PRACTICAL REPRODUCIBILITY WITH CHAMELEON

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CHAMELEON IN A NUTSHELL

- We like to change: a testbed that adapts itself to your experimental needs
  - Deep reconfigurability (bare metal) and isolation
  - power on/off, reboot, custom kernel, serial console access, etc.
- Balance: large-scale versus diverse hardware
  - Large-scale: ~large homogenous partition (~15,000 cores), ~6 PB of storage distributed over 2 sites (UC, TACC) connected with 100G network
  - Diverse: ARMs, Atoms, FPGAs, GPUs, Corsa switches, etc.
- Cloud++: leveraging mainstream cloud technologies
  - Powered by OpenStack with bare metal reconfiguration (Ironic) + “special sauce”
  - Blazar contribution recognized as official OpenStack component
- We live to serve: open, production testbed for Computer Science Research
  - Started in 10/2014, available since 07/2015, renewed in 10/2017, and just now!
  - Currently 5,500+ users, 700+ projects, 100+ institutions, 300+ publications
BY THE NUMBERS

300+ Papers published

700+ Projects

45 Countries

5,500+ Users

160+ Institutions

5+ Years Old

and 3+ more years to grow!
CHI EXPERIMENTAL WORKFLOW

discover resources
- Fine-grained
- Complete
- Up-to-date
- Versioned
- Verifiable

allocate resources
- Allocatable resources: nodes, VLANs, IPs
- Advance reservations and on-demand
- Expressive interface
- Isolation

configure and interact
- Deeply reconfigurable
- Appliance catalog
- Snapshotting
- Orchestration
- Jupyter integration
- Networks: stitching and BYOC

monitor
- Hardware metrics
- Fine-grained data
- Aggregate
- Archive

Authentication via federated identity,
Interfaces via GUI, CLI and python/Jupyter
REPRODUCIBILITY DILEMMA

- Should I invest in making my experiments repeatable?
- Should I invest in repeating this experiment?
- Should I invest in more new research instead?
- Is it faster to reinvent the wheel?

- Reproducibility has a cost: what is the right value proposition?
- Value of repeating experiments: variation and entertainment
- Can experiments be as sharable/repeatable as papers are today?
- Holy grail: reducing time to package (side-effect) and time to repeat
PRACTICAL REPRODUCIBILITY

- Public resource: sharing hardware via instruments held in common
- Clouds: sharing experimental environments
  - Disk images, orchestration templates, and other artifacts
- What is missing?
  - Telling the whole story: hardware + experimental container + experiment workflow + data analysis + story – literate programming
  - The easy button: it has to be easy to package, easy to repeat, easy to find, easy to get credit for, easy to reference, etc.
  - Nits and optimizations: declarative versus imperative, transactional versus transparent

Paper: “The Silver Lining”, IEEE Internet Computing 2020
REPRODUCIBILITY BUILDING BLOCKS

- Hardware: the baseline
  - >105 hardware versions over 5 years
  - Expressive allocation

- Clouds: images and orchestration
  - >130,000 images, >35,000 orchestration templates and counting
  - Portability and federation

- Packaging and repeating: integration with JupyterLab

- Share, find, publish and cite: Trovi and Zenodo
PACKAGING SHARABLE EXPERIMENTS

Literate Programming with Jupyter

Experimental storytelling:
ideas/text, process/code, results

Complex Experimental containers

- Repeatability by default: Jupyter notebooks + Chameleon experimental containers
  - JupyterLab for our users: use jupyter.chameleoncloud.org with Chameleon credentials
  - Interface to the testbed in Python/bash + examples (see LCN’18: https://vimeo.com/297210055)
  - Especially for highly distributed experiments (CHI@Edge) notebook as terminal multiplexer

*Paper: “A Case for Integrating Experimental Containers with Notebooks”, CloudCom 2019*
TROVI: CHAMELEON'S EXPERIMENT PORTAL

Create a new packaged experiment out of any directory of files in your Jupyter server. It is private to you unless shared. Supports sharing similar to Google Drive.

Any user with a Chameleon allocation can find and "replay" the packaged experiment.
SOME RESOURCES

- Trovi depositions
  - [https://www.chameleoncloud.org/experiment/share/?filter=tag:experiment](https://www.chameleoncloud.org/experiment/share/?filter=tag%3Aexperiment)
  - Go to Chameleon Trovi and filter on “experiment” to find packaged experiments
  - Can be used to play with or teach

- Youtube channel, student screencasts:
  - AlexNet
  - DAWNBench
  - LinnOS
  - DTRS experiment from tinyTailFlash

- SC20 poster: “Future-Proof Your Research: Designing for Replicability and Reproducibility”
SHARING EXPERIMENTS: PUBLICATION

Familiar research sharing ecosystem

Trovi: a digital sharing platform
  - Make your experiments sharable within a community of your choice with one click
  - A library of reproduced experiments from foundational papers for research and education (see e.g., Brunkan et al., “Future-Proof Your Research”, SC20 poster)

Integration with Zenodo: make your experimental artifacts citable via Digital Object Identifiers (DOIs) (export/import)

Coming soon: the Chameleon daypass!

Digital research sharing ecosystem

PARTING THOUGHTS

- Time to package is important – but time to repeat is critical!
- Reproducible experiments rely on the existence of public resources
- Use-what-you-have approach: leveraging testbeds/clouds, existing digital artifacts, frameworks, patterns, etc. has the potential to lower the “price” of reproducibility and make it affordable
- We need to create a “marketplace” for repeating research
  - Repeatability and reproducibility can be thought of as the same thing at different “price points”
  - Recognition for published digital artifacts (software, data, experiments, etc.)
  - Starting early: education is an unappreciated tool for fostering reproducible research
- Coming soon: Chameleon daypass and repeatability hackathon!
Chameleon

We’re here to change

www.chameleoncloud.org

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