Interactive-Confirm-Tool

<<<<<<< HEAD

201840058 蒋潇鹏

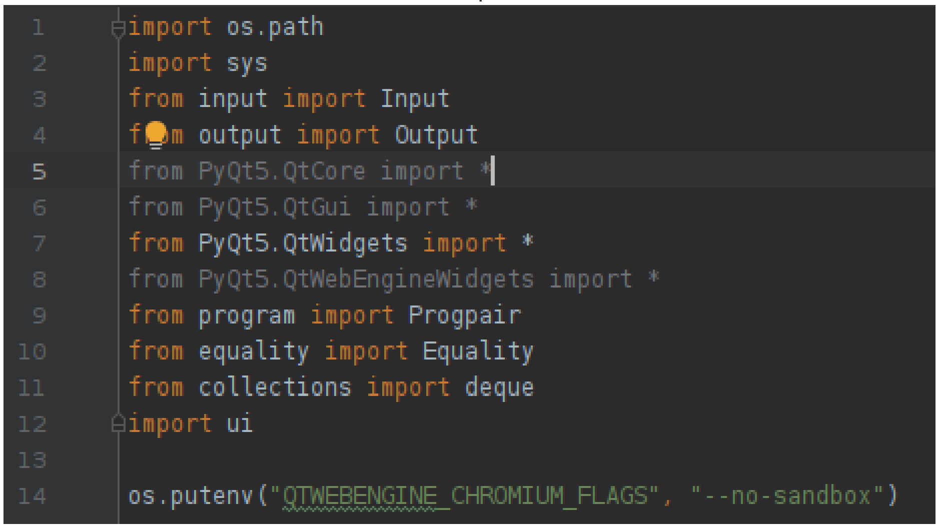
一、项目概述

本次实验目的是完成一个交互式等价确认工具，输入为等价判断程序得出的结果，能为用户提供交互方式，对程序等价性进行。输出为一个csv文件，输出经过验证后的等价程序对。

实验使用的语言为Python，GUI框架为PyQt5。使用的UI设计工具为QtDesigner

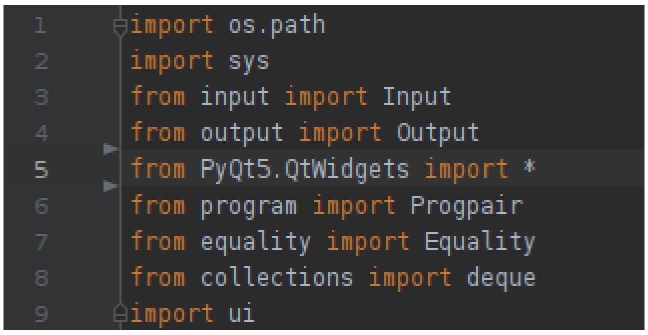
二、Git使用

1. 我在本地尝试了修改操作：
   修改前的代码：完成实验后我发现有些import的库并没有被使用，于是删除：



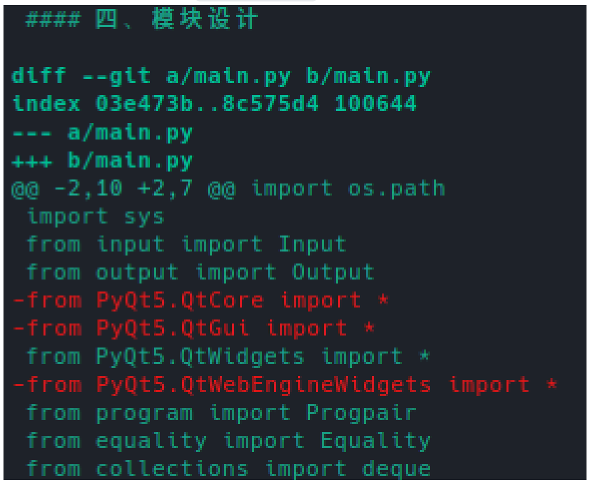
```
import os.path
import sys
from input import Input
from output import Output
from PyQt5.QtCore import *
from PyQt5.QtGui import *
from PyQt5.QtWidgets import *
from PyQt5.QtWebEngineWidgets import *
from program import Progpair
from equality import Equality
from collections import deque
import ui

os.putenv("QTWEBENGINE_CHROMIUM_FLAGS", "--no-sandbox")
```

   这是删除后的代码：



```
import os.path
import sys
from input import Input
from output import Output
from PyQt5.QtWidgets import *
from program import Progpair
from equality import Equality
from collections import deque
import ui
```

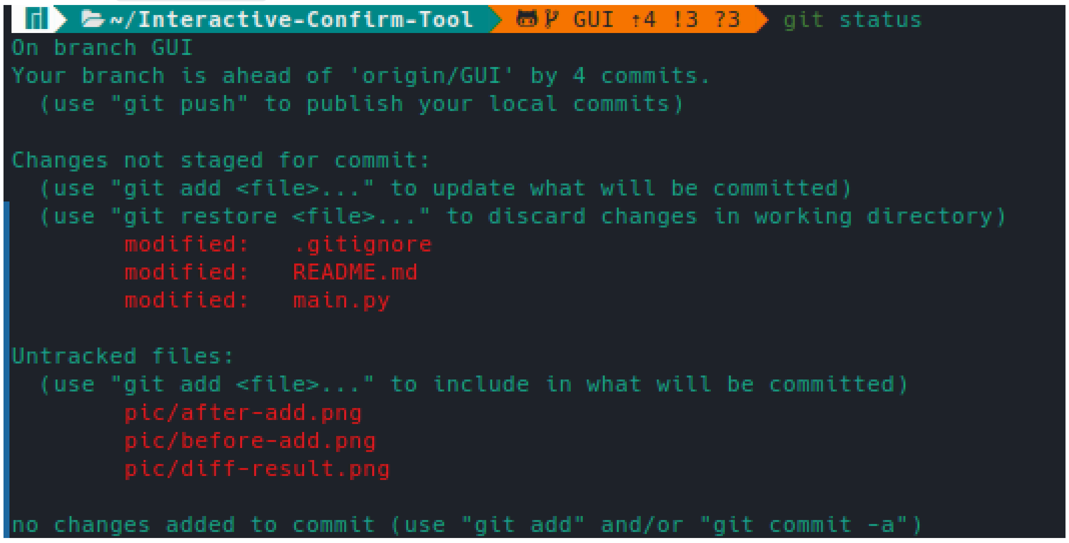
在Terminal运行 `git diff`：



```
 #### 四、模块设计

diff --git a/main.py b/main.py
index 03e473b..8c575d4 100644
--- a/main.py
+++ b/main.py
@@ -2,10 +2,7 @@ import os.path
 import sys
 from input import Input
 from output import Output
-from PyQt5.QtCore import *
-from PyQt5.QtGui import *
 from PyQt5.QtWidgets import *
-from PyQt5.QtWebEngineWidgets import *
 from program import Progpair
 from equality import Equality
 from collections import deque
```

2. 尝试将刚才的修改提交：

   首先运行 `git status` 查看当前状态：

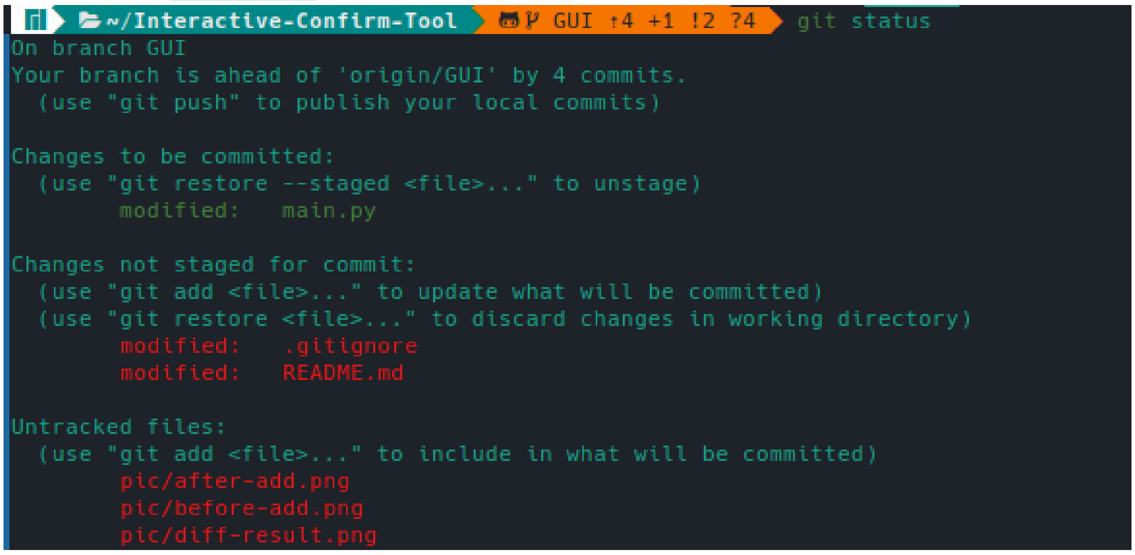


```
 ~/Interactive-Confirm-Tool   GUI ↑4 !3 ?3  git status
On branch GUI
Your branch is ahead of 'origin/GUI' by 4 commits.
  (use "git push" to publish your local commits)

Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git restore <file>..." to discard changes in working directory)
        modified:   .gitignore
        modified:   README.md
        modified:   main.py

Untracked files:
  (use "git add <file>..." to include in what will be committed)
        pic/after-add.png
        pic/before-add.png
        pic/diff-result.png

no changes added to commit (use "git add" and/or "git commit -a")
```

   可以从图中看见所有modified的文件，这些文件是已经被commit了的文件，但被修改了。还有Untracked files，是还没有被添加进git的文件。

   接下来我们运行 `git add main.py`，来把刚才对 `main.py` 文件的修改 commit 到 git 中。

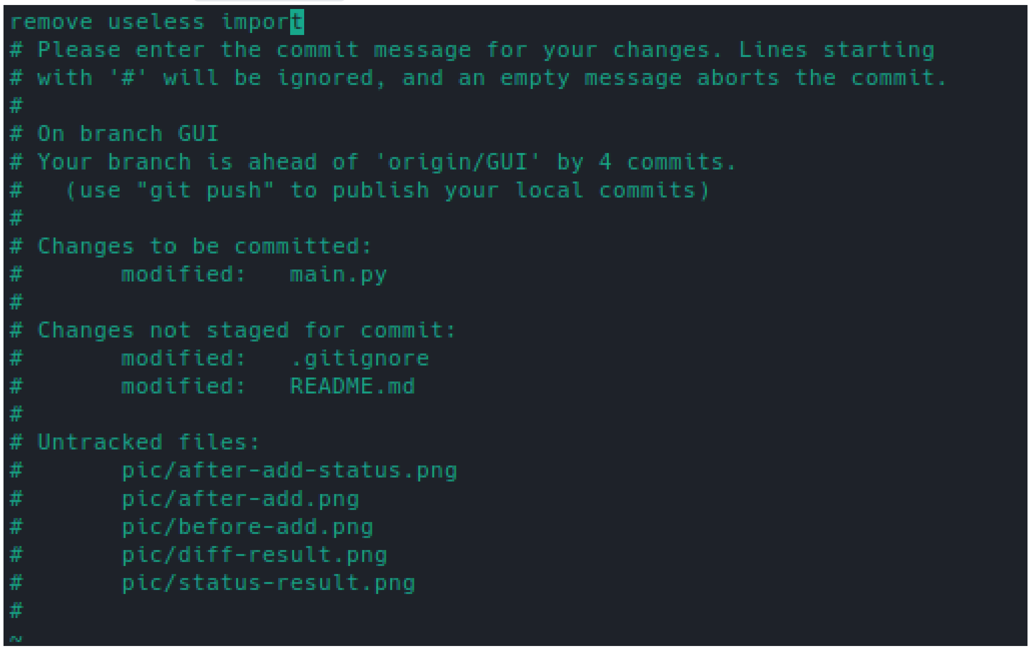
   然后再次运行 `git status` 查看状态：



```
 ~/Interactive-Confirm-Tool   GUI ↑4 +1 !2 ?4  git status
On branch GUI
Your branch is ahead of 'origin/GUI' by 4 commits.
  (use "git push" to publish your local commits)

Changes to be committed:
  (use "git restore --staged <file>..." to unstage)
        modified:   main.py

Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git restore <file>..." to discard changes in working directory)
        modified:   .gitignore
        modified:   README.md

Untracked files:
  (use "git add <file>..." to include in what will be committed)
        pic/after-add.png
        pic/before-add.png
        pic/diff-result.png
```

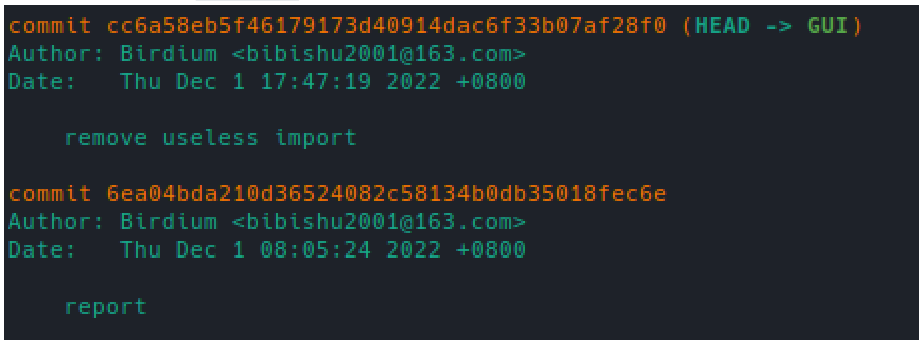
   可以看到之前的 `main.py` 已经从工作区被添加到暂存区了。

接下来我们运行 `git commit`：进入 vim 界面，输入message并保存：



```
remove useless import
# Please enter the commit message for your changes. Lines starting
# with '#' will be ignored, and an empty message aborts the commit.
#
# On branch GUI
# Your branch is ahead of 'origin/GUI' by 4 commits.
#   (use "git push" to publish your local commits)
#
# Changes to be committed:
#       modified:   main.py
#
# Changes not staged for commit:
#       modified:   .gitignore
#       modified:   README.md
#
# Untracked files:
#       pic/after-add-status.png
#       pic/after-add.png
#       pic/before-add.png
#       pic/diff-result.png
#       pic/status-result.png
#
~
```

保存后我们运行 `git log`：



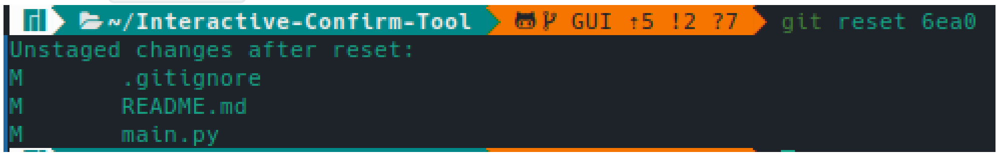
```
commit cc6a58eb5f46179173d40914dac6f33b07af28f0 (HEAD -> GUI)
Author: Birdium <bibishu2001@163.com>
Date:   Thu Dec 1 17:47:19 2022 +0800

    remove useless import

commit 6ea04bda210d36524082c58134b0db35018fec6e
Author: Birdium <bibishu2001@163.com>
Date:   Thu Dec 1 08:05:24 2022 +0800

    report
```

就可以看到上次的提交情况了。

3. 对于回退版本，我们有两种选择：`reset` 和 `revert`：

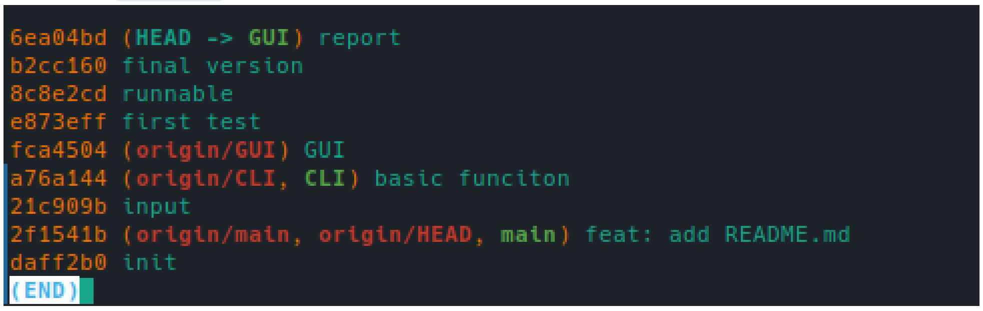
   reset和revert的区别在于，reset是回退到git的某次commit, 在此commit之后的均被舍弃。

   执行命令 `git reset` 如下：



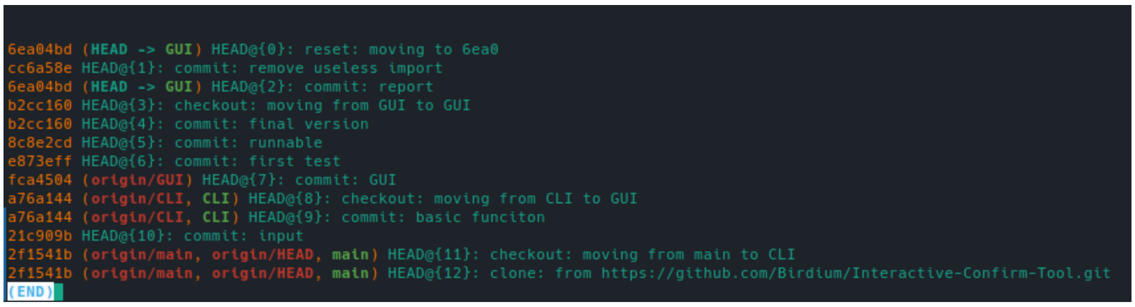
```
 ~/Interactive-Confirm-Tool   GUI ↑5 !2 ?7  git reset 6ea0
Unstaged changes after reset:
M       .gitignore
M       README.md
M       main.py
```

再次查看 `git log`，可以发现此前的提交不见了：



```
6ea04bd (HEAD -> GUI) report
b2cc160 final version
8c8e2cd runnable
e873eff first test
fca4504 (origin/GUI) GUI
a76a144 (origin/CLI, CLI) basic funciton
21c909b input
2f1541b (origin/main, origin/HEAD, main) feat: add README.md
daff2b0 init
(END)
```

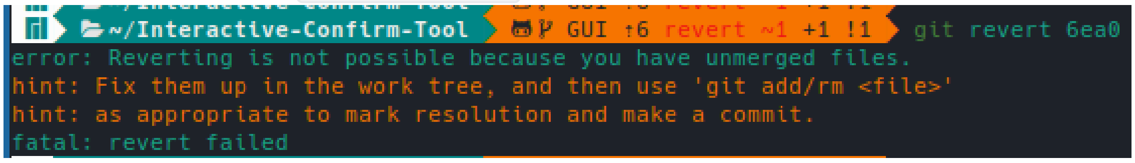
此时运行 `git reflog` 来查看所有的git操作：



```
6ea04bd (HEAD -> GUI) HEAD@{0}: reset: moving to 6ea0
cc6a58e HEAD@{1}: commit: remove useless import
6ea04bd (HEAD -> GUI) HEAD@{2}: commit: report
b2cc160 HEAD@{3}: checkout: moving from GUI to GUI
b2cc160 HEAD@{4}: commit: final version
8c8e2cd HEAD@{5}: commit: runnable
e873eff HEAD@{6}: commit: first test
fca4504 (origin/GUI) HEAD@{7}: commit: GUI
a76a144 (origin/CLI, CLI) HEAD@{8}: checkout: moving from CLI to GUI
a76a144 (origin/CLI, CLI) HEAD@{9}: commit: basic funciton
21c909b HEAD@{10}: commit: input
2f1541b (origin/main, origin/HEAD, main) HEAD@{11}: checkout: moving from main to CLI
2f1541b (origin/main, origin/HEAD, main) HEAD@{12}: clone: from https://github.com/Birdium/Interactive-Confirm-Tool.git
(END)
```

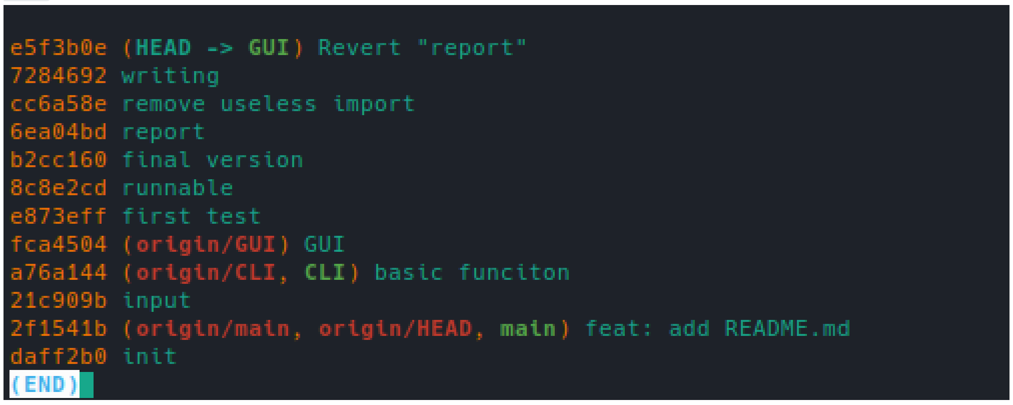
此时使用 `git reset cc6a` 即可恢复回`reset`前的状态。

同样地，我们也可以使用 `git revert 6ea0` ：



```
~/Interactive-Confirm-Tool  GUI ↑6 revert ~1 +1 !1  git revert 6ea0
error: Reverting is not possible because you have unmerged files.
hint: Fix them up in the work tree, and then use 'git add/rm <file>'
hint: as appropriate to mark resolution and make a commit.
fatal: revert failed
```

可以看到出现了错误，那是因为我们还有一些冲突没有解决，解决之后再次执行，可以发现`git log`变成了这样：

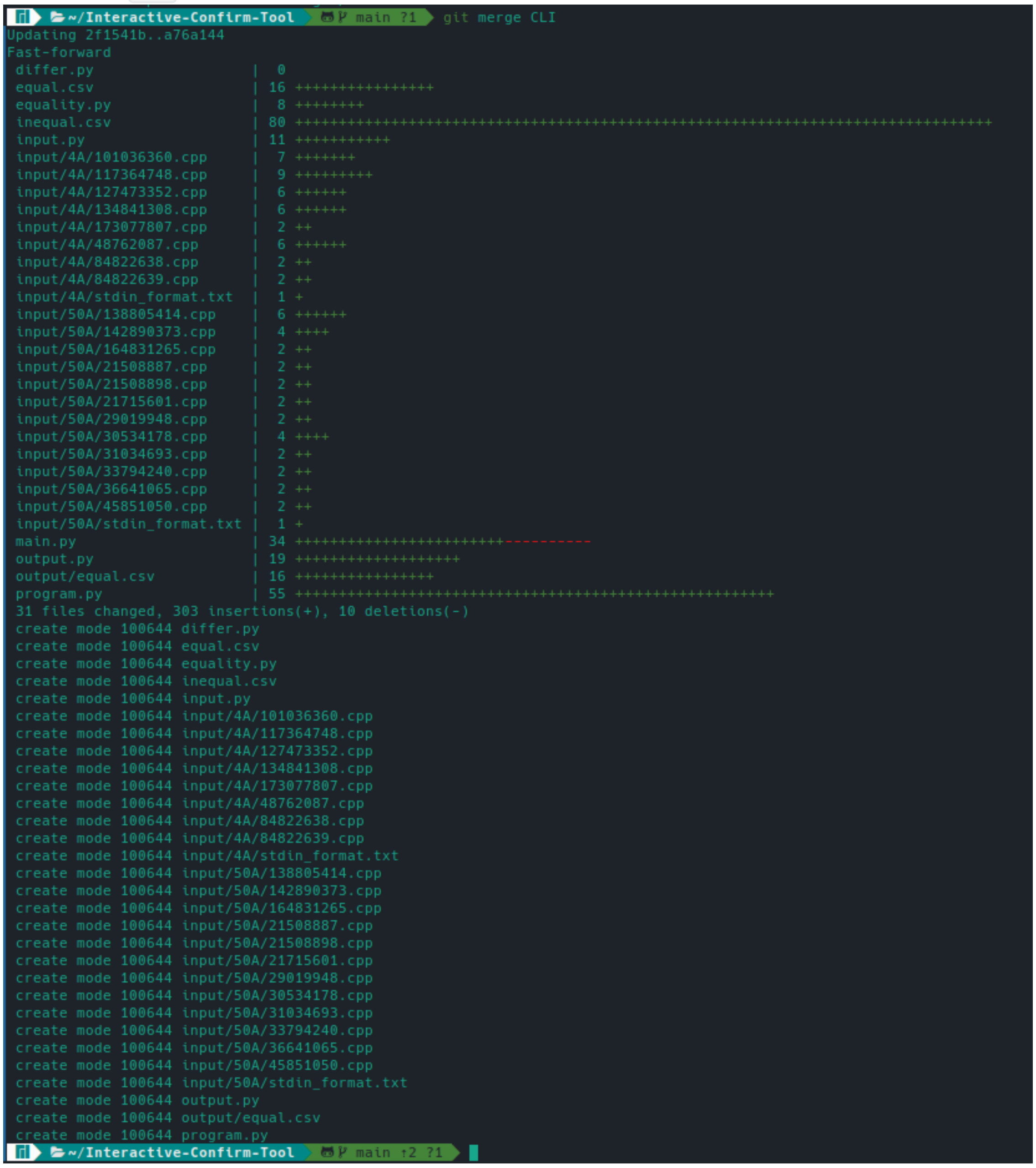


```
e5f3b0e (HEAD -> GUI) Revert "report"
7284692 writing
cc6a58e remove useless import
6ea04bd report
b2cc160 final version
8c8e2cd runnable
e873eff first test
fca4504 (origin/GUI) GUI
a76a144 (origin/CLI, CLI) basic funciton
21c909b input
2f1541b (origin/main, origin/HEAD, main) feat: add README.md
daff2b0 init
(END)
```

由此可以发现，`git reset` 不保留reset后的commit，直接将HEAD置于目标位置，`git revert` 则本质上相当于创建一个新的`commit`来恢复到之前的修改状态。

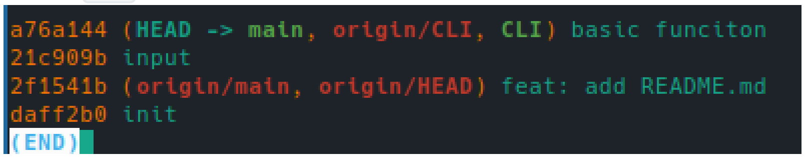
4. 接下来我们来尝试 `merge` 与 `rebase` 。

   首先我们把 `CLI` （命令行版本）merge到main分支里：



```
 ~/Interactive-Confirm-Tool  main ?1  git merge CLI
Updating 2f1541b..a76a144
Fast-forward
 differ.py                  |  0
 equal.csv                  | 16 ++++++++++++++++
 equality.py                |  8 ++++++++
 inequal.csv                | 80 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 input.py                   | 11 +++++++++++
 input/4A/101036360.cpp     |  7 +++++++
 input/4A/117364748.cpp     |  9 +++++++++
 input/4A/127473352.cpp     |  6 ++++++
 input/4A/134841308.cpp     |  6 ++++++
 input/4A/173077807.cpp     |  2 ++
 input/4A/48762087.cpp      |  6 ++++++
 input/4A/84822638.cpp      |  2 ++
 input/4A/84822639.cpp      |  2 ++
 input/4A/stdin_format.txt  |  1 +
 input/50A/138805414.cpp    |  6 ++++++
 input/50A/142890373.cpp    |  4 ++++
 input/50A/164831265.cpp    |  2 ++
 input/50A/21508887.cpp     |  2 ++
 input/50A/21508898.cpp     |  2 ++
 input/50A/21715601.cpp     |  2 ++
 input/50A/29019948.cpp     |  2 ++
 input/50A/30534178.cpp     |  4 ++++
 input/50A/31034693.cpp     |  2 ++
 input/50A/33794240.cpp     |  2 ++
 input/50A/36641065.cpp     |  2 ++
 input/50A/45851050.cpp     |  2 ++
 input/50A/stdin_format.txt |  1 +
 main.py                    | 34 ++++++++++++++++++++++++----------
 output.py                  | 19 +++++++++++++++++++
 output/equal.csv           | 16 ++++++++++++++++
 program.py                 | 55 +++++++++++++++++++++++++++++++++++++++++++++++++++++++
 31 files changed, 303 insertions(+), 10 deletions(-)
 create mode 100644 differ.py
 create mode 100644 equal.csv
 create mode 100644 equality.py
 create mode 100644 inequal.csv
 create mode 100644 input.py
 create mode 100644 input/4A/101036360.cpp
 create mode 100644 input/4A/117364748.cpp
 create mode 100644 input/4A/127473352.cpp
 create mode 100644 input/4A/134841308.cpp
 create mode 100644 input/4A/173077807.cpp
 create mode 100644 input/4A/48762087.cpp
 create mode 100644 input/4A/84822638.cpp
 create mode 100644 input/4A/84822639.cpp
 create mode 100644 input/4A/stdin_format.txt
 create mode 100644 input/50A/138805414.cpp
 create mode 100644 input/50A/142890373.cpp
 create mode 100644 input/50A/164831265.cpp
 create mode 100644 input/50A/21508887.cpp
 create mode 100644 input/50A/21508898.cpp
 create mode 100644 input/50A/21715601.cpp
 create mode 100644 input/50A/29019948.cpp
 create mode 100644 input/50A/30534178.cpp
 create mode 100644 input/50A/31034693.cpp
 create mode 100644 input/50A/33794240.cpp
 create mode 100644 input/50A/36641065.cpp
 create mode 100644 input/50A/45851050.cpp
 create mode 100644 input/50A/stdin_format.txt
 create mode 100644 output.py
 create mode 100644 output/equal.csv
 create mode 100644 program.py
 ~/Interactive-Confirm-Tool  main ↑2 ?1 
```

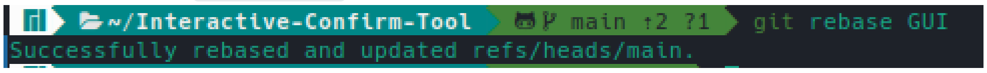
   再查看 `log`



```
a76a144 (HEAD -> main, origin/CLI, CLI) basic funciton
21c909b input
2f1541b (origin/main, origin/HEAD) feat: add README.md
daff2b0 init
(END)
```

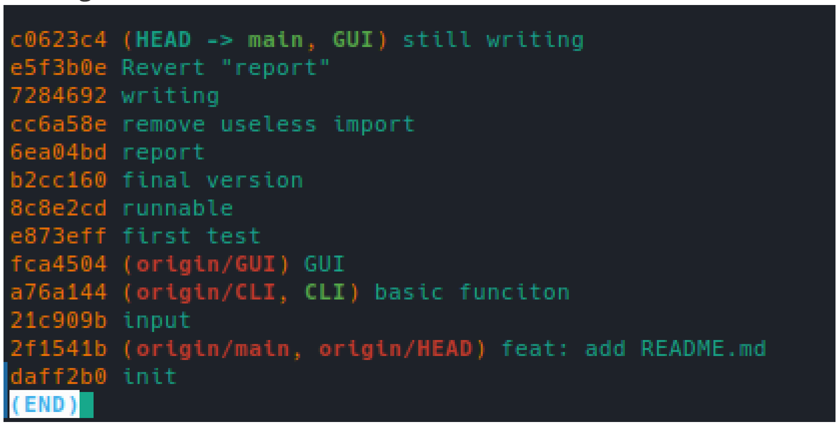
   可以看到CLI的内容被merge进了main，与之相对的是remote中的main(origin/main)

接下来我们尝试 `git rebase` 将GUI分支rebase到main：



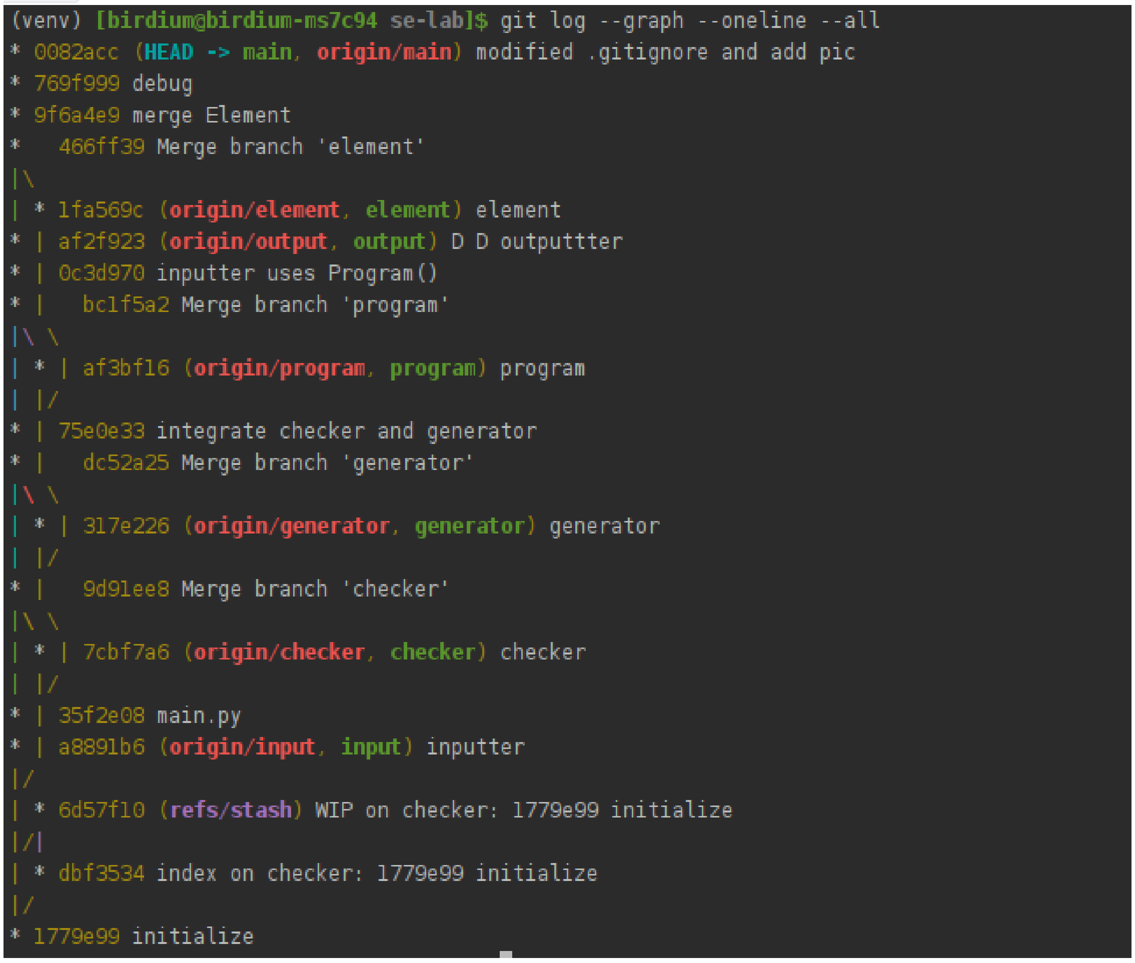
```
~/Interactive-Confirm-Tool  main ↑2 ?1  git rebase GUI
Successfully rebased and updated refs/heads/main.
```

查看log:



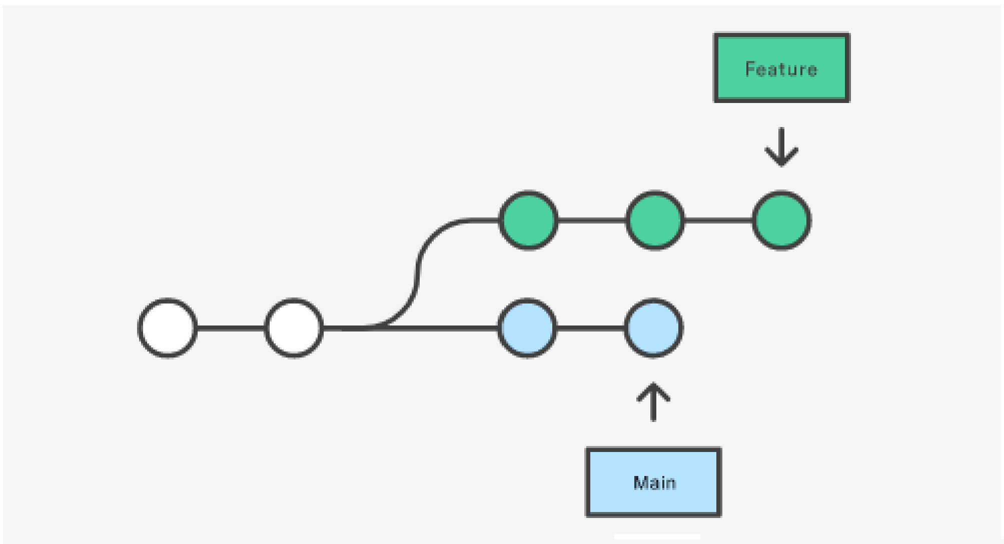
```
c0623c4 (HEAD -> main, GUI) still writing
e5f3b0e Revert "report"
7284692 writing
cc6a58e remove useless import
6ea04bd report
b2cc160 final version
8c8e2cd runnable
e873eff first test
fca4504 (origin/GUI) GUI
a76a144 (origin/CLI, CLI) basic funciton
21c909b input
2f1541b (origin/main, origin/HEAD) feat: add README.md
daff2b0 init
(END)
```

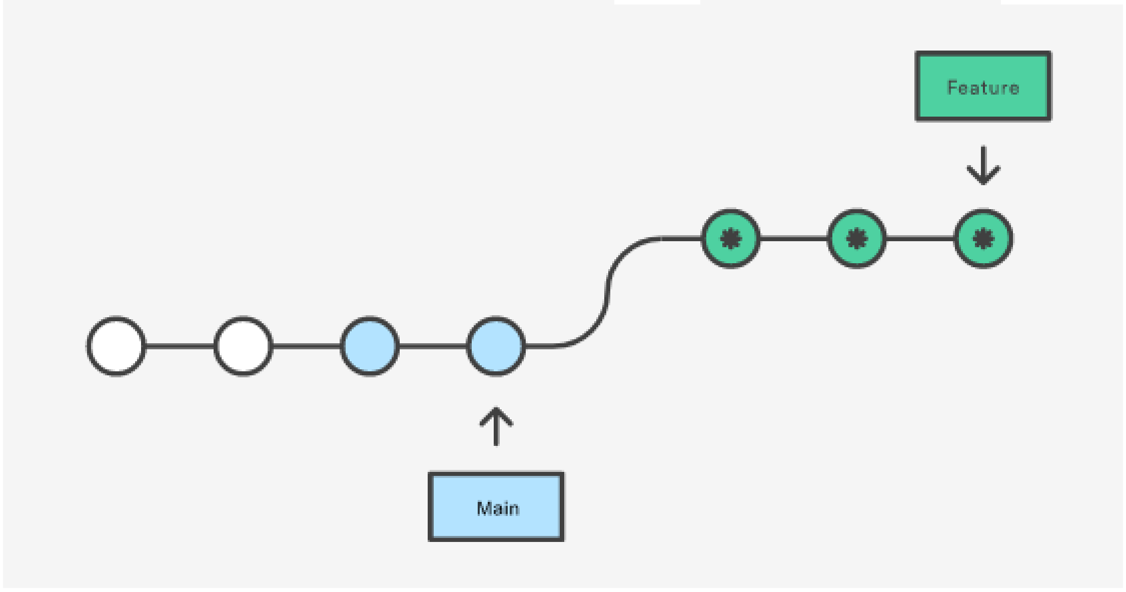
不过这里两个分支的merge都是直线形，并不太能体现其区别。如果有多个同时开发的分支，`git merge` 会在图上显示出合并的路径，如实验4中：



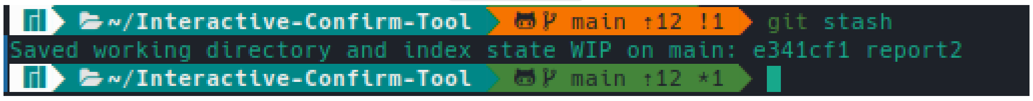
```
(venv) [birdium@birdium-ms7c94 se-lab]$ git log --graph --oneline --all
* 0082acc (HEAD -> main, origin/main) modified .gitignore and add pic
* 769f999 debug
* 9f6a4e9 merge Element
*   466ff39 Merge branch 'element'
|\
| * 1fa569c (origin/element, element) element
* | af2f923 (origin/output, output) D D outputtter
* | 0c3d970 inputter uses Program()
* |   bc1f5a2 Merge branch 'program'
|\ \
| * | af3bf16 (origin/program, program) program
| |/
* | 75e0e33 integrate checker and generator
* |   dc52a25 Merge branch 'generator'
|\ \
| * | 317e226 (origin/generator, generator) generator
| |/
* |   9d91ee8 Merge branch 'checker'
|\ \
| * | 7cbf7a6 (origin/checker, checker) checker
| |/
* | 35f2e08 main.py
* | a8891b6 (origin/input, input) inputter
|/
| * 6d57f10 (refs/stash) WIP on checker: 1779e99 initialize
|/|
| * dbf3534 index on checker: 1779e99 initialize
|/
* 1779e99 initialize
```

而 `git rebase` 就不会这样，它的行为如下图：





5. `git stash`的使用：
   首先我删除了程序中的一行代码，使用`git stash`



```
 ~/Interactive-Confirm-Tool  main ↑12 !1  git stash
Saved working directory and index state WIP on main: e341cf1 report2
 ~/Interactive-Confirm-Tool  main ↑12 *1 
```

   这时候被删除的代码消失了。
   此时我在原先代码上增加一行代码，然后运行 `git stash pop`，提示合并冲突，因为 `git stash pop` 能够恢复之前 `stash` 暂存的内容
6. `git cherry-pick`的使用：将指定的提交应用于其他分支。

三、关键代码介绍

1. 首先设计输入模块，我们考虑输入模块的需求：读取一个csv文件的路径，因此我们只需要提供一个静态的方法，将读入作为一个列表返回。

```python
class Input:

    @staticmethod
    def read(csv_path):
        with open(csv_path, 'r', encoding='utf-8') as f:
            reader = csv.reader(f)
            headers = next(reader)
            return [row for row in reader]
```

2. 然后是设计输出模块，输出模块的需求是写入一个csv文件，内容是verified_pairs。Output类需要先辈verified_pairs 和 output_dir 初始化，随后执行write_csv。

```
class Output:

    def __init__(self, verified_pairs, output_dir):
        self.__output_dir__ = os.path.join(output_dir, "output")
        self.__verified_pairs__ = [pair.get_list() for pair in 
verified_pairs]

    def write_csv(self):
        if not os.path.exists(self.__output_dir__):
            os.mkdir(self.__output_dir__)
        eq_csv_path = os.path.join(self.__output_dir__, "equal.csv")
        header = ['file1', 'file2']
        with open(eq_csv_path, "w", encoding='utf-8', newline='') as eq_csv:
            writer = csv.writer(eq_csv)
            writer.writerow(header)
            writer.writerows(self.__verified_pairs__)
```

3. 接下来设计数据表示模块，这里，数据由一个ProgPair类来表示，元素分别是两个程序路径和等价性。
diff() 调用 difflib来生成 diff比对结果的HTML数据。

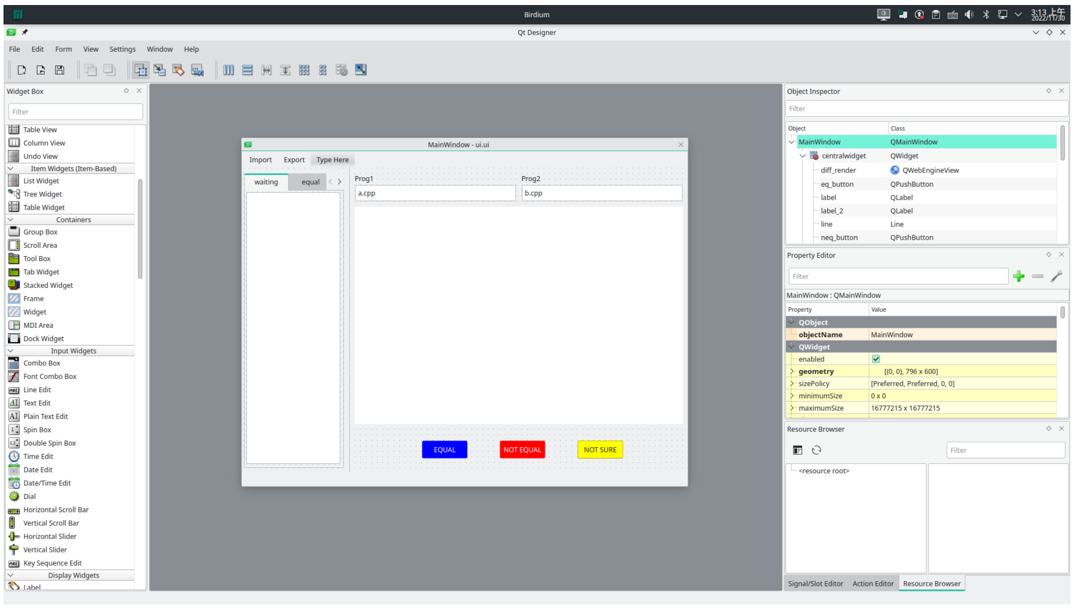
```
class Equality(Enum):
    EQUAL_M = 1
    NOT_EQUAL = 2
    HUMAN_VERIFIED = 3
    DOUBT = 4

class Progpair:
    def __init__(self, prog1, prog2, eq):
        self.prog1 = prog1
        self.prog2 = prog2
        self.eq = eq

    def diff(self):
        with open(self.prog1, 'r', encoding='utf-8') as f1:
            contents1 = f1.read().splitlines(keepends=True)
        with open(self.prog2, 'r', encoding='utf-8') as f2:
            contents2 = f2.read().splitlines(keepends=True)
        d = difflib.HtmlDiff()
        return d.make_file(contents1, contents2)

    def get_eq(self):
        return self.eq

    def set_eq(self, eq):
        self.eq = eq

    def get_list(self):
        return [self.prog1, self.prog2]
```

4. 最后是程序的主逻辑：ConfirmTool类继承了Qt的QMainWindow和ui.Ui_MainWIndow，后者是我在UI中自己设计的窗口。
   下面介绍它的接口：
   1. `load()`从当前路径装载 `input/equal.csv` 和 `input/nequal.csv`
   2. `export()` 将等价程序对输出到 `output/equal.csv`
   3. `display()` 用来更新 Qt 的各个组件状态来渲染
   4. `press()` 是按下UI按钮的响应函数，根据按下按钮的类型来将self.current_pair设置为对应类型。
   5. `get_next()` 是自动获取下一个待比较pair。我维护了一个 worklist 来维护待比较的pairs，get_next() 会从worklist中取出第一个元素（如果worklist）非空。
   6. `item_click_***()` 是按下列表中按钮的不同响应函数，我实现了按下左边菜单栏中的元素，能够将当前比较对重置为选中程序对的功能。

```
class ConfirmTool(QMainWindow, ui.Ui_MainWindow):

    def __init__(self, parent=None):
        super(ConfirmTool, self).__init__(parent)
        self.setupUi(self)
        self.eq_list = []
        self.neq_list = []
        self.worklist: deque = None
        self.eq_pairs = []
        self.neq_pairs = []
        self.human_verified_pairs = []
        self.doubt_pairs = []
        self.current_pair: Progpair = None
        self.load_path = os.path.join(os.getcwd())
        self.export_path = os.path.join(os.getcwd())
        self.eq_button.clicked.connect(lambda:
self.press(Equality.HUMAN_VERIFIED))
        self.neq_button.clicked.connect(lambda:
self.press(Equality.NOT_EQUAL))
        self.notsure_button.clicked.connect(lambda:
self.press(Equality.DOUBT))
        self.actionImport_from.triggered.connect(lambda:
self.load(self.load_path))
        self.actionExport_to.triggered.connect(lambda:
self.export(self.export_path))
        self.waiting_listview.itemClicked.connect(self.item_click_judged)
        self.nequal_listview.itemClicked.connect(self.item_click_neq)
        self.equal_listview.itemClicked.connect(self.item_click_verified)
        self.nsure_listview.itemClicked.connect(self.item_click_doubt)
        self.item_map = {}

    def item_click_judged(self):
        item = self.waiting_listview.selectedItems()[0]
        clicked_pair = self.item_map[item.text()]
        if self.current_pair is not None and self.current_pair is not
clicked_pair:
            self.worklist.appendleft(self.current_pair)
            self.current_pair = clicked_pair
        self.display()
    def item_click_neq(self):
        item = self.nequal_listview.selectedItems()[0]
        clicked_pair = self.item_map[item.text()]
        if self.current_pair is not None and self.current_pair is not
clicked_pair:
            self.worklist.appendleft(self.current_pair)
        self.current_pair = clicked_pair
        self.display()

    def item_click_verified(self):
        item = self.equal_listview.selectedItems()[0]
        clicked_pair = self.item_map[item.text()]
        if self.current_pair is not None and self.current_pair is not
clicked_pair:
            self.worklist.appendleft(self.current_pair)
            self.current_pair = clicked_pair
        self.display()

    def item_click_doubt(self):
        item = self.nsure_listview.selectedItems()[0]
        clicked_pair = self.item_map[item.text()]
        if self.current_pair is not None and self.current_pair is not
clicked_pair:
            self.worklist.appendleft(self.current_pair)
            self.current_pair = clicked_pair
        self.display()

    def get_next(self):
        if len(self.worklist) > 0:
            self.current_pair = self.worklist.popleft()
            self.display()
        widget2list = [
            [self.equal_listview, self.human_verified_pairs],
            [self.nequal_listview, self.neq_pairs],
            [self.waiting_listview, self.eq_pairs],
            [self.nsure_listview, self.doubt_pairs]
        ]
        self.item_map = {}
        for widget, pair_list in widget2list:
            widget.clear()
            for pair in pair_list:
                item_str = pair.prog1 + "," + pair.prog2
                item = QListWidgetItem(pair.prog1 + "," + pair.prog2)
                self.item_map[item_str] = pair
                widget.addItem(item)

    def press(self, equality: Equality):
        if self.current_pair is not None:
            self.current_pair.eq = equality
            for pairlist in [self.eq_pairs, self.neq_pairs,
self.human_verified_pairs, self.doubt_pairs]:
                if self.current_pair in pairlist:
                    pairlist.remove(self.current_pair)

            if equality == Equality.HUMAN_VERIFIED:
                self.human_verified_pairs.append(self.current_pair)
            elif equality == Equality.NOT_EQUAL:
                self.neq_pairs.append(self.current_pair)
            elif equality == Equality.DOUBT:
                self.doubt_pairs.append(self.current_pair)
            self.get_next()

    def display(self):
        if self.current_pair is not None:
            diff = self.current_pair.diff()
            self.prog1_text.setText(self.current_pair.prog1)
            self.prog2_text.setText(self.current_pair.prog2)
            self.diff_render.setHtml(diff)
            if self.current_pair.eq == Equality.EQUAL_M:
                self.pair_category.setText("Machine Judged Equal")
            elif self.current_pair.eq == Equality.NOT_EQUAL:
                self.pair_category.setText("Not Equal")
            elif self.current_pair.eq == Equality.HUMAN_VERIFIED:
                self.pair_category.setText("Human Verified Equal")
            elif self.current_pair.eq == Equality.DOUBT:
                self.pair_category.setText("Doubt")


    def load(self, fname):
        eq_name = os.path.join(fname, 'input/equal.csv')
        neq_name = os.path.join(fname, 'input/inequal.csv')
        self.eq_list = Input.read(eq_name)
        self.neq_list = Input.read(neq_name)
        self.item_map = {}
        self.eq_pairs = [Progpair(pair[0], pair[1], Equality.EQUAL_M) for
pair in self.eq_list]
        self.neq_pairs = [Progpair(pair[0], pair[1], Equality.NOT_EQUAL) for
pair in self.neq_list]
        self.human_verified_pairs = []
        self.doubt_pairs = []
        self.worklist = deque(self.eq_pairs)
        self.get_next()

    def export(self, fname):
        # eq_name = os.path.join(fname, 'input/equal.csv')
        o = Output(self.human_verified_pairs, fname)
        o.write_csv()


if __name__ == '__main__':
    app = QApplication(sys.argv)
    tool = ConfirmTool()
    tool.show()
    sys.exit(app.exec_())
```

四、GUI展示

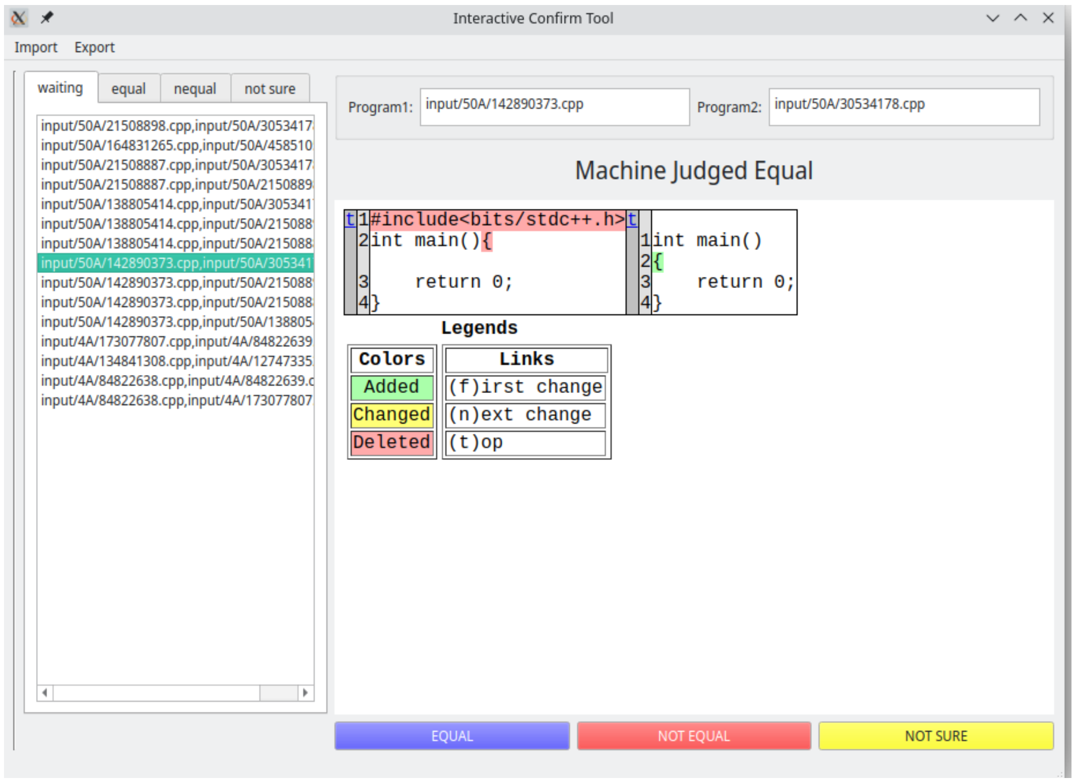
1. 程序运行的流程：
    1. 安装环境:（以Ubuntu为例）
        1. git python： `apt install git python3`
        2. pyqt5, pyqt5-tools, pyqtwebengine: `pip install pyqt5 pyqt5-tools pyqtwebengine`
    2. 运行 `git clone https://github.com/Birdium/Interactive-Confirm-Tool.git`，将代码clone到本地
    3. 向 `input` 文件中添加等价判断程序的输出
    4. 运行 `python3 main.py`
    5. `equal.csv` 文件会被生成到 `output.py` 文件里
2. GUI基本介绍：
    1. 我使用了QtDesigner来设计UI，QtDesigner支持图形化界面设计生成基于Html的.ui文件，之后可以使用pyqt5-tools中的pyuic5，执行 `pyuic5 [ui_file] > [py_file]` 生成对应的python 类文件。



Object	Class
MainWindow	QMainWindow
centralwidget	QWidget
diff_render	QWebEngineView
eq_button	QPushButton
label	QLabel
label_2	QLabel
line	Line
neq_button	QPushButton

MainWindow : QMainWindow

Property	Value
QObject	
objectName	MainWindow
QWidget	
enabled	✓
geometry	[(0, 0), 796 x 600]
sizePolicy	[Preferred, Preferred, 0, 0]
minimumSize	0 x 0
maximumSize	16777215 x 16777215

2. 

input/50A/21508898.cpp,input/50A/3053417
input/50A/164831265.cpp,input/50A/458510
input/50A/21508887.cpp,input/50A/3053417
input/50A/21508887.cpp,input/50A/2150889
input/50A/138805414.cpp,input/50A/305341
input/50A/138805414.cpp,input/50A/215088
input/50A/138805414.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/305341
input/50A/142890373.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/138805
input/4A/173077807.cpp,input/4A/84822639
input/4A/134841308.cpp,input/4A/12747335
input/4A/84822638.cpp,input/4A/84822639.c
input/4A/84822638.cpp,input/4A/173077807

Program1: input/50A/142890373.cpp
Program2: input/50A/30534178.cpp

Machine Judged Equal

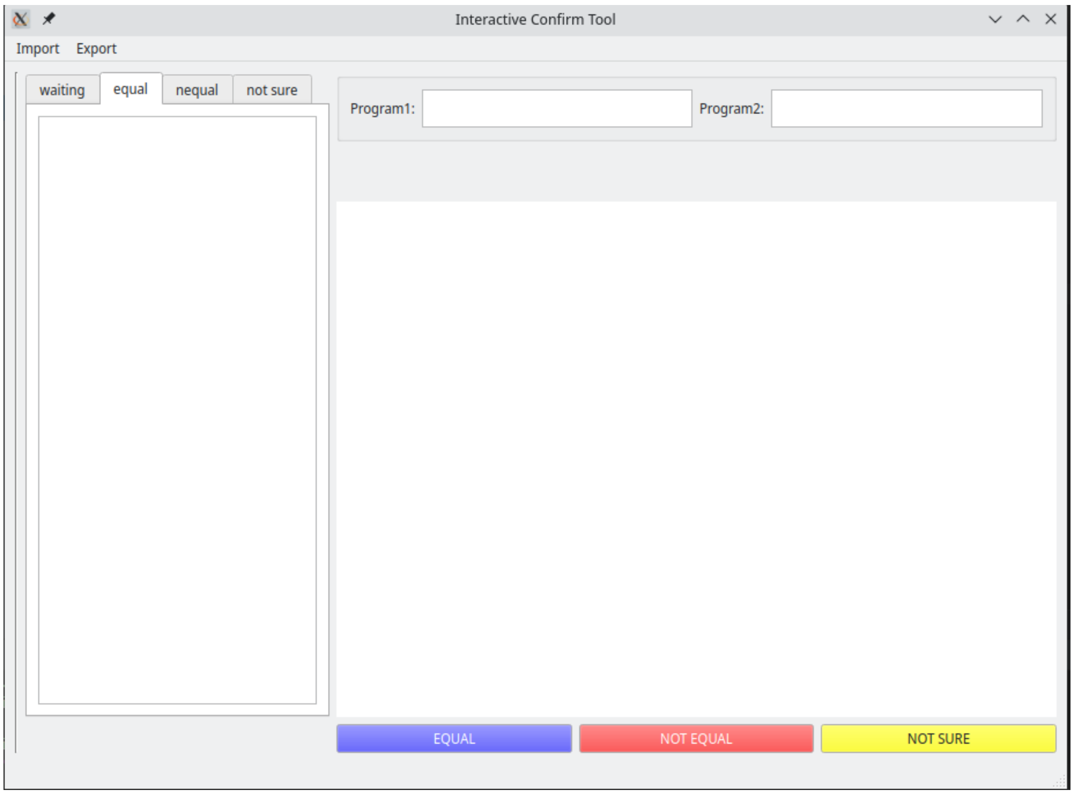
```
#include<bits/stdc++.h>
int main(){                 int main()
                            {
    return 0;                   return 0;
}                           }
```

Legends

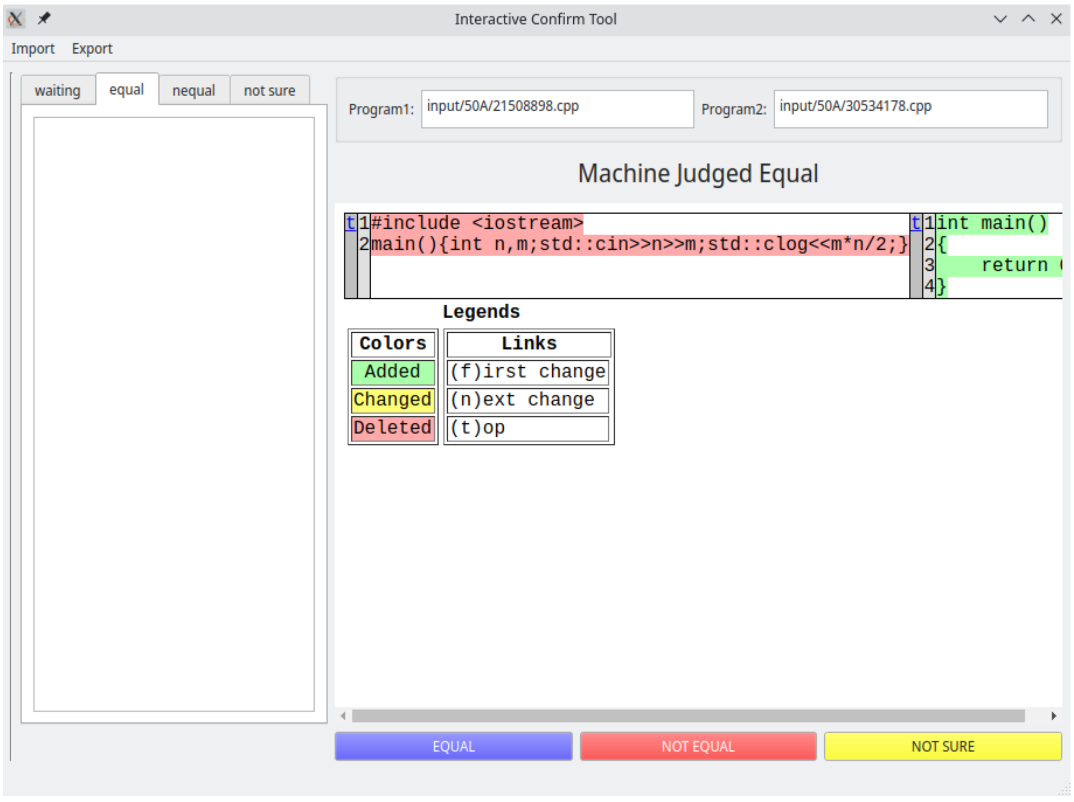
Colors	Links
Added	(f)irst change
Changed	(n)ext change
Deleted	(t)op

3. 菜单栏中的Import, Export使用QMenu和QAction实现了导入导出功能，分别**接受实验4给出的等价程序对作为输入**和**输出人工确认后的等价程序对**
4. 左边是一个QTabView，每个Tab中有一个QListWidget来显示待比较程序对
5. 右边上面是一个QGroupBox中套了两对QLabel和QTextBrowser，来指示正在比较的两个程序名
6. 右边中间是一个QWebEngineView，通过渲染HTML来**直观展示需要进行人工等价性确认的两个文件**
7. 右边下面是三个按钮为用户提供**交互式选项**（等价 不等价 存疑）

3. GUI演示**详细流程**（Manjaro KDE）：

1. 

程序的初始界面，按下Import->Import from，从文件中读取等价判断结果：



Program1: input/50A/21508898.cpp

Program2: input/50A/30534178.cpp

Machine Judged Equal

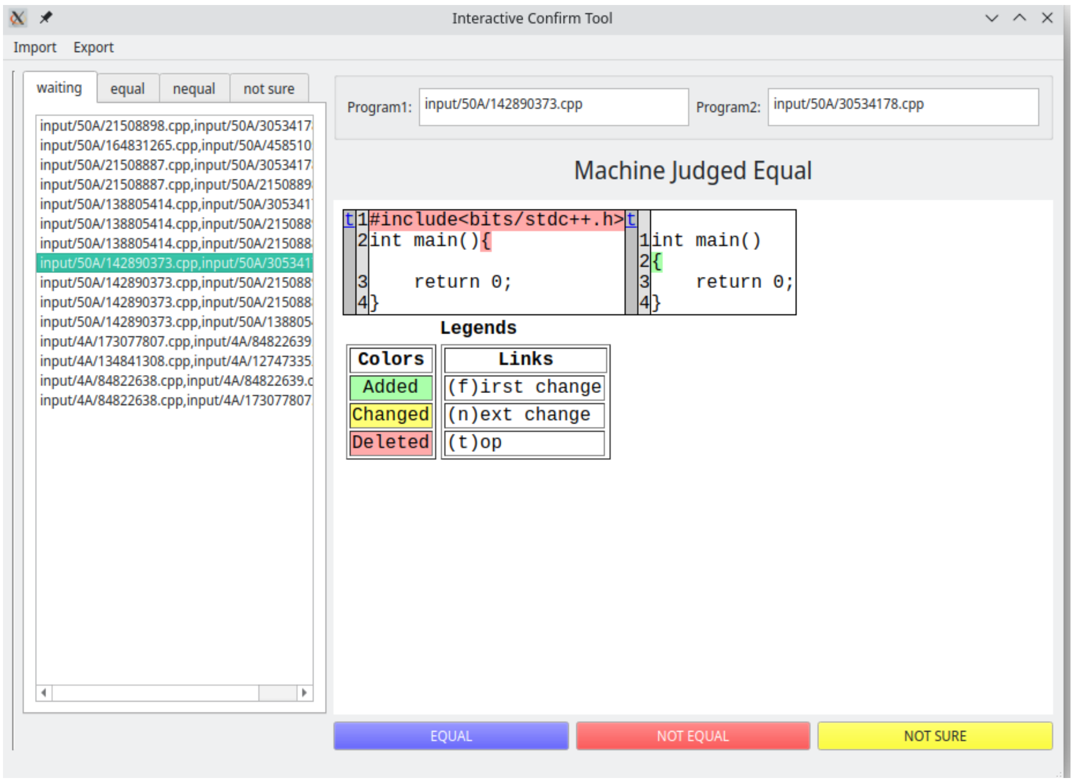
```
t #include <iostream>
  main(){int n,m;std::cin>>n>>m;std::clog<<m*n/2;}
```

```
t int main()
  {
      return (
  }
```

Legends

Colors	Links
Added	(f)irst change
Changed	(n)ext change
Deleted	(t)op

切换到waiting所在tab，点击程序对，可以手动切换程序对。



```
input/50A/21508898.cpp,input/50A/3053417
input/50A/164831265.cpp,input/50A/458510
input/50A/21508887.cpp,input/50A/3053417
input/50A/21508887.cpp,input/50A/2150889
input/50A/138805414.cpp,input/50A/305341
input/50A/138805414.cpp,input/50A/215088
input/50A/138805414.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/305341
input/50A/142890373.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/138805
input/4A/173077807.cpp,input/4A/84822639
input/4A/134841308.cpp,input/4A/12747335
input/4A/84822638.cpp,input/4A/84822639.c
input/4A/84822638.cpp,input/4A/173077807
```

Program1: input/50A/142890373.cpp Program2: input/50A/30534178.cpp

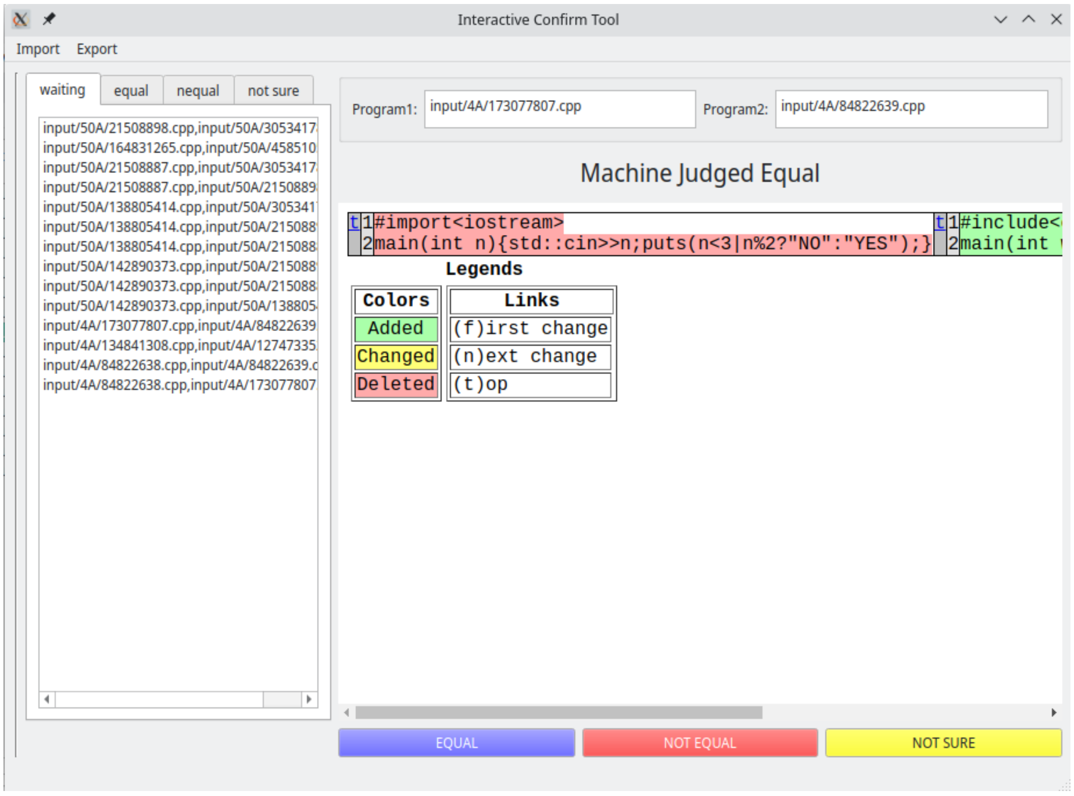
Machine Judged Equal

```
t 1 #include<bits/stdc++.h>   t
  2 int main(){                  1 int main()
                                 2 {
  3     return 0;                3     return 0;
  4 }                            4 }
```

Legends

Colors	Links
🟩 Added	(f)irst change
🟨 Changed	(n)ext change
🟥 Deleted	(t)op

点击EQUAL，该程序对从waiting中消失，并推荐了下一对程序对：



```
input/50A/21508898.cpp,input/50A/3053417
input/50A/164831265.cpp,input/50A/458510
input/50A/21508887.cpp,input/50A/3053417
input/50A/21508887.cpp,input/50A/2150889
input/50A/138805414.cpp,input/50A/305341
input/50A/138805414.cpp,input/50A/215088
input/50A/138805414.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/138805
input/4A/173077807.cpp,input/4A/84822639
input/4A/134841308.cpp,input/4A/12747335
input/4A/84822638.cpp,input/4A/84822639.c
input/4A/84822638.cpp,input/4A/173077807
```

Program1: input/4A/173077807.cpp Program2: input/4A/84822639.cpp

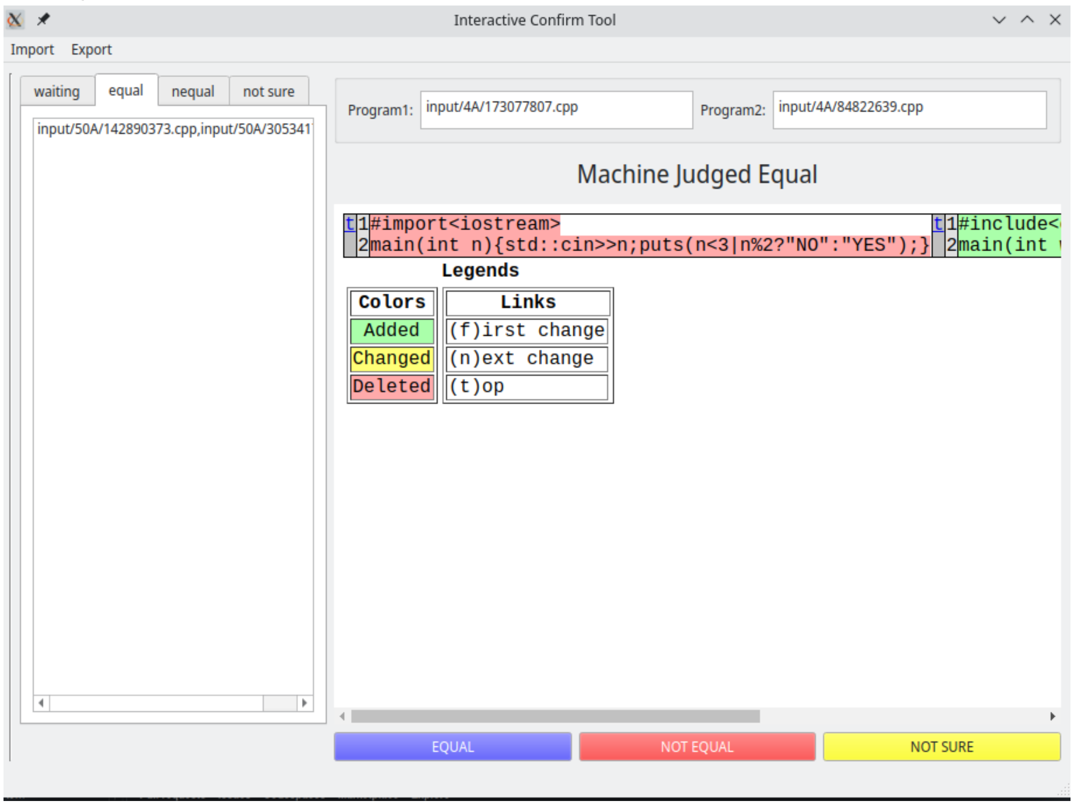
Machine Judged Equal

```
t 1 #import<iostream>                                    t 1 #include<
  2 main(int n){std::cin>>n;puts(n<3|n%2?"NO":"YES");}      2 main(int
```

Legends

Colors	Links
Added	(f)irst change
Changed	(n)ext change
Deleted	(t)op

转到equal tab，可以发现已经有一程序对完成了判断



```
input/50A/142890373.cpp,input/50A/305341
```

Program1: input/4A/173077807.cpp Program2: input/4A/84822639.cpp

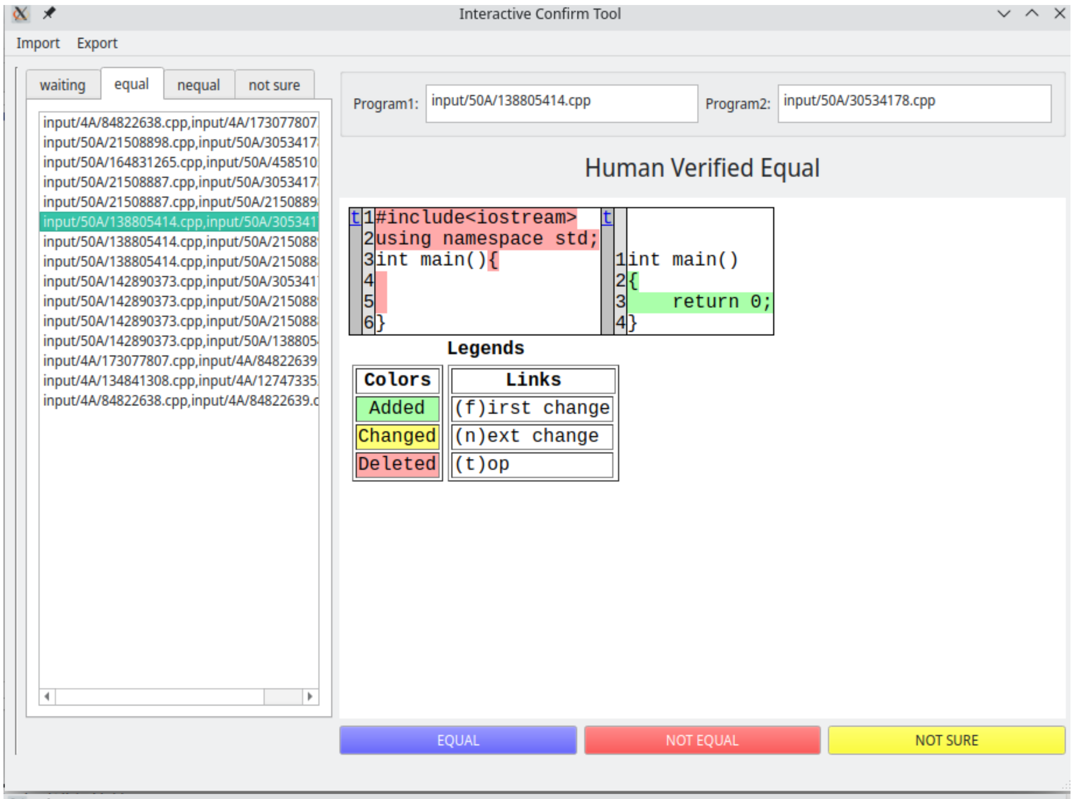
Machine Judged Equal

```
t 1 #import<iostream>                                    t 1 #include<
  2 main(int n){std::cin>>n;puts(n<3|n%2?"NO":"YES");}      2 main(int
```

Legends

Colors	Links
Added	(f)irst change
Changed	(n)ext change
Deleted	(t)op

对剩余程序对进行比较后得到结果：



```
input/4A/84822638.cpp,input/4A/173077807
input/50A/21508898.cpp,input/50A/3053417
input/50A/164831265.cpp,input/50A/458510
input/50A/21508887.cpp,input/50A/3053417
input/50A/21508887.cpp,input/50A/2150889
input/50A/138805414.cpp,input/50A/305341
input/50A/138805414.cpp,input/50A/215088
input/50A/138805414.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/305341
input/50A/142890373.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/138805
input/4A/173077807.cpp,input/4A/84822639
input/4A/134841308.cpp,input/4A/12747335
input/4A/84822638.cpp,input/4A/84822639.c
```

Program1: input/50A/138805414.cpp Program2: input/50A/30534178.cpp

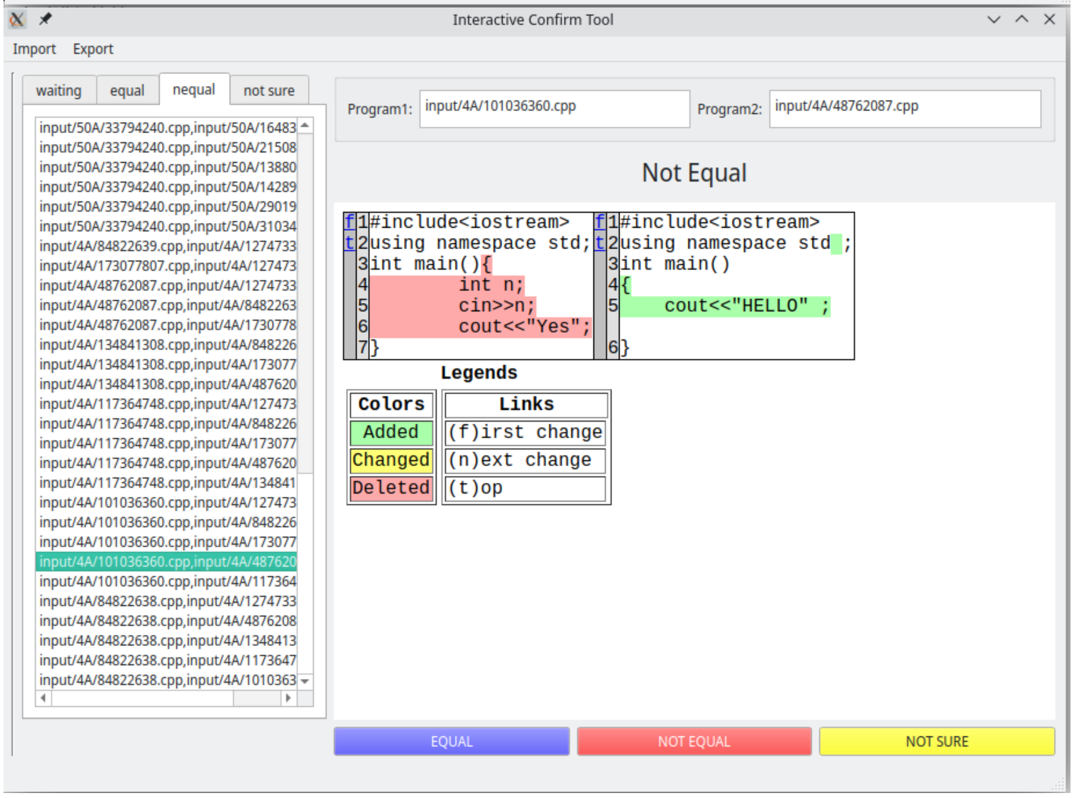
Human Verified Equal

```
t #include<iostream>        t
  using namespace std;
  int main(){                 int main()
                              {
                                  return 0;
  }                           }
```

Legends

Colors
Added
Changed
Deleted

Links
(f)irst change
(n)ext change
(t)op



```
input/50A/33794240.cpp,input/50A/16483
input/50A/33794240.cpp,input/50A/21508
input/50A/33794240.cpp,input/50A/13880
input/50A/33794240.cpp,input/50A/14289
input/50A/33794240.cpp,input/50A/29019
input/50A/33794240.cpp,input/50A/31034
input/4A/84822639.cpp,input/4A/1274733
input/4A/173077807.cpp,input/4A/127473
input/4A/48762087.cpp,input/4A/1274733
input/4A/48762087.cpp,input/4A/8482263
input/4A/48762087.cpp,input/4A/1730778
input/4A/134841308.cpp,input/4A/848226
input/4A/134841308.cpp,input/4A/173077
input/4A/134841308.cpp,input/4A/487620
input/4A/117364748.cpp,input/4A/127473
input/4A/117364748.cpp,input/4A/848226
input/4A/117364748.cpp,input/4A/173077
input/4A/117364748.cpp,input/4A/487620
input/4A/117364748.cpp,input/4A/134841
input/4A/101036360.cpp,input/4A/127473
input/4A/101036360.cpp,input/4A/848226
input/4A/101036360.cpp,input/4A/173077
input/4A/101036360.cpp,input/4A/487620
input/4A/101036360.cpp,input/4A/117364
input/4A/84822638.cpp,input/4A/1274733
input/4A/84822638.cpp,input/4A/4876208
input/4A/84822638.cpp,input/4A/1348413
input/4A/84822638.cpp,input/4A/1173647
input/4A/84822638.cpp,input/4A/1010363
```

Program1: input/4A/101036360.cpp Program2: input/4A/48762087.cpp

Not Equal

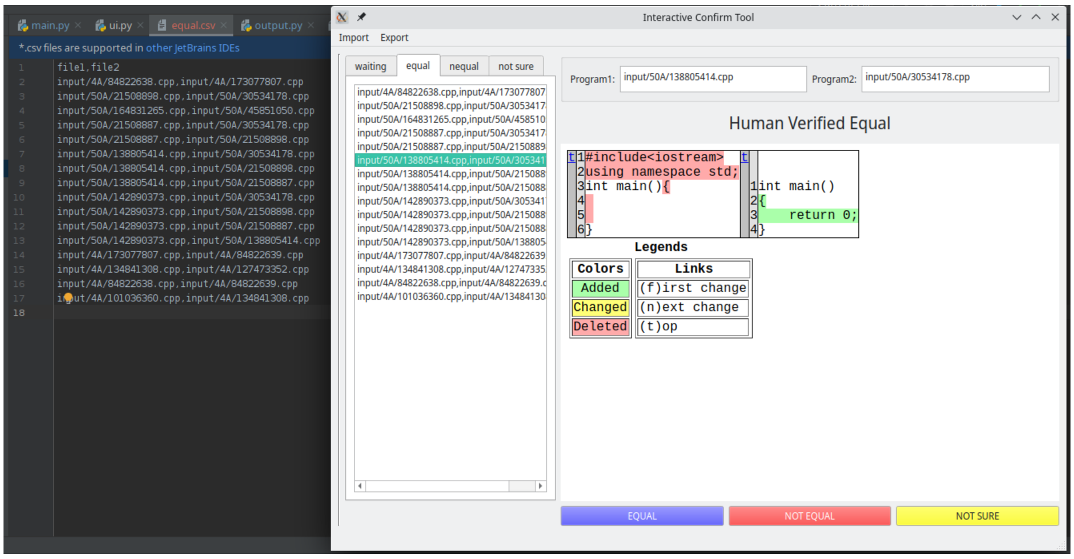
```
f #include<iostream>        f #include<iostream>
t using namespace std;      t using namespace std ;
  int main(){                 int main()
          int n;              {
          cin>>n;                 cout<<"HELLO" ;
          cout<<"Yes";
  }                           }
```

Legends

Colors
Added
Changed
Deleted

Links
(f)irst change
(n)ext change
(t)op

按下Export->Export to导出文件到`output/equal.csv`



```
file1,file2
input/4A/84822638.cpp,input/4A/173077807.cpp
input/50A/21508898.cpp,input/50A/30534178.cpp
input/50A/164831265.cpp,input/50A/45851050.cpp
input/50A/21508887.cpp,input/50A/30534178.cpp
input/50A/21508887.cpp,input/50A/21508898.cpp
input/50A/138805414.cpp,input/50A/30534178.cpp
input/50A/138805414.cpp,input/50A/21508898.cpp
input/50A/138805414.cpp,input/50A/21508887.cpp
input/50A/142890373.cpp,input/50A/30534178.cpp
input/50A/142890373.cpp,input/50A/21508898.cpp
input/50A/142890373.cpp,input/50A/21508887.cpp
input/50A/142890373.cpp,input/50A/138805414.cpp
input/4A/173077807.cpp,input/4A/84822639.cpp
input/4A/134841308.cpp,input/4A/127473352.cpp
input/4A/84822638.cpp,input/4A/84822639.cpp
input/4A/101036360.cpp,input/4A/134841308.cpp
```

```
input/4A/84822638.cpp,input/4A/173077807
input/50A/21508898.cpp,input/50A/3053417
input/50A/164831265.cpp,input/50A/458510
input/50A/21508887.cpp,input/50A/3053417
input/50A/21508887.cpp,input/50A/2150889
input/50A/138805414.cpp,input/50A/305341
input/50A/138805414.cpp,input/50A/215088
input/50A/138805414.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/305341
input/50A/142890373.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/215088
input/50A/142890373.cpp,input/50A/138805
input/4A/173077807.cpp,input/4A/84822639
input/4A/134841308.cpp,input/4A/12747335
input/4A/84822638.cpp,input/4A/84822639.c
input/4A/101036360.cpp,input/4A/13484130
```

Program1: input/50A/138805414.cpp Program2: input/50A/30534178.cpp

Human Verified Equal

```
t 1 #include<iostream>        t
  2 using namespace std;
  3 int main(){                 1 int main()
  4                             2 {
  5                             3     return 0;
  6 }                           4 }
```

Legends

Colors	Links
Added	(f)irst change
Changed	(n)ext change
Deleted	(t)op

可以看到，成功地导出了文件。

五、额外功能

1. 使用了difflib实现了diff，QtWebEngineView功能来渲染HTML（如上图演示）
2. 不仅支持自动推荐下一个程序对，还支持用户自由选择程序对
3. 基于PyQt5的可自由拖拽缩放的跨平台UI