Towards Social Botnet Behavior Detecting in the End Host

Yuede Ji, Yukun He, Xinyang Jiang, and Qiang Li
Jilin University

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Outline

1. Introduction
2. Design and Analysis of Wbbot
3. Host Behaviors of Social Bots
4. Methodology
5. Experiment
6. Discussion
7. Conclusion

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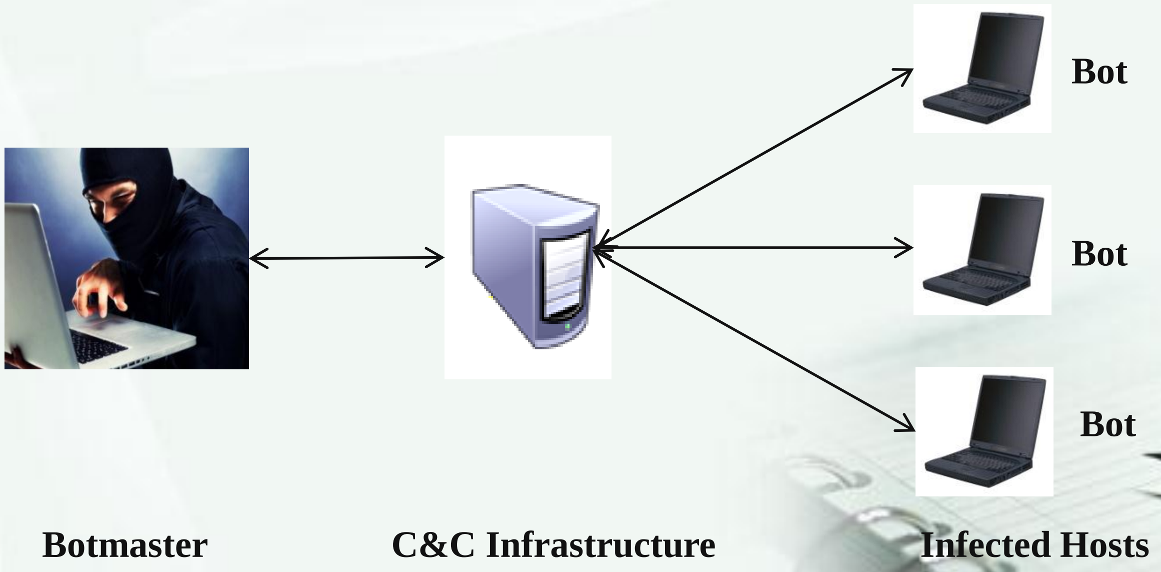
1.1 What is Botnet and Bot?

- A botnet is a network composed by a large scale of infected hosts under the control of a botmaster through Command and Control (C&C) channel.
- Bot is the infected host



1.1 What is Botnet and Bot?

- 3 basic elements:
  - Bot, C&C channel, botmaster
- C&C channel
  - Biggest difference between bot and other malwares
  - Centralized: IRC, HTTP
  - Decentralized: Peer-to-Peer (P2P)
- A major threat to Internet security
  - DDoS, spam, identity theft, phishing

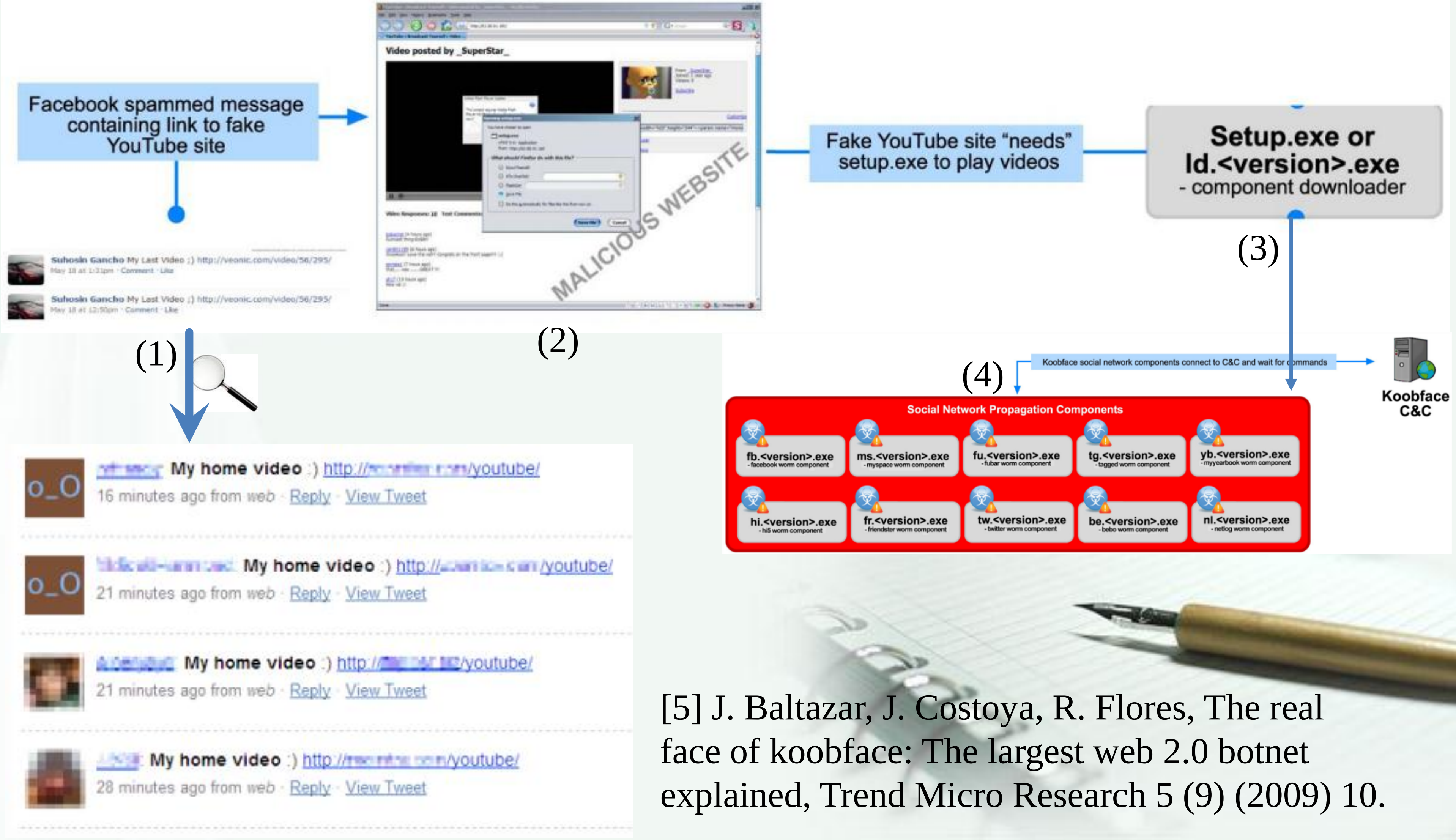
1.2 What is Social Botnet?

- Social botnet utilizes Online Social Network (OSN) as C&C channel.

- Social bot runs on user hosts stealthily, controls user account on OSN site, and communicates with the botmaster.

1.2 What is Social Botnet?

- Example: koobface



Facebook spammed message containing link to fake YouTube site

Suhosin Gancho My Last Video ;) http://veonic.com/video/56/295/
May 18 at 1:31pm · Comment · Like

Suhosin Gancho My Last Video ;) http://veonic.com/video/56/295/
May 18 at 12:50pm · Comment · Like

Fake YouTube site "needs" setup.exe to play videos

Setup.exe or ld.<version>.exe - component downloader

Koobface social network components connect to C&C and wait for commands

Koobface C&C

Social Network Propagation Components

fb.<version>.exe - facebook worm component	ms.<version>.exe - myspace worm component	fu.<version>.exe - fubar worm component	tg.<version>.exe - tagged worm component	yb.<version>.exe - myyearbook worm component
hi.<version>.exe - hi5 worm component	fr.<version>.exe - friendster worm component	tw.<version>.exe - twitter worm component	be.<version>.exe - bebo worm component	nl.<version>.exe - netlog worm component

[redacted] My home video :) http://[redacted]/youtube/
16 minutes ago from web · Reply · View Tweet

[redacted] My home video :) http://[redacted]/youtube/
21 minutes ago from web · Reply · View Tweet

[redacted] My home video :) http://[redacted]/youtube/
21 minutes ago from web · Reply · View Tweet

[redacted] My home video :) http://[redacted]/youtube/
28 minutes ago from web · Reply · View Tweet

[5] J. Baltazar, J. Costoya, R. Flores, The real face of koobface: The largest web 2.0 botnet explained, Trend Micro Research 5 (9) (2009) 10.

1.3 Existing Detection Approaches

- Server-side:
  - mainly use classification methods to identify malicious accounts or messages

- Host-side:
  - mainly monitor the abnormal behaviors on host to determine whether it is infected

1.4 Our Contributions

1. We design a social botnet, named wbbot, based on Sina Weibo.

2. We identify six critical phases based on life cycle, and analyze social bot behaviors based on these phases.

3. We propose a behavior tree-based detection approach, which can get a fairly good detection rate compared with others.

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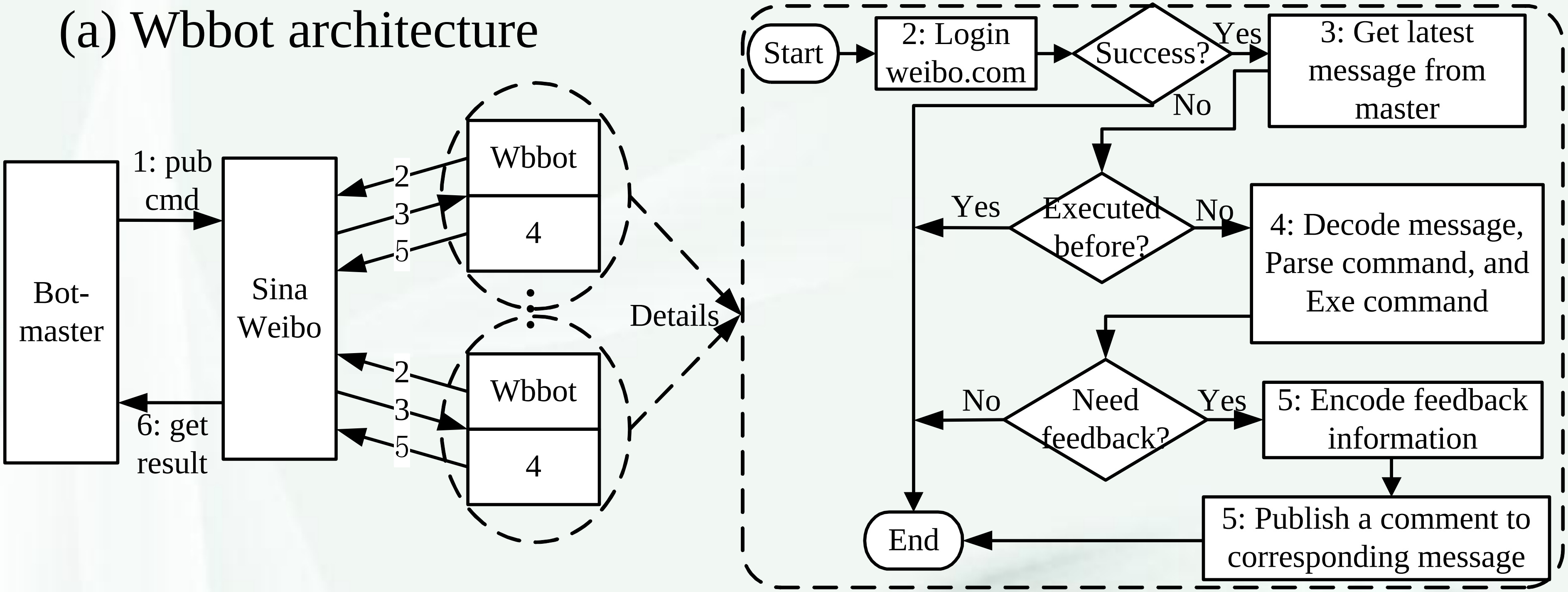
2.1 Wbbot Architecture

(b) Wbbot control flow on host

(a) Wbbot architecture


Bot-master
1: pub cmd
6: get result
Sina Weibo
2
3
5
Wbbot
4
Wbbot
4
Details
Start
2: Login weibo.com
Success?
Yes
No
3: Get latest message from master
Executed before?
Yes
No
4: Decode message, Parse command, and Exe command
Need feedback?
No
Yes
5: Encode feedback information
5: Publish a comment to corresponding message
End

(a)

(b)

2.2 Wbbot Behaviors

- Wbbot behaviors can be classified into two categories:
  - host based
  - social network based

	Command	Description
Host	getNetInfo	get host information (MAC, IP, username, etc.)
	getVersion	get the windows system Version
	exeCmd	execute a DOS command
	timeExeCmd	execute a DOS command at a specific time
	visit	force the IE browser to open an URL
	redirect	rebind the domain and IP
Social network	pubWeiboText	order wbbot to publish a message
	postComment	order wbbot to comment a message on a user
	addFollowing	order wbbot to follow an account
	autoAddFollowing	order wbbot to automatically follow others

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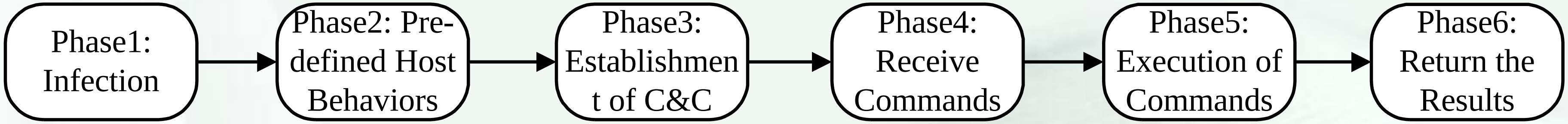
3. Host Behaviors of Social Bots

- Analyze existing social bots:
  - Two samples: koobface, Naz bot;
  - Three laboratory works: stegobot, bot designed by Boshmaf, and facebot.

- Divide their behaviors into six phases:



Phase1: Infection

Phase2: Pre-defined Host Behaviors

Phase3: Establishmen t of C&C

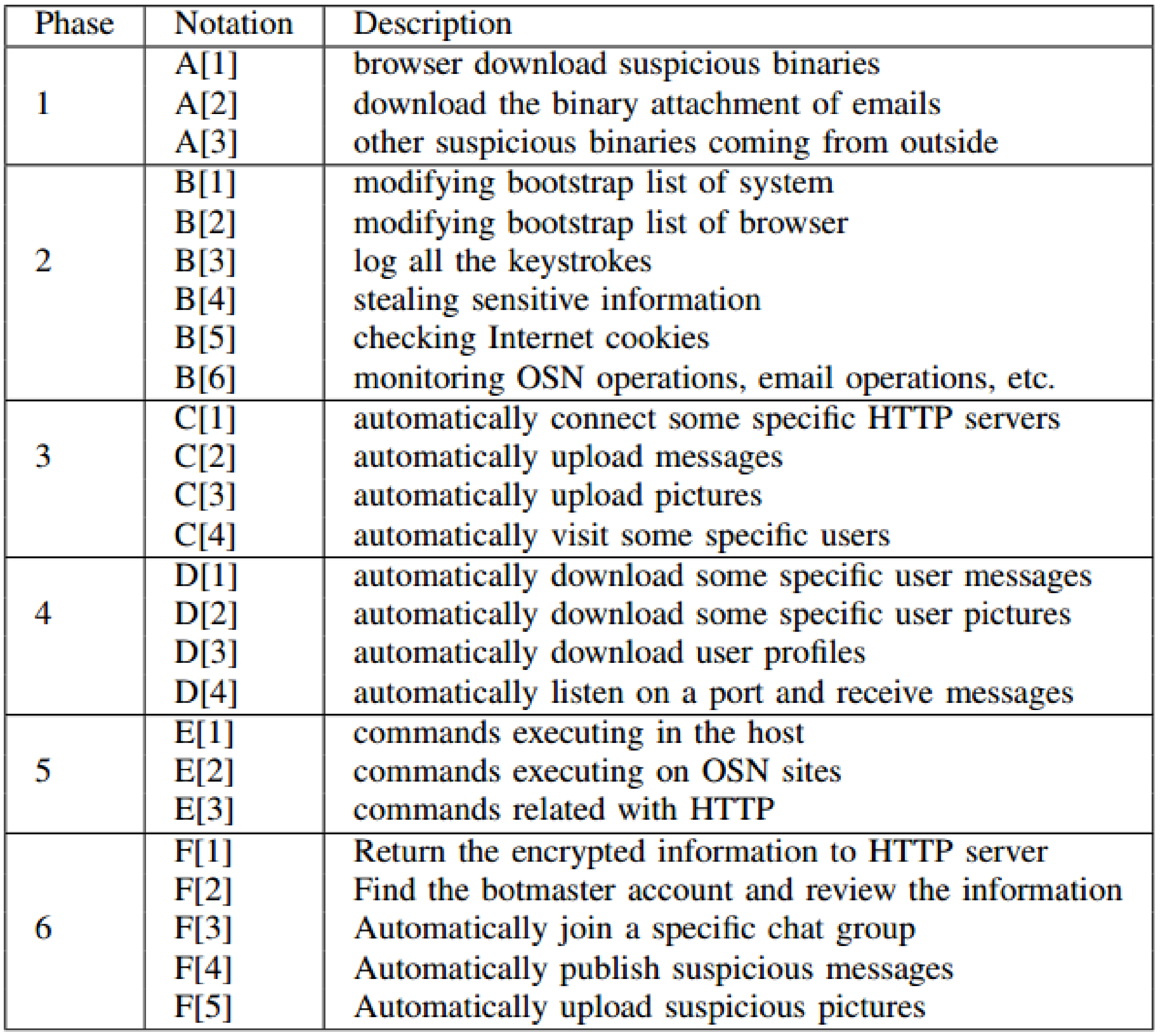
Phase4: Receive Commands

Phase5: Execution of Commands

Phase6: Return the Results

3. Host Behaviors of Social Bots

In each phase, social bots can have several possible behaviors.



Phase	Notation	Description
1	A[1]	browser download suspicious binaries
	A[2]	download the binary attachment of emails
	A[3]	other suspicious binaries coming from outside
2	B[1]	modifying bootstrap list of system
	B[2]	modifying bootstrap list of browser
	B[3]	log all the keystrokes
	B[4]	stealing sensitive information
	B[5]	checking Internet cookies
	B[6]	monitoring OSN operations, email operations, etc.
3	C[1]	automatically connect some specific HTTP servers
	C[2]	automatically upload messages
	C[3]	automatically upload pictures
	C[4]	automatically visit some specific users
4	D[1]	automatically download some specific user messages
	D[2]	automatically download some specific user pictures
	D[3]	automatically download user profiles
	D[4]	automatically listen on a port and receive messages
5	E[1]	commands executing in the host
	E[2]	commands executing on OSN sites
	E[3]	commands related with HTTP
6	F[1]	Return the encrypted information to HTTP server
	F[2]	Find the botmaster account and review the information
	F[3]	Automatically join a specific chat group
	F[4]	Automatically publish suspicious messages
	F[5]	Automatically upload suspicious pictures

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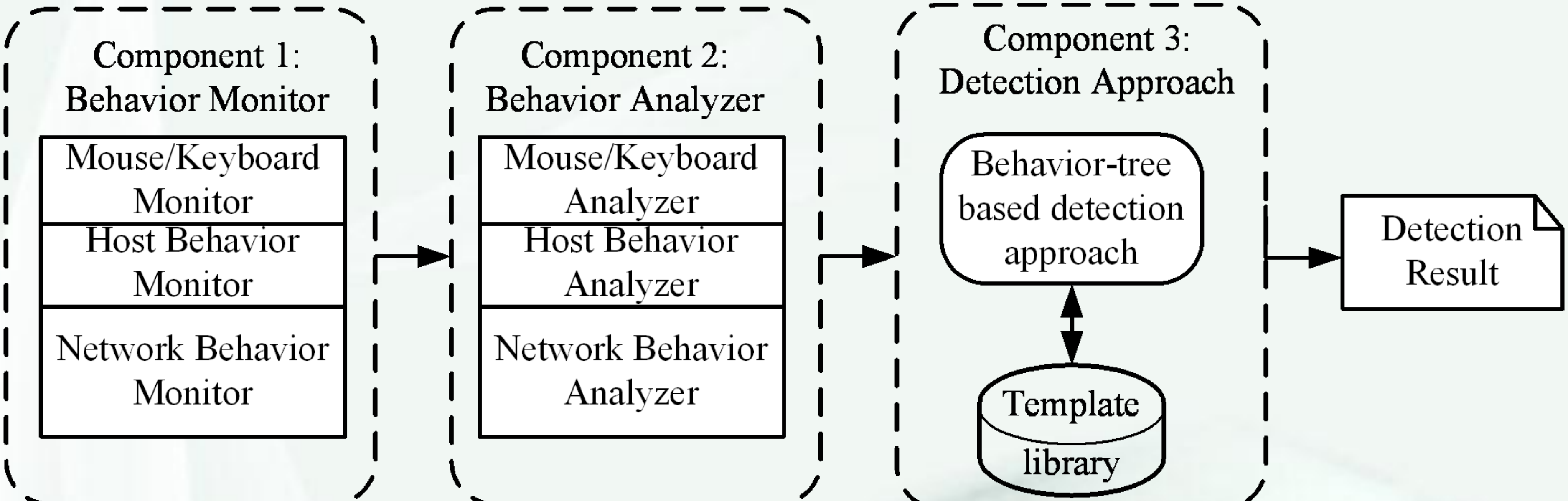
4.1 Detection System Architecture



Component 1: Behavior Monitor

Mouse/Keyboard Monitor

Host Behavior Monitor

Network Behavior Monitor

Component 2: Behavior Analyzer

Mouse/Keyboard Analyzer

Host Behavior Analyzer

Network Behavior Analyzer

Component 3: Detection Approach

Behavior-tree based detection approach

Template library

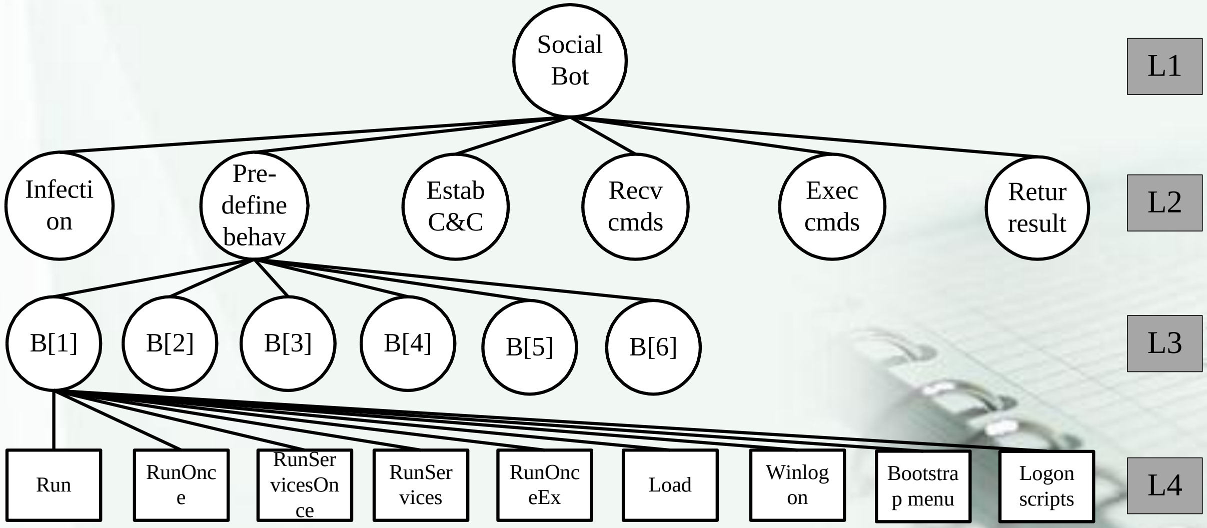
Detection Result

4.2 Behavior Tree-based Approach

(1) Behavior Tree Representation

- T = <V, E>
- L1, root layer, represent the detection result
- L2, six phases based on life cycle
- L3, specific behaviors of L2
- L4, implementations of each behavior

Example: B[1]

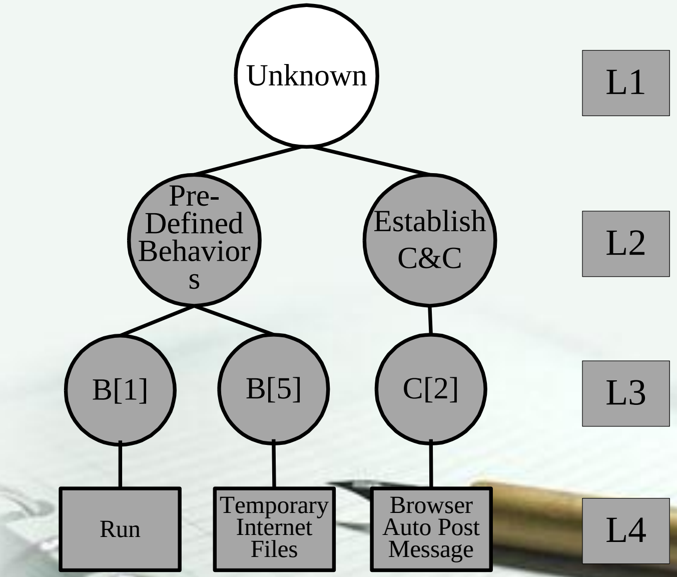


4.2 Behavior Tree-based Approach

(2) Behavior Tree Construction:

- Once the behavior in L4 layer is identified, we will flag the nodes from bottom to top

- Example: the suspicious process has the following behaviors:
  - modify the Registry value of Run,
  - check Internet cookies,
  - automatically upload messages using POST function to OSN sites.



4.2 Behavior Tree-based Approach

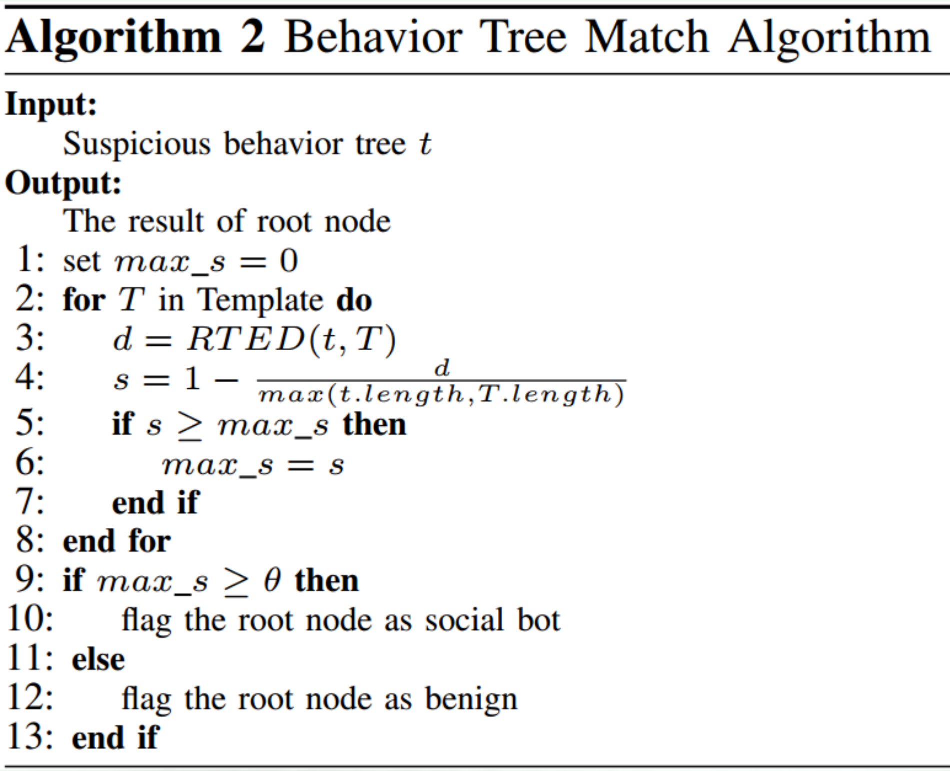
(3) Template Library Construction:

- Off-line process based on three aspects:
  - existing social bot samples,
  - possible social bots of laboratory works,
  - possible implementations from our analysis.

4.2 Behavior Tree-based Approach

(4) Behavior Tree Match :

- Utilize tree edit distance to calculate tree similarity *s*.
- Robust Tree Edit Distance algorithm (RTED)
  - [21] M. Pawlik, N. Augsten, Rted: a robust algorithm for the tree edit distance, Proceedings of the VLDB Endowment 5 (4) (2011) 334–345.
- Calculation of trees similarity
  - $s = 1 - \frac{d}{\max(m,n)}$



Algorithm 2 Behavior Tree Match Algorithm

```
Input:
    Suspicious behavior tree $t$
Output:
    The result of root node
set $max\_s = 0$
for $T$ in Template do
    $d = RTED(t, T)$
    $s = 1 - \frac{d}{max(t.length, T.length)}$
    if $s \geq max\_s$ then
        $max\_s = s$
    end if
end for
if $max\_s \geq \theta$ then
    flag the root node as social bot
else
    flag the root node as benign
end if
```

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5.1 Data Collection

Social Bot	Source	Duration	Size
Koobface	Open Malware	24 h	5.32 GB
Twitterbot	The author shared their source code with us	24 h	8.36 GB
TWebot	The author of a social botnet detection approach shared TWebot builders and binaries with us	18 h	2.77 GB
Yazanbot	We reproduced it based on their paper.	24 h	7.36 GB
FixNazbot	We reproduced it based on their paper.	24 h	4.99 GB
Wbbot	We designed.	18 h	11.5 GB
Fbbot	We designed.	5 h	4.65 GB

http://pan.baidu.com/s/1hqvHoSO

5.2 Detection Result

(1) Detection Result

Trace	Avg FP Rate	Avg FN Rate
Koobface	35.9%	31.8%
FixNazbot	34.7%	0%
Yazanbot	35.0%	0%
Twitterbot	15.4%	0%
Fbbot	25.6%	0%
Wbbot	35.3%	0%
TWebot	25.2%	0%
Total	29.6%	4.5%

(2) Result Analysis:

a) FP rate is a little high

- many benign processes perform similar behaviors as social bots
- most social bots mimic user activities or benign application activities

b) Koobface has a high FN rate

- we only have their binaries and cannot configure them

5.2 Detection Result

(1) VirusTotal Detection Result

Trace	Detection Ratio
Koobface	47 / 54
FixNazbot	0 / 54
Yazanbot	1 / 51
Twitterbot	2 / 54
Fbbot	2 / 54
Wbbot	3 / 53
TWebot	2 / 54
Total	15.2%

(2) Result Analysis:

a) Koobface has a high detection ratio

- Koobface has been already in signature database of most antivirus engines

b) Others have a very low detection ratio

c) Compared with them, our detection result is fairly good.

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6. Discussion

1. Limitation
   (1) The FP rate of our detection system is a little high.
   (2) The construction of template library is static

2. Future Work
   (1) Try to improve the detection rate
   (2) Try to improve the construction mechanism of template library

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7. Conclusion

1. Compared with other detection tools, our approach can still get a fairly good result

2. Our research still exists some flaws

3. The topic is interesting and needs a lot of further works…

Thanks for your attention!

Questions?