Case Study for HitFox

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Dedication

For HitFox Company

Abstract

This document is a description of the tasks and steps I carried out to fulfil them. The introduction into designed classes for C++/python/Java is given. The three different language specifications are used to solve the given problems.

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> ***Note***
>
> The solution, presented here, are not optimal! Additional efforts can be requested to find better ways of solving the problems.

1 Task A

1.1 Introduction to Taks A

- Given is an unordered list of numbers (which can appear repeatedly), and we would like to generate a data structure which has the following structure:

```
DivisorsHash { key: 'number' => value: 'divisors of the number in the list' }
```

- Moreover, there some extra requirements.
  - Keys must be stored ordered in the data structure, in a way that when iterated over its keys they will be returned in an ordered manner.
  - List of values for each key must be ordered.

```
Example Input:
 [7,4,2,10,3,6,4,5]

Example Output:
 {
    2 => [1],
    3 => [1],
    4 => [1,2],
    5 => [1],
    6 => [1,2,3],
    7 => [1],
    10 => [1,2,5],
 }
```

- Code the defined data structure and write an algorithm which, given a list of numbers, returns a filled instance of it. Tasks:
- Write class `DivisorsHash`
- Write `DivisorsHash generate(...)` method on class `ProblemA`

1.2 Realization of Taks A

First, we consider the C++ implementation. There are two classes:

- `class DivisorsHash` --> to store divisors of one key
- `class ProblemA` --> to generate a list of divisors for a list of keys

The method `std::vector<int> DivisorsHash::findDivisors ()` performs the finding for all divisors of any non-zero and positivie integer [divisors_in_c].

1.2.1 Task A in C++

`cat include/DivisorsHash.h` [code].

```
#include <string>
#include <iostream>
#include <vector>
#include <iostream>
#include <sstream>
#include <stdio.h>
#include <math.h>
#include <algorithm>

#ifndef DivisorsHash_H
#define DivisorsHash_H


 bool wayToSortInt(int i, int j) { return i < j; }


 class DivisorsHash {
 public:

/// ctor by default is empty
     DivisorsHash (): key(0){}


     ~DivisorsHash() {}


     void setKey (int i) { key=i; return; }
     int  getKey () const { return key;}
```

```
        std::vector<int> findDivisors () {
             if (key<0) key*=-1;

                unsigned int  keysqrt = (unsigned int) sqrt (key);
                for (unsigned int i=1; i<=keysqrt;i++ )
                    if (key%i==0) { divisors.push_back(i);
                    if (i>1 && i< key/i)
                     divisors.push_back(key/i); }

                std::sort(divisors.begin(),divisors.end(),wayToSortInt);
                return divisors;
     }


         std::vector<int> getDivisors() const { return divisors;}

/// to print out the DivisorsHash
friend std::ostream & operator <<(std::ostream & out,
```

```
            const DivisorsHash & right){

            std::stringstream ss;
            std::vector<int> Divisors = right.getDivisors();
            int Key = right.getKey();
            char str[100];
            sprintf(str, "%d => [", Key);
            std::string tmp = str;
            ss<<tmp;
            for (int i=0;i<Divisors.size()-1;i++)
                    {
                            sprintf(str,"%d,",Divisors[i]);
                            tmp=str;
                            ss<<tmp;
                    }
            sprintf(str,"%d]",Divisors[Divisors.size()-1]);
            tmp=str;
            ss<<tmp;
            out<<ss.str();
    }

private:

    int key;
       std::vector<int> divisors;

};


#endif
```

cat include/ProblemA.h

```
#include <string>
#include <iostream>
#include <vector>
#include <iostream>
#include <sstream>
#include <stdio.h>
#include <algorithm>
#include "DivisorsHash.h"

#ifndef ProblemA_H
#define ProblemA_H

bool wayToSort(DivisorsHash i, DivisorsHash j) { return i.getKey() < j.getKey(); }

class ProblemA {
public:

/// ctor by default is empty
    ProblemA () {}
```

```
     ~ProblemA() {}


     void setKeys (std::vector<int>  _keys) { keys=_keys; return;}

     std::vector<DivisorsHash> generate ( ) const {
             std::vector<DivisorsHash> divisors;
             for (int i=0; i<keys.size();i++) {
              divisors.push_back(DivisorsHash());
              divisors.back().setKey(keys[i]);
              divisors.back().findDivisors();
             }

     return divisors;
     }

/// to print out the ProblemA
friend std::ostream & operator <<(std::ostream & out,
                     const ProblemA & right){

             std::vector<DivisorsHash> Divisors = right.generate();
             std::sort(Divisors.begin(),Divisors.end(),wayToSort);
             out<<"{\n";
             for (int i=0; i< Divisors.size(); i++)
              {out<<"\t"; out<< Divisors[i]; out<<",\n";}
             out<<"}\n";
     }


private:

     std::vector<int> keys;
        std::vector<DivisorsHash> divisors;

};

#endif
```

The steering program `main()` uses the `class DivisorsHash` and `class ProblemA` are in the following manner

```
#include "ProblemA.h"
#include <fstream>
#include <iostream>
#include <vector>


using namespace std;
int main ()
{

     int indexs [] = {7,4,2,10,3,6,18,5};
     size_t size = sizeof(indexs)/sizeof(int);
     std::vector<int> vec_indx (size);
```

```
     vec_indx.assign(indexs,indexs+size);


     ProblemA prblmA;

     prblmA.setKeys(vec_indx);

     cout<<prblmA;

return 0;
}
```

It produces the output:

```
{
     2 => [1],
     3 => [1],
     4 => [1,2],
     5 => [1],
     6 => [1,2,3],
     7 => [1],
     10 => [1,2,5],
     18 => [1,2,3,6,9],
}
```

```
def test():
""" test """
 print "How are you"?

 return
```

1.2.2 Task A in Python

The same classes were written using the sysntax of `Python`. Two modules

- `DivisorsHash.py` and
- `ProblemA.py`

were developed to code the task.

`cat scripts/ProblemA/DivisorsHash.py`

```
#! /usr/bin/env python

"""
This is the DivisorsHash  class to  generate   and store divisors of any numeric key

  "DivisorsHash { key: 'number' => value: 'divisors of the number in the list' }"

To test the class :

      ./%prog --test  --debug
```

```
"""

__author__ =  'Igor Marfin'
__copyright__ = "Copyright 2013, DESY HiggsGroup"
__credits__ = ["Igor Marfin", "DESY HiggsGroup"]
__license__ = "GPL"
__version__ = "0.0.1"
__maintainer__ = "Igor Marfin"
__email__ = "marfin@mail.desy.de"
__status__ = "Test"


# import all modules which might be useful


import time
import os
import sys
import commands
import re
from optparse import OptionParser

import types
import math
import unittest
import logging
import inspect

parser2=OptionParser(usage=__doc__)


parser2.add_option("--test",dest="test",
help="to perform test of helper classes",
default=False,action="store_true")
parser2.add_option("--debug",dest="debug",
help="to print debug info",default=False,action="store_true")
parser2.add_option("--tkinter",dest="tkinter",
help="to print debug info",default=False,action="store_true")



if ("pydoc" in str(sys.argv)):
 parser2.add_option("-w",dest="none",default=False,action="store_true")

(options2,args2)=parser2.parse_args()

####################
# Logging Service
####################
#
# logging level
if options2.debug:
```

```
 LOG_LEVEL=logging.DEBUG
 logging.basicConfig(stream=sys.stderr, level=LOG_LEVEL)
 logger = logging.getLogger(inspect.stack()[-1][1])
else:
 LOG_LEVEL=logging.WARNING
 logging.basicConfig(stream=sys.stderr, level=LOG_LEVEL)
 logger = logging.getLogger(inspect.stack()[-1][1])


#
#my autolog
#
def autolog(message,mylogger=None):
 """ to print debug messages """

# Get the previous frame in the stack, otherwise it would
# be this function!!!
 func = inspect.currentframe().f_back.f_code
# Dump the message + the name of this function to the log.
 if (mylogger==None):
  logger.debug("%s in %i ==> %s  " % (
  func.co_name,
  func.co_firstlineno,
  message
  ))
 else:
  mylogger.debug("%s in %s:%i ==> %s  " % (
  func.co_name,
  func.co_filename,
  func.co_firstlineno,
  message
  ))
  return
###################

"""
helper classes   and tests

"""

class DivisorsHash(object):
 """ class to store and generate divsors """


 def __init__(self, key=None):
  """ constructor """
  self.logger = logging.getLogger(self.__class__.__name__)
  self.__key=key
  self.__divisors=[]
  pass


 def setKey(self,key=None):
  """ to set the key """
```

```
  if key == None:
   self.logger.warning("provide me a numeric key")
   raise ValueError("key is empty ")
  if not isinstance(key, types.IntType):  raise TypeError("key is non-integer")
  self.__key=key
  pass



 def getKey(self):
  """ to get the key """
  return self.__key


 def findDivisors(self):
  """ find and returns all divisors (as an ordered list) """

  if (self.__key == None):
   self.logger.warning("provide me a numeric key")
   raise ValueError("key is empty ")

  if not isinstance(self.__key, types.IntType):  raise TypeError("key is non-integer")

  if self.__key < 0 : self.__key*=-1
  keysqrt = math.sqrt(self.__key)
  for i in range(1,int(keysqrt)+1):
   if self.__key%i==0:
    self.__divisors.append(i)
    if i>1 and i<self.__key/i: self.__divisors.append(self.__key/i)
  self.__divisors.sort()
  return self.__divisors


 def getDivisors(self):
  """ return the list of divisors """
  return self.__divisors


# uncomment the line if you need a public "key" attribute
# key = property(getKey, setKey)



 def __repr__ (self):
  """ return the representation "{ key: 'number' => value: 'divisors of the number in the list' }" """
  return "  key: %d => %s " %(self.getKey(),repr(self.getDivisors()))


 def __str__ (self):
  """ return the representation "{ key: 'number' => value: 'divisors of the number in the list' }" """
  return "  key: %d => %s " %(self.getKey(),repr(self.getDivisors()))
```

```
class MyTests(unittest.TestCase):
 """ to test features """

 def __ini__(self):
  pass

 def test1(self):
  """ to test setKey()/getKey() """
```

```
  autolog("test of setKey() ")

  dh = DivisorsHash()
  try:
   dh.setKey(None)
  except Exception as e:
   autolog("Some problems are detected: %s"%e)


  try:
   dh.setKey("test")
  except Exception as e:
   autolog("Some problems are detected: %s"%e)

  try:
   dh.setKey(10)
   autolog("the key is %d"%dh.getKey())
  except Exception as e:
   autolog("Some problems are detected: %s"%e)

  self.failUnless(True)


 def test2(self):
  """ to test findDivisors() """

  autolog("test of findDivisors() ")

  dh = DivisorsHash()

  try:
   dh.setKey(10)
   autolog("the key is %d"%dh.getKey())
   autolog("the list of divisors is %s"%repr(dh.findDivisors()))
  except Exception as e:
   autolog("Some problems are detected: %s"%e)

  self.failUnless(True)



 def test3(self):
  """ to test representation of DivisorsHash """

  autolog("test of __str__() ")

  dh = DivisorsHash()

  try:
   dh.setKey(10)
   dh.findDivisors()
   autolog("%s"%dh)
  except Exception as e:
   autolog("Some problems are detected: %s"%e)
```

```
  self.failUnless(True)



"""
main subroutine

"""

if  __name__ == '__main__':
 """ main subroutine """

### read options and prepare settings

 if options2.test and str(__status__).lower()=="test":
  autolog("Test of the helper classes:\n\n\n")
  sys.argv=[sys.argv[0]]
  unittest.main()
```

The following features are exploited in the code:

- `logging` service to dump the debug information;
- rising `Exception` to indicate the wrong input given by user;
- `__str__()` and `__repr__()` methods to properly print out the `DivisorsHash`;
- Implementation of `class unittest.TestCase` to make basic tests of the functionality.

The `class problemA` has `logging` service, `__str__()` and `__repr()__` supports. But `unittest.TestCase` is not introduced. The module `ProbleA` has two `entry points` used in the `setup.py` tool. This will be discussed later.

`cat scripts/ProblemA/ProblemA.py`

```
#! /usr/bin/env python



"""
This is the ProblemA  class to  generate     divisors of  numeric keys in a list:

Example Input:
[7,4,2,10,3,6,4,5]

Example Output:
{
2 => [1],
3 => [1],
4 => [1,2],
5 => [1],
6 => [1,2,3],
7 => [1],
10 => [1,2,5],
}
```

```
To test the class :

       ./%prog   [--debug] [--tkinter] <args>
       where <args> is the space-separated list of numbers:   7 4 2 10 3 6 4 5


"""

__author__ =  'Igor Marfin'
__copyright__ = "Copyright 2013, DESY HiggsGroup"
__credits__ = ["Igor Marfin", "DESY HiggsGroup"]
__license__ = "GPL"
__version__ = "0.0.1"
__maintainer__ = "Igor Marfin"
__email__ = "marfin@mail.desy.de"
__status__ = "Test"


# import all modules which might be useful


import time
import os
import sys
import commands
import re
from optparse import OptionParser

import types
import math
import unittest
import logging
import inspect


parser=OptionParser(usage=__doc__)


parser.add_option("--debug",dest="debug",
help="to print debug info",default=False,action="store_true")
parser.add_option("--tkinter",dest="tkinter",
help="to start gui",default=False,action="store_true")



if ("pydoc" in str(sys.argv)):
 parser.add_option("-w",dest="none",default=False,action="store_true")

(options,args)=parser.parse_args()



###################
```

```
# Logging Service
###################
```

```
#
# logging level
if options.debug:
 LOG_LEVEL=logging.DEBUG
 logging.basicConfig(stream=sys.stderr, level=LOG_LEVEL)
 logger = logging.getLogger(inspect.stack()[-1][1])
else:
 LOG_LEVEL=logging.WARNING
 logging.basicConfig(stream=sys.stderr, level=LOG_LEVEL)
 logger = logging.getLogger(inspect.stack()[-1][1])


#
#my autolog
#
def autolog(message,mylogger=None):
 """ to print debug messages """

# Get the previous frame in the stack, otherwise it would
# be this function!!!
 func = inspect.currentframe().f_back.f_code
# Dump the message + the name of this function to the log.
 if (mylogger==None):
  logger.debug("%s in %i ==> %s  " % (
  func.co_name,
  func.co_firstlineno,
  message
  ))
 else:
  mylogger.debug("%s in %s:%i ==> %s  " % (
  func.co_name,
  func.co_filename,
  func.co_firstlineno,
  message
  ))
  return
###################



"""
helper classes   and tests

"""

from DivisorsHash import DivisorsHash



class ProblemA(object):
 """ class of ProblemA """
```

```
def __init__(self, keys=None):
 """ constructor """
 self.logger = logging.getLogger(self.__class__.__name__)
 self.__keys=keys
 self.__divisors=[]
 if ( isinstance(keys,types.ListType)): self.__keys.sort()
 pass


def setKeys(self,keys=None):
 """ to set the keys """
 if keys == None:
  self.logger.warning("provide me a numeric key")
  raise ValueError("keys are empty ")
 if ( not isinstance(keys,types.ListType)):
  raise TypeError("It's not  the list of keys")
 if not all(isinstance(key, types.IntType) for key in keys):
  raise TypeError("keys are not integers all")
 self.__keys=keys
 self.__keys.sort()
 pass


def generate(self):
 """ to generate divisors for all input number """
 if self.__keys == None:
  self.logger.warning("provide me a numeric key")
  raise ValueError("keys are empty ")
 if ( not isinstance(self.__keys,types.ListType)):
  raise TypeError("It's not  the list of keys")
 if not all(isinstance(key, types.IntType) for key in self.__keys):
  raise TypeError("keys are not integers all")
 for key in self.__keys:
  dh=DivisorsHash(key)
  dh.findDivisors()
  self.__divisors.append(dh)
 return self.__divisors



def __repr__ (self):
 """ return the list of the representation "{ key:
 'number' => value: 'divisors of the number in the list' }" """
 str1="{\n"
 for i in range(len(self.__keys)):
  if (i<len(self.__keys)-1): str1+=repr(self.__divisors[i])+",\n"
  else: str1+=repr(self.__divisors[i])+"\n } \n"

 return str1



def __str__ (self):
```

```
  """ return the list of the representation
  "{ key: 'number' => value: 'divisors of the number in the list' }" """
  str1="{\n"
  for i in range(len(self.__keys)):
   if (i<len(self.__keys)-1): str1+=str(self.__divisors[i])+",\n"
   else: str1+=str(self.__divisors[i])+"\n } \n"

  return str1




"""
main subroutine

"""

def main():
 """ main subroutine """

### read options and prepare settings

 if (len(args)<1):
  print "provide the input list"
  print __doc__
 else:
  keys=[int(x) for x in args]
  pA = ProblemA()
  pA.setKeys(keys)
  pA.generate()
  print pA
 return

def mainTkinter():
 """ main subroutine with GUI """

 import Tkinter

 class simpleapp_tk(Tkinter.Tk):
    def __init__(self,parent):
        Tkinter.Tk.__init__(self,parent)
        self.parent = parent
        self.initialize()
        pass

    def initialize(self):
        self.grid()
        self.title("ProblemA")

        self.entryVariable = Tkinter.StringVar()
        self.labelVariable = Tkinter.StringVar()
```

```
        self.entry = Tkinter.Entry(self,textvariable=self.entryVariable)
        self.entry.bind("<Return>", self.OnPressEnter)
        self.entry.grid(column=0,row=0,sticky='EW')

        button = Tkinter.Button(self,text=u"Process Numbers !",
        command=self.OnButtonClick)
        button.grid(column=1,row=0)


        label = Tkinter.Label(self,textvariable=self.labelVariable,
                              anchor="w",fg="white",bg="blue")
        label.grid(column=0,row=1,columnspan=2,sticky='EW')

        self.grid_columnconfigure(0,weight=1)
        self.resizable(True,False)

        pass


    def OnButtonClick(self):
        self.OnPressEnter(self)

    def OnPressEnter(self,event):
        args1 =  self.entryVariable.get().split()
        keys=[int(x) for x in args1]
        pA = ProblemA()
        pA.setKeys(keys)
        pA.generate()
        self.labelVariable.set("%s"%pA)



 app = simpleapp_tk(None)
 app.mainloop()
 return


if  __name__ == '__main__':
 """ main subroutine """

 if options.tkinter: mainTkinter()
 else: main()
```

The option `--tkinter` and the `entry point mainTkinter()` are intended to implement the GUI using `Tkinter` windows manager [tkineter]. Running the `scripts/ProblemA/ProblemA.py --tkinter` will give the window like one shown in the Figure 1.

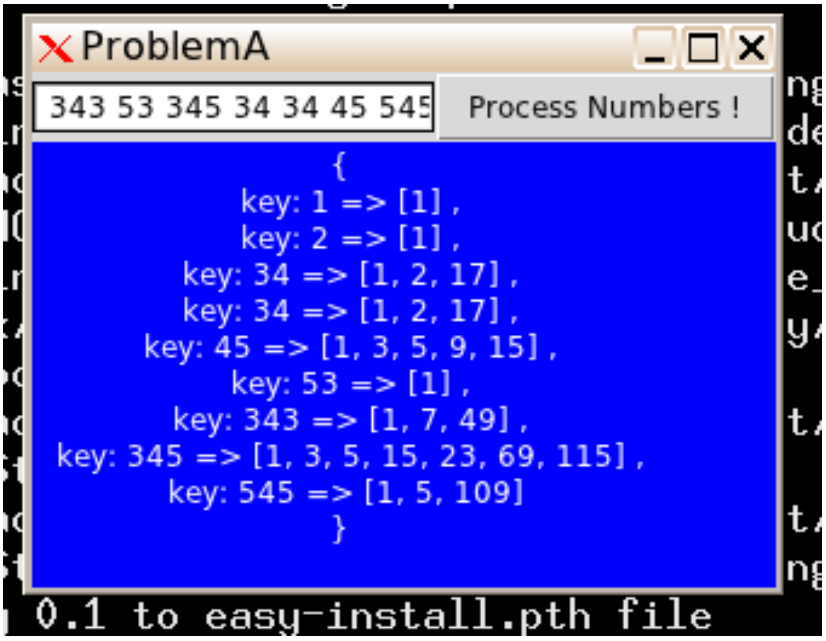

Figure 1. Tkinter window realized in `ProblemA`

1.2.3 Task A installation in Python

To install properly `ProblemA.py` and `DivisorsHash.py` modules, we organized them in the package `ProblemA` with `__init__.py` support [python_package]. This is a tree of the package [tree]

```
scripts/ProblemA/
  |---- DivisorsHash.py
  |----DivisorsHash.pyc
  |---- __init__.py
  |---- __init__.pyc
  |---- ProblemA.py
  |---- ProblemA.pyc

0 directories, 6 files
```

The `__init__.py` file declares the content of the `ProblemA` python package:

```
__all__ = ['DivisorsHash','ProblemA', 'main' ]

# deprecated to keep older scripts who import this from breaking
#from ProblemA.DivisorsHash import DivisorsHash
from DivisorsHash import DivisorsHash
from ProblemA import ProblemA
from ProblemA import main
```

The `setup.py` file was designed to make python packages to be installed in the easiest way [pip]:

```
#! /usr/bin/env python


from setuptools import setup, find_packages
```

```
from setuptools.command.install import install
from setuptools.command.bdist_egg import bdist_egg as _bdist_egg


"""
taken from

http://www.niteoweb.com/blog/setuptools-run-custom-code-during-install
http://stackoverflow.com/questions/20194565/running-custom-setuptools-build-during-install
https://github.com/quasiyoke/keys_of_peace/blob/master/setup.py

"""

"""
class bdist_egg(_bdist_egg):
    def run(self):
        self.run_command('build_css')
        _bdist_egg.run(self)
"""

class CustomInstallCommand(install):
    """Customized setuptools install command - prints a friendly greeting."""
    sub_commands = install.sub_commands + [('test', None)]

    def run(self):
        print "Hello, developer, how are you? :)"
        install.run(self)


setup(
    name = "HitFox_Case_Study",
    version = "0.1",
    packages = find_packages(),
#    scripts = ['ProblemA.py'],

    entry_points = {
        'console_scripts': [
#            'ProblemA_python = ProblemA.ProblemA:main' # console app
            'ProblemA_python = ProblemA.ProblemA:mainTkinter',  # window app
            'ProblemB_python = ProblemB.ProblemB:mainTkinter'  # window app
        ]
    },

    # Project uses reStructuredText, so ensure that the docutils get
    # installed or upgraded on the target machine
    install_requires = ['docutils>=0.3',  'PIL>=1.1.7'
    ],

    package_data = {
        # If any package contains *.txt or *.rst files, include them:
        '': ['*.rst'],
    },

    cmdclass={
```

```
          'install': CustomInstallCommand,
     },

# instead of

#    test_suite = 'ProblemB.suite',

# use
```

```
# python setup.py test --test-suite='ProblemB.suite'

    tests_require = 'docutils >= 0.3',


    # metadata for upload to PyPI
    author = "Igor Marfin",
    author_email = "me@example.com",
    description = "This is an Example Package",
    license = "GPL",
    keywords = "HitFox Case Study",
    url = "https://github.com/igormarfin/HitFox_Case_Study.git", # project home page, if any

    # could also include long_description, download_url, classifiers, etc.
)
```

This `setup.py` file allows to setup the python projects in three different ways:

```
# First, CREATE .egg file

python setup.py bdist_egg

# Then install
# EASY_INSTALL METHOD (requries the .egg file)   (Method 1)

myplace=/mnt/WorkingPlace/Case_Study/hitfox/python/test
script_dir=/mnt/WorkingPlace/Case_Study/hitfox/bin
python_prefix=lib/python2.7/site-packages
mkdir -p ${myplace}/${python_prefix}
sudo sh -c "export PYTHONPATH=${myplace}/${python_prefix}:$PYTHONPATH;\
easy_install --prefix=${myplace}  dist/HitFox_Case_Study-0.1-py2.7.egg "

# install running script into different folder     with EASY_INSTALL METHOD
sudo sh -c "export PYTHONPATH=${myplace}/${python_prefix}:$PYTHONPATH;\
easy_install --install-dir=${myplace}/${python_prefix} --script-dir=${script_dir}
dist/HitFox_Case_Study-0.1-py2.7.egg "


# SETUP.PY METHOD (requires the folder with srcs, here
# the project folder is 'ProblemA' )                  (Method 2)

mkdir -p ${myplace}/${python_prefix}
export  PYTHONPATH=${myplace}/${python_prefix}:$PYTHONPATH
python setup.py install --prefix=${myplace}


# PIP METHOD         (Method 3)

#first, create a tgz or folder project:
python setup.py sdist

sudo sh -c "export PYTHONPATH=${myplace}/${python_prefix}:$PYTHONPATH;\
pip install -e /mnt/WorkingPlace/Case_Study/hitfox/python/HitFox\ Case\ Study-0.1/\
--install-option=\"--prefix=${myplace}\" "
```

The python projects supports also `unittests`, which are used here to test python features and the system to have some external tools needed for properly workflow and compiling of the code. One can simply run

```
python setup.py test --test-suite='ProblemB.suite'
```

to test. This command is implemented in `Makefile`.

2 `Makefile` - the way to build and install the projects

To build projects in C/C++, python and upload them to SVN and GIT repos, the `Makefile` is created. The following keywords, i.e `make keyword`, are supported:

```
all                         Commit2SVN                  info        makeSVN
clean                       DEPENDENCE.ProblemB_python  Makefile    rm_python_dirs
Commit2Git                  dirs2SVN                    makeGit
```

The Makefile is based on the use of hast tables (associative arrays) [makefile_assoc] and technique for processing multiple sub-folders with one Makefile [makefile_trick]. Each sub-project, either C/C++ or python, or JAVA, has two its own FLAGS (for compiling) and dependencies, like

```
#### Specific settings
DEPENDENCE.DivisorsHash                     :=
DEPENDENCE.ProblemA                 := $(INC_DIR)/DivisorsHash.h
DEPENDENCE.Node                             := $(INC_DIR)/Node_Edge.cc
DEPENDENCE.Graph                    := $(INC_DIR)/Node_Edge.cc
DEPENDENCE.ProblemB                 := $(INC_DIR)/Node_Edge.cc

FLAGS.ProblemB                      := -DINT_MAX=100000

DEPENDENCE.ProblemB_python          := DEPENDENCE.ProblemB_python


DEPENDENCE.ProblemB_python:
        cd $(PYTHON_DIR) ; python setup.py test --test-suite='ProblemB.suite';
```

which are used to independently assemble the different sub-projects.

To build and setup executables, just do

```
make clean
make
```

Also, SVN and GIT repositories are supported. If user has registered to `googlecode.com` or `github.com`, it is possible to run the commands

```
# to creat SVN repo  and  upload the projects
make clean
make makeSVN
make dirs2SVN
sudo make Commit2SVN


# to create GIT repo and upload the projects
make clean
make makeGit
make Commit2Git
```

The `` cat Makefile`` gives:

```
#### Common settings

PROJECT                 := HitFox_Case_Study
TMPDIR = $$HOME/tmp/$(PROJECT)
TMPDIR2SVN = $$HOME/tmp/$(PROJECT)/SVN
CURDIR=${shell pwd }
Dirs            := ${shell find . -type d | grep -v ".svn" | grep  "./"}

### SVN repo settings
SVNREPO         := https://my-code-iggy-floyd-de.googlecode.com/svn/branches
SVNUSER                 := iggy.floyd.de@gmail.com

### GIT repo settings
GITREPOPATH     := https://api.github.com/user/repos
GITREPO         := $(PROJECT)
GITUSER         :=   igormarfin


### Compilers settings and C/C++ src/includes

CXX             := g++
CPPFLAGS        :=-g
SRC_DIR         := src
BIN_DIR                 := bin
INC_DIR                 := include


INCLUDES        := $(addprefix -I, $(INC_DIR))
SRC             := $(foreach sdir,$(SRC_DIR),$(wildcard $(sdir)/*.cc))
PROGS           := $(patsubst $(SRC_DIR)/%.cc,%,$(SRC))
HEADERS                 := $(patsubst $(SRC_DIR)/%.cc,$(INC_DIR)/%.h,$(SRC))
PROGS_IN_BIN    := $(patsubst src/%.cc,$(BIN_DIR)/%,$(SRC))



#### python programs settings



PYTHON_DIR      := scripts
PYTHON_INSTALL  := $(shell echo `pwd`/$(PYTHON_DIR)/test)

PYTHON_SRC      := $(shell ls -d $(PYTHON_DIR)/*/ | grep -v "build" | grep -v "dist" \
                   | grep -v $(PROJECT) | grep -v "test")
PYTHON_SRC      := $(patsubst $(PYTHON_DIR)/%,%,$(PYTHON_SRC))
PYTHON_SRC      := $(patsubst %/,%,$(PYTHON_SRC))

PYTHON_PROGS_IN_BIN     := $(addprefix $(BIN_DIR)/,$(patsubst %, %_python, $(PYTHON_SRC)))
PYTHON_PREFIX            := lib/python2.7/site-packages
```

```
VPATH           := $(SRC_DIR)  $(PYTHON_DIR) $(addprefix $(PYTHON_DIR)/, $(PYTHON_SRC))
FLAGS           := -std=c++0x



#### Specific settings  for C/C++ executables
DEPENDENCE.DivisorsHash                         :=
DEPENDENCE.ProblemA                     := $(INC_DIR)/DivisorsHash.h
```

```
DEPENDENCE.Node                             := $(INC_DIR)/Node_Edge.cc
DEPENDENCE.Graph                        := $(INC_DIR)/Node_Edge.cc
DEPENDENCE.ProblemB                     := $(INC_DIR)/Node_Edge.cc

FLAGS.ProblemB                          := -DINT_MAX=100000



all: rm_python_dirs   $(PROGS_IN_BIN) $(PYTHON_PROGS_IN_BIN)


#### Specific setting for python executables
DEPENDENCE.ProblemB_python              := DEPENDENCE.ProblemB_python


DEPENDENCE.ProblemB_python:
       cd $(PYTHON_DIR) ; python setup.py test --test-suite='ProblemB.suite';



#### To clear python directories

rm_python_dirs:
       - rm -r $(shell echo `pwd`/$(PYTHON_DIR))/dist
       - rm -r $(shell echo `pwd`/$(PYTHON_DIR))/build
       - rm -r $(shell echo `pwd`/$(PYTHON_DIR))/$(PROJECT).egg-info
       - rm -r $(shell echo `pwd`/$(PYTHON_DIR))/test


define make-goal
$(BIN_DIR)/$1: $2 $3 ${DEPENDENCE.${1}}
       $(CXX) $(INCLUDES) $(CPPFLAGS) $(FLAGS)  ${FLAGS.${1}} $$< ${DEPENDENCE.${1}}   -o $$@
endef



define make-goal-python
$(BIN_DIR)/$1: $2 ${DEPENDENCE.${1}}
       cd $(PYTHON_DIR);  python setup.py bdist_egg;
       mkdir -p $(PYTHON_INSTALL)/$(PYTHON_PREFIX)
       sudo  sh -c "export PYTHONPATH=$(PYTHON_INSTALL)/$(PYTHON_PREFIX):${PYTHONPATH};\
       easy_install --install-dir=$(PYTHON_INSTALL)/$(PYTHON_PREFIX)\
       --script-dir=$(shell echo `pwd`/$(BIN_DIR)) $(shell echo `pwd`/$(PYTHON_DIR)/dist/$(PROJECT)\
       -0.1-py2.7.egg)"
       echo export PYTHONPATH=$(PYTHON_INSTALL)/$(PYTHON_PREFIX):${PYTHONPATH}
endef


info:
       $(info  SOURCES:         $(SRC))
       $(info  PROGRAMS:        $(PROGS))
       $(info  INCLUDES:        $(INCLUDES))
       $(info  HEADERS:         $(HEADERS))
```

```
       $(info  PYTHON_SRC:      $(PYTHON_SRC))
       $(info  PYTHON_INSTALL:  $(PYTHON_INSTALL))
       $(info  PYTHON_PROGS_IN_BIN:     $(PYTHON_PROGS_IN_BIN))


clean: rm_python_dirs
       - rm $(BIN_DIR)/*


$(foreach prog,$(PYTHON_SRC),$(eval $(call make-goal-python,$(prog)_python,\
                  $(PYTHON_DIR)/$(prog)/$(prog).py )))
```

```
$(foreach prog,$(PROGS),$(eval $(call make-goal,$(prog),$(SRC_DIR)/$(prog).cc,\
                $(INC_DIR)/$(prog).h )))



###SVN support
makeSVN:
        svn mkdir  $(SVNREPO)/$(PROJECT) --username $(SVNUSER) ;\

dirs2SVN:
       - for dir in $(Dirs); do \
       svn mkdir  $(SVNREPO)/$(PROJECT)/$${dir} --username $(SVNUSER) "adding $${dir}" ; \
       done;



Commit2SVN:
        mkdir -p $(TMPDIR2SVN); \
        cd  $(TMPDIR2SVN) ; \
        svn co $(SVNREPO)/$(PROJECT); \
     ls ; \
     cd - ; \
     find  ./ -iname "*" | grep -v "*.svn*" | xargs -I {} install -D {}\
     $(TMPDIR2SVN)/$(PROJECT)/{} ; \
     cd  $(TMPDIR2SVN)/$(PROJECT)  \
        ls ;\
        pwd ;\
        svn status | grep '?'   | sed 's/^.* /svn add --parents --force\
        --username $(SVNUSER) /' | bash ; \
        svn ci ; \
        cd $(CURDIR) ;\
        rm -r  $(TMPDIR2SVN);


##########Git support
makeGit:
       curl -u '$(GITUSER)' $(GITREPOPATH)  -d '{"name":"$(GITREPO)"}'

Commit2Git:
       git init
       git add ./
       git commit -m "adding to GitHub.com"
       git remote add origin git@github.com:$(GITUSER)/$(GITREPO).git
       git push -u origin master

.PHONY: all  info clean rm_python_dirs   makeSVN dirs2SVN Commit2SVN
```

3 Task B

3.1 Introduction to Taks B

- Find shortest path
- Given is a directed & weighted graph defined by the following interfaces:

```
public Interface IGraph {
public Set<INode> getNodes();
}

public interface INode {
public String getName();
public List<IEdge> getEdges();
}
```

```
public interface IEdge {
public INode getOriginNode();
public INode getTargetNode();
public int getWeight();
}
```

- Code an algorithm which finds the shortest path between two given nodes. Tasks:
  - Fill class `Path`.
  - Fill method `IPath getShortestPath(...)` on class `ProblemB`.

```
public interface IPath {
  public List<Node> getPath();
  public int getTotalWeight();
}

public class Path implements IPath(){
// TODO
 }

public class ProblemB {
    private IGraph graph;
    public ProblemB(IGraph graph){
    this.graph = graph;
    }

    public IPath getShortestPath(INode initNode, INode endNode){
           // TODO
    }
}
```

3.2 Realization of Taks B

First of all, some efforts were needed to find the algorithms for the theory of graphs. I've considered, studied and tested the following methods:

- `Breadth-first search (BFS)` is good to search in unweighted graphs using a "queue" datastructures [BFS];
- `Depth-first search` is as `BFS` but uses `stacks` [DFS];
- `Dijkstra algorithm` solves the single-source shortest path problem for a graph with non-negative edge path costs [Dijk].

Finally, I've created a method which is a mixture of `BFS`, using ideas discussed in the post [BFS_post], and the pseudo code from `Dijkstra's algorithm` published in the wiki [Dijk]. Insead of using a `priority queues` [priority_q], I've exploited sorted sets of nodes. Sorting was done by means of comparing `pair<float,int>` [pair_type] structures. Only `IPath getShortestPath(...)` is illustrated in the following snips. The C/C++ code of the algorithm is

`cat include/Node_Edge.cc` [code].

```
#include "Edge.h"
#include "Node.h"
#include "Graph.h"
```

```
#include "Path.h"
#include "ProblemB.h"
#include <stdio.h>
#include <map>

unsigned int Node::index=0;
float * ProblemB::dist = NULL;



Path ProblemB::getShortestPath(Node *src, Node *trgt) const
{

    if (src == NULL || trgt == NULL || gr == NULL )     return Path("shortest-path");

    std::set<Node> nodes = gr->getNodes();
    std::vector<Edge *> edges = gr->getEdges();
    std::map<int, std::list<Node> > paths;
    std::list<Node> path;
    std::list<Node>::iterator it3;


    unsigned int nNodes=nodes.size();
    std::list<std::pair<Node,float> > *adj = new\
    std::list<std::pair<Node,float> >[nNodes];    // Pointer to an array containing adjacency lists
    unsigned int i,j;
    std::list<std::pair<Node,float> >::iterator it;
    for (i=0;i<edges.size();++i)\
    adj[edges[i]->getOrigin()->getIndex()].\
    push_back(std::make_pair(*edges[i]->getTarget(),edges[i]->getWeight()));


    unsigned int srcIndx= src->getIndex();
    unsigned int trgtIndx=trgt->getIndex();

    i=0.;
    std::set<Node>::iterator it1, it2;
    for ( it1=nodes.begin(); it1!=nodes.end(); ++it1) {
        if (i==srcIndx) dist[i]=0.;
        else dist[i]=INT_MAX;
        ++i;
    }



    std::set< Node, ltDist > q;
    q.insert( *src );
    paths[src->getIndex()].push_back(*src);

    while( !q.empty() ) {
        Node u = *q.begin();   // like u = q.front()
        q.erase( q.begin() ); // like q.pop()
        if(trgtIndx==u.getIndex())
              return Path("shortest-path",paths[trgtIndx]);
```

```
        for(it = adj[u.getIndex()].begin(); it != adj[u.getIndex()].end(); ++it)
        {
            float newDist = dist[u.getIndex()] + it->second;

            if (newDist < dist[it->first.getIndex()] )
            {
                if( q.count( it->first ) ) q.erase( it->first );
                dist[it->first.getIndex()] = newDist;
                q.insert( it->first );
                paths[it->first.getIndex()]=paths[u.getIndex()];
```

```
                paths[it->first.getIndex()].push_back(it->first);

            }
        }


    }

    return Path("shortest-path");


    }
```

while the python version is

```
def getShortestPath(self, nd1, nd2):
 """ find the shorters weighted path between nd1 and nd2 """

 if (len(nd1.getEdges())*len(nd2.getEdges())<1 ): return Path.Path("shortest-path")
 if (len(self.__graph.getNodes())<1): return Path.Path("shortest-path")

 nodes = self.__graph.getNodes()
 edges = self.__graph.getEdges()
 paths={}
 path=[]
 adj={}
 for edg in edges:

  _dict=adj.get(edg.getOrigin().getIndex(),{})
  _dict.update({edg.getTarget():edg.getWeight()})
  adj[edg.getOrigin().getIndex()]=_dict

 srcIndex = nd1.getIndex()
 trgtIndex = nd2.getIndex()

 for i in range(len(nodes)):
  if (i==srcIndex):
   self.__dist[i]=0.
  else:
   self.__dist[i]=INT_MAX

 q=set()
 q.add(nd1)
 paths[nd1.getIndex()]=paths.get(nd1.getIndex(),[]) + [nd1]
 while len(q)>0:
  q=set(sorted(q,cmp=self.sort))
  node=q.pop()
  if (trgtIndex == node.getIndex()): return   Path.Path("shortest-path",paths[trgtIndex])
  for k,v in adj[node.getIndex()].items():
    newDist = self.__dist[node.getIndex()] + v
    if newDist<self.__dist[k.getIndex()]:
     if k in q: q.remove(k)
     self.__dist[k.getIndex()] = newDist
     q.add(k)
     paths[k.getIndex()]=paths[node.getIndex()]
     paths[k.getIndex()]=paths.get(k.getIndex(),[]) + [k]


 return Path.Path("shortest-path")
```

Running the code, for example, the python executable, the initial graph and the shortes path between some two nodes can be plotted using the `tkz-graph` latex package [tkz-graph], as it is shown in the Figure 2.

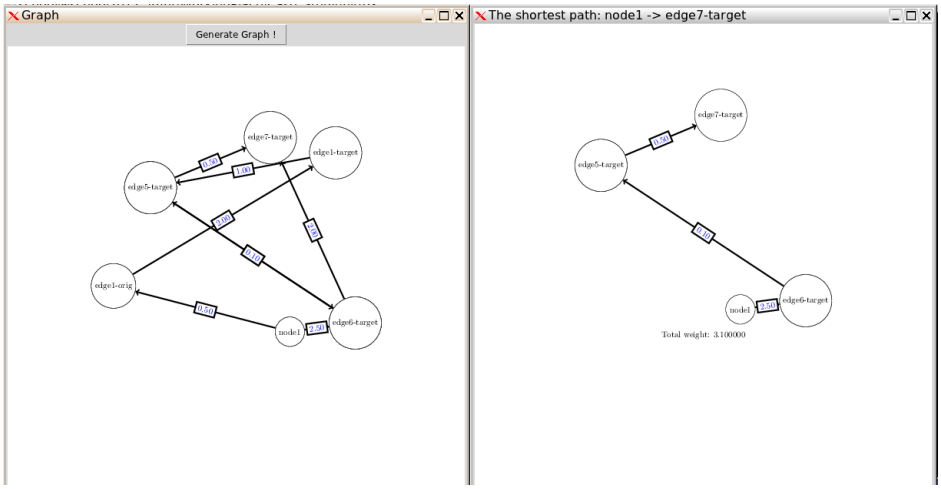

Figure 2. Tkinter python application realized `ProblemB`

The file `tkz-graph.py` should be found: i.e it is properly installed or it is in the current directory. In order to run python scripts, the PYTHONPATH is required to have the installing path of the python package. `Makefile` prints out the path as a final step of the installing the package.

3.3 Installation of `Taks B`

Instructions can be found under Task A installation in Python and Makefile - the way to build and install the projects.

4 `Task C`

4.1 Introduction to `Taks C`

5 HOW-TO obtain different format from RST source

- the `HTML` format:

```
rst2html.py HOW-TO.rst --syntax-highlight="long" > HOW-TO.html
```

- the `PDF` format:

```
rst2pdf   HOW-TO.rst
```

- the `TeX` format:

```
rst2latex   HOW-TO.rst  > HOW-TO.tex
```

- the `twiki` (for CERN twiki) format:

```
cat   HOW-TO.rst | rst2twiki.py  > HOW-TO.twiki
```

- the `wiki` format:

```
cat   HOW-TO.rst | rst3wiki.py  > HOW-TO.wiki
```

Good Luck!

6 References

code	The code insertion are obtained using the following shell command `cat src/ProblemA.cc | awk '{printf "  %s\n",$0}' > code.rst`
divisors_in_c	The fastest method to find all divisors http://www.cplusplus.com/forum/beginner/11510/
tkineter	Building a basic GUI application step-by-step in Python with Tkinter and wxPython http://sebsauvage.net/python/gui/#import
python_package	How do I write good/correct __init__.py files http://stackoverflow.com/questions/1944569/how-do-i-write-good- correct-init-py-files
tree	The package tree was built by means of `tree scripts/ProblemA`
pip	The following materials were used during the preparation of the manual http://mindref.blogspot.de/2010/06/python-setuptools.html http://stackoverflow.com/questions/20194565/running-custom- setuptools-build-during-install http://pythonhosted.org/an_example_pypi_project/setuptools.html http://programmingnotes.freeweq.com/?p=3737 http://guide.python-distribute.org/pip.html http://reinout.vanrees.org/weblog/2010/01/06/zest-releaser-entry-points.html http://pythonhosted.org/setuptools/ http://pythonhosted.org/setuptools/easy_install.html#compressed-installation http://www.siafoo.net/article/77 http://www.mxm.dk/2008/02/python-eggs-simple-introduction.html http://stackoverflow.com/questions/9185307/setup-py-and-installing-a-python-project http://mrtopf.de/blog/en/a-small-introduction-to-python-eggs/ http://stackoverflow.com/questions/9950362/how-do-i-create-python-eggs- from-distutils-source-packages http://stackoverflow.com/questions/739993/get-a-list-of-installed-python-modules
makefile_assoc	Makefile: find in array. http://stackoverflow.com/questions/7282414/makefile-find-in-array
makefile_trick	How to generate a Makefile with source in sub-directories using just one makefile http://stackoverflow.com/questions/231229/how-to-generate-a-makefile-with-source- in-sub-directories-using-just-one-makefil
BFS	Breadth-first search http://en.wikipedia.org/wiki/Breadth-first_search
DFS	Depth-first search http://en.wikipedia.org/wiki/Depth-first_search

Dijk(1, 2)	Dijkstra's algorithm http://en.wikipedia.org/wiki/Dijkstra%27s_algorithm
BFS_post	Using BFS to find shortest path (C++) http://blogse.quora.com/Using-BFS-to-find-shortest-path-C++
priority_q	Easiest way of using min priority queue with key update in C++ http://stackoverflow.com/questions/9209323/easiest-way- of-using-min-priority-queue-with-key-update-in-c http://www.cplusplus.com/reference/algorithm/make_heap/ http://www.cplusplus.com/reference/algorithm/push_heap/ http://www.cplusplus.com/reference/algorithm/pop_heap/
pair_type	`std::pair` http://www.cplusplus.com/reference/utility/make_pair/ http://www.cplusplus.com/reference/utility/pair/
tkz-graph	Typesetting a directed, weighted graph with TikZ http://tex.stackexchange.com/questions/37185/typesetting- a-directed-weighted-graph-with-tikz http://graphtheoryinlatex.wordpress.com/2011/10/17/options-for-vertices/ http://www.texample.net/tikz/examples/state-machine/
1	A footnote contains body elements, consistently indented by at least 3 spaces. This is the footnote's second paragraph.
2	Footnotes may be numbered, either manually (as in [1]) or automatically using a "#"-prefixed label. This footnote has a label so it can be referred to from multiple places, both as a footnote reference ([2]) and as a hyperlink reference (label).
3	This footnote is numbered automatically and anonymously using a label of "#" only.
*	Footnotes may also use symbols, specified with a "*" label. Here's a reference to the next footnote: [*].
†	This footnote shows the next symbol in the sequence.