

# Preparing Tools

The Brown Dog Data Transformation Service (DTS) is a highly extensible/distributed service providing a uniform means of managing and accessing transformation capabilities within the web. Utilized tools can come in the form of command line applications, GUI driven applications, libraries, and/or other services. Here we go over the process of preparing a new transformation tool, either an [extractor](#) or a [converter](#), for usage with the DTS.

## Using the BD Development Base

BD-base runs the necessary dockerized Brown Dog Data Transformation Service components (Clowder, Polyglot, Fence, RabbitMQ, MongoDB, Redis, an example extractor, an example converter, and the BD CLI) allowing a developer to get up and running more quickly as they create and debug new extractors/converters. You can get the BD-base by cloning the git repo:

```
git clone https://opensource.ncsa.illinois.edu/bitbucket/scm/bd/bd-base.git
```

or download the VirtualBox VM image and run it:

<https://browndog.ncsa.illinois.edu/downloads/bd-base.ova>

After downloading BD-base, users can simply run the bash script in the command-line to start up the BD development base.

```
cd bd-base
./bd
```

The BD-base script will split your terminal into panes and start each of the services needed for the Brown Dog DTS. This provides a useful and convenient way to view the logs of running services in panes.

```
:27017, type=UNKNOWN, state=CONNECTING]}. Waiting for 30000 ms before timing out
I 0622 15:55:21.914 THREAD1: Starting server...
I 0622 15:55:22.125 THREAD26: Opened connection [connectionId{localValue:1, serverValue:2}] to mongo:27017
I 0622 15:55:22.128 THREAD26: Monitor thread successfully connected to server with description ServerDescription{address=mongo:27017, type=STANDALONE, state=CONNECTED, ok=true, version=ServerVersion{versi
onList=[3, 4, 5]}, minWireVersion=0, maxWireVersion=5, maxDocumentSize=16777216, roundTripTimeNanos=1364578}
I 0622 15:55:22.149 THREAD33: Opened connection [connectionId{localValue:5, serverValue:6}] to mongo:27017
I 0622 15:55:22.148 THREAD30: Opened connection [connectionId{localValue:2, serverValue:3}] to mongo:27017
I 0622 15:55:22.155 THREAD32: Opened connection [connectionId{localValue:4, serverValue:5}] to mongo:27017
I 0622 15:55:22.164 THREAD31: Opened connection [connectionId{localValue:3, serverValue:4}] to mongo:27017
I 0622 15:55:22.449 THREAD1: Tracer: com.twitter.finagle.zipkin.thrift.SamplingTracer
I 0622 15:55:22.478 THREAD38: Created index date_1
I 0622 15:55:22.648 THREAD38: Created index resource_1
I 0622 15:55:22.776 THREAD38: Created index resource_id_1
I 0622 15:55:22.930 THREAD38: Created index user_1

2017-06-22 15:55:32,983 - [DEBUG ] - application - Adding new vocabulary definition MetadataDefinition(594be1d0c74e4b0960d44ea7514,None,{"label":"GeoJSON","uri":"http://geojson.org/geojson-spec.html","type":"wkt"})
2017-06-22 15:55:32,985 - [DEBUG ] - application - Getting value for countof.users
2017-06-22 15:55:32,987 - [DEBUG ] - application - Exchange is not an empty string: clowder
2017-06-22 15:55:32,990 - [INFO ] - application - Application has started
2017-06-22 15:55:32,991 - [INFO ] - application - [securesocial] loaded identity provider: userpass
2017-06-22 15:55:32,992 - [INFO ] - application - [securesocial] loaded event listener SecureSocialEventLis
tner
2017-06-22 15:55:32,993 - [INFO ] - play - Application started (Prod)
2017-06-22 15:55:33,116 - [INFO ] - application - Starting extraction status receiver
2017-06-22 15:55:33,147 - [INFO ] - play - Listening for HTTP on /0:0:0:0:0:0:9000

docker logs -f 72785ac2272e && clear
[Not privileged to set domain environment.
wifi-60-41:bd-tmux bing$ docker logs -f 72785ac2272e && clear
[2017-06-22 15:55:23,271 INFO : ocr - Registering extractor...
[2017-06-22 15:55:23,274 WARNING : ocr - Error in registering extractor: HTTPConnectionPool(ho
st='clowder', port=9000): Max retries exceeded with url: /api/extractors?key=1ek3rs (Caused b
y NewConnectionError('<requests.packages.urllib3.connection.HTTPConnection object at 0x7f3bbad
188a90>: Failed to establish a new connection: [Errno 111] Connection refused',))
[2017-06-22 15:55:23,505 INFO : pyclowder.extractors - Waiting for messages. To exit press
CTRL+C

Not privileged to set domain environment.
wifi-60-41:bd-tmux bing$ docker logs -f c16f717691c9 && clear
[Thu Jun 22 15:55:28 2017] [steward]: Successfully connected to RabbitMQ: server: 172.17.0.3, vhost: /.
[Thu Jun 22 15:55:28 2017] [steward]: polyglot_ip: 172.17.0.6
Starting the internal HTTP client
Starting the internal [HTTP/1.1] server on port 8184
Starting edu.illinois.ncsa.isda.softwareserver.polyglot.PolyglotRestlet$4 application
Polyglot restlet is running...
[Thu Jun 22 15:55:28 2017] [steward]: Adding 172.17.0.5:1:49693cfa

Available Software:
ImageMagick (ImageMagick)

Software server is running ...
Starting the internal HTTP client
Starting the internal [HTTP/1.1] server on port 8182
Starting edu.illinois.ncsa.isda.softwareserver.SoftwareServerRestlet$2 application
Starting distributed software restlet notification thread
Connecting to RabbitMQ server and starting consumer thread
Connecting to RabbitMQ server and starting registration thread

docker exec -it -u bdcli 0d6c864c6da2 bash
[Not privileged to set domain environment.
wifi-60-41:bd-tmux bing$ docker exec -it -u bdcli 0d6c864c6da2 bash
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.
bdcli@0d6c864c6da2:~$
```

Users can switch between panes using [Tmux](#) commands. The panes are as follows: Fence (top), Clowder (middle-left), example extractor (middle-right), Polyglot (middle-left), example convert (middle-right), and the BD CLI (bottom). In the bottom pane, users can run [BD-CLI](#) commands to interact with the Brown Dog Data Transformation Service (username: bd, password: browndog):

```
bdcli@2f09151958f8:~$ bd -o bmp -b http://fence:8080 sample.jpg
Brown Dog API URL: http://fence:8080
Key not available. Getting new key.
Username: fence
Password:
Key: 6e8e0e0d-09de-49a9-9a2a-96b50a166d1a
Token expired or not available. Getting new token.
Token: 1219d9b4-311a-453c-86c5-d61a2125d1b1
sample.bmp
bdcli@2f09151958f8:~$ ls
sample.bmp sample.jpg supervisor
```

```
bdcli@f95d84b0ecec:~$ bd -v -b http://fence:8080 sample.jpg
Brown Dog API URL: http://fence:8080
Key not available. Getting new key.
Username: fence
Password:
Key: be3c6ffd-6151-430d-8683-2e966c412c32
Token expired or not available. Getting new token.
Token: 234d2d20-abde-4e7b-83ba-ad0ae5b2a955

{"metadata.jsonId": [{"content": {"ocr_text": "EB BROWSER MOSAIC THE FIRST POPULAR FOR THE WORLD WIDE BY MARC AND REESSEN BINA THE NATIONAL CENTER COMPUTING APPLICATIONS NCSM 1993 RELEASE TO THE PUBLIC INTERNET USERS EASY ACCESS TO SOURCES OF INFORMATION WYN HAVE TRANSFORMED THE INFORMATION UNIVERSITY OF"}, "@context": ["https://clowder.ncsa.illinois.edu/contexts/metadata.jsonId", {"ocr_text": "http://clowder.ncsa.illinois.edu/ncsa.image.ocr#ocr_text"}]}, {"created_at": "Tue Jun 27 15:02:40 UTC 2017", "agent": {"extractor_id": "https://clowder.ncsa.illinois.edu/clowder/api/extractors/ncsa.image.ocr", "@type": "cat:extractor", "name": "https://clowder.ncsa.illinois.edu/clowder/api/extractors/ncsa.image.ocr"}}, {"versusmetadata": {}, "tags": {}, "filename": "sample.jpg", "technicalmetadata": {}, "id": "59527389e4b005e57b632f98"}

sample.json [OK]
Elapsed time: 8 seconds
```

CTRL-b <arrow key> will navigate panes.

Exit the bd-base session by typing CTRL-b then :kill-session.

**NOTE:** There is a .tmux.conf file included in bd-base. If you copy this file into your home directory before starting a bd-base session you will be able to navigate panes via the mouse and end the session by typing CTRL-b then CTRL-c.

## Extractors

Here we describe the process for taking a working piece of code and deploying it as a Brown Dog extractor. For simplicity, it is assumed that the method can be invoked from a single call. In this example, we are using the python extractor wrapper and will invoke a python function. In a very similar fashion, a method developed in a language other than python can be invoked using subprocess.

The main steps:

1. Wrap the tool for use as an extractor in [Clowder](#) (and through that Brown Dog)
2. Dockerize the extractor
3. Deploy the extractor
4. Add the extractor to the Tools Catalog

A few assumptions are that you have a tool that extracts some kind of metadata from a file or dataset and that you have installed Python, Git, and Docker as well other specific software needed by your extractor (if any) on your computer.

### 1. Install pyClowder2

Install `pyClowder2`, which is a Python library that helps to easily communicate with Clowder - the backend service of Brown Dog which handles extractions. The advantage of using this library is that it manages all communications with Clowder and RabbitMQ (the distributed messaging bus) and the developer doesn't have to take care of such tasks. Needless to say, an extractor can also be written in native Python without the use of `pyClowder2`, but it could be more

```
pip install --upgrade pip
pip install -r https://opensource.ncsa.illinois.edu/bitbucket/projects/CATS/repos/pyclowder2/raw/requirements.txt
git clone https://opensource.ncsa.illinois.edu/bitbucket/scm/cats/pyclowder2.git
```

## 2. Get Your Code Together

We have developed a template extractor written in Python. It is a simple word count extractor that counts lines, words, and characters in a text file. Clone the template extractor and rename the directory to an appropriate name that reflects the purpose of your extractor.

```
git clone https://opensource.ncsa.illinois.edu/bitbucket/scm/bd/extractors-template.git
mv extractors-template/ <your_extractor_name>
cd <your_extractor_name>
```

Make changes to `extractors.py` (main program). Consider the `process_file` method as the main method of an extractor and accordingly it needs to contain the main logic. You can call other methods in your python code from this method after importing necessary modules into this file.

```
# -----
# Process the file and upload the results
def process_file(parameters):
    global extractorName

    inputfile = parameters['inputfile']

    # Call word count command
    result = subprocess.check_output(['wc', inputfile], stderr=subprocess.STDOUT)
    (lines, words, characters, filename) = result.split()

    # Context url
    context_url = 'https://clowder.ncsa.illinois.edu/contexts/metadata.jsonld'

    # Store results as metadata
    metadata = \
        {
            '@context': [
                context_url, {
                    'lines': 'http://clowder.ncsa.illinois.edu/' + extractorName + '#lines',
                    'words': 'http://clowder.ncsa.illinois.edu/' + extractorName + '#words',
                    'characters': 'http://clowder.ncsa.illinois.edu/' + extractorName + '#characters'
                }
            ],
            'attachedTo': {
                'resourceType': 'file', 'id': parameters["fileid"]
            },
            'agent': {
                '@type': 'cat:extractor',
                'extractor_id': 'https://clowder.ncsa.illinois.edu/clowder/api/extractors/' + extractorName
            },
            'content': {
                'lines': lines,
                'words': words,
                'characters': characters
            }
        }

    print metadata

    # Upload metadata
    extractors.upload_file_metadata_jsonld(mdata=metadata, parameters=parameters)
```

## 3. Edit extractor\_info.json

This file contains information about the extractor in JSON-LD format. Update all relevant fields as needed.

```
1 {
2   "@context": "http://clowder.ncsa.illinois.edu/contexts/extractors.jsonld",
3   "name": "wordCount",
4   "version": "1.0",
5   "description": "Brown Dog template extractor",
6   "author": "Rob Kooper <kooper@illinois.edu>",
7   "contributors": ["Gregory Jansen <jansen@umd.edu>", "Sandeep Puthanveetil Satheesan <sandeeps@illinois.edu>"],
8   "contexts": [],
9   "repository": {"repType": "git", "repUrl": "https://opensource.ncsa.illinois.edu/bitbucket/scm/bd/extractors-template.git"},
10  "external_services": [],
11  "dependencies": [],
12  "bibtex": []
13 }
```

## 4. Configuration Parameters

Extractors obtain the configuration details required to connect to RabbitMQ, Clowder, etc., either from command-line arguments or environment variables. If you look at the Dockerfile inside the template extractor directory you can see some of the environment variables being set. For the purpose of running your extractor using BD Development Base, you DO NOT have to change anything.

Note: The remaining part of this section is relevant ONLY if you want to run your extractor against another production instance at some other location. Otherwise, you can skip and continue reading the next section.

If you are planning to run your extractor using Docker, you will need to modify the Dockerfile to set the environment variables as required.

```
# Setup environment variables. These are passed into the container. You can change
# these to your setup. If RABBITMQ_URI is not set, it will try and use the rabbitmq
# server that is linked into the container. MAIN_SCRIPT is set to the script to be
# executed by entrypoint.sh. REGISTRATION_ENDPOINTS should point to a central clowder
# instance, for example it could be https://clowder.ncsa.illinois.edu/clowder/api/extractors?key=secretKey

ENV RABBITMQ_URI="" \
    RABBITMQ_EXCHANGE="clowder" \
    RABBITMQ_QUEUE="ncsa.wordcount" \
    REGISTRATION_ENDPOINTS="https://clowder.ncsa.illinois.edu/extractors" \
    MAIN_SCRIPT="wordcount.py"
```

Otherwise, if you run your extractor as a standalone program (outside of Docker), you will need to set the relevant command-line arguments. You can get a list of these parameters by running your extractor with the help option (-h, --help).

```
bd@bd-base:~/extractors-template$ ./wordcount.py -h
usage: wordcount.py [-h] [--connector [{RabbitMQ,HPC,Local}]]
                  [--logging [LOGGING]] [--num [NUM]]
                  [--pickle [HPC_PICKLEFILE [HPC_PICKLEFILE ...]]]
                  [--register [REGISTRATION_ENDPOINTS]]
                  [--rabbitmqURI [RABBITMQ_URI]]
                  [--rabbitmqQUEUE [RABBITMQ_QUEUENAME]]
                  [--rabbitmqExchange [RABBITMQ_EXCHANGE]]
                  [--mounts MOUNTED_PATHS]
                  [--input-file-path INPUT_FILE_PATH]
                  [--output-file-path OUTPUT_FILE_PATH] [--sslignore]
                  [--version] [--no-bind]
```

WordCount extractor. Counts the number of characters, words and lines in the text file that was uploaded.

optional arguments:

```
-h, --help                show this help message and exit
--connector [{RabbitMQ,HPC,Local}], -c [{RabbitMQ,HPC,Local}]
                          connector to use (default=RabbitMQ)
--logging [LOGGING], -l [LOGGING]
                          file or url or logging configuration (default=None)
--num [NUM], -n [NUM]    number of parallel instances (default=1)
--pickle [HPC_PICKLEFILE [HPC_PICKLEFILE ...]]
                          pickle file that needs to be processed (only needed
                          for HPC)
--register [REGISTRATION_ENDPOINTS], -r [REGISTRATION_ENDPOINTS]
                          Clowder registration URL (default=)
--rabbitmqURI [RABBITMQ_URI]
                          rabbitMQ URI
                          (default=amqp://guest:guest@127.0.0.1/%2f)
--rabbitmqQUEUE [RABBITMQ_QUEUENAME]
                          rabbitMQ queue name (default=ncsa.wordcount)
--rabbitmqExchange [RABBITMQ_EXCHANGE]
                          rabbitMQ exchange (default=clowder)
--mounts MOUNTED_PATHS, -m MOUNTED_PATHS
                          dictionary of {'remote path':'local path'} mount
                          mappings
--input-file-path INPUT_FILE_PATH, -ifp INPUT_FILE_PATH
                          Full path to local input file to be processed (used by
                          Big Data feature)
--output-file-path OUTPUT_FILE_PATH, -ofp OUTPUT_FILE_PATH
                          Full path to local output JSON file to store metadata
                          (used by Big Data feature)
--sslignore, -s          should SSL certificates be ignores
--version                show program's version number and exit
--no-bind                instance will bind itself to RabbitMQ by name but NOT
                          file type
```

## 5. Edit the Dockerfile

Update the Dockerfile to install your software dependencies, provide necessary instructions in Dockerfile using the RUN command. You will need to add a line in Dockerfile to switch to the root user (`USER root`) for getting proper permissions. For e.g., to install ImageMagick package using apt-get, add the following commands to Dockerfile:

```
USER root
RUN apt-get update && apt-get install -y imagemagick
```

## 6. Test the Extractor

You can test your extractor as follows:

```
docker build -t <your_extractor_name> .
docker run -it --link browndog_crowder_1 --link browndog_rabbitmq_1:rabbitmq <your_extractor_name>
```

You should see the following in the terminal. This means that the extractor is running and waiting for messages:

```
INFO : pycrowder.extractors - Waiting for messages. To exit press CTRL+C
```

## Converters

Here we described the process for taking a working piece of code (an application, library, other service, etc) and deploying it as a Brown Dog converter. In this example, we describe the creation of a converter using the popular image converter tool, ImageMagick.

### 1. Get Your Code Together

We have developed a template converter. It is a simple image converter that converts between different image formats using ImageMagick tool. Clone the template converter and rename the directory to an appropriate name that reflects the purpose of your converter

```
git clone https://opensource.ncsa.illinois.edu/bitbucket/scm/bd/convertors-template.git
mv convertors-template/ <your_converter_name>
cd <your_converter_name>
```

Rename and edit *ImageMagick\_convert.sh* script to wrap your conversion tool. This script file should be named in the format **<alias>\_convert.<script\_type>**. Here **<alias>** needs to be replaced by the name of the conversion tool with which the converter registers with Polyglot and **<script\_type>** needs to be replaced by the extension for the type of script this wrapper is written in. Polyglot currently supports scripts written in Python, Bash, R, AutoHotKey, AutoIT, and Sikuli (e.g. \*.py, \*.sh, etc.). For the sake of ease of explanation, we will rename the script file as **MyTool\_convert.sh**. This script accepts three parameters:

1. Full path to input file
2. Full path to output file (including filename)
3. Full local path to available scratch space (optional)

This script will be used by the [Software Server](#) to run the tool and carry out any requested conversions. The example script ImageMagick\_convert.sh that uses ImageMagick tool to convert images between different formats is shown below. The conversion script follows a specific header and is written as comments:

1. First line is the [shebang](#) line
2. Second line contains the name of the converter followed by the version (if any)
3. Third line refers to the type of the data that it can convert
4. Fourth line contains a comma-separated list of the input file formats accepted by this converter
5. Fifth line contains a comma-separated list of the output file formats that this converter can generate
6. This is followed by the actual code that does conversion.

```
#!/bin/sh
#ImageMagick (v6.5.2)
#image
#bmp, dib, eps, fig, gif, ico, jpg, jpeg, jp2, pcd,
#bmp, dib, eps, gif, jpg, jpeg, jp2, pcd, pdf, pgm,

output_filename=$(basename "$2")
output_format="{output_filename##*.*}"

#Output PGM files as ASCII
if [ "$output_format" = "pgm" ]; then
    convert "$1" -compress none "$2"
else
    convert "$1" "$2"
fi
```

## 2. Edit the Dockerfile

Modify the Dockerfile in the converter directory to replace ImageMagick with MyTool. Specifically change line numbers 11, 15, 16 and 17. You need to also change other fields like maintainer and may need to add instructions to install any specific software required by your converter. For example, you can see instruction to install ImageMagick software in the example Dockerfile:

### Dockerfile

```
# Create softwareserver for polyglot.
FROM ncsapolyglot/polyglot:develop
MAINTAINER Rob Kooper <kooper@illinois.edu>

USER root
# - install requirements
# - enable shellscripts to be scanned
# - enable imagemagick conversion by adding to .aliases.txt
RUN apt-get update && apt-get -y install vim nano imagemagick && \
    /bin/sed -i -e 's/^\([^#]*Scripts=)\/#\1/' -e 's/^\#(ShellScripts=)\/#\1/' /home/polyglot/polyglot
/SoftwareServer.conf && \
    echo "ImageMagick" > /home/polyglot/polyglot/scripts/sh/.aliases.txt

# copy convert file to scripts/sh folder in container
# this is done to keep cache so you can debug script easily
COPY ImageMagick_convert.sh /home/polyglot/polyglot/scripts/sh/
RUN chown polyglot /home/polyglot/polyglot/scripts/sh/ImageMagick_convert.sh && \
    chmod +x /home/polyglot/polyglot/scripts/sh/ImageMagick_convert.sh

# back to polyglot
CMD ["softwareserver"]
```

Specifically, modify:

```
echo "ImageMagick" > /home/polyglot/polyglot/scripts/sh/.aliases.txt
```

to:

```
echo "MyTool" > /home/polyglot/polyglot/scripts/sh/.aliases.txt
```

modify:

```
COPY ImageMagick_convert.sh /home/polyglot/polyglot/scripts/sh/
```

to:

```
COPY MyTool_convert.sh /home/polyglot/polyglot/scripts/sh/
```

and modify:

```
RUN chown polyglot /home/polyglot/polyglot/scripts/sh/ImageMagick_convert.sh && \  
  chmod +x /home/polyglot/polyglot/scripts/sh/ImageMagick_convert.sh
```

to:

```
RUN chown polyglot /home/polyglot/polyglot/scripts/sh/MyTool_convert.sh && \  
  chmod +x /home/polyglot/polyglot/scripts/sh/MyTool_convert.sh
```

## 6. Test the Converter

You can test your converter as follows:

```
docker build -t mytool .  
docker run -it --link browndog_rabbitmq_1:rabbitmq mytool
```

You should see the following in the terminal. This means that the converter is running and waiting for messages:

```
Available Software:  
  ImageMagick (ImageMagick)
```