Pararell and distribiuted programming

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Contents

1 Abstract

This report outlines the design and development of a computer software system for pararell XML xpath extraction from RSS feeds with support for a yet unknown database. This program was written in Python to run under the Unix operating system.

The design and ensuing program are modular in nature (server-client architecture) and make maximum use of abstract data types and of software re-use. Particular attention is paid to performance increase through pararellization Client-server architecture provides the ability to use implemented features from any other program.

The report includes a full user manual, as well as the whole of the code that was written. The source code was written with a particular focus on readability and clarity.

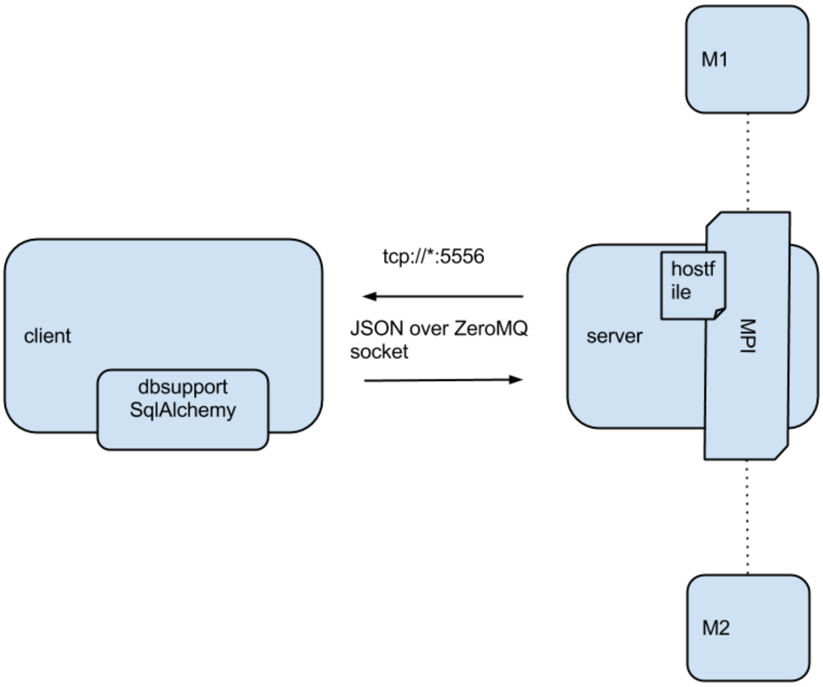
2 Background

Used technologies:

- MPI - Message Passing Interface
- PyZMQ - ZeroMQ bindings for Python
- SqlAlchemy - generalized database access
- JSON - JavaScript Object Notation

3 Design, implementation , and test setup

The architecture.



3.1 Data format

Format request sent by client to server (inludes authentication tokens: appid, appkey):

```
{
"appid":appid,
"appkey":appkey
"url":url,
"article_nums": article_nums,
"xpath": xpath
}
```

Format of answers sent by server to client:

```
Reply format:
{
"article number' : list of extracted items,
"article number' : list of extracted items,
  ...
  }
```

3.2 server.py

A program serving extracts of contents of articles in rss feed over zmq sockets using json as data format. This implementation uses MPI for speeding up execution so it is taking advantage of concurrency features of modern systems. Server requires authentication tokens appid and appkey.

```
class InvalidCredentialsError(Exception)
    thrown on Invalid authentication tokens

is_authenticated(appid, apikey)
    a placeholder for proper accessing a database of registered api users

server( port )
  Start a server listening for connections with zmq socket at 'port'
  for json requests from clients.

extract( xml, article_nums, xpath ) -> dict
  Return a dict containing article extracts.
```

3.3 client.py

An implementation of a client:

- request from server extracts of contents of articles in rss feed
- fetch the response
- write results to a dummy database:

  ```
  TExtract( url, xpath, contents ) |one-to-many| TContent( content )
  ```

- print out database

Uses json as data format. ZeroMQ is deployed for communication between client and server. SQLAlchemy for database access.

```
get_article_extracts( port, url, article_nums, xpath ) -> dict
  Return a dict containing rss article extracts.

main()
```

3.4 dbsupport.py

A file containing classes implementing access to databases through SqlAlchemy.

```
class TExtract(Base)

class TContent(Base)

class DbSupport( object )
```

4 Installation

Install required packages on all hosts.

```
apt-get install openmpi-bin libopenmpi-dev build-essentials python-dev python-zm
pip install mpi4py
```

If server is supposed to run on multiple machines create a hostfile where server.py will be started. The username should be the same on all machines. 4k2 directory should be the same on all machines.

```
root@voyage:~/4k2# cat ~/hostfile
192.168.0.17
192.168.0.19
```

5 Experiments

Start server on a machine. Include hostfile if running on multiple machines.

```
mpirun -np 4 --hostfile ~/hostfile python server.py
```

Extracting articles from a remote rss feed.

```
 python client.py \
-H 192.168.0.17 \
-f http://feeds.feedburner.com/TechCrunch \
-n 2,5,6,9,10 -s category[1]
```

Example client output.

```
Sending request {"url": "http://feeds.feedburner.com/TechCrunch",
  "xpath": "category[1]", "article_nums": [2, 5, 6, 9, 10]}
TExtract(u'http://feeds.feedburner.com/TechCrunch',
  u'category[1]', [TContent(u'Fundings & Exits')])
TExtract(u'http://feeds.feedburner.com/TechCrunch',
  u'category[1]', [TContent(u'Startups')])
TExtract(u'http://feeds.feedburner.com/TechCrunch',
  u'category[1]', [TContent(u'Social')])
TExtract(u'http://feeds.feedburner.com/TechCrunch',
  u'category[1]', [TContent(u'Enterprise')])
TExtract(u'http://feeds.feedburner.com/TechCrunch',
  u'category[1]', [TContent(u'TC')])
```

6 Conclusion and future owrk

Possible future directions:

- authentication using OAuth
- tcp over ssl

7 Code

7.1 client.py

```
#! /usr/bin/python2.7
# -*- coding: utf-8 -*-
# python <3
# 2013 Artur Skonecki

"""
An implementation of a client:
- request from server extracts of contents of articles in rss feed
- fetch the response
- write results to a dummy database:
  TExtract( url, xpath, contents ) |one-to-many| TContent( content )
- print out database
Uses json as data format.
ZeroMQ is deployed for communication between client and server.
SQLAlchemy for database access.
```

```
"""

PORT = "5556"

import json
import zmq

from optparse import OptionParser

import dbsupport

# Connect to a server over zmq socket. Send a request for contents (xpath)
# from specific articles (article_nums) published on a rss feed (url).
# Fetch the reponse back.
def get_article_extracts( host, port, url, article_nums, xpath ):
  '''get_article_extracts( port, url, article_nums, xpath ) -> dict

  Return a dict containing rss article extracts.
  '''

  # connect to a server
  context = zmq.Context()
  socket = context.socket( zmq.REQ )
  socket.connect ( "tcp://%s:%s" % (host, port) )

  # format and send a json request over zmq socket
  jdata = json.dumps(
    "APPID" : "myawesomeapp",
    "APIKEY": "mysecretapikey",
    "url":url,
    "article_nums": article_nums,
    "xpath": xpath
     )
  print( "Sending request " + str( jdata ) )
  socket.send( jdata )

  # get the reply and decode json
  message = socket.recv()
  json_decoder = json.JSONDecoder()
  jdata_reply = json_decoder.decode( message )
  return jdata_reply

def main():
  ’’’main()’’’
  parser = OptionParser(
    usage = ’Usage: python client.py  -f http://feeds.feedburner.com/TechCrunch

  parser.add_option( "-H", None,
    action="store",
    dest="host",
    default="localhost" )
  parser.add_option( "-f", None,
    action="store",
    dest="url",
    default="http://feeds.feedburner.com/TechCrunch" )
  parser.add_option( "-n", None,
    action="store",
    dest="article_nums",
    default="1,2,3" )
  parser.add_option( "-s", None,
    action="store",
    dest="xpath",
    default = ’category’ )

  options = parser.parse_args()[0]

  extracts = get_article_extracts( options.host, PORT,
    options.url,
    [ int( x ) for x in options.article_nums.split( ’,’ ) ],
    options.xpath )

  dba = dbsupport.DbSupport( ’sqlite:///:memory:’ )

  dba.write( options.url,
    options.xpath,
    extracts )

  dba.print_db()

if __name__ == ’__main__’:
  main()
```

7.2 server.py

```
# -*- coding: utf-8 -*-
# Example usage: mpiexec -n 3 python server.py
# python <3
# 2013 Artur Skonecki

'''
A program serving extracts of contents of articles in rss feed over zmq
sockets using json as data format.  This implementation uses MPI for
speeding up execution so it is taking advantage of concurrency features
of modern systems.
'''

PORT = 5556

import json
import urllib2
import zmq

from lxml import etree
from mpi4py import MPI
import logging
import sys

import datetime

now = datetime.datetime.now()

logging.basicConfig(format='%(levelname)s:%(message)s', level=logging.DEBUG)


sys.stderr = open("/tmp/stderr-4k2-server", 'w')
sys.stdout = open("/tmp/stdout-4k2-client", 'w')
sys.stderr.write("hello-" + now.strftime("%Y-%m-%d %H:%M") + "\n")
sys.stdout.flush(); sys.stderr.flush()

class InvalidCredentialsError(Exception):
    '''thrown on Invalid authentication tokens'''
    pass

def is_authenticated(appid, apikey):
    '''a placeholder for proper accessing a database of registered api users'''
    print appid, apikey
    if appid == "myawesomeapp" and apikey == "mysecretapikey":
        print True
        return True
    else:
        print False
        return False


def extract( xml, article_nums, xpath ):
  '''extract( xml, article_nums, xpath ) -> dict

  Return a dict containing article extracts.
  '''

  # extract items containing articles
  tree = etree.XML( xml )
  items = tree.xpath( 'channel/item' )

  # divide articles between RANKs for processing
  basic_range_width = len( article_nums ) / SIZE
  extended_range_width = len( article_nums ) % SIZE

  slice_of_article_nums = article_nums[
    RANK * basic_range_width : ( RANK + 1 ) * basic_range_width ]

  # assign the remainder of articles to RANK 0
  if RANK == 0:
    slice_of_article_nums += article_nums[
      SIZE * basic_range_width :
      SIZE * basic_range_width + extended_range_width ]
  # contains extracts from articles for a given xpath in a RANK
  # e.g. RANK 0 articles {1: ['Gadgets'], 4: ['TC'], 5: ['Mobile']}
  rank_article_extracts = {}

  for article_num in slice_of_article_nums:
    article_extracts = []
    # extract contents from every artile based on xpath
    try:
      for item in items[ article_num ].xpath( xpath ):
        article_extracts.append(item.text)
    except etree.XPathEvalError:
      logging.error('Invalid xpath')
      pass
    rank_article_extracts[ article_num ] = article_extracts

  ## print out extracts of articles for the current RANK
  #print( 'RANK ' + str( RANK ) +
  #  ' articles ' + str( rank_article_extracts ) )

  # get all extracts form RANKs
  extracts = COMM.gather( rank_article_extracts, root = 0 )

  # join returned dicts in extracts into a single dict
  if RANK == 0:
    nextracts = {}
    for data in extracts:
      nextracts.update(data)
  else:
    nextracts = None

  return nextracts


def server( port ):
  '''server( port )

  Start a server listening for connections with zmq socket at 'port'
  for json requests from clients.

  Request fromat:
  {
```

```
"url":url,
"article_nums": article_nums,
"xpath": xpath
}

Reply format:
{
"article number’ : list of extracted items,
...
}
’’’
sys.stderr.write("hello RANK %d\n" % RANK)
sys.stdout.flush(); sys.stderr.flush()
if RANK == 0:
  json_decoder = json.JSONDecoder()

  # set up a socket for communication with clients
  context = zmq.Context()
  socket = context.socket( zmq.REP )
  socket.bind( "tcp://*:%s" % port )
  sys.stderr.write("server starting at %s\n" % port)
  sys.stdout.flush(); sys.stderr.flush()

while True:
  try:
      jdata = None
      xml = None
      if RANK == 0:
        #  Wait for a next json request from clients and decode json
        message = socket.recv()
        jdata = json_decoder.decode( message )
        if not is_authenticated( jdata[’APPID’], jdata[’APIKEY’]):
            raise InvalidCredentialsError
        xml = urllib2.urlopen( jdata[’url’] ).read()
        logging.info( "Received json: " + str( jdata ) )

      # send data to other RANKs
      jdata = COMM.bcast( jdata, root=0 )
      xml = COMM.bcast( xml, root=0 )
      sys.stderr.write("bcast RANK %d\n" % RANK)
      sys.stdout.flush(); sys.stderr.flush()
```

```
        article_nums = jdata[ 'article_nums' ]
        xpath = jdata[ 'xpath' ]

        # do the magic - extract contents from articles based on xpath
        extracts = extract( xml, article_nums, xpath )

        # send extracts of articles down the pipe
        if RANK == 0:
          logging.info( 'Sending extracts ' + str( extracts ) )
          jdata = json.dumps( extracts )
          socket.send( jdata )
    except InvalidCredentialsError:
        logging.warning("Invalid credentials")



if __name__ == '__main__':

  # initialize MPI
  COMM = MPI.COMM_WORLD
  SIZE = COMM.Get_size()
  RANK = COMM.Get_rank()

  server( PORT )
```

7.3 dbsupport.py

```
# -*- coding: utf-8 -*-
# python <3
# 2013 Artur Skonecki

'''
A file containing classes implementing access to databases through SqlAlchemy
'''

from sqlalchemy import *
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm import relation, sessionmaker, relationship, backref
```

```
Base = declarative_base()

class TExtract(Base):
  __tablename__ = ’extracts’

  id = Column(Integer, primary_key=True)

  url = Column(String(255), nullable=False)
  xpath = Column(String(255), nullable=False)
  contents = relationship("TContent", backref="extracts")

  def __init__(self, url=None, xpath=None, contents=None):
    self.url = url
    self.xpath = xpath
    for item in contents:
      self.contents.append( TContent( item ) )
  def __repr__(self):
    return "TExtract(%r, %r, %r)" % ( self.url, self.xpath, self.contents )

class TContent(Base):
  __tablename__ = ’contents’
  cid = Column(Integer, primary_key=True)
  parent_id = Column(Integer, ForeignKey(’extracts.id’))
  content = Column(String(1023))

  def __init__(self, content=None):
    self.content = content

  def __repr__(self):
    return "TContent(%r)" % ( self.content )

class DbSupport( object ):

  def __init__( self, dba ):
    ’’’Contruct a new ‘‘DbSupport‘‘ object

    :param dba: specify database for SqlAlchemy
      e.g.:
        DbSupport( ’sqlite:///:memory:’ )
    ’’’
    engine = create_engine( dba )
    Base.metadata.create_all( engine )

    Session = sessionmaker(bind=engine)
    self.session = Session()


  def write( self, url, xpath, extracts ):
    '''Write records to database'''
    try:
      for content in extracts.itervalues():
        #print content
        self.session.add( TExtract( url, xpath, content ) )
      self.session.commit()
    except:
      self.session.rollback()
      raise

  def print_db( self ):
    '''Print out all TExtract records'''
    alldata = self.session.query(TExtract).all()
    for data in alldata:
      print( data )
```