Extending SPL with Custom Search Commands

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Who am I?

• Splunker for 2 years, based in San Francisco

• Engineering lead for...
  – Machine Learning Toolkit
  – ITSI Anomaly Detection and Adaptive Thresholding features
  – Splunk custom search command interface

• Implemented Search Command Protocol Version 2

• Die-hard Longhorns fan
Agenda

- Introduction to Custom Search Commands
- How do Custom Search Commands work?
  - High-level concepts
  - Low-level details
- Types of Search Commands
- How to create new Custom Search Commands
- Wrap-up
What is a Custom Search Command?

- A user-defined SPL command.
```
index=_internal
| timechart span=1h sum(bytes) as bytes_per_hour
| eventstats avg(bytes_per_hour) as avg, stdev(bytes_per_hour) as sd
| where bytes_per_hour > avg+2*sd
```
What is a Custom Search Command?

- A user-defined SPL command.

- Can be used to extend the SPL language!
Who uses Custom Search Commands?

• Partners
  – Concanon, etc.

• Customers
  – Use-case specific analytics

• Splunk!
  – `predict` command
  – DB Connect
  – Machine Learning Toolkit

• Anyone who wants to extend the Splunk platform
  – Integration with 3rd party services
  – Implementation of custom logic
How do Custom Search Commands work?
How do Custom Search Commands work?

1. When parsing SPL, splunkd interrogates each command. “Are you a Custom Search Command?”

2. If so, spawn external process and allow it to parse arguments.

3. During search, pipe search results through external process.
Parsing #1: Split search into commands

```
| inputlookup geo_attr_us_states.csv | GOCRAZY | head 5 |
```

```
inputlookup geo_attr_us_states.csv
```

```
GOCRAZY
```

```
head 5
```

```
```
Parsing #2: Look for custom search commands

| inputlookup geo_attr_us_states.csv | GOCRAZY | head 5

commands.conf
[gocrazy]
...

inputlookup geo_attr_us_states.csv

GOCRAZY

head 5

[Image of Splunk logo]
Parsing #3: Spawn external process

| inputlookup geo_attr_us_states.csv | GOCRAZY | head 5

```
$inputlooku$ geo_attr_us_states.csv
```

```
GOCRAZY
```

```
head 5
```

```
$SPLUNK_HOME/bin/python gocrazy.py
```
Parsing #4: Let external process parse arguments

\[ \text{inputlookup geo_attr_us_states.csv} \quad \text{GOCRAZY} \quad \text{head 5} \]
Search: Pipe results **through** external process

```
| inputlookup geo_attr_us_states.csv | GOCRAZY | head 5
```

```
$SPLUNK_HOME/bin/python gocrazy.py
```
Recap: high-level concepts

- Enable you to register new SPL commands, extend the language.

- Allow you to intercept and modify search results during a search.
  - CSV in → CSV out

- Implemented as an external process (i.e. a program you write).
  - Typically written in Python.
Custom Commands: low-level details

- How results are exchanged between splunkd and external process
- “Types” of search commands
splunkd ↔ custom command

- There are two “protocols” for custom commands:
  - Version 1, legacy protocol used by Intersplunk.py (available since Splunk 3.0)
  - Version 2, new protocol used by Python SDK (available since 6.3)
  - In both protocols, all communication over stdin/stdout

- Version 2 protocol
  - Spawns external process once, streams results through chunk by chunk
  - Simple commands.conf configuration
    - “chunked=true”
  - Support for platform-specific programs

- Version 1 protocol
  - Spawns external process for each chunk of search results (!)
  - “Transforming” commands limited to 50,000 events
## Search Command protocol comparison

<table>
<thead>
<tr>
<th>Protocol</th>
<th>APIs</th>
<th>Performance</th>
<th>Scalability</th>
<th>Simple configuration</th>
<th>Platform-specific programs</th>
<th>Programming languages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version 1 (legacy)</td>
<td>Intersplunk.py, Python SDK</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>Python</td>
</tr>
<tr>
<td>Version 2</td>
<td>Python SDK</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>Python, Javascript, bash, Shell, arbitrary binaries</td>
</tr>
</tbody>
</table>
Search Command Protocol Version 2

- Transaction-oriented
  - splunkd sends a command, external process responds with reply

- Simple bi-directional transport protocol:
  - ASCII transport header
  - JSON metadata payload
  - CSV search results payload

- Every search starts with a “getinfo” command (capability exchange)
- Subsequently, issues “execute” commands with search results
Transport “chunk”

Transport header
Metadata (JSON)
Data payload (CSV)

chunked 1.0, 22, 54
{"action": "execute"}
_raw, a, b, c
hello, 0, 1, 2
everyone, 3, 4, 5
howareyou, 6, 7, 8
Example: GOCRAZY

| inputlookup geo_attr_us_states.csv | head 5 | GOCRAZY |

chunked 1.0,22,106
{"action": "execute"}
state_code,state_fips,state_name
AL,01,Alabama
AK,02,Alaska
AZ,04,Arizona
AR,05,Arkansas
CA,06,California

chunked 1.0,18,106
{"finished": true}
dste_aecot,pste_asfit,mste_aenat
LA,10,aaalbmA
KA,20,laaskA
ZA,40,iaorznA
RA,50,Akaasnsr
AC,60,iCifolarna

$SPLUNK_HOME/bin/python
gocrazy.py
Protocol Version 2: Transaction timeline

“What kind of command are you?”

splunkd

getinfo command

getinfo reply

execute command

execute reply

execute command

execute reply

: closes stdin pipe

kills external process

external process

“Hey! I’m a streaming command!”
“getinfo” command

- Metadata in the getinfo command sent by splunkd:
  - Command arguments
  - Full SPL query string
  - Execution context (app, user)
  - Search sid
  - splunkd URI and auth token (for making REST requests)

- Metadata in the custom command’s reply:
  - Type of search command (streaming/stateful/reporting/etc.)
  - Which fields splunkd should extract (required fields)
  - Whether or not it generates results (e.g. must be first search command)
Sample “getinfo” metadata

```json
{
  "action": "getinfo",
  "streaming_command_will_restart": false,
  "searchinfo": {
    "earliest_time": "0",
    "raw_args": [
      "LinearRegression", "petal_length", "from", "petal_width"
    ],
    "session_key": "...",
    "maxresultrows": 50000,
    "args": [
      "LinearRegression", "petal_length", "from", "petal_width"
    ],
    "dispatch_dir": "/Users/jleverich/builds/conf_mlapp_demo/var/run/splunk/dispatch/1475007525.265",
    "command": "fit",
    "latest_time": "0",
    "sid": "1475007525.265",
    "splunk_version": "6.5.0",
    "username": "admin",
    "search": "%C%20inputlookup%20iris.csv%20%7C%20fit%20LinearRegression%20petal_length%20from%20petal_width",
    "splunkd_uri": "https://127.0.0.1:8090",
    "owner": "admin",
    "app": "Splunk_ML_Toolkit"
  },
  "preview": false
}
```
“execute” command

- Metadata in execute command sent by splunkd
  - Whether or not preceding commands are “finished”

- Metadata in the custom command’s reply:
  - Whether or not this command is “finished”

- splunkd and search commands negotiate completion of search
  - Both must indicate “finished” = True
Types of Search Commands
Types of Search Commands

- “Streaming” commands
- “Stateful Streaming” commands
- “Transforming” commands
  - “Events” commands
  - “Reporting” commands
“Streaming” commands

- Process search results one-by-one
  - Can’t maintain global state
  - Must not re-order search results

- Eligible to run at Indexers
  - Can run in parallel on Indexers

- Examples:
  - eval
  - where
  - rex
“Streaming” command example

Remote results

<table>
<thead>
<tr>
<th>field_A</th>
<th>field_B</th>
<th>field_C</th>
</tr>
</thead>
<tbody>
<tr>
<td>the</td>
<td>jumps</td>
<td>dog</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>field_A</th>
<th>field_B</th>
<th>field_C</th>
</tr>
</thead>
<tbody>
<tr>
<td>quick</td>
<td>over</td>
<td>oops</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>field_A</th>
<th>field_B</th>
<th>field_C</th>
</tr>
</thead>
<tbody>
<tr>
<td>brown</td>
<td>the</td>
<td>too</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>field_A</th>
<th>field_B</th>
<th>field_C</th>
</tr>
</thead>
<tbody>
<tr>
<td>fox</td>
<td>lazy</td>
<td>many</td>
</tr>
</tbody>
</table>

... | eval foo="bar" | ...

Indexers

Search head

Final search results

<table>
<thead>
<tr>
<th>field_A</th>
<th>field_B</th>
<th>field_C</th>
<th>foo</th>
</tr>
</thead>
<tbody>
<tr>
<td>the</td>
<td>jumps</td>
<td>dog</td>
<td>bar</td>
</tr>
<tr>
<td>quick</td>
<td>over</td>
<td>oops</td>
<td>bar</td>
</tr>
<tr>
<td>brown</td>
<td>the</td>
<td>too</td>
<td>bar</td>
</tr>
<tr>
<td>fox</td>
<td>lazy</td>
<td>many</td>
<td>bar</td>
</tr>
</tbody>
</table>
“Stateful Streaming” commands

- Process search results one-by-one
  - *Can* maintain global state
  - Must not re-order search results

- Only run at Search Head

- Examples:
  - accum
  - streamstats
  - dedup
"Stateful Streaming" command example

... | accum foo | ...

<table>
<thead>
<tr>
<th>field_A</th>
<th>field_B</th>
<th>field_C</th>
<th>foo</th>
</tr>
</thead>
<tbody>
<tr>
<td>the</td>
<td>jumps</td>
<td>dog</td>
<td>1</td>
</tr>
<tr>
<td>quick</td>
<td>over</td>
<td>oops</td>
<td>1</td>
</tr>
<tr>
<td>brown</td>
<td>the</td>
<td>too</td>
<td>1</td>
</tr>
<tr>
<td>fox</td>
<td>lazy</td>
<td>many</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>field_A</th>
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<td>over</td>
<td>oops</td>
<td>2</td>
</tr>
<tr>
<td>brown</td>
<td>the</td>
<td>too</td>
<td>3</td>
</tr>
<tr>
<td>fox</td>
<td>lazy</td>
<td>many</td>
<td>4</td>
</tr>
</tbody>
</table>
“Events” commands

• Process search results as a whole
  – May re-order search results
  – Typically maintain all fields in each event, especially:
    › _raw, _time, index, sourcetype, source, host

• Only run at Search Head

• May run several times for “preview”

• Examples:
  – sort
  – eventstats
“Events” command example

... | sort field_A | ...

<table>
<thead>
<tr>
<th>field_A</th>
<th>field_B</th>
<th>field_C</th>
<th>foo</th>
</tr>
</thead>
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<td>3</td>
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<td>many</td>
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<td>2</td>
</tr>
<tr>
<td>the</td>
<td>jumps</td>
<td>dog</td>
<td>1</td>
</tr>
</tbody>
</table>
“Reporting” commands

• Process search results as a whole
  – Typically transform the results (e.g. aggregate, project, summarize, etc.)

• Only run at Search Head

• May run several times for “preview”

• Results show up in the “Statistics” tab

• Examples:
  – stats
  – timechart
  – transpose
“Reporting” command example

... | stats count | ...

<table>
<thead>
<tr>
<th>field_A</th>
<th>field_B</th>
<th>field_C</th>
<th>foo</th>
</tr>
</thead>
<tbody>
<tr>
<td>the</td>
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<td>dog</td>
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<td>too</td>
<td>3</td>
</tr>
<tr>
<td>fox</td>
<td>lazy</td>
<td>many</td>
<td>4</td>
</tr>
</tbody>
</table>

count

4
Beware of large result sets!

- “Events” and “Reporting” commands process results as a whole.
  - May contain 1,000,000s of search results!
  - Write Streaming or Stateful commands instead when possible.

- Build-in capacity limits, or spill results to disk when necessary.
Streaming “pre-op”

- Commands may specify a “pre-op” to prepend in SPL

```
... | stats count | ... ➔ ... | prestats count | stats count | ... 
```

- Communicated to splunkd in getinfo metadata (streaming_preop)
- Useful to parallelize computation, reduce volume of data transfer
- Must be “Streaming” (i.e., may run at Indexers)
Implementing Custom Search Commands with the Splunk SDK for Python
Basic steps to create a search command

1. Create an “App”
2. Deploy the Python SDK for Splunk in the bin directory
3. Write a script for your Custom Search Command
4. Register your command in commands.conf
5. Restart Splunk Enterprise
6. (optional) Export the command to other apps
Create an “App”

![Image of Splunk interface with focus on creating an app]

### Apps

<table>
<thead>
<tr>
<th>Name</th>
<th>Folder name</th>
<th>Version</th>
<th>Update checking</th>
<th>Visible</th>
<th>Sharing</th>
<th>Status</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>SplunkForwarder</td>
<td>SplunkForwarder</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>App</td>
<td>Disabled</td>
<td>Enable</td>
</tr>
<tr>
<td>SplunkLightForwarder</td>
<td>SplunkLightForwarder</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>App</td>
<td>Disabled</td>
<td>Enable</td>
</tr>
<tr>
<td>ML Toolkit and Showcase</td>
<td>Splunk_ML_Toolkit</td>
<td>1.2</td>
<td>Yes</td>
<td>Yes</td>
<td>App</td>
<td>Enabled</td>
<td>Disable</td>
</tr>
<tr>
<td>Python for Scientific Computing</td>
<td>Splunk_SA_Scientific_Python_darwin_x86_64</td>
<td>1.2</td>
<td>Yes</td>
<td>No</td>
<td>App</td>
<td>Permissions Enabled Disable Edit properties</td>
<td></td>
</tr>
<tr>
<td>Log Event Alert Action</td>
<td>alert_logevent</td>
<td>6.4.1</td>
<td>Yes</td>
<td>No</td>
<td>App</td>
<td>Enabled</td>
<td>Disable</td>
</tr>
<tr>
<td>Webhook Alert Action</td>
<td>alert_webhook</td>
<td>6.4.1</td>
<td>Yes</td>
<td>No</td>
<td>App</td>
<td>Enabled</td>
<td>Disable</td>
</tr>
</tbody>
</table>
Deploy the Python SDK in the `bin` directory

```bash
cd $SPLUNK_HOME/etc/apps/MyNewApp/bin

pip install -t . splunk-sdk
```
import sys
from splunklib.searchcommands import dispatch, StreamingCommand, Configuration

@Configuration()
class FoobarCommand(StreamingCommand):
    def stream(self, records):
        for record in records:
            record['foo'] = 'bar'
            yield record

if __name__ == '__main__':
    dispatch(FoobarCommand, sys.argv, sys.stdin, sys.stdout, __name__)

$SPLUNK_HOME/etc/apps/MyNewApp/bin/foobar.py
Register your command in `commands.conf`

```
$SPLUNK_HOME/etc/apps/MyNewApp/default/commands.conf
[foobar]
chunked=true
# filename=foobar.py    ## optional
```
Restart Splunk Enterprise

$SPLUNK_HOME/bin/splunk restart
Export to other apps (optional)

<table>
<thead>
<tr>
<th>Name</th>
<th>Folder name</th>
<th>Version</th>
<th>Update checking</th>
<th>Visible</th>
<th>Sharing</th>
<th>Status</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>SplunkForwarder</td>
<td>SplunkForwarder</td>
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<tr>
<td>SplunkLightForwarder</td>
<td>SplunkLightForwarder</td>
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<tr>
<td>ML Toolkit and Showcase</td>
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<td>No</td>
<td>App</td>
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<td>Log Event Alert Action</td>
<td>alert_logevent</td>
<td>6.4.1</td>
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<td>Permissions</td>
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<td>App</td>
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<td>custom_search_example</td>
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<td>App</td>
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<td>App</td>
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<td>Getting started</td>
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<td>Yes</td>
<td>App</td>
<td>Permissions</td>
<td>Enabled</td>
</tr>
<tr>
<td>introspection_generator_addon</td>
<td>introspection_generator_addon</td>
<td>6.4.1</td>
<td>Yes</td>
<td>No</td>
<td>App</td>
<td>Permissions</td>
<td>Enabled</td>
</tr>
</tbody>
</table>
Export to other apps (optional)

<table>
<thead>
<tr>
<th>Name</th>
<th>Config type</th>
<th>Owner</th>
<th>App</th>
<th>Sharing</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>events</td>
<td>commands</td>
<td>No owner</td>
<td>custom_search_example</td>
<td>Global</td>
<td>Permissions</td>
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<td>report</td>
<td>commands</td>
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<td>custom_search_example</td>
<td>Global</td>
<td>Permissions</td>
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<td>Global</td>
<td>Permissions</td>
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<td>custom_search_example</td>
<td>Global</td>
<td>Permissions</td>
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<td>go crazy</td>
<td>commands</td>
<td>No owner</td>
<td>custom_search_example</td>
<td>Global</td>
<td>Permissions</td>
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<td>levenstein</td>
<td>commands</td>
<td>No owner</td>
<td>custom_search_example</td>
<td>Global</td>
<td>Permissions</td>
</tr>
</tbody>
</table>
Export to other apps (optional)
import sys
from splunklib.searchcommands import dispatch, StreamingCommand, Configuration

@Configuration()
class ExStreamCommand(StreamingCommand):
    def stream(self, records):
        for record in records:
            record['foo'] = 'bar'
            yield record

if __name__ == '__main__':
    dispatch(ExStreamCommand, sys.argv, sys.stdin, sys.stdout, __name__)
Example Stateful Streaming Command

```python
import sys
from splunklib.searchcommands import dispatch, StreamingCommand, Configuration

@Configuration(local=True)
class ExStatefulCommand(StreamingCommand):
    def stream(self, records):
        for record in records:
            record['foo'] = 'bar'
            yield record

if __name__ == '__main__':
    dispatch(ExStatefulCommand, sys.argv, sys.stdin, sys.stdout, __name__)
```

$SPLUNK_HOME/etc/apps/MyNewApp/bin/exstateful.py
import sys
from splunklib.searchcommands import dispatch, EventingCommand, Configuration

@Configuration()
class ExEventsCommand(EventingCommand):
    def transform(self, records):
        l = list(records)
        l.sort(key=lambda r: r['_raw'])
        return l

if __name__ == '__main__':
    dispatch(ExEventsCommand, sys.argv, sys.stdin, sys.stdout, __name__)
import sys
from splunklib.searchcommands import dispatch, ReportingCommand, Configuration

@Configuration()
class ExReportCommand(ReportingCommand):
    @Configuration()
    def map(self, records):
        return records

    def reduce(self, records):
        count = 0
        for r in records:
            count += 1
        return [{'count': count}]

if __name__ == '__main__':
    dispatch(ExReportCommand, sys.argv, sys.stdin, sys.stdout, __name__)
A little advice

- Custom commands are **programs** that run on Splunk instances
  - **BEWARE UNVALIDATED INPUT!**
  - Sanitize user arguments AND search results

- Use role-based access control to restrict access

- Be prepared to handle 1,000,000s of events

- Be excellent to each other.
What Now?

- [https://github.com/splunk/splunk-sdk-python](https://github.com/splunk/splunk-sdk-python)
  - [https://github.com/splunk/splunk-sdk-python/tree/master/examples/searchcommands_app](https://github.com/splunk/splunk-sdk-python/tree/master/examples/searchcommands_app)
- Dev Portal Documentation
  - [http://dev.splunk.com/view/python-sdk/SP-CAAAEU2](http://dev.splunk.com/view/python-sdk/SP-CAAAEU2)
- Detailed specification for Protocol Version 2 available by request
- PM Contact: Mark Groves <mgroves@splunk.com>
THANK YOU
Streaming Commands only serialize required fields

```json
{“required_fields”: [“fieldX”], …}
```

Internal result set

<table>
<thead>
<tr>
<th>_raw, _time, _cd, _indextime, ..., fieldX</th>
</tr>
</thead>
<tbody>
<tr>
<td>a,1400000000,x:y,1400000010,...,BOB</td>
</tr>
<tr>
<td>a,1400000001,x:y,1400000011,...,JIM</td>
</tr>
<tr>
<td>a,1400000002,x:y,1400000012,...,BOB</td>
</tr>
<tr>
<td>a,1400000003,x:y,1400000013,...,JIM</td>
</tr>
<tr>
<td>a,1400000004,x:y,1400000014,...,JIM</td>
</tr>
<tr>
<td>a,1400000005,x:y,1400000015,...,BOB</td>
</tr>
<tr>
<td>a,1400000006,x:y,1400000016,...,JIM</td>
</tr>
<tr>
<td>a,1400000007,x:y,1400000017,...,BOB</td>
</tr>
<tr>
<td>a,1400000008,x:y,1400000018,...,BOB</td>
</tr>
<tr>
<td>a,1400000009,x:y,1400000019,...,JIM</td>
</tr>
</tbody>
</table>

External result set

<table>
<thead>
<tr>
<th>_chunked_idx, fieldX</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,BOB</td>
</tr>
<tr>
<td>1,JIM</td>
</tr>
<tr>
<td>2,BOB</td>
</tr>
<tr>
<td>3,JIM</td>
</tr>
<tr>
<td>4,JIM</td>
</tr>
<tr>
<td>5,BOB</td>
</tr>
<tr>
<td>6,JIM</td>
</tr>
<tr>
<td>7,BOB</td>
</tr>
<tr>
<td>8,BOB</td>
</tr>
<tr>
<td>9,JIM</td>
</tr>
</tbody>
</table>
“Right outer-join” on required fields

- Supports
  - Removing events
  - Adding events
  - Editing fields
  - Adding fields
- Can’t re-order events
Performance comparison

2.5 million events

- **Runtime (seconds)**

- **Splunk**
- **Protocol v1**
- **Protocol v2**

- **Echo**
- **Echo (CSV)**
- **Echo (selected)**
- **| where**
"Streaming" command example

... | eval foo="bar" | ...

<table>
<thead>
<tr>
<th>field_A</th>
<th>field_B</th>
<th>field_C</th>
</tr>
</thead>
<tbody>
<tr>
<td>the</td>
<td>jumps</td>
<td>dog</td>
</tr>
<tr>
<td>quick</td>
<td>over</td>
<td>oops</td>
</tr>
<tr>
<td>brown</td>
<td>the</td>
<td>too</td>
</tr>
<tr>
<td>fox</td>
<td>lazy</td>
<td>many</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>field_A</th>
<th>field_B</th>
<th>field_C</th>
<th>foo</th>
</tr>
</thead>
<tbody>
<tr>
<td>the</td>
<td>jumps</td>
<td>dog</td>
<td>bar</td>
</tr>
<tr>
<td>quick</td>
<td>over</td>
<td>oops</td>
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<td>brown</td>
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<td>many</td>
<td>bar</td>
</tr>
</tbody>
</table>