Facilitating Remote Resources usage via User Driven Web Applications

Weijia Xu

Texas Advanced Computing Center
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Background

• Data-driven AI analytics help organizations gain new insights
  • Decision making
  • Scientific discovery
  • Marketing potentials

• Due to increasing data storage requirement, computing complexity, there is an increasing trend to move to remote advanced computing resources
  • Commercial cloud
  • Cyberinfrastructure
Observations of new user needs on cyberinfrastructure

• Interact with data and analysis process
  • Data review
  • Data curation
  • Results review.

• Sharing data access and analysis

• More interdisciplinary research project
  • Users from diverse domain backgrounds with less computing background.
Traditional Service Models

• Command line based interface
  • Users log on and transfer files using SSH terminal via login nodes
  • Users request computing resources via resource managers, such as Slurm
  • Different pre-built software tools and environment can be dynamically managed and switched as modules.

• Concerns
  • Batch processing oriented with very little interactivity support.
  • Obscure interface with high initial learning curve
Web Portal Model

- Community focused web portal deployment.
  - Integration with a list of community software and tools
  - Web platform for user to manage data.

- Concerns
  - Requires significant efforts on portal development and deployment.
  - Service provider driven model
  - Not easy for user to customize and add new applications
Project Goals

- A user driven model that empowers users to easily setup and deploy applications on supercomputers with web UIs for interactivities.

- Enable user to share the session dynamically with collaborators and/or students.

- Hide resources and allocation details from end users.

- Portable and extensible

- Easy Access Control
  - Temporary access support
  - Authentication through other service providers.
Architecture Design
Implementation

• Enable initialization of web UI through a configuration file.
  • The web UI consists of multiple tasks
  • Implemented with Play web framework, a reactive web framework implemented in Scala/java
  • Self-contained packages with no additional software other than Java needed on the host system.

• Tasks and web applications can be specified through json files.
  • User can customize individual pre-built task or extend the code to develop new task
  • Tasks can run in a given order or in parallel based on dependencies.

• Support dynamic credential management with Oauth2
  • Enable creating temporary password by admin account.
  • Connecting with existing credential on the remote resources
  • Connecting with existing social credentials.
TASK Classes

```
- Task
  - + name: String
  - + type: String
  - + run(_): String
  - + configure(_): Int

- FileUploadTask
- Show_Results
- CheckJobTask
- CheckClusterTask
- Run_Script
- Run_MPI
- Run_Zeppelin
```
Examples:

• Define Task:

```json
{
    "head": "Simple Workflow Example",
    "description": "This is a workflow example.",
    "tasks": [
        {
            "task_name": "Preparation",
            "task_type": "fileUpload",
            "description": "Upload file for execution"
        },
        {
            "task_name": "Run Analysis",
            "task_type": "runMPITask",
            "description": "Run analysis using MPI"
        },
        {
            "task_name": "Postprocessing",
            "task_type": "showResultTask",
            "description": "Display result of analysis."
        }
    ]
}
```
Example:

- Generate Web Application
Example:

- Workflow Management for admin user
Use case Example: Twitter Data Analysis Pipeline

• Motivation
  • Twitter analysis has gained increasing popularity across many fields.
  • Not just traditional computational fields, but also many others.
    • Culture trends, political campaigns, social movements etc.

• Challenges
  • knowledge/skills to access real-time tweets
  • resource to store and carry out large-scale computation
Generic Twitter Analysis Workflow

1. Login to the remote resources via ssh connection through a command line interface
2. Move libraries/tools required to the remote resource.
3. Submit a request to start collecting tweets using a Python script.
4. While the Tweets are being accumulated, an R script is used to perform statistical analysis on metadata of tweets, such as its origination locations.
5. After a number of tweets have been accumulated, sentimental analysis are conducted through a zeppelin notebook service.
6. Download the analysis results for inspection
Exemplar Solution

```json
{
    "head": "Tweets Aggregation and Analysis Workflow",
    "description": "test",
    "tasks":
    [
        
        {
            "task_name": "Upload files",
            "task_type": "fileUpload",
            "description": "upload prepare_files_and_directory.sh, streaming.py, credentials.py, run_streaming_keywords.sh, run_streaming_and_map_script.sh, process_tweets_log.R files"
        },
        {
            "task_name": "Run preparing script",
            "task_type": "runScript",
            "description": "In prepare_files_and_directory.sh, edit SOURCE_CODE_DIR to your upload directory, edit NEW_DIR to create a new directory to store required scripts and log folder"
        },
        {
            "task_name": "Run streaming script and map script",
            "task_type": "runScript",
            "description": "In run_streaming_and_map_script.sh, edit NEW_DIR to point to the new directory created"
        },
        {
            "task_name": "Show Result",
            "task_type": "showResult",
            "description": "Input tweets_map.png path and show tweets map"
        },
        {
            "task_name": "Hadoop Reservation Information",
            "task_type": "checkHadoop",
            "description": "check Hadoop reservation Information"
        },
        {
            "task_name": "Launch Zeppelin",
            "task_type": "startZeppelin",
            "description": "start Zeppelin server and load analysis notebook"
        }
    ]
} 
```
User Driven Analysis

- User may choose different subset of tasks
- User can further customize their analysis details
- User can customize and specify dependencies among tasks.

Step 2: Run preparing script

File path:
/work/0307B/huang/twitter/prepares_files_and_directory.sh

Show contents

```
# File: prepares_files_and_directory.sh

SOURCE_CODE_DIR=/work/0307B/twitter

NEW_DIR=/work/0307B/twitter/Tweets_stream

LOG_DIR=$NEW_DIR/log

# remove old tweets log if exist
if [-f $LOG_DIR/log ]; then
    rm $LOG_DIR/log
fi

# make a twitter directory and a log directory under it
mkdir -p $NEW_DIR

# add python and R script to the twitter directory
cp $SOURCE_CODE_DIR/twitter_streaming_keywords.sh $NEW_DIR/twitter_streaming_keywords.sh

Save edits to file and/or Run script in the text area above

Run successfully
```
Post Analysis Support

- Visualizing the results

File path
/work/03076/rhuang/wrangler/Tweets_stream/tweets_map.png

Show
Supporting Education Activities using Cluster

• Instructor can start application for student to access temporarily during the class.

• Providing credential management to support temporary access.
  • Typical process requires handling out temporary training password to students or ask them to set up account ahead of time.

• User may launch additional GUI tool such as notebook, R studios
Credential Management Design Overview
User Management

<table>
<thead>
<tr>
<th>User</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ First Name</td>
</tr>
<tr>
<td>+ Last Name</td>
</tr>
<tr>
<td>+ Email</td>
</tr>
<tr>
<td>+ Password</td>
</tr>
<tr>
<td>+ Role</td>
</tr>
</tbody>
</table>

```json
{
    "users": [
        {
            "firstName": "Admin",
            "lastName": "User",
            "password": "1111",
            "email": "admin@utexas.edu",
            "role": "AdminRole"
        },
        {
            "firstName": "General",
            "lastName": "User",
            "password": "1111",
            "email": "general@utexas.edu",
            "role": "UserRole"
        }
    ]
}
```
Different User Roles

AdminRole

Set Up Workflow

Workflow Management

Define Task Predecessor

Task 1: None

Run All Tasks

Choose File: No file chosen
Download Current Workflow

Upload New Workflow

UserRole

Set Up Workflow

Workflow Management

Define Task Predecessor

Task 1: None

Run All Tasks
## Different User Roles

### AdminRole

<table>
<thead>
<tr>
<th>Home</th>
<th>News</th>
<th>Contact</th>
<th>About</th>
<th>Admin User</th>
<th>Sign Out</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Use Case: Generate Random Users</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Use Case: Set Up Workflow</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### UserRole

<table>
<thead>
<tr>
<th>Home</th>
<th>News</th>
<th>Contact</th>
<th>About</th>
<th>Yige Wang</th>
<th>Sign Out</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td><strong>Use Case: Set Up Workflow</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Generating New User

```json
{
  "users": [
    {
      "firstName": "training1",
      "lastName": "auto",
      "password": "uo57APcL2T",
      "email": "training1@utexas.edu",
      "role": "UserRole"
    },
    {
      "firstName": "training2",
      "lastName": "auto",
      "password": "Stq2KwWIp4",
      "email": "training2@utexas.edu",
      "role": "UserRole"
    },
    {
      "firstName": "training3",
      "lastName": "auto",
      "password": "qyeJTrGxvx",
      "email": "training3@utexas.edu",
      "role": "UserRole"
    }
  ]
}
```
Other Authentication Support

- OAuth 2.0

Social Platforms:
- Facebook
- Google

...
Mapping other credential to internal accounts.

```
{
  "training_accounts": [
    {
      "username": "train250",
      "password": "U8@L3#z4"
    },
    {
      "username": "train251",
      "password": "e8^d8!s5"
    },
    {
      "username": "train252",
      "password": "7H(7Y^9e"
    },
    ...
  ]
}
```
Integration with other GUI tools.

- Integration with Additional Tool

```scala
Step 5: Launch Zeppelin
http://zeppelin.tacc.texas.edu:5036
```

```scala
// Using Stanford Core NLP for sentiment analysis
val sentiments = tweets.filter("description is not null")
  .select("id", explode(splitit("description")), "sentiment", "sentiment_label"("sentiment"))
  .collect().select("id", "sentiment", "sentiment_label"("sentiment"))

val sentiment_output_path = z.fs.path("sentiment_output_path")
sentiments.write.parquet(sentiment_output_path)

sentiments.createOrReplaceTempView("sentiments")

val ssdf = spark.sql("SELECT sentiment.status, count(1) as total FROM sentiments group by sentiment")
ssdf.show()
```

**Sentiment Analysis**

```scala
import org.apache.spark.sql.functions._
import com.databricks.spark.corenlp.functions._
import org.apache.spark.sql.types._
// Using Stanford Core NLP for sentiment analysis
val sentiments = tweets.filter("description is not null")
  .select("id", explode(splitit("description")), "sentiment", "sentiment_label"("sentiment"))
  .collect().select("id", "sentiment", "sentiment_label"("sentiment"))

val sentiment_output_path = z.fs.path("sentiment_output_path")
sentiments.write.parquet(sentiment_output_path)

sentiments.createOrReplaceTempView("sentiments")

val ssdf = spark.sql("SELECT sentiment.status, count(1) as total FROM sentiments group by sentiment")
ssdf.show()
```
Support on Spoken Audio Processing using Machine Learning for Libraries, Archives and Museums (LAM)

- Need new ways to procure access to large-scale audio collections.
- Machine Learning (ML) can accelerate and improve audio processing.
- Use ML to describe audio data.
- Operationalize and embed LAM values, best practices, and needs in the ML system.
- Road ahead: design, explore, and implement ML methods.
- Requires interdisciplinary work.
Typical Workflow

1. Login to the remote resources via ssh connection through a command line interface.
2. Installing libraries/tools required to the remote resource. (very hard for librarian)
3. Moving data to the remote resources.
4. Submit a batch script to run speech recognition.
5. Download the analysis results check and possibly repeat from 3.
Interfaces for Transparency and Reproducibility
What the interface enables:

- Review audio files: a large audio collections stored on the storage clusters
- Start transcribing the results and review results
- Run additional processing scripts.
- Provide feedbacks on label inference results
- The web application can run dynamically by users or setting up on a separate VM.
Integration with Javascripting

• A use case web application for traffic camera video analysis.
Summary

• A new model for serving remote computing resources

• Focus on empowering users to carry out data driven analysis

• Customizable and extensible by users

• Complimentary to existing services models used in the
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• Questions?
  • xwj@tacc.utexas.edu
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The Networking and Information Technology Research and Development (NITRD) Program

Mailing Address: NCO/NITRD, 2415 Eisenhower Avenue, Alexandria, VA 22314

Physical Address: 490 L'Enfant Plaza SW, Suite 8001, Washington, DC 20024, USA Tel: 202-459-9674, Fax: 202-459-9673, Email: nco@nitrd.gov, Website: https://www.nitrd.gov