Cyborg Teams

Training Machines to be Contributors

Stef Walter

Red Hat
[We] ate all the low-hanging fruit of modern history ...
— Tyler Cowen
You see the computer age everywhere but in the productivity statistics.

— Robert Solow
"But we use machines!"
Cyborg Teams
A team that is part human, part machine
We speak "machine"!

This is why it's a low hanging fruit
The Proof
Hardware: TAROX Basic 7000BD
Asset Tag: 1437471
Machine ID: a20c82e128524937ad8...
Operating System: Employee SKU
Secure Shell Keys: Show fingerprints
Host Name: Falcon (falcon.the...)
Domain: Join Domain
System Time: 2017-10-17 13:47
Power Options: Restart
Performance Profile: none
Store Performance Data: OFF
<table>
<thead>
<tr>
<th>System</th>
<th>Hardware</th>
<th>TAROX Basic 7000BD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Asset Tag</td>
<td>1437471</td>
</tr>
<tr>
<td></td>
<td>BIOS</td>
<td>American Megatrends Inc. 2001 (06/16/2014)</td>
</tr>
<tr>
<td></td>
<td>Operating System</td>
<td>Fedora 23 (Workstation Edition)</td>
</tr>
<tr>
<td></td>
<td>Host Name</td>
<td>Falcon (falcon.thewalter.lan)</td>
</tr>
<tr>
<td></td>
<td>Domain</td>
<td>Join Domain</td>
</tr>
</tbody>
</table>
### 90+ APIs: File, Command, REST, DBus, Socket

<table>
<thead>
<tr>
<th>API</th>
<th>File, Command, REST, DBus, Socket</th>
</tr>
</thead>
<tbody>
<tr>
<td>abrt</td>
<td>AppStream</td>
</tr>
<tr>
<td>chpasswd</td>
<td>CloudForms</td>
</tr>
<tr>
<td>device-mapper</td>
<td>docker-storage-setup</td>
</tr>
<tr>
<td><code>/etc/kdump.conf</code></td>
<td><code>/etc/passwd</code></td>
</tr>
<tr>
<td>GSSAPI</td>
<td>named</td>
</tr>
<tr>
<td>iptables</td>
<td>iscsi-tools</td>
</tr>
<tr>
<td>krb5</td>
<td>Kubernetes /api/</td>
</tr>
<tr>
<td>lvm</td>
<td>mdadm</td>
</tr>
<tr>
<td>Openshift /oapi/</td>
<td>OpenShift OAuth2</td>
</tr>
<tr>
<td>PackageKit</td>
<td>passwd</td>
</tr>
<tr>
<td><code>/proc/mounts</code></td>
<td><code>/proc/net/dev...</code></td>
</tr>
<tr>
<td>qemu</td>
<td>realmd</td>
</tr>
<tr>
<td>selinux-policy-target...</td>
<td>selinux-utils</td>
</tr>
<tr>
<td>shutdown</td>
<td>sosreport</td>
</tr>
<tr>
<td>ssh</td>
<td>ssd</td>
</tr>
<tr>
<td><code>/sys/fs/cgroup</code></td>
<td><code>/sys/kernel</code></td>
</tr>
<tr>
<td>Tuned</td>
<td>udev</td>
</tr>
<tr>
<td><code>/usr/bin/virt-install</code></td>
<td><code>/var/log/wtmp</code></td>
</tr>
<tr>
<td>xfsprogs</td>
<td>yum</td>
</tr>
</tbody>
</table>

- abrt: Application Break Report Tool
- AppStream: Application Stream
- apt-get: Advanced Package Tool
- atomic: A tool for managing containers
- Candlepin /candlepin/: A package management tool
- CloudForms: A graphical interface for OpenShift
- cryptsetup: Cryptic Setup
- curl: A command-line utility for transferring data in an arbitrary format with HTTP/HTTPS/FTP
- dbus-daemon: A D-Bus daemon for running services
- docker: A container engine
- docker-storage-setup: A tool for setting up Docker storage
- e2fsprogs: Extended-2 Filesystem Progs
- etcd: A distributed key-value store
- FreeIPA: An open source identity and access management solution
- GnuTLS: GNU TLS
- GSSAPI: Generic Security Services Application Programming Interface
- hostnamed: Host Name Daemon
- ipa-client: IPA Client
- iproute: Internet Protocol Suite
- journalctl: Journal Control Tool
- kdump: Kernel dump
- krb5: Kerberos
- Kubernetes /api/: Kubernetes API
- lastlog: Last Log
- libvirt: Virtualization Solution
- loginctl: Login Control Tool
- libvirt: Virtualization Solution
- oddjob: Odd Job
- PackageKit: A package management tool
- passwd: Password Management System
- PCP: Performance and Configuration Monitor
- PolicyKit: Policy Kit
- `/proc/meminfo...`: `/proc/meminfo` includes various memory-related information
- `/proc/stat`: `/proc/stat` includes system statistics
- `/proc/mounts`: `/proc/mounts` includes mount points
- `/proc/net/dev...`: `/proc/net/dev` includes network device statistics
- `/proc/sys/vfs`: `/proc/sys/vfs` includes virtual file system parameters
- `/proc/selinux`: `/proc/selinux` includes SELinux policy information
- `/proc/sys/kernel`: `/proc/sys/kernel` includes system kernel parameters
- `/sys/fs/cgroup`: `/sys/fs/cgroup` includes cgroup parameters
- `/sys/kernel`: `/sys/kernel` includes system kernel information
- `/sys/power`: `/sys/power` includes power management parameters
- `/usr/bin/kubectl`: `/usr/bin/kubectl` includes Kubernetes client
- `/usr/bin/timedatectl`: `/usr/bin/timedatectl` includes system time and date
- `/usr/bin/virt-install`: `/usr/bin/virt-install` includes virtualization tool
- `/var/log/wtmp`: `/var/log/wtmp` includes system log
- `/var/run/utmp`: `/var/run/utmp` includes system log
- `/var/run/utmp`: `/var/run/utmp` includes system log
- virsh: Virtual Machine MONITOR
- who/w: Who/Whoami
- xfsprogs: XFS Filesystem Progs
- yum: Your Universal Manager
### 15+ Linuxes and Products

<table>
<thead>
<tr>
<th>Linux</th>
<th>Version/Build Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>CentOS</td>
<td>(7.x, Atomic)</td>
</tr>
<tr>
<td>Fedora</td>
<td>(25, 26, 27, Atomic)</td>
</tr>
<tr>
<td>Ubuntu</td>
<td>(stable, 16.04)</td>
</tr>
<tr>
<td>RHEL</td>
<td>(7.x, 7.4, Extras, Atomic)</td>
</tr>
<tr>
<td>Debian</td>
<td>(stable, testing)</td>
</tr>
<tr>
<td>Openshift</td>
<td></td>
</tr>
<tr>
<td>RHEV Hypervisor</td>
<td></td>
</tr>
</tbody>
</table>
5+ maintained branches

<table>
<thead>
<tr>
<th>Branch</th>
</tr>
</thead>
<tbody>
<tr>
<td>master</td>
</tr>
<tr>
<td>rhel-7.5</td>
</tr>
<tr>
<td>rhel-7.4</td>
</tr>
<tr>
<td>i386</td>
</tr>
<tr>
<td>ppc64</td>
</tr>
<tr>
<td>3+ browsers</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Google Chrome</td>
</tr>
<tr>
<td>Internet Explorer</td>
</tr>
<tr>
<td>Firefox</td>
</tr>
</tbody>
</table>
Weekly releases
92 × 15 × 5 × 3 × 50
The effort of a solely human team does not scale past a certain complexity point
Cyborg Teams

Machines as team members
Bots own **mundane work**

Pair programming with bots

Humans train the bots

Bots learn from humans

Bots ship Cockpit
Bots own mundane work
Update translations from Fedora Zanata #7906

cockpituous opened this issue just now - 0 comments

cockpituous commented just now

Update translations from Fedora Zanata

- po-refresh

cockpituous added the bat label just now
WIP: cockpit-tasks-jrsf1: Update translations from Fedora Zanata #7906

cockpituos commented just now

Update translations from Fedora Zanata

cockpituos added the bot label just now
$ make po/cockpit.pot
$ make upload-pot
$ make download-po
$ git add po/
$ git checkout -b po-refresh-xxx
$ git commit -m "po: Update from Fedora Zanata"
$ git push cockpitous po-refresh-xxx
Update translations from Fedora Zanata #7906

cockpituous commented 31 seconds ago • edited

Update translations from Fedora Zanata

- po-refresh

cockpituous added the bot label 4 minutes ago

cockpituous commented 3 minutes ago

po-refresh in progress on cockpit-tasks-jsf1.
Log: http://fedorapeople.org/groups/cockpit/logs/po-refresh-7906-20171018-192929/

cockpituous changed the title from Update translations from Fedora Zanata to WIP: cockpit-tasks-jsf1: Update translations from Fedora Zanata 3 minutes ago

cockpituous commented 31 seconds ago

Some checks haven't completed yet
17 pending checks

- avocado/fedora-25 — Testing in progress [veritymachine5]
- container/kubornelos — Not yet tested
- selenium/chrome — Testing in progress [cockpit-tasks-bof770]
- selenium/explorer — Testing in progress [cockpit-tasks-x2zt2]
- selenium/firefox — Testing in progress [cockpit-tasks-js1f1]
- semaphorecl — The build is pending on Semaphore.
- verify/centos-7 — Testing in progress [cockpit-tasks-c881x]
- verify/debian-stable — Not yet tested
- verify/debian-testing — Testing in progress [cockpit-tasks-3991c]
- verify/fedora-27 — Testing in progress [cockpit-tasks-b6f6gb]
- verify/fedora-atomic — Testing in progress [cockpit-tasks-f195f]
- verify/fedora-1386 — Testing in progress [cockpit-tasks-431nk]
- verify/rhel-7 — Testing in progress [cockpit-tasks-qzn35]
- verify/rhel-7-4 — Testing in progress [cockpit-tasks-jsg6c]
- verify/rhel-atomic — Testing in progress [cockpit-tasks-wx977]
- verify/ubuntu-1604 — Testing in progress [cockpit-tasks-x14pv]
- verify/ubuntu-stable — Testing in progress [cockpit-tasks-1m11b]
$ zcat tests-train-1.jsonl.gz | wc
  867590  67669917 1317326557
$ zgrep -f ""failure"" tests-train-1.jsonl.gz | wc
  12407  2142463  86009034
Pair programming with bots
Humans train the bots
$ git shortlog --summary -- bots/ test/
Marius Vollmer
Dominik Perpeet
Peter Volpe
Stef Walter
Martin Pitt
Jan Scotka
Lars Karlitski
Subin M
Marek Libra
Andreas Nilsson
Matej Marusak
Stephen Gallagher
...

Bots learn from humans
testSuper (check_reauthorize, TestReauthorize) # duration: 25s

```
# testSuper (check_reauthorize, TestReauthorize)
#
# truncate() failed: Permission denied

DevTools listening on ws://127.0.0.1:9032/devtools/browser/28132904-84a8-492a-bda1-0705995e814
[0123/152927.520842:ERROR:zygote_host_impl_l1inux.cc[260]] Failed to adjust OOM score of renderer with pid 123004: Permission denied (13)
[0123/152928.864472:ERROR:zygote_host_impl_l1inux.cc[260]] Failed to adjust OOM score of renderer with pid 123081: Permission denied (13)
> log: done
> log: fail
Traceback (most recent call last):
  File "/build/cockpit/bots/.../test/verify/check-reauthorize", line 84, in testSuper
    self.assertEqual(b.text("<super-channel span"), 'result: access-denied')
AssertionError: u'result: disconnected' != 'result: access-denied'

not ok 85 testSuper (check_reauthorize, TestReauthorize) # duration: 25s
Wrote screenshot to TestReauthorize-testSuper-fedora-1386-127.0.0.2-2001-FAIL.png
Wrote HTML dump to TestReauthorize-testSuper-fedora-1386-127.0.0.2-2001-FAIL.html
Wrote JS log to TestReauthorize-testSuper-fedora-1386-127.0.0.2-2001-FAIL.js.log
Journal extracted to TestReauthorize-testSuper-fedora-1386-127.0.0.2-2001-FAIL.log
```

# Flake probability: 72.5% (neural network)
# Flake likely 66.2% (clustering)
Bots ship Cockpit
Human signs a tag in git
Bots scurry about

- Make **tarballs and patches**
- Update RPM spec files and Debian control files
- **Release** preview builds
- Update and push **Fedora** packages
- Upload packages into **Ubuntu**
- Upload packages into **Debian**
- Upload **tarballs**
- Container rebuilds on **Docker Hub**
- Online documentation update
Bots as committers
$ git shortlog -ns | head -n10 | cut -c8-30 | nl | grep Cockpit
 4  Cockpituous
Team stops without bots
Behavior is driven by two forces

1. Driving forces
   Push you in a specific direction

2. Restraining forces
   Prevent you from going there
First: Diminish restraining forces  
Second: Increase the driving forces  
— Kurt Lewin
So why don't we see Cyborg Teams everywhere?
Laws of Cyborg Teams

1. Teaching a machine must be as easy as teaching a human.
2. Machines must produce feedback into the team's workflow.
3. A human should be able to impersonate a machine, and...
Tests: The Soul of a Robot

Teaching machines right and wrong, good and evil
Techniques
Don't assume bots can't
Don't rework process (yet)
Containerize your bots, yo!
Organic and distributed bots
Self-validating and self-aware bots
Don't assume bots can't
Don't rework process (yet)
Containerize your bots, yo!
Testing containers in Virtual Machines in container bots running on virtual machines on turtles
Organic and distributed bots
Cockpit Task Bots

Task system is distributed with GitHub as the single point of failure

Every pull request is booted 100's of times in Atomic, Debian, Fedora, RHEL, before it hits master.

Containers that start 1,000 - 10,000 test VMs a day

These containers can run anywhere
Post logs, attachments and publicly

fedorapeople.org
Log Sink

Other Host
Log Sink

GitHub
Rest API
Web App

Bot Container
Cockpit git checkout

Bot Container
Cockpit git checkout

OS VM when testing
Cockpit git checkout

Bot Container
GitHub
Bots share state

- fedorapeople.org
  - Log Sink

- Other Host
  - Log Sink

- GitHub
  - Rest API
  - Web App

Bot Container
  - Cockpit git checkout
  - OS VM when testing
  - DNS/SDNS update
Collision avoidance and detection
# Scan for all tests
bots/tests-scan

# File issues for these tasks
bots/po-trigger
bots/image-trigger
bots/npm-trigger
bots/naughty-trigger

# Any tasks related to issues
bots/issue-scan
PRIORITY=0009 bots/image-refresh --issue='7950' debian-testing
PRIORITY=0009 bots/image-refresh --issue='7949' rhel-7-4
PRIORITY=0009 bots/image-refresh --issue='7948' ubuntu-1604

PRIORITY=0006 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d4'
PRIORITY=0006 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d4'
PRIORITY=0006 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d4'
PRIORITY=0006 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d4'
PRIORITY=0005 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d4'
PRIORITY=0000 touch /tmp/cockpit-image-prune.stamp && bots/image-prune
...

GEN  dist/ostree/Makefile.deps
GEN  dist/networkmanager/Makefile.deps
GEN  dist/machines/Makefile.deps
GEN  dist/kubernetes/Makefile.deps
GEN  dist/kdump/Makefile.deps
GEN  dist/docker/Makefile.deps
GEN  dist/dashboard/Makefile.deps
GEN  dist/apps/Makefile.deps

Expecting "WIP: cockpit-tasks-3991c: Update translations from Fedora Zanata"
State not as expected. Possible collision. Aborting.
Self-validating self-aware bots
Make your bots try out changes to the bots
kvm = os.access("/dev/kvm", os.R_OK | os.W_OK)

try:
    urllib.urlopen(REDHAT_PING).read()
    redhat = os.path.exists(os.path.expanduser(REDHAT_CREDS))
except IOError:
    redhat = False
Machine learning: Test flakes are food
Flakes are just fuzzing mutations
ML techniques in use

- Term Frequency - Inverse Document Frequency
- Normalized Compression Distance
- DBSCAN unsupervised clustering
- K-nearest Neighbors classification
testSuper (check_reauthorize.TestReauthorize) # duration: 255s  screenshot  journal

# testSuper (check_reauthorize.TestReauthorize)
# truncate() failed: Permission denied

DevTools listening on ws://127.0.0.1:9032/devtools/browser/28132094-84e8-492a-bdal-07659595e014
[0123/152927.020842:ERROR:zygote_host_impl lineman.cc(266)] Failed to adjust OOM score of renderer with pid 123456: Permission denied (13)
[0123/152927.064472:ERROR:zygote_host_impl lineman.cc(266)] Failed to adjust OOM score of renderer with pid 123456: Permission denied (13)
> log: done
> log: fail
Traceback (most recent call last):
  File "/build/cockpit/bots/..test/verify/check-reauthorize", line 84, in testSuper
    self.assertEqual(b.text(".super-channel span"), 'result: access-denied')
AssertionError: u'result: disconnected' != 'result: access-denied'

not ok testSuper (check_reauthorize.TestReauthorize) # duration: 255s
Wrote screenshot to TestReauthorize-testSuper-fedora-1386-127.0.0.2-2001-FAIL.png
Wrote HTML dump to TestReauthorize-testSuper-fedora-1386-127.0.0.2-2001-FAIL.html
Wrote JS log to TestReauthorize-testSuper-fedora-1386-127.0.0.2-2001-FAIL.js.log
Journal extracted to TestReauthorize-testSuper-fedora-1386-127.0.0.2-2001-FAIL.log

# Flake probability: 72.5% (neural network)
# Flake likely 66.2% (clustering)
Term Frequency - Inverse Document Frequency

# testTeam (check_networking_team.TestNetworking)
#
<table>
<thead>
<tr>
<th>NAME</th>
<th>UUID</th>
<th>TYPE</th>
<th>DEVICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>System eth0</td>
<td>5fb06bd0-0bb0-7ffb-45f1-d6edd65f3e03</td>
<td>802-3-ethernet</td>
<td>eth0</td>
</tr>
<tr>
<td>virbr0</td>
<td>8240fafa-cb6b-4f4c-8eb6-65f1a2ff8da</td>
<td>bridge</td>
<td>virbr0</td>
</tr>
<tr>
<td>System eth1</td>
<td>9c92fad9-6ecb-3e6c-eb4d-8a47c6f50c04</td>
<td>802-3-ethernet</td>
<td>--</td>
</tr>
</tbody>
</table>

52:54:01:00:00:03 -> eth2
52:54:01:00:00:03 -> eth2
52:54:01:00:00:04 -> eth3
52:54:01:00:00:04 -> eth3

not ok 139 testTeam (check_networking_team.TestNetworking) duration: 106s
Traceback (most recent call last):
  File "/build/cockpit/bots/../test/verify/check-networking-team", line 81
    b.waitpresent("#network-interface-slaves tr[data-interface='%s']" % iface00

# testTeam (check_networking_team.TestNetworking)
#
<table>
<thead>
<tr>
<th>NAME</th>
<th>UUID</th>
<th>TYPE</th>
<th>DEVICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>System eth000</td>
<td>000f000bd000-000bb000-000ff000-d000edd000f000e000</td>
<td>000</td>
<td>000</td>
</tr>
<tr>
<td>virbr000</td>
<td>000f000bd000-000bb000-000ff000-d000edd000f000e000</td>
<td>000</td>
<td></td>
</tr>
<tr>
<td>System eth000</td>
<td>000c000fad000-000ecb-000e000c-eb000d-000a000c-000f000c000</td>
<td>bridge</td>
<td>000</td>
</tr>
<tr>
<td>System eth000</td>
<td>000c000fad000-000ecb-000e000c-eb000d-000a000c-000f000c000</td>
<td>bridge</td>
<td>000</td>
</tr>
</tbody>
</table>

File "check-networking-team", line 000, in testTeam
b.waitpresent("#network-interface-slaves tr[data-interface='%s']" % iface00
Normalized Compression Distance

\[ NCD_Z(x, y) = \frac{Z(xy) - \min\{Z(x), Z(y)\}}{\max\{Z(x), Z(y)\}}. \]

\( Z = \text{lambda } v: \text{len(zlib.compress(v))} \)
DBSCAN
Density-based spatial clustering of applications with noise
k-nearest neighbor
I want!
$ bots/image-download --state tests-learn-1.gz
...
$ bots/learn-tests --dry
Loading existing tests data
14208: Items to train
...
100933632: Computed distances in 1181 seconds on 32 cores
332: Clusters (13962 items, 246 noise)

$ cat example-test.log | bots/tests-policy fedora-27
...
...
# Flake probability: 100.0% (neural network)
# Flake likely 58.6% (clustering)
SHUT UP AND TAKE MY MONEY!
Add tests to my Fedora/RHEL package

fedoraproject.org/wiki/CI/Tests
Run simple tests on GitHub pull requests

Add `.travis.yml` and use Travis CI
Run a full userland for integration tests

Semaphore CI and example

github.com/cockpit-project/cockpituous
Run my CI in Openshift

Contact CentOS CI for an account
Copy pipelines built in Openshift/Jenkins

Continuous Infra team at Red Hat, speaking at DevConf
Run VMs in Openshift for testing

Look at how Linux System Roles did it really simply
Basic bots for delivery, dist-git, Bodhi, Koji

Look at cockpit/release container
Try out Machine Learning

Use scikit-learn
Cyborg Teams

Happy humans, tired machines
Questions?

cockpit-project.org
#cockpit on FreeNode

Credits:
Machines: tt2times on Flickr
Pear Programming: mendhak on Flickr
Shut up and Take my Money: liliana_von_k on Flickr
Clusters: Chire on Wikipedia