

Cyborg Teams

**Training Machines to be
Contributors**

Stef Walter

Red Hat



**[We] ate all the low-hanging fruit
of modern history ...**

— Tyler Cowen

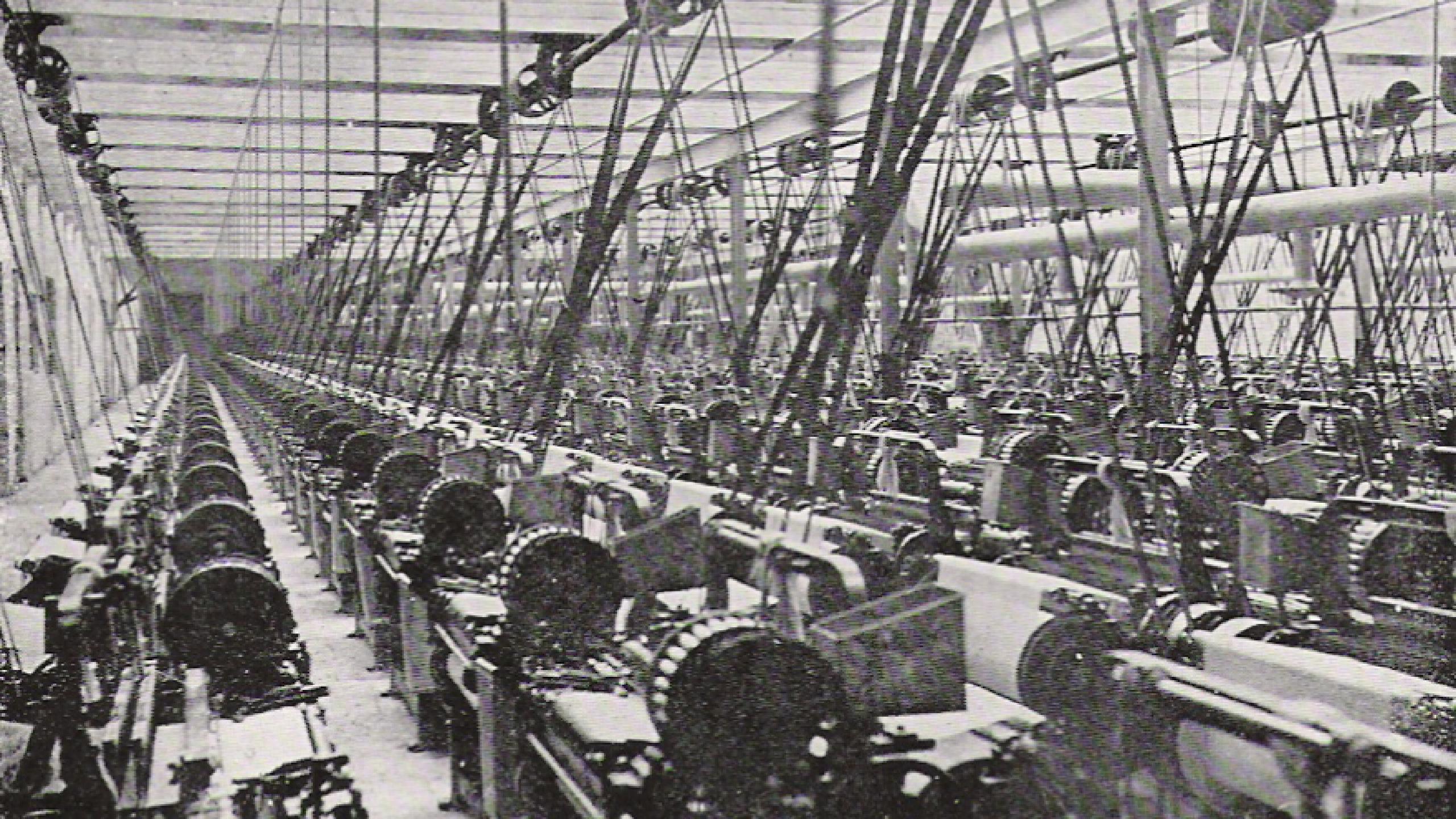
Y O U R W A L L P A P E R V . C O M

MACHINES!

**You see the computer age everywhere
but in the productivity statistics.**

— Robert Solow

"But we use machines!"

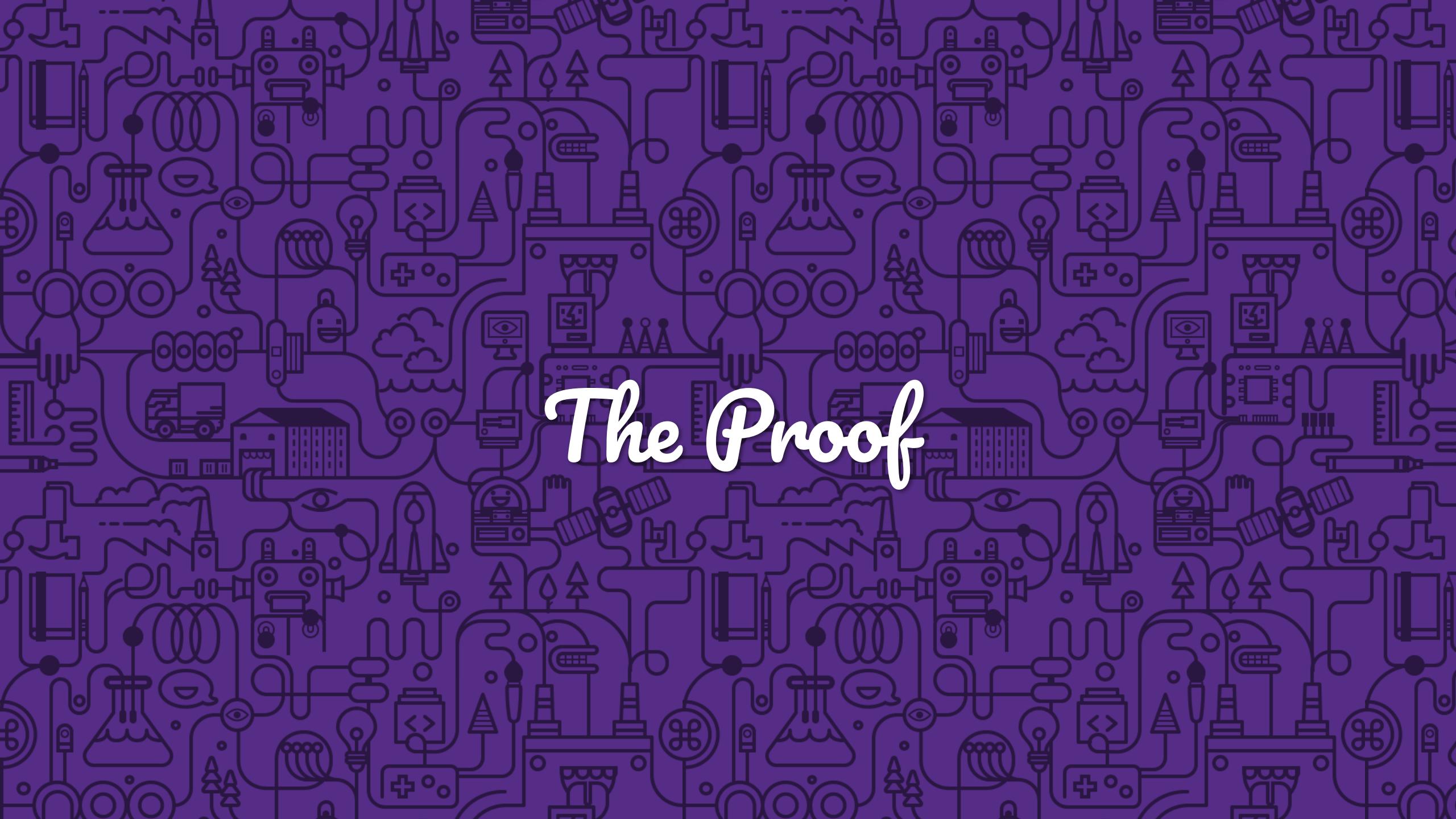


Cyborg Teams

A team that is part human, part machine

We speak "machine"!

This is why its a low hanging fruit



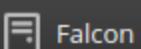
The Proof



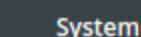
RED HAT ENTERPRISE LINUX SERVER

Unlocked

Stef



Falcon



System

Logs

Storage

Networking

Containers

oVirt Machines

Accounts

Services

Applications

Diagnostic Reports

Kernel Dump

SELinux

Software Updates

Subscriptions

Terminal

Dashboard

Cluster

Image Registry

Hardware TAROX Basic 7000BD

Asset Tag 1437471

Machine ID a20c82e128524937ad8...

Operating System Employee SKU

Secure Shell Keys [Show fingerprints](#)

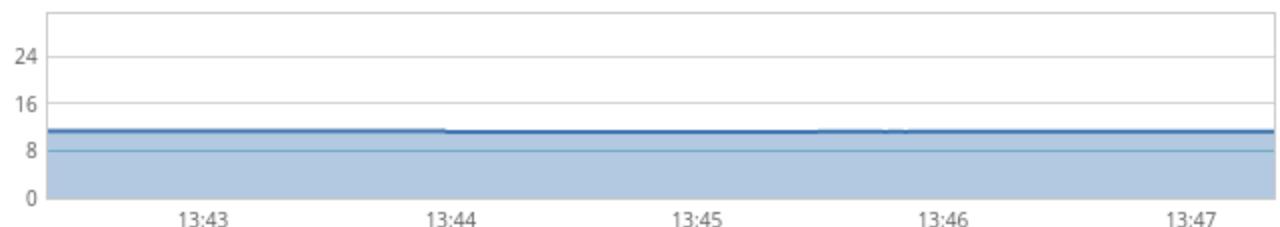
Host Name Falcon (falcon.thewalter...

Domain [Join Domain](#)System Time 2017-10-17 13:47 [i](#)Power Options [Restart](#) ▾Performance Profile none [i](#)Store Performance Data [OFF](#)

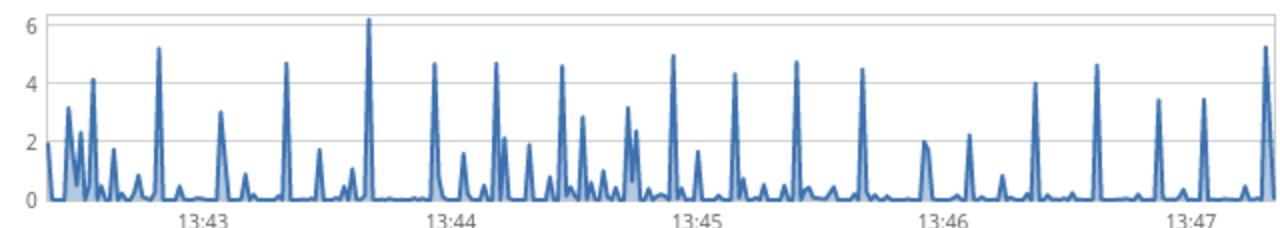
% CPU



GiB Memory



MiB/s Disk I/O



Mbps Network Traffic



RED HAT ENTERPRISE LINUX SERVER

Unlocked

Stef

Falcon

Dashboard

Cluster

Image Registry

Overview

Nodes

Containers

Topology

Details

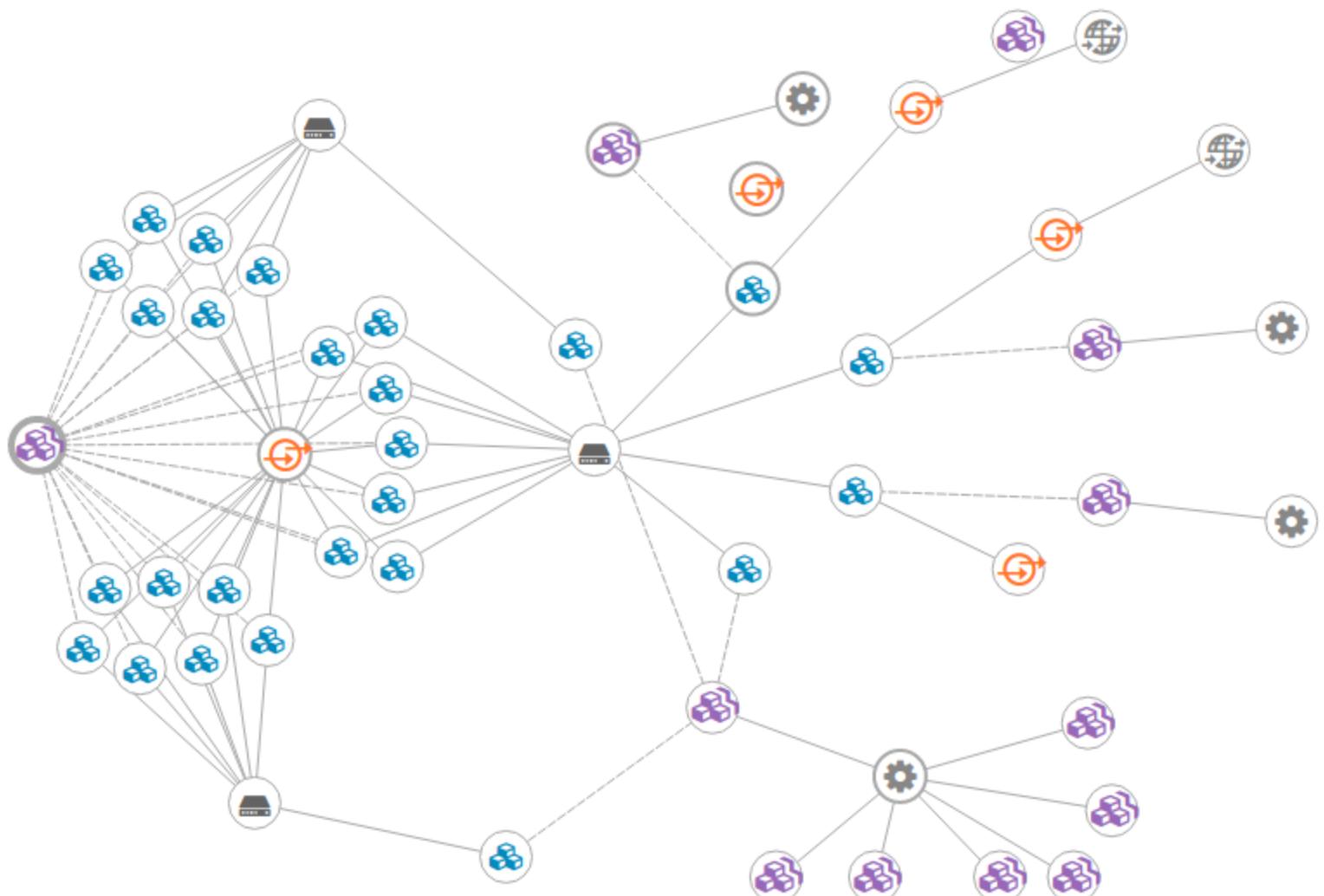
Volumes

Images

Projects

All Projects

▼



ReplicationController

Name	cockpit-tasks
Namespace	verify
Created	Sep 20, 2017 10:42:49 AM
Replicas	20

Selector

infra	cockpit-tasks
-------	---------------

Pod Template

Restart policy	Always
DNS policy	ClusterFirst
Service account	cockpituous

Containers

Name	cockpit-tasks
Image	docker.io/cockpit/tests
Ports	none
Env vars	TEST_JOBS=8 TEST_PUBLISH=sink

Name	cockpit-images
Image	docker.io/cockpit/images
Ports	80/TCP

FEDORA SERVER



System

Services

Containers

Logs

Storage

Networking

Hardware TAROX Basic 7000BD

Asset Tag 1437471

BIOS American Megatrends Inc. 2001 (06/16/2014)

Operating System Fedora 23 (Workstation Edition)

Host Name Falcon (falcon.thewalter.lan)

Domain [Join Domain](#)



Elements

Console

Sources

Network

Timeline

Profiles

Resources



<top frame>



Preserve log



FEDORA SERVER



System

Services

Containers

Logs

Storage

Networking

Hardware TAROX Basic 7000BD

Asset Tag 1437471

BIOS American Megatrends Inc. 2001 (06/16/2014)

Operating System Fedora 23 (Workstation Edition)

Host Name Falcon (falcon.thewalter.lan)

Domain [Join Domain](#)



Elements

Console

Sources

Network

Timeline

Profiles

Resources



<top frame>



Preserve log





90+ APIs: File, Command, REST, DBus, Socket

abrt	AppStream	apt-get	atomic	Candlepin /candlepin/
chpasswd	CloudForms	cryptsetup	curl	dbus-daemon
device-mapper	docker-storage-setup	docker	e2fsprogs	etcd
/etc/kdump.conf	/etc/passwd	firewalld	FreeIPA	GnuTLS
GSSAPI	hostnamed	ipa-client	ipa-client	iproute
iptables	iscsi-tools	journalctl	kdump	klist
krb5	Kubernetes /api/	lastlog	libvirt	loginctl
lvm	mdadm	NetworkManager	NetworkManager-te...	oddjob
Openshift /oapi/	Openshift OAuth2	openssl	ostree	oVirt /api/
PackageKit	passwd	PCP	PolicyKit	/proc/meminfo...
/proc/mounts	/proc/net/dev...	procps-ng	/proc/stat	pwquality
qemu	realmd	rm ...	rpmostreed	rpm
selinux-policy-target...	selinux-utils	setenforce	Setroubleshootd	shadow-utils
shutdown	sosreport	ssh-agent	sshd	ssh-keygen
ssh	sssd	storaged	subscription-manager	sudo
/sys/fs/cgroup	/sys/kernel	/sys/power	systemd	timedated
Tuned	udev	UDisks2	/usr/bin/kubectl	/usr/bin/timedatectl
/usr/bin/virt-install	/var/log/wtmp	/var/run/utmp	virsh	who/w
xfsprogs	yum			

15+ Linuxes and Products

CentOS (7.x, Atomic)

Fedora (25, 26, 27, Atomic)

Ubuntu (stable, 16.04)

RHEL (7.x, 7.4, Extras, Atomic)

Debian (stable, testing)

Openshift

RHEV Hypervisor

5+ maintained branches

master

rhel-7.5

rhel-7.4

i386

ppc64

3+ browsers

Google Chrome

Internet Explorer

Firefox



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**

Code Issues Pull requests Projects Wiki Insights Settings

Update translations from Fedora Zanata #7906

Open cockpituous opened this issue just now · 0 comments

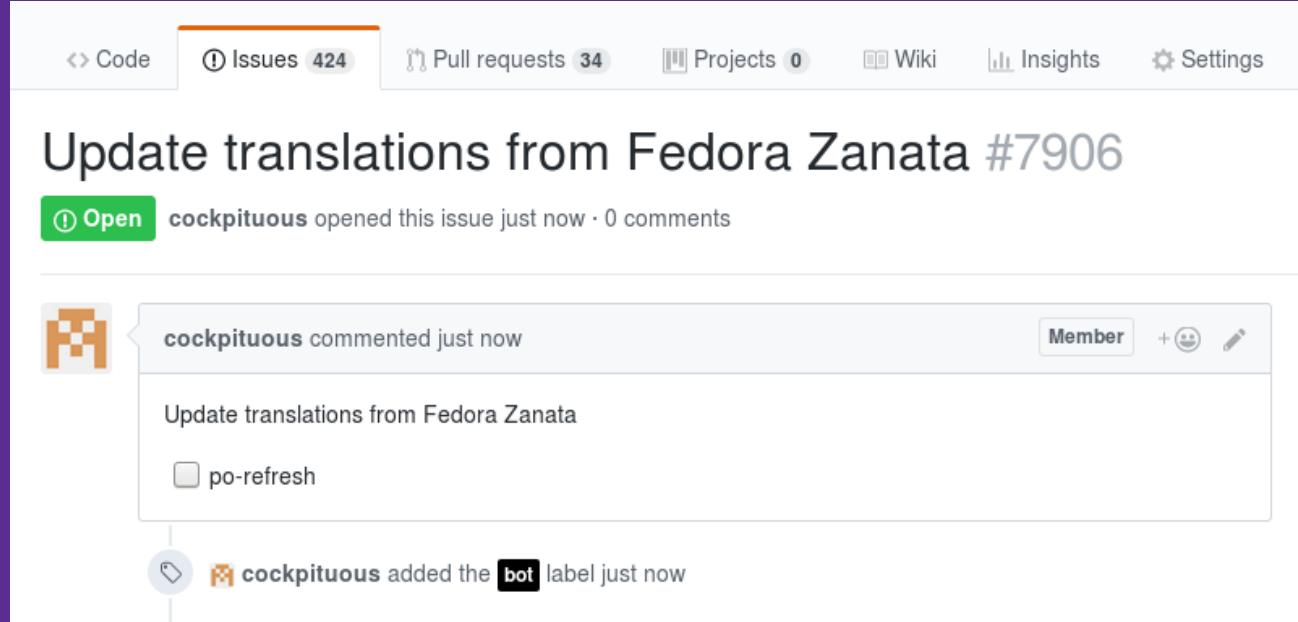
 cockpituous commented just now

Member + 😊 🖊

Update translations from Fedora Zanata

po-refresh

 cockpituous added the **bot** label just now



WIP: cockpit-tasks-jrsf1: Update translations from Fedora Zanata #7906

 Open **cockpituous** opened this issue 44 seconds ago · 1 comment



cockpituous commented just now

Member



Update translations from Fedora Zanata

po-refresh

  **cockpituous** 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
```

< Code Issues Pull requests Projects Wiki Insights Settings

Update translations from Fedora Zanata #7906

Open cockpituous wants to merge 1 commit into `cockpit-project:master` from `cockpituous:po-refresh-20171018`

Conversation 2 Commits 1 Files changed 19

 **cockpituous** commented 31 seconds ago • edited Member + 

Update translations from Fedora Zanata

po-refresh

  **cockpituous** added the `bot` label 4 minutes ago

 **cockpituous** commented 3 minutes ago Member +  

po-refresh in progress on cockpit-tasks-jrsf1.
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-jrsf1: Update translations from Fedora Zanata** 3 minutes ago

 **cockpituous** commented 31 seconds ago Member +  

po-refresh done: <https://github.com/cockpituous/cockpit/commits/po-refresh-20171018-193232>



Some checks haven't completed yet

17 pending checks

[Hide all checks](#)

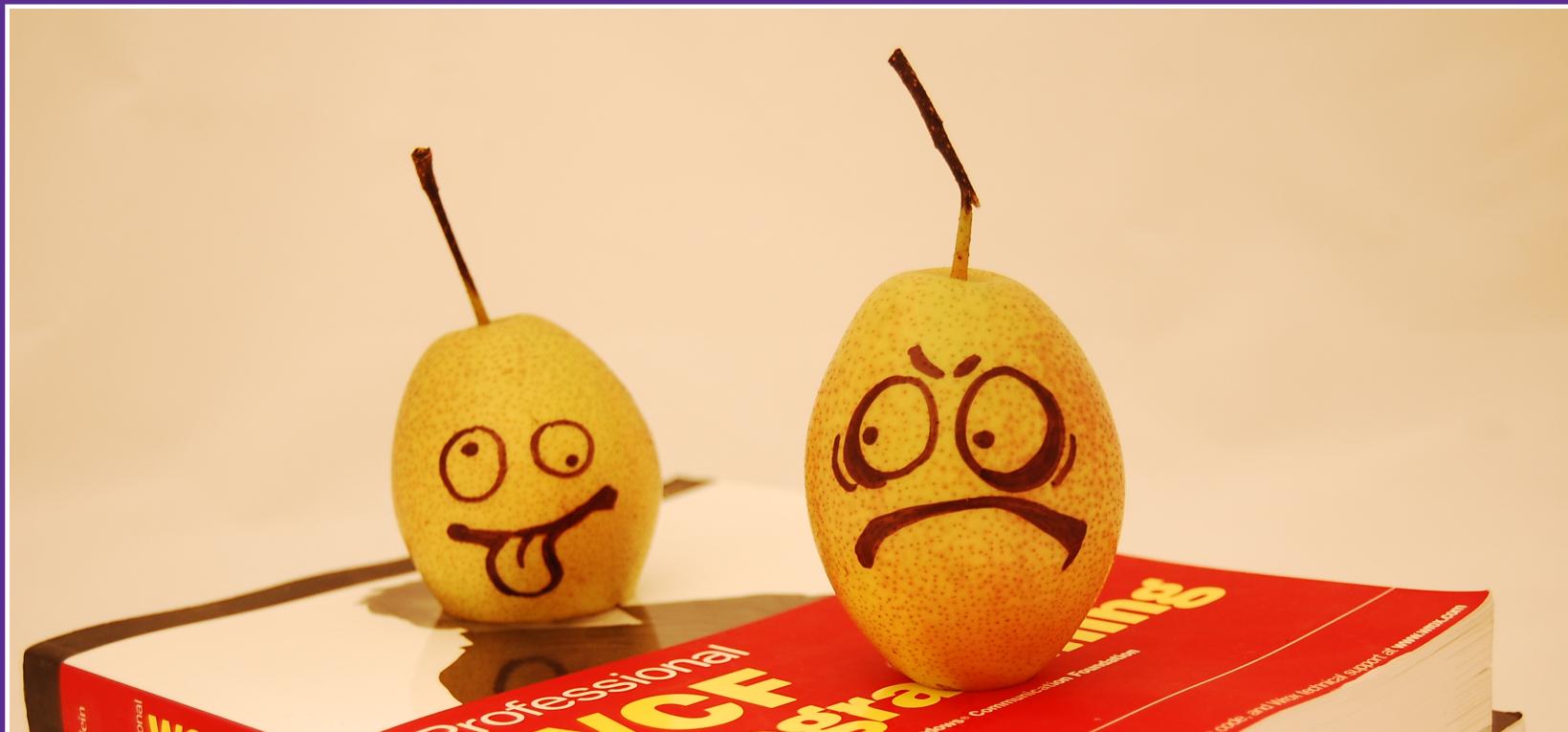
- **avocado/fedora-25** — Testing in progress [verifymachine5] [Details](#)
- **container/kubernetes** — Not yet tested
- **selenium/chrome** — Testing in progress [cockpit-tasks-bcf7n] [Details](#)
- **selenium/explorer** — Testing in progress [cockpit-tasks-x2zt2] [Details](#)
- **selenium/firefox** — Testing in progress [cockpit-tasks-jrsf1] [Details](#)
- **semaphoreci** — The build is pending on Semaphore. [Details](#)
- **verify/centos-7** — Testing in progress [cockpit-tasks-c861x] [Details](#)
- **verify/debian-stable** — Not yet tested
- **verify/debian-testing** — Testing in progress [cockpit-tasks-3991c] [Details](#)
- **verify/fedora-27** — Testing in progress [cockpit-tasks-bq6gb] [Details](#)
- **verify/fedora-atomic** — Testing in progress [cockpit-tasks-flr95] [Details](#)
- **verify/fedora-i386** — Testing in progress [cockpit-tasks-4sfnk] [Details](#)
- **verify/rhel-7** — Testing in progress [cockpit-tasks-qzh35] [Details](#)
- **verify/rhel-7-4** — Testing in progress [cockpit-tasks-jsngc] [Details](#)
- **verify/rhel-atomic** — Testing in progress [cockpit-tasks-wx97l] [Details](#)
- **verify/ubuntu-1604** — Testing in progress [cockpit-tasks-xh4pv] [Details](#)
- **verify/ubuntu-stable** — Testing in progress [cockpit-tasks-lm1b] [Details](#)



```
$ zcat tests-train-1.jsonl.gz | wc  
867590 67669917 1317326557  
$ zgrep -f '"failure"' tests-train-1.jsonl.gz | wc  
12407 2142463 86009034
```

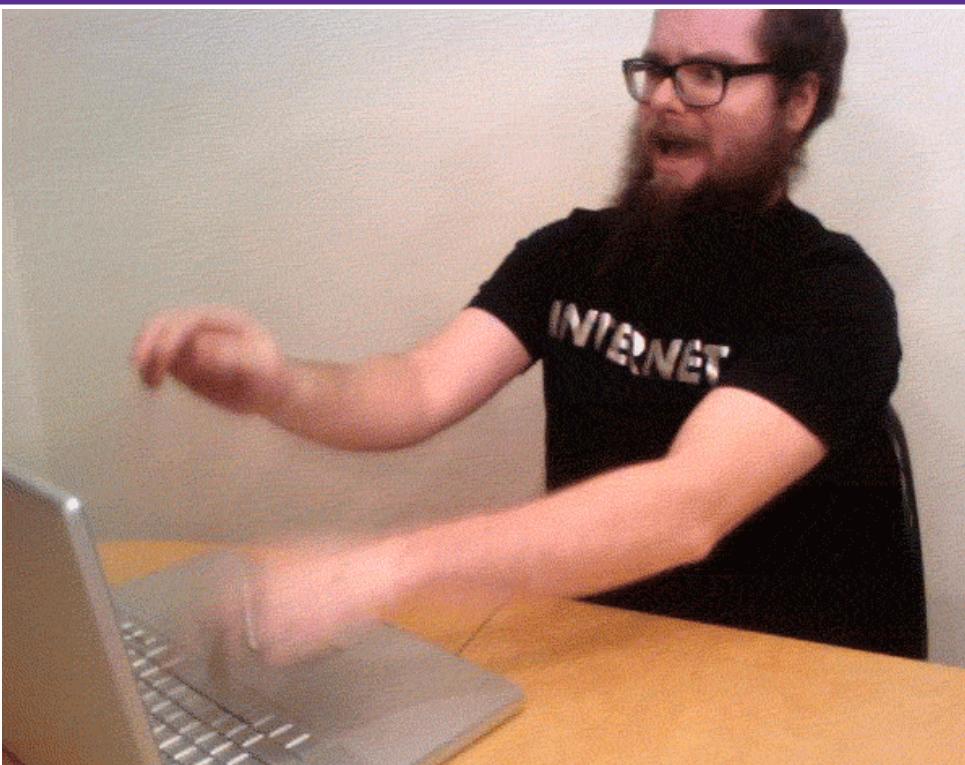


Pair programming with bots





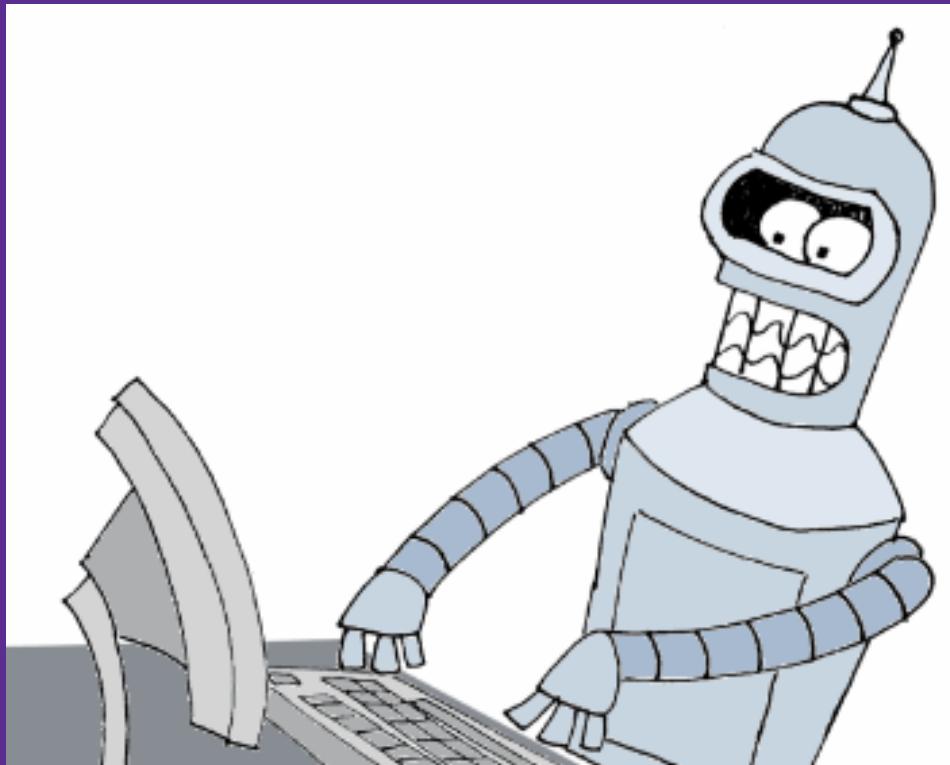
Humans train the bots



```
$ 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



❗ 85: testSuper (check_reauthorize.TestReauthorize) # duration: 25s 📸 screenshot 📄 journal

```
# testSuper (check_reauthorize.TestReauthorize)
#
ftruncate() failed: Permission denied

DevTools listening on ws://127.0.0.1:9832/devtools/browser/28132994-84e8-492a-bda1-07059595e814
[0123/152927.820842:ERROR:zygote_host_impl_linux.cc(268)] Failed to adjust OOM score of renderer with pid 123004: Permission denied (13)
[0123/152928.864472:ERROR:zygote_host_impl_linux.cc(268)] 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-i386-127.0.0.2-2601-FAIL.png
Wrote HTML dump to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.html
Wrote JS log to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.js.log
Journal extracted to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.log

# Flake probability: 72.5% (neural network)

# Flake likely 66.2% (clustering)
```



Bots ship Cockpit

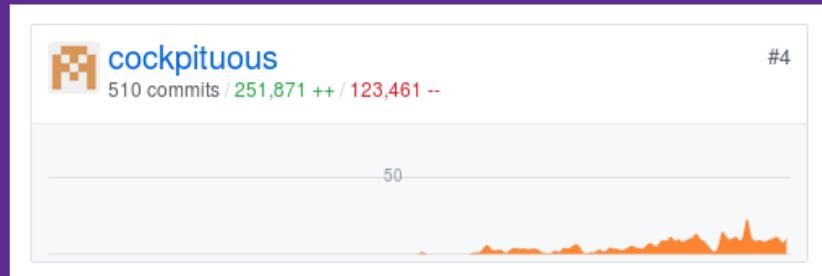
Human signs a tag in git

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



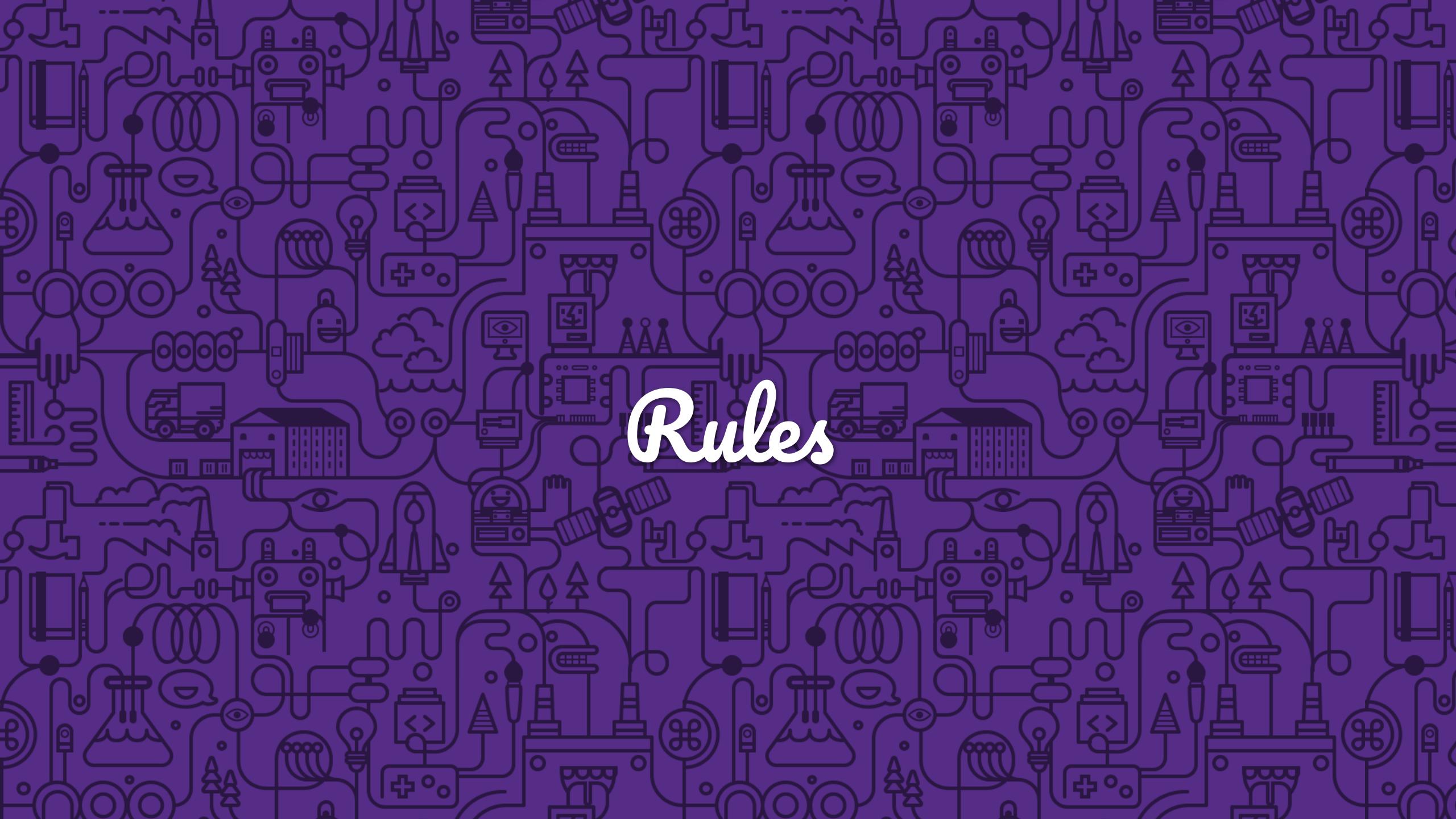
Bots as committers



```
$ git shortlog -ns | head -n10 | cut -c8-30 | nl | grep Cockpit
 4  Cockpituous
```



Team stops without bots



Rules

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

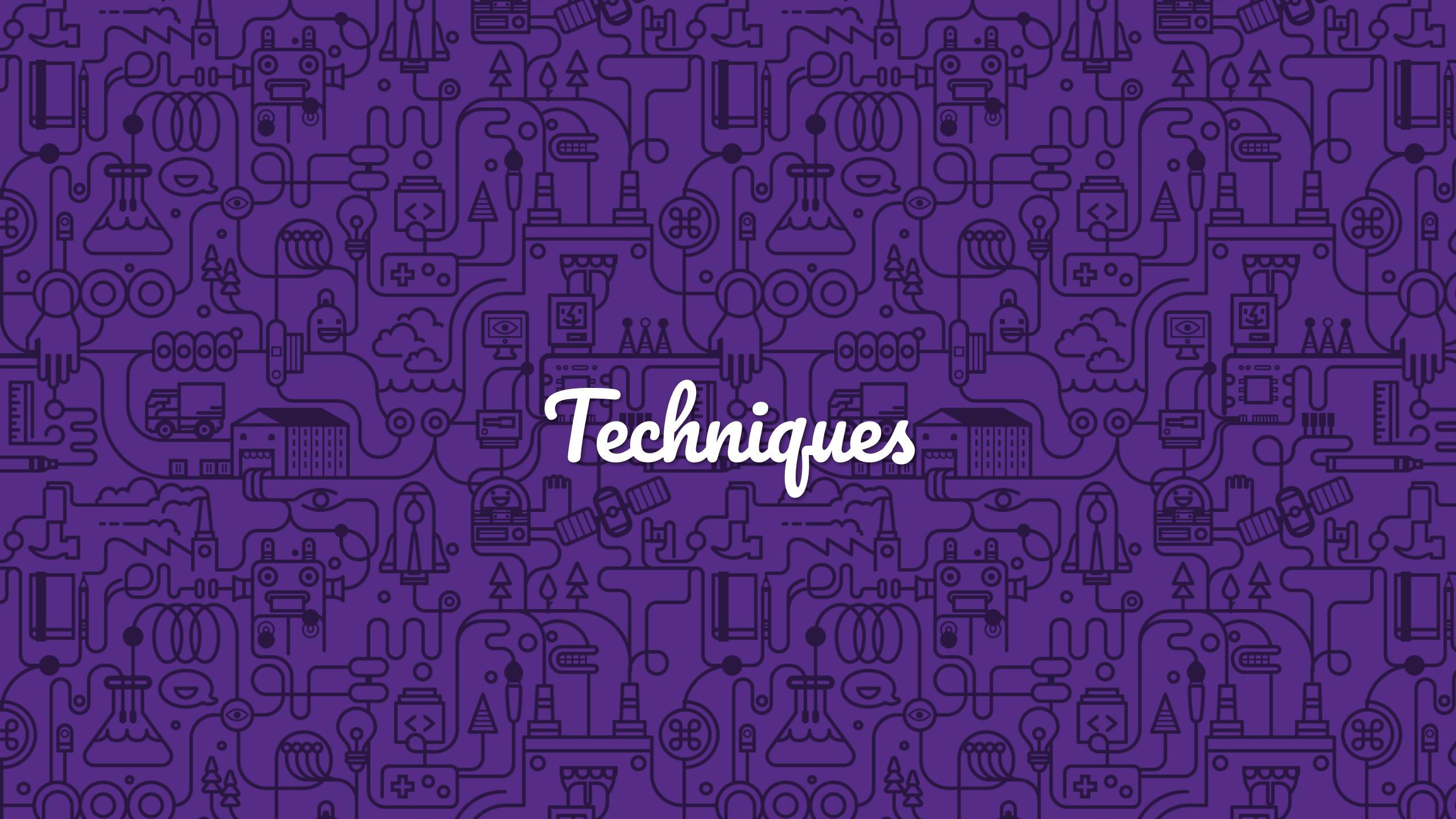
So why don't we see Cyborg Teams everywhere?

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

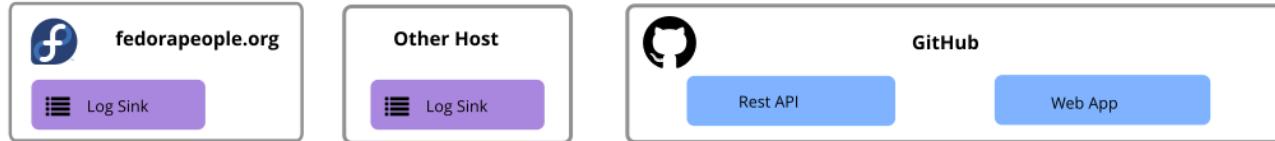
Yo Dawg...
~



Organic and distributed bots

Cockpit Task Bots

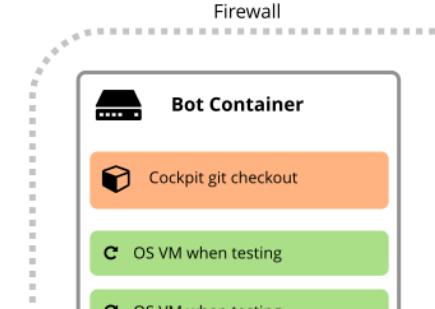
Task system is distributed with GitHub as the single point of failure



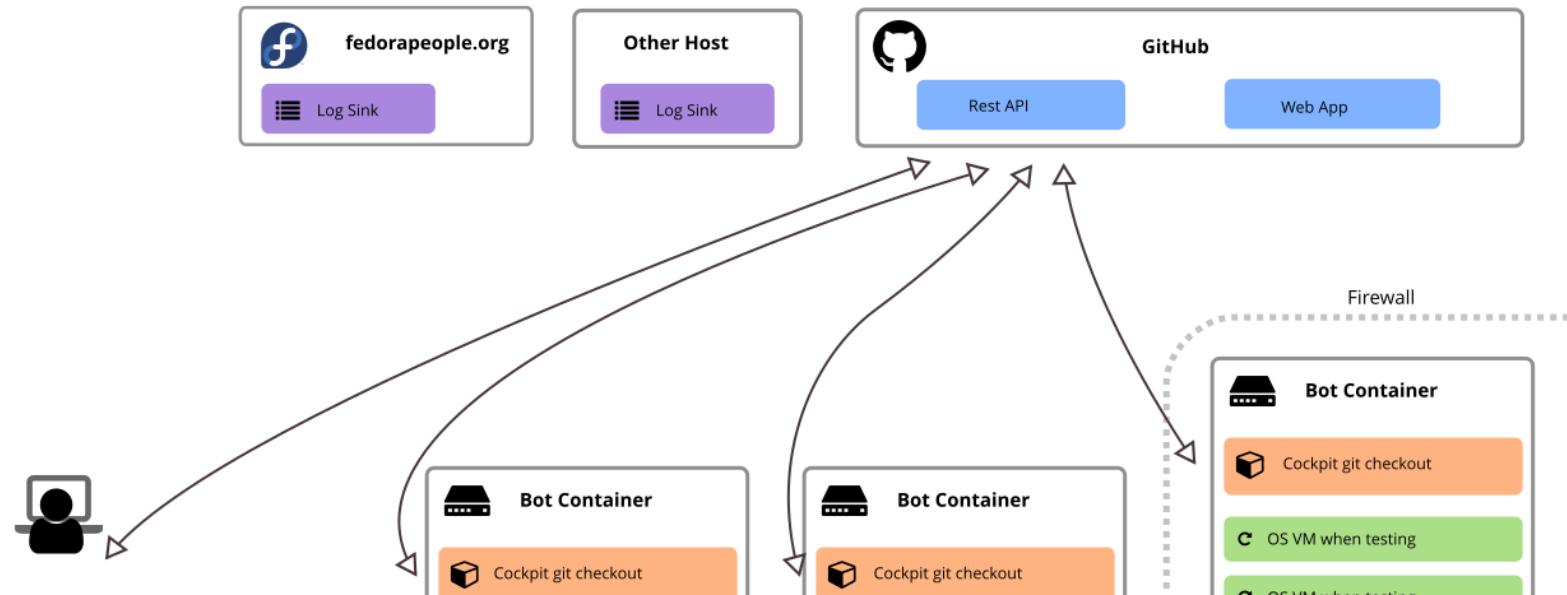
Every pull request is booted 100's of times
in Atomic, Debian, Fedora, RHEL, before it hits master.

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

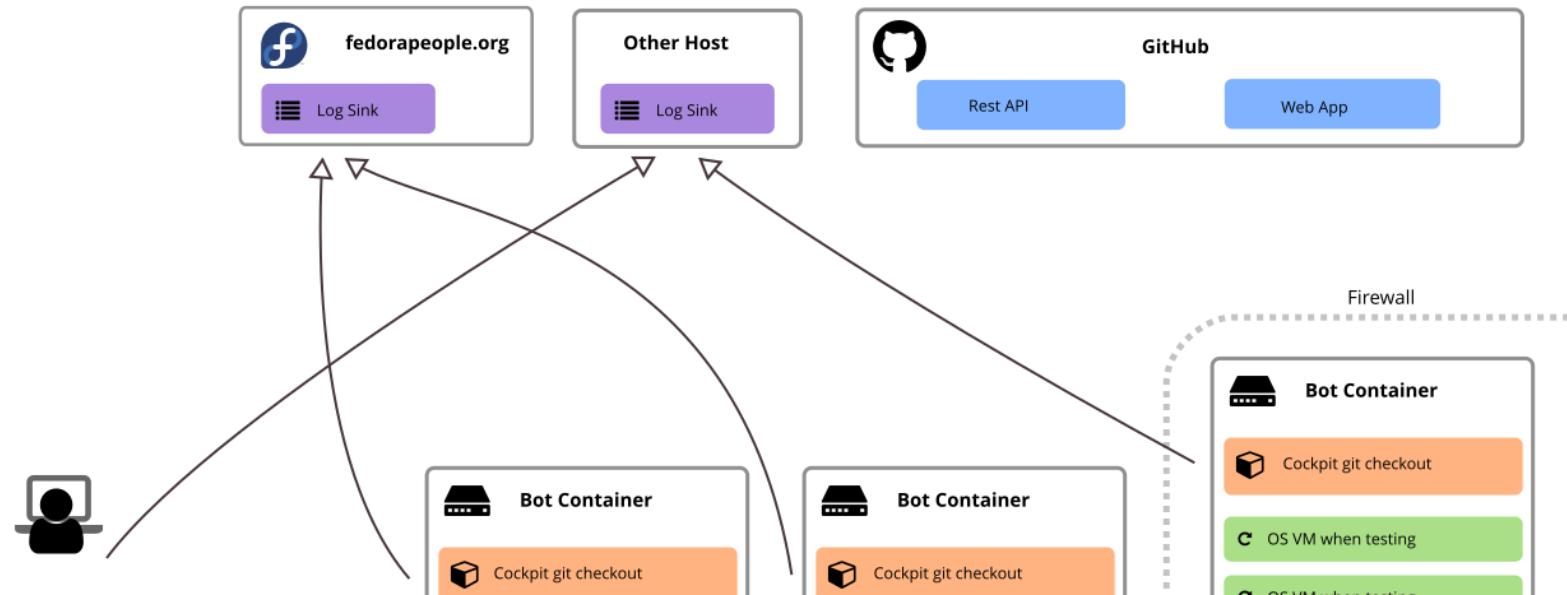
These containers can run anywhere



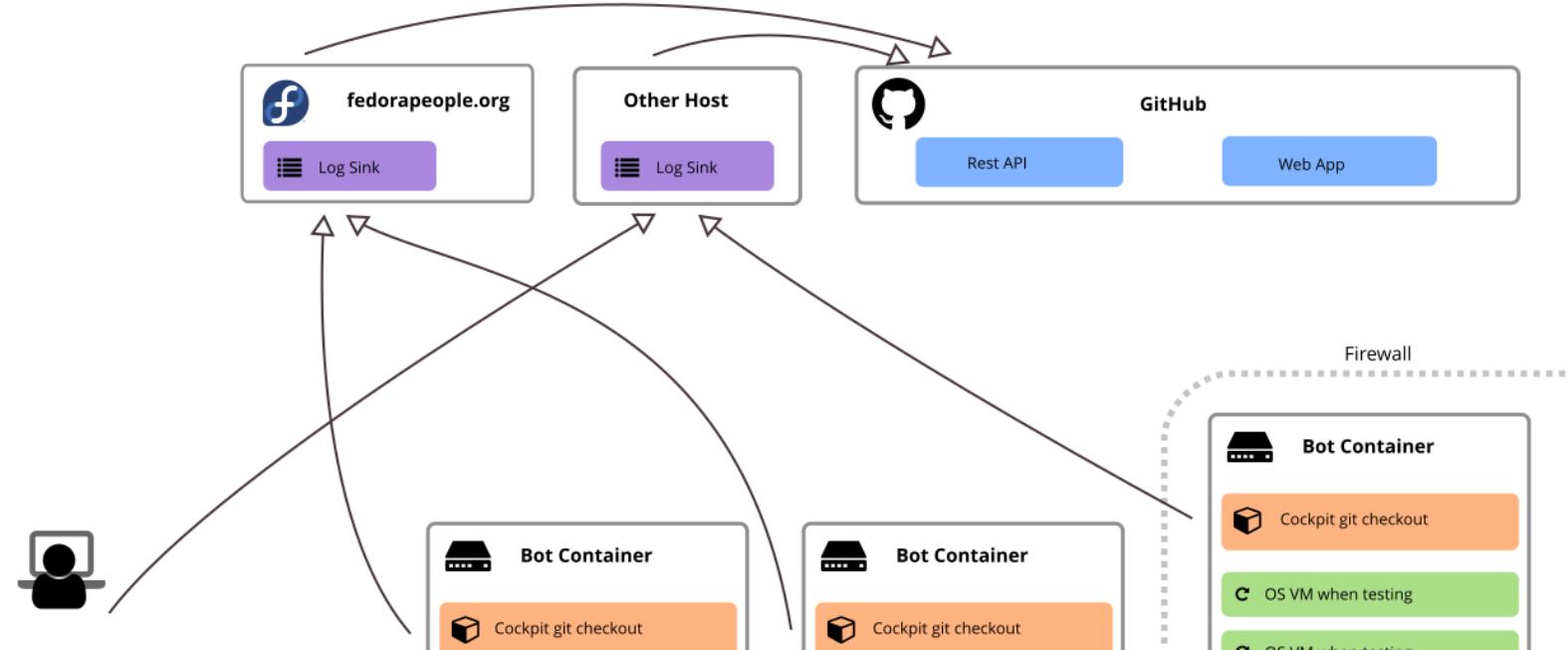
Looking for Tasks



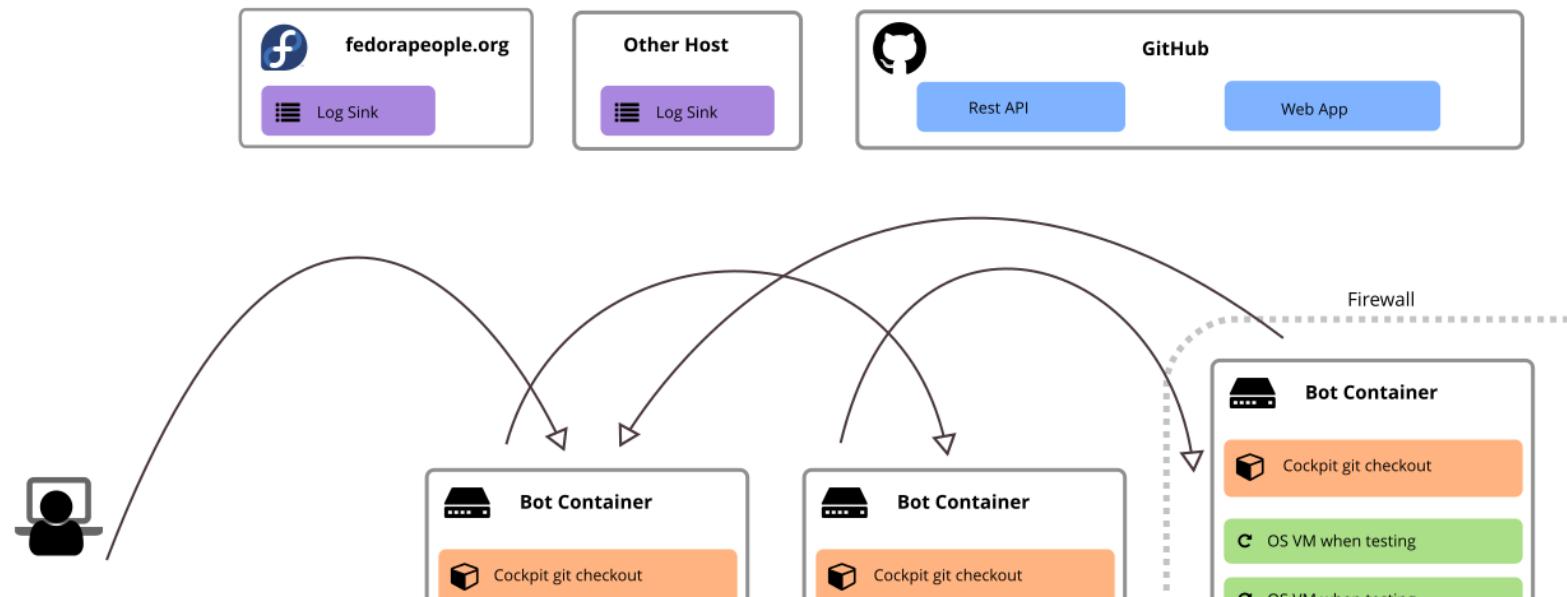
Post logs, attachments and publicly



Status updates to Pull Requests



Bots share state





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='c9a5bec1d'
PRIORITY=0006 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d'
PRIORITY=0006 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d'
PRIORITY=0006 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d'
PRIORITY=0005 TEST_NAME='rhel-7.4-20171024-112020' TEST_REVISION='c9a5bec1d'
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

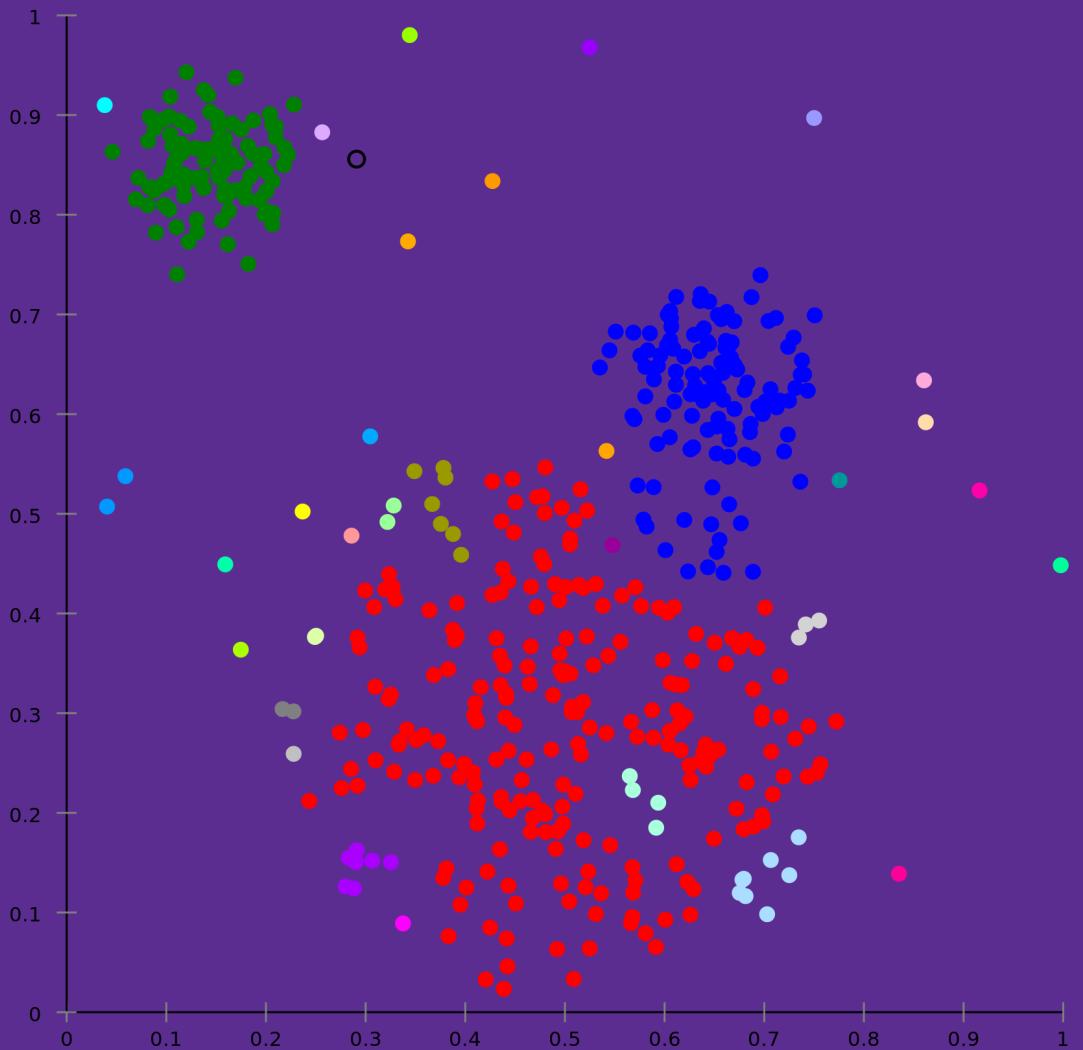
```
kvm = os.access("/dev/kvm", os.R_OK | os.W_OK)

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

❗ 85: testSuper (check_reauthorize.TestReauthorize) # duration: 25s 📸 screenshot 📄 journal

```
# testSuper (check_reauthorize.TestReauthorize)
#
ftruncate() failed: Permission denied

DevTools listening on ws://127.0.0.1:9832/devtools/browser/28132994-84e8-492a-bda1-07059595e814
[0123/152927.820842:ERROR:zygote_host_impl_linux.cc(268)] Failed to adjust OOM score of renderer with pid 123004: Permission denied (13)
[0123/152928.864472:ERROR:zygote_host_impl_linux.cc(268)] 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-i386-127.0.0.2-2601-FAIL.png
Wrote HTML dump to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.html
Wrote JS log to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.js.log
Journal extracted to TestReauthorize-testSuper-fedora-i386-127.0.0.2-2601-FAIL.log

# Flake probability: 72.5% (neural network)

# Flake likely 66.2% (clustering)
```

Term Frequency - Inverse Document Frequency

```
# -----
# testTeam (check_networking_team.TestNetworking)
#
NAME          UUID                               TYPE      DEVICE
System eth0   5fb06bd0-0bb0-7ffb-45f1-d6edd65f3e03 802-3-ethernet eth0
virbr0        82404faf-cb6b-4f4c-8eb6-65fc1a2ff8da  bridge      virbr0
System eth1   9c92fad9-6ecb-3e6c-eb4d-8a47c6f50c04 802-3-ethernet --
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.wait_present("#network-interface-slaves tr[data-interface='%s']" %
```

```
# testTeam (check_networking_team.TestNetworking)
NAME          UUID                               TYPE      DEVICE
System eth000  000fb000bd000-000bb000-000ffb-000f000-d000edd000f000e000 000
virbr000     000faf-cb000b-000f000c-000eb000-000fc000a000ff000da  bridge
System eth000  000c000fad000-000ecb-000e000c-eb000d-000a000c000f000c000 000
File "check-networking-team", line 000, in testTeam
b.wait_present("#network-interface-slaves tr[data-interface='%s']" % iface000
```

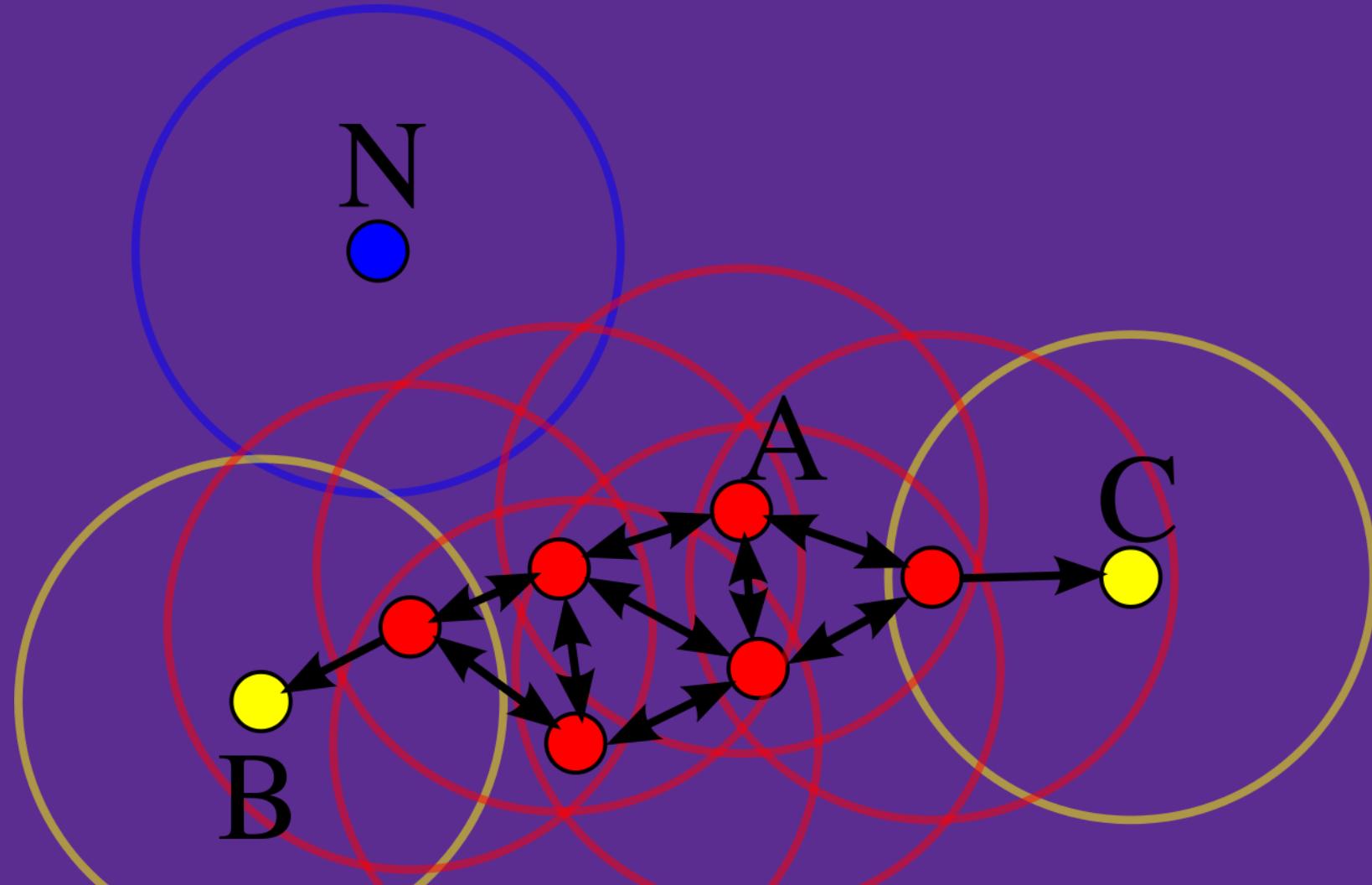
Normalized Compression Distance

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

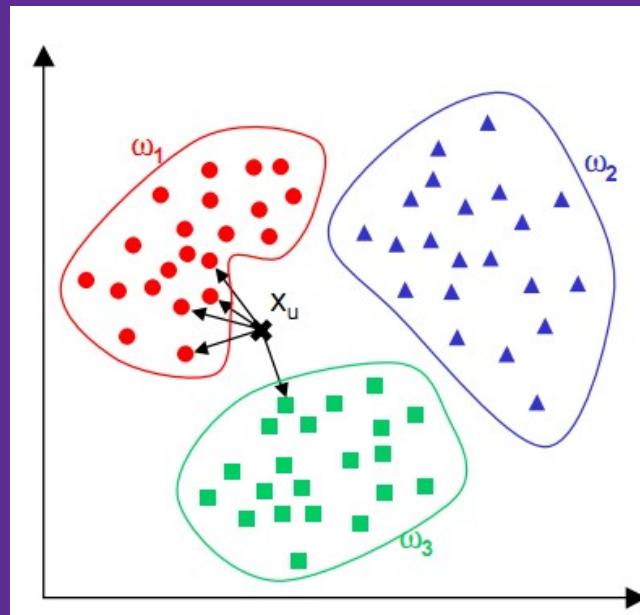
```
Z = lambda v: len(zlib.compress(v))
```

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)
```



Add tests to my Fedora or Debian package

fedoraproject.org/wiki/CI/Tests

people.debian.org/~mpitt/autopkgtest/README.package-tests.html

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 Kubernetes

Contact CentOS CI for an account

Run VMs in Containers 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

