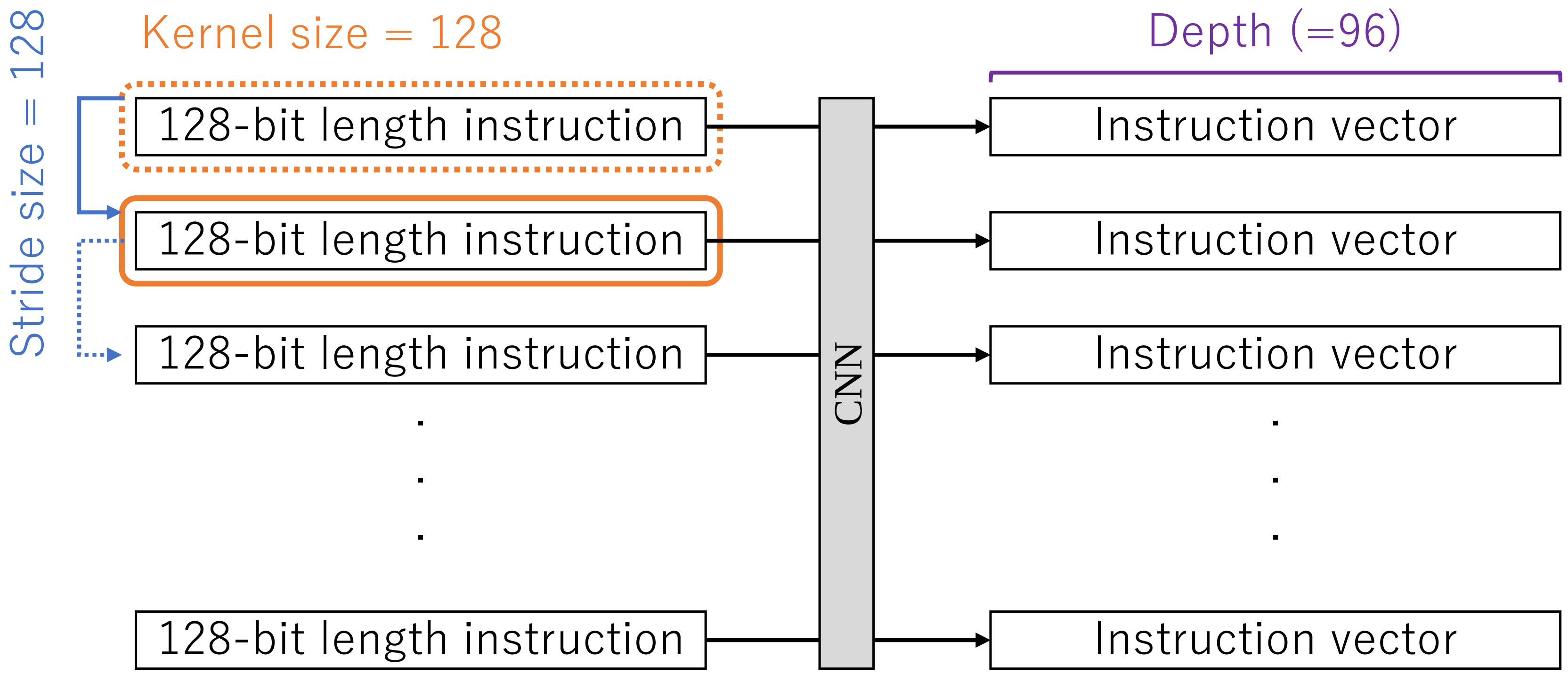


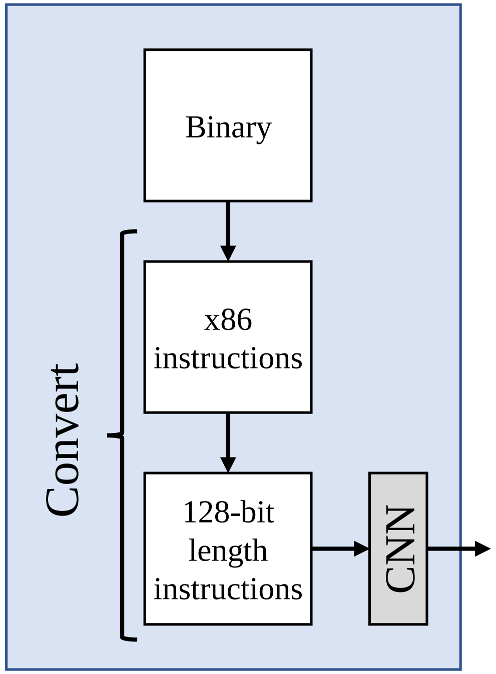
Same as o-glasses

The 1st CNN Layer

Each unit in CNN has specially local connections to the input units, called a Kernel.
Every kernel shares the weight parameters with the others in the same layer.

Each kernel covers a single instruction by adjusting the hyperparameters.





Same as o-glasses

Evaluation

Training Dataset

Collecting source code files from GitHub
Compiling various compilers and options

Total : 19 labels
Compiler : 4 families
Visual C++, GCC, Clang and Intel C++ Compiler
Opt. level : 2 types
maximum or not
CPU Arc. : 2 types
x86 or x86-64

TABLE II. DATASET COMPILATION SETTINGS.

Compiler family	Version	Architecture x86	Architecture x86-64	Optimization Level Low	Optimization Level High
VC	2003	✓		-Od	-Ox
	2017	✓	✓	-Od	-Ox
GCC	6.3.0	✓	✓	-O0	-O3
Clang	5.0.2	✓	✓	-O0	-O3
ICC	19.0.0.117	✓	✓	-O0	-O3

			Label	#Binaries	#Code
Program	VC2017	x86	VC17,32,none(Od)	1,170	369,605
			VC17,32,max(Ox)	1,147	255,143
		x86-64	VC17,64,none(Od)	1,456	540,568
			VC17,64,max(Ox)	1,242	542,020
	VC2003	x86	VC03,32,none(Od)	1,350	292,277
			VC03,32,max(Ox)	1,306	270,743
		x86-64	-	-	-
			-	-	-
	GCC	x86	GCC,32,none(O0)	2,111	227,004
			GCC,32,max(O3)	1,844	239,821
		x86-64	GCC,64,none(O0)	1,582	283,276
			GCC,64,max(O3)	1,580	287,775
	Clang	x86	Clang,32,none(O0)	1,205	101,024
			Clang,32,max(O3)	1,196	86,521
		x86-64	Clang,64,none(O0)	1,892	332,278
			Clang,64,max(O3)	1,883	246,500
	ICC	x86	ICC,32,none(Od)	1,761	1,494,677
			ICC,32,max(Ox)	1,724	1,161,499
		x86-64	ICC,64,none(Od)	1,796	1,419,705
			ICC,64,max(Ox)	1,728	1,046,958
			Others	101	912,855
			Total	28,074	10,110,249

4-fold Cross Validation (Input: 64 instructions)

Train \ Predict		VC						GCC				Clang				ICC				Others			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	R	P	F1
VC03,32,none(Od)	1	.9604	.0355	.0026	.0002	.0002	.0002	.0001	.0000	.0000	.0000	.0001	.0000	.0000	.0000	.0001	.0002	.0000	.0000	.0004	.9500	.9604	.9552
VC17,32,none(Od)	2	.0463	.9517	.0002	.0007	.0001	.0001	.0000	.0000	.0000	.0000	.0001	.0000	.0000	.0000	.0000	.0002	.0000	.0000	.0006	.9625	.9517	.9570
VC03,32,max(Ox)	3	.0026	.0001	.9875	.0061	.0001	.0003	.0000	.0002	.0000	.0000	.0000	.0002	.0000	.0000	.0000	.0022	.0000	.0000	.0006	.9786	.9875	.9830
VC17,32,max(Ox)	4	.0004	.0010	.0144	.9774	.0001	.0005	.0000	.0001	.0000	.0001	.0001	.0008	.0000	.0001	.0000	.0044	.0000	.0000	.0007	.9887	.9774	.9830
VC17,64,none(Od)	5	.0002	.0001	.0002	.0001	.9978	.0008	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0001	.0000	.0001	.0001	.0001	.0004	.9977	.9978	.9977
VC17,64,max(Ox)	6	.0002	.0001	.0004	.0004	.0013	.9931	.0000	.0000	.0000	.0005	.0000	.0000	.0001	.0006	.0000	.0001	.0000	.0023	.0008	.9955	.9931	.9943
GCC,32,none(O0)	7	.0002	.0000	.0001	.0000	.0000	.0000	.9973	.0009	.0004	.0001	.0003	.0004	.0000	.0000	.0002	.0000	.0000	.0000	.0000	.9972	.9973	.9973
GCC,32,max(O3)	8	.0001	.0000	.0005	.0002	.0000	.0000	.0011	.9921	.0000	.0003	.0002	.0051	.0000	.0000	.0000	.0004	.0000	.0000	.0000	.9946	.9921	.9933
GCC,64,none(O0)	9	.0001	.0001	.0000	.0000	.0000	.0000	.0008	.0000	.9970	.0006	.0000	.0000	.0010	.0002	.0000	.0000	.0001	.0000	.0000	.9979	.9970	.9975
GCC,64,max(O3)	10	.0000	.0000	.0000	.0000	.0001	.0002	.0001	.0006	.0003	.9800	.0000	.0003	.0003	.0168	.0000	.0001	.0001	.0012	.0000	.9819	.9800	.9809
Clang,32,none(O0)	11	.0003	.0002	.0000	.0000	.0000	.0000	.0004	.0004	.0000	.0001	.9972	.0006	.0007	.0000	.0001	.0000	.0000	.0000	.0000	.9959	.9972	.9965
Clang,32,max(O3)	12	.0001	.0000	.0006	.0011	.0000	.0001	.0004	.0068	.0000	.0003	.0006	.9869	.0000	.0019	.0000	.0012	.0000	.0000	.0000	.9790	.9869	.9829
Clang,64,none(O0)	13	.0000	.0000	.0000	.0000	.0000	.0001	.0000	.0000	.0009	.0003	.0010	.0000	.9973	.0003	.0000	.0000	.0000	.0001	.0000	.9979	.9973	.9976
Clang,64,max(O3)	14	.0000	.0000	.0001	.0001	.0001	.0006	.0000	.0001	.0002	.0147	.0000	.0015	.0002	.9810	.0000	.0001	.0001	.0013	.0001	.9796	.9810	.9803
ICC,32,none(Od)	15	.0001	.0000	.0001	.0000	.0000	.0000	.0002	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.9994	.0002	.0000	.0000	.0000	.9995	.9994	.9994
ICC,32,max(Ox)	16	.0002	.0001	.0029	.0028	.0000	.0001	.0000	.0003	.0000	.0001	.0000	.0005	.0000	.0000	.0001	.9930	.0000	.0001	.0000	.9916	.9930	.9923
ICC,64,none(Od)	17	.0000	.0000	.0000	.0000	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.9996	.0001	.0000	.9995	.9996	.9995
ICC,64,max(Ox)	18	.0000	.0000	.0001	.0000	.0001	.0016	.0000	.0001	.0000	.0012	.0000	.0000	.0000	.0013	.0000	.0001	.0002	.9952	.0000	.9948	.9952	.9950
Others	19	.0000	.0000	.0000	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.9997	.9964	.9997	.9980

Comparison of Performance of Related Work

		o-glassesX (L=64)	o-glassesX (L=16)	o-glasses[23] (L=64)	o-glasses[23] (L=16)	Rosenblum's[29]	ORIGIN[26] (SVM)	ORIGIN[26] (CRF)	BinComp[25]
Accuracy	All components	.9884 (19)	.9555 (19)	.9421 (19)	.9323 (19)	.924 (3)	.604 (18)	.918 (18)	.801 (6)
	Compiler family	.9886 (4)	.9670 (4)	.9140 (4)	.9271 (4)	.924 (3)	.983 (3)	.999 (3)	–
	Optimization	.9989 (2)	.9943 (2)	.9830 (2)	.9864 (2)	–	.971 (2)	.999 (2)	.917 (2)
	Architecture	.9997 (2)	.9985 (2)	.9959 (2)	.9940 (2)	–	–	–	–
	Code/Non-code	.9999 (2)	.9995 (2)	.9991 (2)	.9987 (2)	–	–	–	–
ML model		Attention	Attention	CNN	CNN	CRF	SVM	CRF	(k-means)
Dataset	Features	64 Instructions	16 Instructions	64 Instructions	16 Instructions	Byte Seq.	1 Function	Function Seq.	1 File
	#Samples	1,793,478	1,900,000	471,124	1,886,521	81,886,169	955,000	955,000	1,177
	#Binaries	28,074	28,074	28,074	28,074	1,119	2,686	2,686	1,177
#Variations	VC	6	6	6	6	1	6	6	2
	GCC	4	4	4	4	1	8	8	2
	Clang	4	4	4	4	-	-	-	-
	ICC	4	4	4	4	1	4	4	2
	Non-code	1	1	1	1	-	-	-	-
K-fold cross-validation		4	4	4	4	(Anomalous)	(Anomalous)	(Anomalous)	10

Calculating ‘Why’ with the Attention Mechanism

Input	
ENTER 0x558b, 0x8	.222
MOV [EDX+0xc], ECX	.115
CMP DWORD [EBP+0x10], 0x80	.029
JNZ 0x40001b7	.016
MOV EAX, [EBP+0x8]	.019
MOV ECX, [EAX+0xc]	.079
MOV [EBP-0x8], ECX	.036
MOV EDX, [EBP-0x8]	.041
SHR EDX, 0x10	.063
AND EDX, 0xff	.255
MOV EAX, [EDX*4+0x0]	.153
AND EAX, 0xff000000	.044
MOV ECX, [EBP+0x8]	.062
XOR EAX, [ECX]	.207
MOV EDX, [EBP-0x8]	.039
SHR EDX, 0x8	.063

Algorithm 1 Automatic feature extraction procedure

```
InputFile ← Compile(SourceFile,Optimization).pullCode()
Offset ← 0
while Offset < InputFile.EndOffset do
    Input ← InputFile.pull(Offset,L)
    Result ← model.predictor(Input)
    if Result.Label = RealLabel then
        if Result.Confidence > 0.99 then
            i ← argsmax(L2(Result.AttentionWeight))
            Count[input[i]] ++
        end if
    end if
    Offset ++
end while
Print(Ranking(Count))
```

Typical Instructions for each compiler

e.g.,
when focusing on the NOP instruction...

	VC03,32,none(Od)	VC17,32,none(Od)	GCC,32,none(O0)	Clang,32,none(O0)	ICC,32,none(Od)
1	XOR ECX, [EAX*4+0x0]	IMUL ECX, EAX, 0x0	AND EAX, 0xff000000	AND EAX, 0xff000000	IMUL EAX, EAX, 0x4
2	AND EAX, 0xff000000	IMUL ECX, EAX, 0x9	MOVZX EAX, AL	NOP WORD [EAX+EAX+0x0]	AND EAX, 0xff000000
3	XOR EDX, [EAX*4+0x0]	IMUL EDX, ECX, 0xc	LEA EDX, [EAX*4+0x0]	AND ECX, 0xff0000	IMUL EDX, EDX, 0x4
4	AND ECX, 0xff0000	XOR ECX, EBP	ADD DWORD [EBP-0x8], 0x1	XOR EAX, [ECX*4+0x1028]	CALL 0x4003c76
5	XOR EAX, [EDX*4+0x0]	IMUL ECX, EAX, 0x3	AND EAX, 0xff0000	NOP DWORD [EAX+0x0]	MOV EAX, 0xffffffff

	VC03,32,max(Ox)	VC17,32,max(Ox)	GCC,32,max(O3)	Clang,32,max(O3)	ICC,32,max(Ox)
1	AND ESI, 0xff0000	NOP	LEA ESI, [ESI+0x0]	NOP WORD [CS:EAX+EAX+0x0]	NOP DWORD [EAX+0x0]
2	AND ECX, 0xff0000	MOVZX ECX, BYTE [EAX+EBP]	LEA EDI, [EDI+0x0]	MOV EBP, 0xff000000	LEA EBX, [EDX+EDX]
3	AND EDI, 0xff	PUSH DWORD [ESP+0x24]	AND EAX, 0xff000000	MOV EDX, 0xff00	LEA ECX, [ESI+ESI]
4	XOR ECX, EBP	SUB DWORD [ESP+0x2c], 0x1	AND EAX, 0xff0000	MOV DL, [ESP+0x15]	LEA EDX, [ESI+ESI]
5	AND ECX, 0xff	XOR EAX, ESP	AND EBX, 0xff0000	MOV ESI, 0xff00	PXOR XMM0, [ESP+0x20]

Fig. 5. Typical instructions for each compiler against aes.c

Case Study: Various Optimization Levels

OfficeMalScanner.exe (OMS)

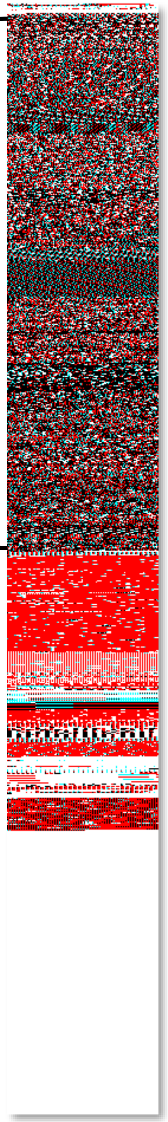
Function name	Segment	Start	Length
sub_401010	.text	00401010	0000014C
sub_401160	.text	00401160	0000023A
sub_4013A0	.text	004013A0	00000147
sub_4014F0	.text	004014F0	000000BF
sub_4015B0	.text	004015B0	0000039D
_main	**.text**	**00401950**	**00004129**
sub_405AA0	.text	00405AA0	00000046
sub_405AF0	.text	00405AF0	00000085
sub_405B80	.text	00405B80	0000042D
sub_405FB0	.text	00405FB0	000001E7
sub_4061A0	.text	004061A0	00000015
sub_4061C0	.text	004061C0	0000002D
MakeMnemonic	.text	004061EE	00000006
InstrDasm	.text	004061F4	00000006
InstrDecode	.text	004061FA	00000006
___crtCorExitProcess	.text	00406200	0000002B
___crtExitProcess	.text	0040622B	00000017
__lockexit	.text	00406243	00000009
__unlockexit	.text	0040624C	00000009
__init_pointers	.text	00406255	00000033
__initterm_e	.text	00406288	00000024
__cinit	.text	004062AC	00000097
_doexit	.text	00406343	00000140
_exit	**.text**	**00406483**	**00000016**
__exit	**.text**	**00406499**	**00000016**
__cexit	**.text**	**004064AF**	**0000000F**
__c_exit	**.text**	**004064BE**	**0000000F**
__amsg_exit	.text	004064CD	0000001D
_printf	**.text**	**004064EB**	**000000A7**

Original Code
(no optimization)

Static Link Library
(maximum optimization)

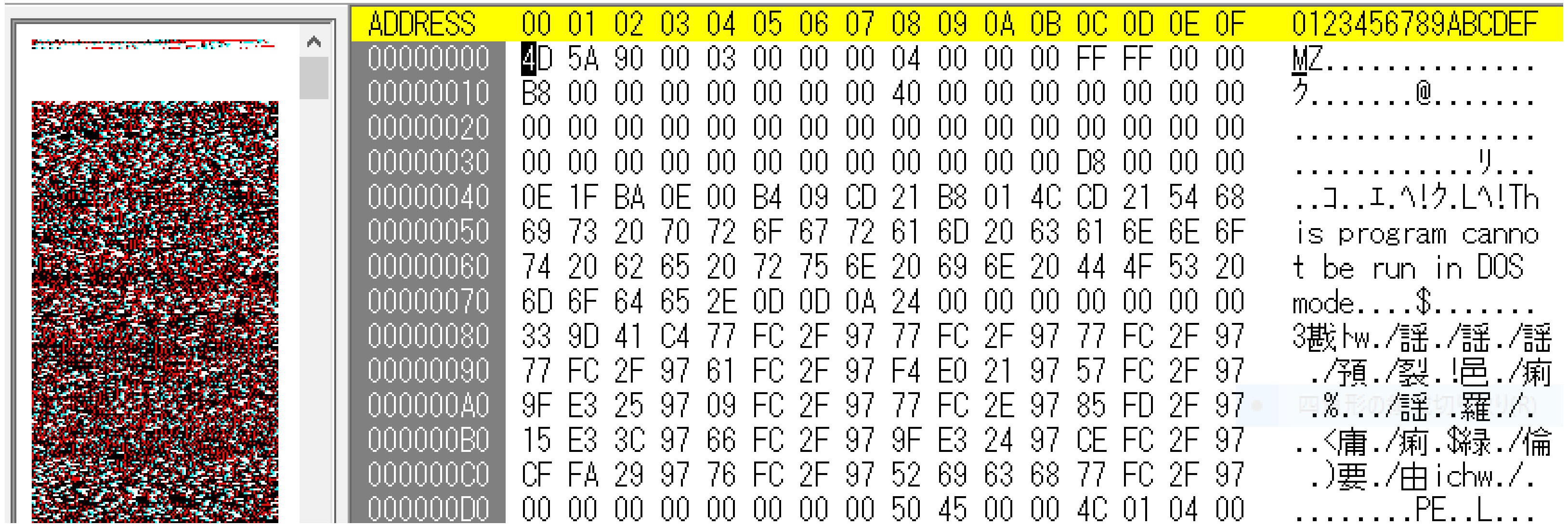
Bit-Image of OMS

.text segment (Program Code)



- NULL (0x00)
- Control Characters (0x01-0x1F)
- Printable Characters (0x20-0x7F)
- Others (0x80-0xFF)

Stirling[10] : a hex editor

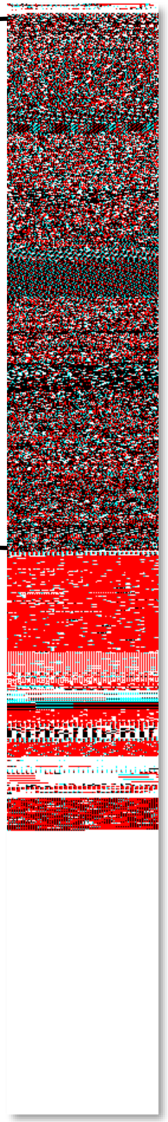


Bit-Image View

Hex View

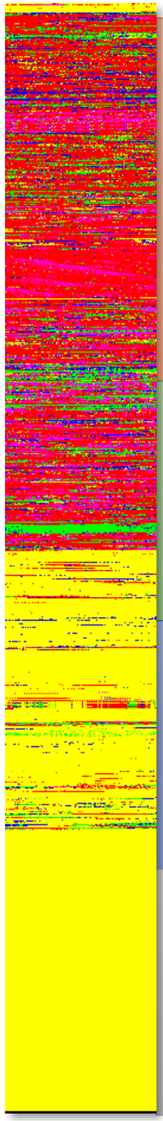
[10] K. Goto, "Stirling," https://www.vector.co.jp/soft/win95/util/se079072.html, 1998.

Visualization of OMS by o-glassesX



.text segment (Program Code)

- 0x00
- 0x01-0x1F
- 0x20-0x7F
- 0x80-0xFF



Visual C++
1 VC03,32,none
2 VC17,32,none
3 VC03,32,max
4 VC17,32,max
5 VC17,64,none
6 VC17,64,max

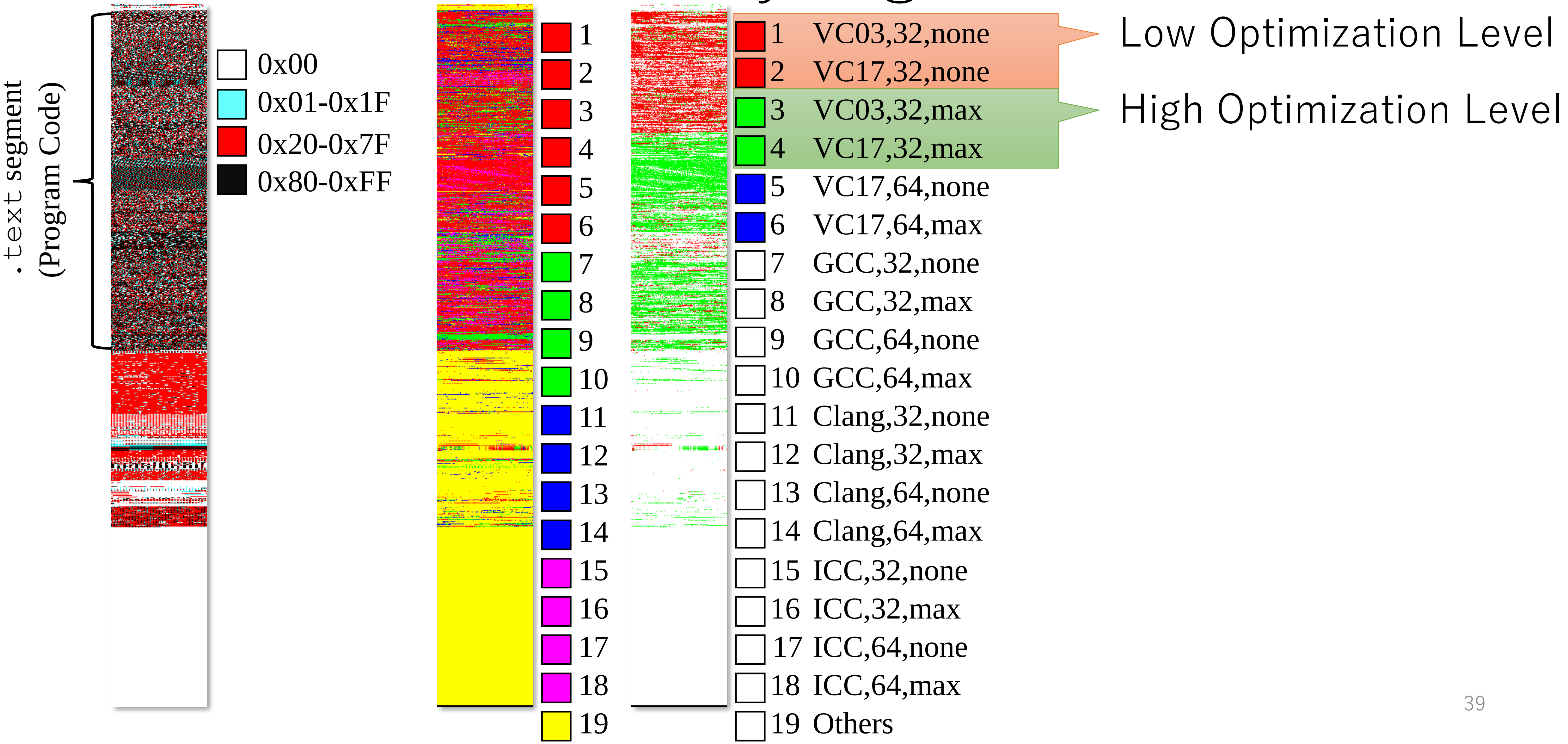
GCC
7 GCC,32,none
8 GCC,32,max
9 GCC,64,none
10 GCC,64,max

Clang
11 Clang,32,none
12 Clang,32,max
13 Clang,64,none
14 Clang,64,max

Intel C++ Compiler
15 ICC,32,none
16 ICC,32,max
17 ICC,64,none
18 ICC,64,max

19 Others

Visualization of OMS by o-glassesX



Case Study: Tracking Emdivi RATs in Dev. Env.

EMDIVI malware family is used in targeted email attacks against Japanese organizations.
It allows machines to be remotely controlled by attackers for malicious commands and other activities.

The Version of Emdivi

```
sub_4282BD proc near
push    offset aT17_08_26_kenp ; "t17.08.26.KENPO0202"
mov     ecx, offset unk_437590
call    sub_401F54
push    offset sub_42905B
call    _atexit
pop     ecx
retn
sub_4282BD endp
```

- Almost attached malware is compiled just before used
  So, the sender and the developer may be in the same group

- Frequently Updated
  t17 : For initial compromise
  t19,t20 : For expanding the intrusion (High stealth performance)

https://www.macnica.net/security/report_01.html/

Emdivi dataset

Analysis Report made by Macnica Netwoks
https://www.macnica.net/security/report_01.html/

163 MD5 Hashes of the Emdivi Family

Appendix Emdivi RAT ハッシュ値

MD5	Version	Compile Time (UTC+8)
7fa87d1adc06bb19dde13689afe8f8ef	t9_4_sender	2012/05/28 10:02:45
2f210e5e55eb90880c12019e358c43fb	t9_5_system	2012/05/30 12:49:25
66680364d2f006db747dd640b044efe3	t9_5_system	2012/05/30 11:51:39
d953cadc4be2ab27219ef87a6a1aad87	t9_5_system	2012/05/30 14:47:22
3a68b60202787c4c779f8534ea186c75	t9_5_system	2012/05/30 12:49:25
b1f967dfe09603844a2354977356165f	t9_5_system	2012/05/30 14:47:22
4aa0d9c2b300d627c1f5abd048331597	t9_6	2012/06/01 22:07:15
094d87782555477fdc6325c56c28ff30	t9_6	2012/06/01 22:07:15
a219e2c31784bec4fc159400b229f4e0	t9_6	2012/06/01 18:27:44
dfb0ad1e22d60716512855602d47392d	t9_6	2012/06/01 19:24:13
e01e34660211bb8c7c746a6819f81c2b	t9_6	2012/06/01 19:24:13
d2f46428e1651ab6555d6f5ee87b04e9	t11.05	2012/09/13 12:58:32
1c462660b33130f5e9c2ad664eeedb40	t15.07	2013/04/22 13:17:43
402406d85bcec25b14e2baa1c7b9584c	t16.19	2013/07/25 16:21:30

Difference of Emdivi Rats in Dev. Env.

All Sample

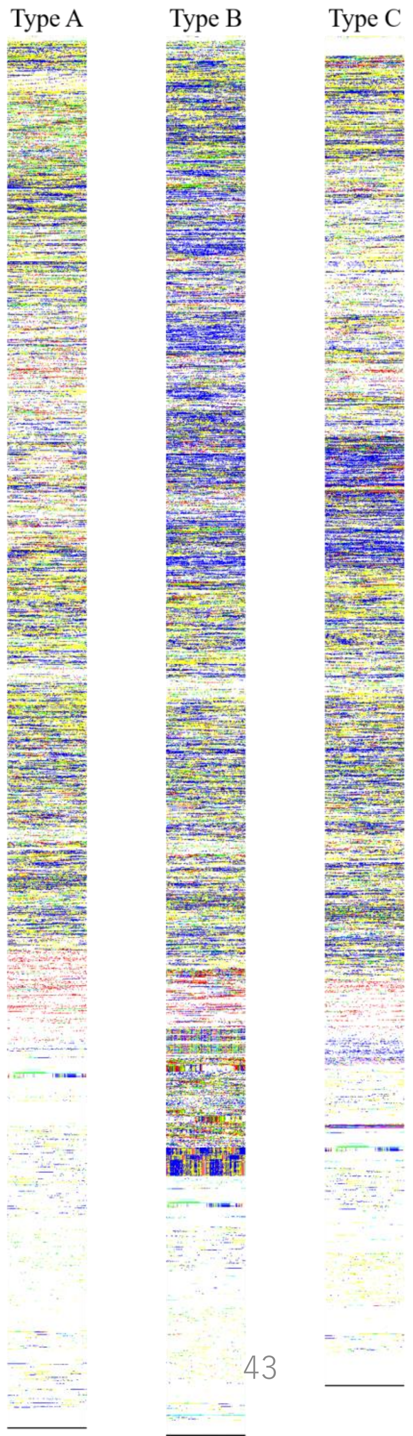
Architecture : 32-bit (x86)
Compiler family : Visual C++
Optimization level : max

Focusing on Compiler Version

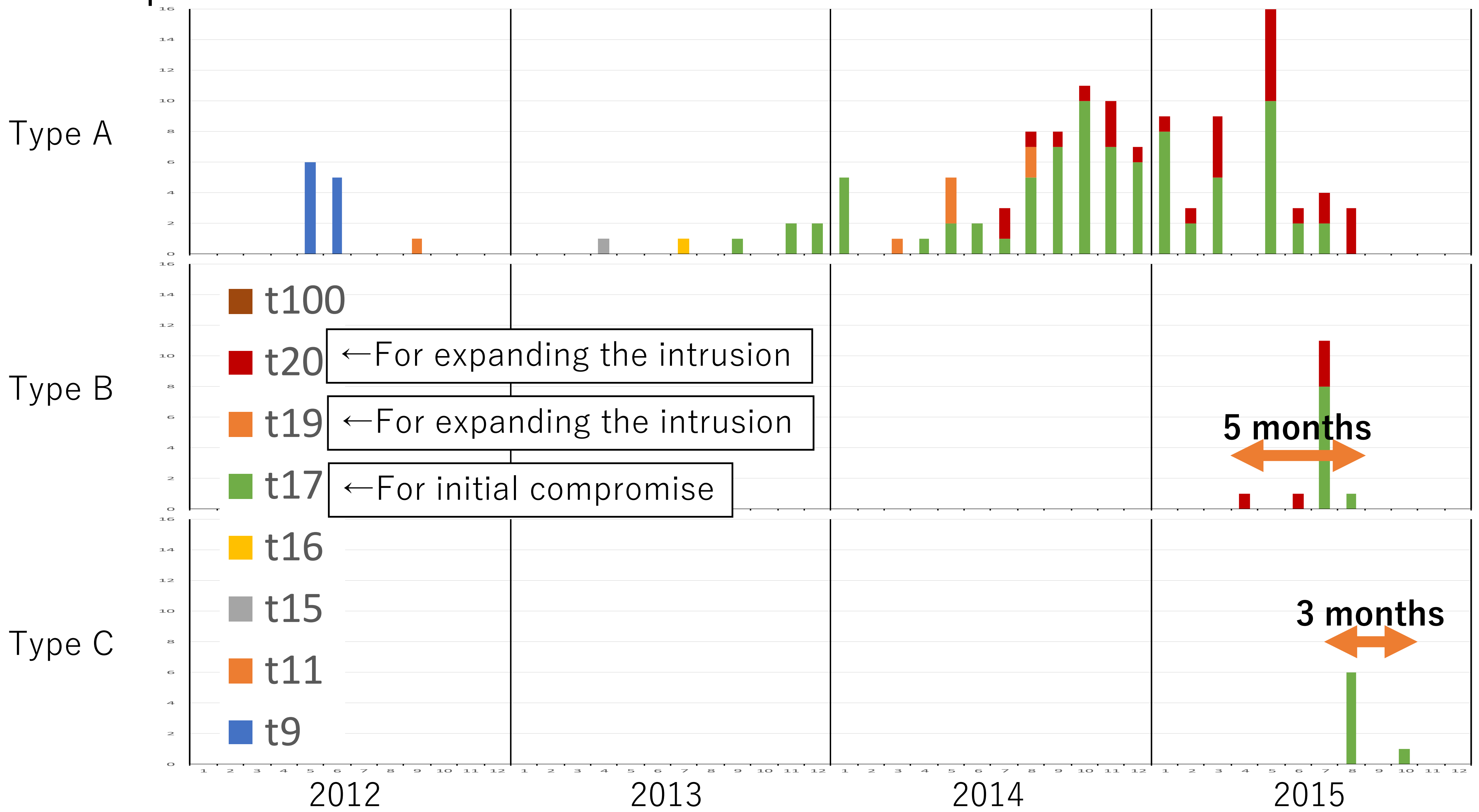
Yellow : relatively new compiler
Blue : relatively old compiler

Type A: Yellow
Type B: Blue -> Yellow
Type C: Yellow -> Blue -> Yellow

- VC03,32,none
- VC17,32,none
- **VC03,32,max**
- **VC17,32,max**
- VC17,64,none
- VC17,64,max



Compile-time and version of Emdivi RATs



Limitation

Obfuscated Code

Input machine code need to be already de-obfuscated.

Multi CPU Architectures

This method may be applied to many CPU architecture besides x86.
Splitting binary by instruction is difficult in two more CPU architectures inputs at the same time.
This limitation will be resolved, if new bin2vec method supporting multi CPU Arc. is released…

Conclusion

High Recognition Rate for Stripped Machine Code

16-instruction input: .956 accuracy
64-instruction input: .988 accuracy

Solution to Black Box Problem

o-glassesX can calculate how much input data contributes to output in units of instructions

Case Study: Emdivi

It has been revealed that there are three attackers in the same attack group.

o-glassesX and our dataset are available at

https://github.com/yotsubo/o-glassesX