The |format Solves the Riddle

Deep Dive on Using the Format Command to Instrument Indicators of Compromise

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October 2018 | Version 0.8

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splunk> .conf18

Who am I?

- I'm Trevor Ford
- I've been getting my Splunk on for nearly ten years now
- That makes me feel old
- I'm a cyber security analyst at the Federal Reserve Bank of San Francisco
- *The views expressed in the presentation do not necessarily present the view of the Federal Reserve Bank*

What Are We Talking About?

- This presentation is about the |format command!
- We'll go through some background explaining how the command works and how it's already used within Splunk
- We'll finish with a few interesting use cases to demonstrate what we learned
- The expected audience for this talk is advanced Splunk users
  - If you don't think you're an advanced user, you're more than welcome to stay! I hope this is still useful

Why Am I So Excited About This?

- Threat intelligence is *everywhere*
  - Commercial
  - Industry-confidential
  - Open source
  - Some guy you work with named Ronald McDonald, who is real smart and also a real clown

- Making the most of that intel requires translating a “feed” into actual Splunk searches!
  - We’re balancing effectiveness, Splunk resource consumption, and ease of maintenance
  - There’s no perfect solution – patterns are distinct from atomic indicators which are distinct from multiple-indicator compositions

|format – What's the Deal?

|format – What's the Deal?

The Documentation

- Format is a command in Splunk! (base Splunk Enterprise, not ES)
- It even has documentation!
  - This command is used implicitly by subsearches. This command takes the results of a subsearch, formats the results into a single result and places that result into a new field called search.
  - http://docs.splunk.com/Documentation/Splunk/7.1.2/SearchReference/Format

splunk> .conf18

|format – What's the Deal?

Fun Format Facts

- At its core, |format takes a table and makes it a string
- That string is stored in the field "search"
- Format is used by default every time you feed a subsearch into a search
- It has default values
- We don't have to accept that reality

|format – What's the Deal?

Here's What We're Doing

- Let's turn this:

A	B	C
D	E	F

- Into this:

A	B	C

D	E	F

splunk> .conf18

|format – What's the Deal?

Let's Break This Down

Command Syntax

```
| format  [
"<row prefix>"
"<column prefix>"
"<column separator>"
"<column end>"
"<row separator>"
"<row end>"]
```

Default Values

```
| format  [
“(“
“(“
“AND”
“)”
“OR”
“)”]
```

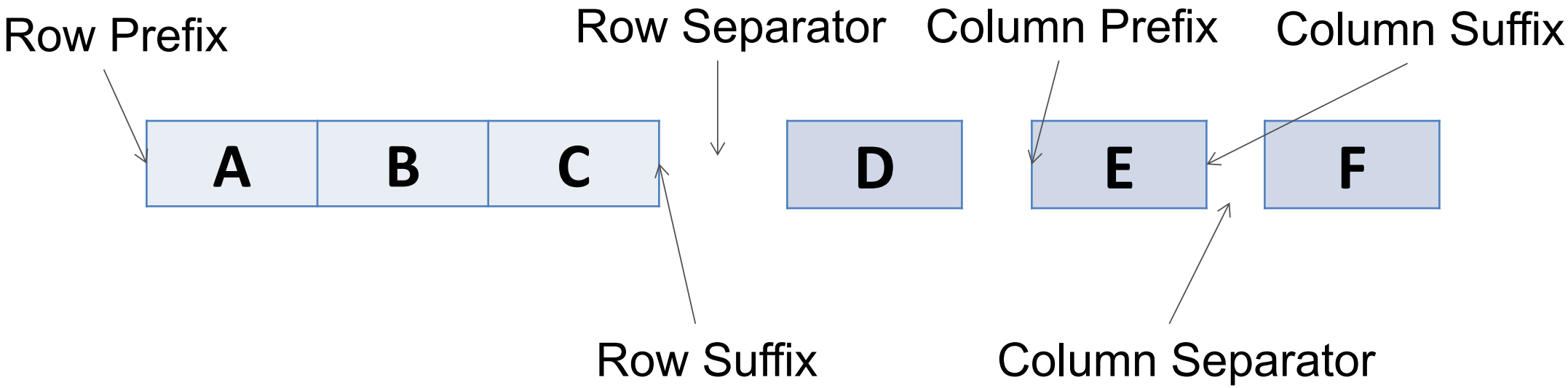
Boring Example Data

A	B	C
D	E	F

splunk> .conf18

|format – What's the Deal?

How Does It Fit Together



|format – What's the Deal?

Pull It Together!

Command Syntax

```
| format  [
"<row prefix>"
"<column prefix>"
"<column separator>"
"<column end>"
"<row separator>"
"<row end>"]
```

Default Values

```
| format  [
“(“
“(“
“AND”
“)”
“OR”
“)”]
```

Boring Example Data

A	B	C
D	E	F

((A) AND (B) AND (C)) OR ((D) AND (E) AND (F))

|format – What's the Deal?

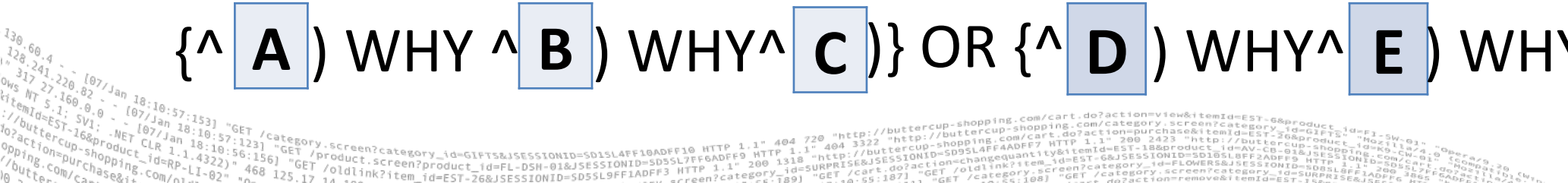
We're Too Special For Defaults

Command Syntax	New Exciting Values	Boring Example Data
| format [	| format [	
"<row prefix>"	"{"	
"<column prefix>"	"^"	
"<column separator>"	"WHY"	
"<column end>"	")"	
"<row separator>"	"OR"	
"<row end>"]	"}"]	

A	B	C
D	E	F

Note: this is gibberish.

{^ **A**) WHY ^ **B**) WHY^ **C**)} OR {^ **D**) WHY^ **E**) WHY^ **F**)}



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|format – What's the Deal?

Recap!

- What do we know about the format command?
  - It has *great* documentation
  - It turns a matrix into a single string
  - That string is in a field called "search"
  - The defaults are great, but we have the unspeakable power to ditch them

The End of a Subsearch

The End of a Subsearch

Let's Talk Defaults

- Format is automatically called with its default arguments at the end of a subsearch!
- Default arguments: separate columns with AND, separate rows with OR, use parentheses to turn each row into a tuple
- In practical terms, it turns each row into a set of criteria and feeds back a query to match any whole row
  - ((dest=8.8.8.8) AND (dest_host=google.com)) OR (dest=9.9.9.9 AND dest_host=fake.com))
- The default includes the field names/column headers in the result string

The End of a Subsearch

Who Hates Field Names? Query Hates Field Names.

- Suppose you're a rebel and you want your subsearch to feed back values but not field names
- You can use two special fields to get that done: "search" and "query"
  - A field renamed "search" or "query" will be included by |format without a field name – just the raw data
  - | rename dest_host AS query | format
    - ((dest=8.8.8.8) AND (google.com)) OR (dest=9.9.9.9 AND fake.com))

Modifying the Search String

Modifying the Search String

This is sed.

- The |format command shoves its results into the “search” field
- By default, it just passes that back
- You’re a hotshot, though, and you don’t need no stinkin defaults
- The “search” field is a string. How do we edit strings?
- That’s right, it’s sed

- |rex mode=sed field=search “s/z/ijusthatethatletter/g”

Use Cases for “Fun” and “Profit”

Use Cases

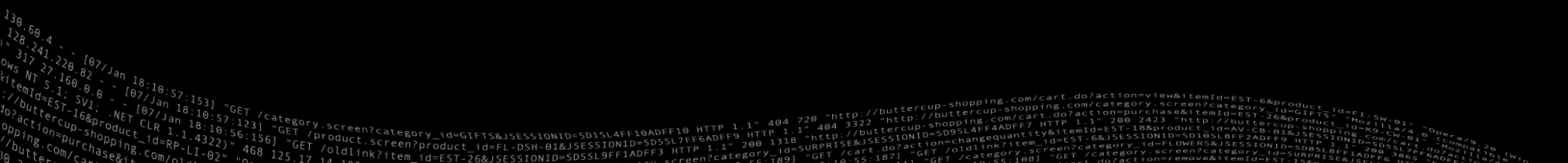
Introduction/Why Are We Here

- This presentation is about matching indicators of compromise (or indicators of bad-dude-ness, or whatever vocab term you'd like)
- All that background on |format laid out special tools for very specific situations
- Special tool situations are rare! You mostly want to do the boring stuff
- We're going to talk about lookup, about subsearching |inputlookup, and getting crazy with eval functions

Use Cases

Let's Talk About Lookup

- The base lookup command is my go-to, and it should be yours
- It's simple and straightforward
- It does, however, have some weaknesses:
  - You have to pull data, *then* match, *then* filter to matched results. This can be sloooow
  - Pattern matching is limited to wildcard characters



Use Cases

Fast IP Matching

- Quick aside: the Splunk term index!
- Splunk builds fantastic search term indexes to speed up searches
- IPv4 addresses were designed specifically to screw up term indexes:
  - The . character is a major separator. IPs have three of them
  - 1.2.3.4 becomes (1), (1.2), (1.2.3), and (1.2.3.4)
- Despite this, we can tell Splunk to jump straight to the point by searching TERM(1.2.3.4)

Use Cases

Fast IP Matching

- Situation: I have a lookup of IP addresses. The list is too long to search manually. Using |lookup is taking too long
- Desire: TERM() wrap each IP to speed things up!
- Method: |inputlookup and |format in a subsearch
- Sample SPL:
  - index=very_cool_firewall_data [
    | inputlookup baddest_dudes.csv
    | fields ipv4_address
    | rename ipv4_address AS query
    | format “(“ “TERM(“ “OR” “)” “OR” “)”]

Use Cases

Fast IP Matching

- So what happens in that search?

[| inputlookup baddest_dudes.csv	Pull in our lookup table
| fields ipv4_address	Cut it down to just the values to match
| rename ipv4_address AS query	Ditch the field name with query
| format “(“ “TERM(“ “OR” “)” “OR” “)”]	Wrap each value in TERM(<value>)

- We’re left with a list of OR-delimited search terms in the initial part of the main query – Splunk distributes the search and we’re off to the races

Use Cases

Fast IP Matching – But With Context

- That TERM() query only retrieves matching events – it doesn't include any of the context we might have documented in our lookup table of the baddest dudes
- We can still use |lookup! Even better, we're only using |lookup on events that we know will match a value in the table
- Sample SPL:
  - index=very_cool_firewall_data [
    | inputlookup baddest_dudes.csv
    | fields ipv4_address
    | rename ipv4_address AS query
    | format "(" "TERM(" "OR" ")" "OR" ")"]
    | lookup baddest_dudes.csv ipv4_address AS dest OUTPUT name_of_baddest_dude

Use Cases

Expressions so Fun They Call Them Regular

- Situation: I find myself with a growing list of regular expressions that match malicious activity (GET query string formats is a common one)
- Desire: maintain a lookup table of regexes and feed those into a search
- Method: |inputlookup combined with |format to populate an eval/where function
- Sample SPL:
  - index=very_cool_proxy_data
    | where [
    | inputlookup spooky uri_stems.csv
    | fields ioc_regex
    | format “” “match(_raw,” “OR” “)” “OR” “”
    | rex mode=sed field=search “s/ioc_regex\=//g”]

Use Cases

Throw a Little Context in There. For Flavor.

- That's a basic match, but indicators are less useful if you're trying to figure out which one did the match
- How do we combine matching logic plus context? Case statements and eval!
- Sample SPL:
  - index=very_cool_proxy_data
    | eval [
    | inputlookup spooky uri_stems.csv
    | fields ioc_id, ioc_regex
    | format "ioc_match=case(" "match(_raw," "),"" "","" ")"
    | rex mode=sed field=search "s/ioc_id\=//g"
    | rex mode=sed field=search "s/ioc_regex\=//g"]

Use Cases

Wait, What?

| eval [	Building an eval
| inputlookup spooky uri_stems.csv	Pull in our lookup of regexes
| fields ioc_id, ioc_regex	Include a table ID and the regex
| format “ioc_match=case(“ “match(_raw,” “),” “” “,” “)”	Populate the ioc_match field with the result of a case() statement that passes each lookup value into the match() function
| rex mode=sed field=search “s/ioc_id\=//g”	Clear the ID field name out of the case()
| rex mode=sed field=search “s/ioc_regex\=//g”	Clear the regex field name out of the match() functions

Use Cases

Additional Notes on That Query

- You may find yourself with an excess of escaped backslashes (\ )
- You may find yourself with improperly escaped quotations
- And you may ask yourself, how do I work here?

- sed. sed it all away

- Expect some pre/post processing if you're collecting regexes from the internet
- Even formats like STIX seem to allow enough variation to make life interesting

Use Cases

Why? Why do this thing?

- What do we really want?
  - Lookup-style management (CSV, KVS, etc)
  - Complex pattern matching
- Can we get it without these crazy queries?
  - *Kinda?*
  - Could maintain macros
  - Could maintain searches for each regex, or set of regexes
  - Could maintain field extractions!
- In my experience, lookups are the most automatable way to manage threat intelligence inside of Splunk. Your experience may differ

Last Words

Before We Go

- Operationalizing threat intelligence is hard!
  - It's worth the time to think through which data you're matching to which indicators
  - The easy stuff isn't necessarily that easy
- My advice: bust out the crazy stuff when it's needed but don't be crazy for crazy's sake

- Subject matter experts make everything easier
  - Incident responders are your best friends
  - Threat intelligence experts are also your best friends
  - Make lots of best friends

Thank You!

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