Preface

بۇ [Tesseract] دەرسلىكى پۈتۈنلەي ئىنگلىزچە نۇسخىسى، ئۇيغۇر تىلى دەرسلىكى پات ئاردا چىقىدۇ.

ئۇيغۇر تىلى دەرسلىكى ئۇلان قىلىنىشنى كۆتۈپ تۇرالمىسا، ئېلخەت يېزىپ ئىلتىماس قىلىڭ ياكى ياردەم سوراڭ. بۇلارنىڭ ھەممىسى ھەقسىز ياردەم قىلىدۇ .

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This is Tesseract Tutorials is fully English version, and Uyghur Language tutorials coming soon.

What if can't wait Uyghur language tutorials release, please write E-mail: com_at_dlnu@126.com

to ask request OR any help. That all help free of charge.

Tesseract Tutorials

1   OCR Profile

What is OCR? And how the working principle of OCR?

OCR (Optical Character Recognition) refers the OCR goes to find any printable character area, which detect light, dark spot and its shape, size, then based on above properties translate into printable character from an image.

#	EN	UY	CN
Terminology		
1	Feature extraction	ئالاھەدبلىكنى ئېلىش	特征提取
2	Orientation and Segmentation	ئورۇن بەلگىلەش ۋە پارچىلاش	定位和分割
3			
4			

2   Tesseract Profile

2.1   Tesseract Quick Intro

Tesseract is Open Source OCR Engine, which is current stable version is Tesseract 5.x. Before Tesseract 4.x (exclude), Tesseract recognition is based character patterns which calls Tesseract legacy OCR engine mode.

But begins from Tesseract 4, Tesseract adds a new Neural Net (LSTM) based OCR engine which is focused on line recognition, but also still supports the legacy Tesseract OCR engine of Tesseract 3. Compatibility with Tesseract 3 is enabled by using the Legacy OCR Engine mode with (--oem 0) options. But have to know that, the traineddata files also need to support the legacy engine, for example those from the tessdata repository.

Tesseract Trained-data Repository table		
#	Repository	Profile
1	tessdata_fast	Fast trained LSTM models; Speed high, but NOT so high accurate percentage. *ONLY LSTM Engine mode;*
2	tessdata	Trained models with fast variant of the "best" LSTM models + legacy models *LSTM Engine mode +* legacy *Engine mode;*
3	tessdata_best	Best (most accurate) trained LSTM models; Speed low, but high accurate percentage. *ONLY LSTM Engine mode;*

Tesseract support cross platform, Windows, Mac OS, Linux all available。Tesseract support multiple image format such as JPEG、PNG、TIFF etc. And the Tesseract output also supports various output formats: plain text, HTML, PDF, TSV.

Tesseract use multiple image handle operation, feature extraction and machine learning tech. to implement OCR procedure. Tesseract work principle is using trained-data to recognize character first, and refer to the context and language model to make adjustment crude recognition result to empower recognition percentage.

Tesseract OCR Repository profile table		
#	Item	Value
1	Tesseract official website	N/A
2	Tesseract official Repository	https://github.com/tesseract-ocr/tesseract
3	GitHub repository Info	Languages C++ 96.5% Java 1.0% Makefile 0.9% CMake 0.8% C 0.5% Shell 0.3%
4	Supported Compilers	GCC 4.8 and above Clang 3.4 and above

	MSVC 2015, 2017

The Tesseract 4 (LSTM based) stable version is **4.0.0**, released on October 29, 2018.

The Tesseract 5 (LSTM based) stable version is **5.4.1**, released on June 11, 2024.

Tesseract can be used directly via command line, or (for programmers) by using an API to extract printed text from images.

Tesseract OCR Related Repository Profile Table			
#	**Item**	**Value**	**Profile**
1	Tesseract OCR DOC	https://github.com/tesseract-ocr/tessdoc https://github.com/tesseract-ocr/tessdoc.git https://tesseract-ocr.github.io/tessdoc/	Tesseract OCR Engine complete documentation
2			Data used for LSTM model training

2.2   Tesseract Windows

Tesseract for Windows maintains libtesseract, which is OCR engine library file; And tesseract, which is command line program. Developers can use libtesseract C or C++ API to build their own application.

```
Volkan@DESKTOP-LCD3FQ6 MINGW64 /c/Program Files/Tesseract-OCR/TESSERACT_4
$ ls -hl *tesseract*
-rwxr-xr-x 1 Volkan 197121  63M Mar 14  2019 libtesseract-4.dll*
-rwxr-xr-x 1 Volkan 197121 127K Sep  7 07:19 tesseract-uninstall.exe*
-rwxr-xr-x 1 Volkan 197121 835K Mar 14  2019 tesseract4.exe*
```

Command line

```
$ tesseract imagename outputbase [-l lang] [--oem ocrenginemode] [--psm pagesegmode] [configfiles...]
```

Argument intro:

imagename: Name of image to be OCR.

This argument value can be "image name", "image list" OR "stdin", means single image, OR image list, even stdin.

outputbase: OCR output result.

This argument value can be "output name" OR "stdout", means single image.

-l lang: Specify OCR recognition natural language.

--oem: OCR Engine Mode

This argument specifies OCR Engine type.

--psm: Page Segmentation Mode

This argument page segmentation type.

configfile: NOT so common use.

Using One Language

`$ tesseract images/eurotext.png file_out -l eng` // recognize English

Using Multiple Languages

`$ tesseract images/eurotext.png - -l eng+uig` // recognize English & Uyghur

Tesseract command line also support multiple image do OCR at once. Just crate a file, append OCR image target list, and use that image list file as an input.

```
Volkan@DESKTOP-LCD3FQ6 MINGW64 /f/xx/Train Tesseract 5.x/train_imgs_src
$ cat todo.txt
train_img1.png
train_img2.png
train_img3.png
train_img4.png
train_img5.png

Volkan@DESKTOP-LCD3FQ6 MINGW64 /f/xx/Train Tesseract 5.x/train_imgs_src
```

```
F:\xx\Train Tesseract 5.x\train_imgs_src>
F:\xx\Train Tesseract 5.x\train_imgs_src>tesseract5 todo.txt stdout -l num
Page 0 : train_img1.png
1234567890
Page 1 : train_img2.png
▯1234567890
Page 2 : train_img3.png
▯1234567890
Page 3 : train_img4.png
▯1234567390
Page 4 : train_img5.png
▯2234567890

F:\xx\Train Tesseract 5.x\train_imgs_src>
```

Have to notice that the "TODO.txt" image list file, every image line by line, and the line separator with "\n". If line operator is "\r\n", the command line occurs an error. In other word, use "Git Bash" tools "vi" command to create that "TODO.txt" file.

Windows Tesseract installation path would have lots of executables, which is helpful for main command line Tesseract works.

ambiguous_words.exe	12/14/2022 10:25	Application	1,120 KB
classifier_tester.exe	12/14/2022 10:25	Application	5,538 KB
cntraining.exe	12/14/2022 10:25	Application	5,203 KB
combine_lang_model.exe	12/14/2022 10:25	Application	4,028 KB
combine_tessdata.exe	12/14/2022 10:25	Application	1,308 KB
dawg2wordlist.exe	12/14/2022 10:26	Application	598 KB
lstmeval.exe	12/14/2022 10:26	Application	9,582 KB
lstmtraining.exe	12/14/2022 10:26	Application	10,656 KB
merge_unicharsets.exe	12/14/2022 10:26	Application	425 KB
mftraining.exe	12/14/2022 10:26	Application	5,873 KB
set_unicharset_properties.exe	12/14/2022 10:26	Application	7,386 KB
shapeclustering.exe	12/14/2022 10:26	Application	5,540 KB
tesseract5.exe Tesseract exe. file	12/14/2022 10:26	Application	1,369 KB
tesseract-uninstall.exe	09/07/2024 05:43	Application	147 KB
text2image.exe	12/14/2022 10:26	Application	11,200 KB
unicharset_extractor.exe	12/14/2022 10:26	Application	4,063 KB
winpath.exe	12/14/2022 09:23	Application	19 KB
wordlist2dawg.exe	12/14/2022 10:27	Application	1,109 KB

The helpful sub-command line intro would be coming soon.

3 Tesseract Install

3.1 Tesseract Windows

Go to website download latest Tesseract OCR Windows 64.

URI: https://digi.bib.uni-mannheim.de/tesseract/
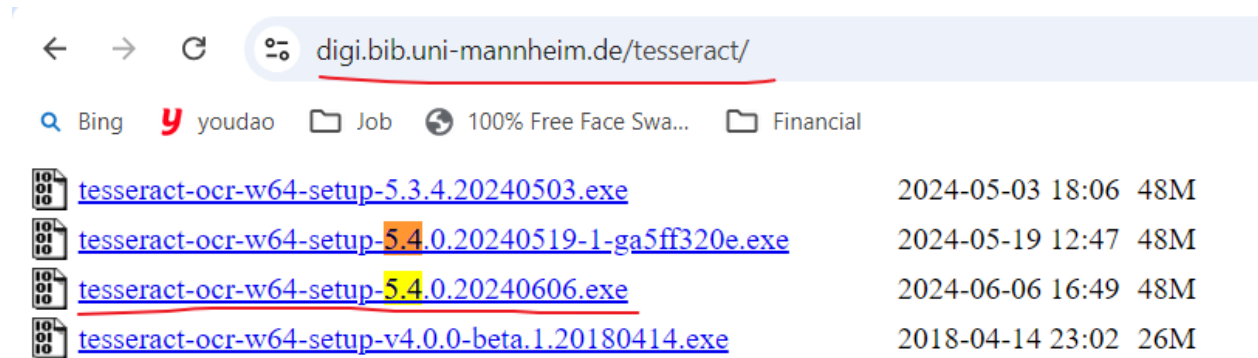
OR download directly tesseract-ocr-w64-setup-5.4.0.20240606.exe:

https://digi.bib.uni-mannheim.de/tesseract/tesseract-ocr-w64-setup-5.4.0.20240606.exe

After finish install, remember that append Tesseract bin path, and TESSDATA_PREFIX add into Environment variable. Environment variable TESSDATA_PREFIX refers {TESSERACT_OCR}/tessdata directory, which stores *. traineddata directory.

After configuration, if could output like below, means Tesseract 5 install succeeded.

```
C:\Users\Volkan>echo %TESSDATA_PREFIX%
C:\Program Files\Tesseract-OCR\TESSERACT_5\tessdata

C:\Users\Volkan>tesseract
Usage:
  tesseract5 --help | --help-extra | --version
  tesseract5 --list-langs
  tesseract5 imagename outputbase [options...] [configfile...]

OCR options:
  -l LANG[+LANG]          Specify language(s) used for OCR.
NOTE: These options must occur before any configfile.

Single options:
  --help                  Show this help message.
  --help-extra            Show extra help for advanced users.
  --version               Show version information.
  --list-langs            List available languages for tesseract engine.

C:\Users\Volkan>
```

3.2   Tesseract Fedora

Pre-install: build dependencies

$ sudo dnf install gcc gdb gcc-c++ autoconf automake libtool libjpeg-devel libpng-devel libtiff-devel zlib-devel

And also need to install Leptonica with source code (**Run dependency**). About Leptonica look at Appendix I.

Install Leptonica commands:

```
$ wget https://github.com/DanBloomberg/leptonica/releases/download/1.84.0/leptonica-1.84.0.tar.gz
$ tar -xf leptonica-1.84.0.tar.gz -C install_ leptonica-1.84.0
$ cd install_ leptonica-1.84.0
$ ./autogen.sh
$ ./configure --prefix=/usr/local/leptonica
$ make
$ sudo make install
```

```
[atie@localhost ~/AtieSpace]
$ tar -xf leptonica-1.84.0.tar.gz -C install_leptonica-1.84.0
[atie@localhost ~/AtieSpace]
$ cd install_leptonica-1.84.0/
[atie@localhost ~/AtieSpace/install_leptonica-1.84.0]
$ ll
total 4
drwxr-xr-x. 8 atie atie 4096 Sep 19 18:13 leptonica-1.84.0
[atie@localhost ~/AtieSpace/install_leptonica-1.84.0]
$ cd leptonica-1.84.0/
[atie@localhost ~/AtieSpace/install_leptonica-1.84.0/leptonica-1.84.0]
$ ll
total 1144
-rw-r--r--. 1 atie atie  52323 Dec 24  2023 aclocal.m4
-rwxr-xr-x. 1 atie atie    326 Sep  5 1.2018 autogen.sh
drwxr-xr-x. 2 atie atie    118 Dec 24  2023 autom4te.cache
drwxr-xr-x. 3 atie atie     46 Dec 24  2023 cmake
-rw-r--r--. 1 atie atie  12518 Jun 17  2023 CMakeLists.txt
drwxr-xr-x. 2 atie atie    162 Dec 24  2023 config
-rwxr-xr-x. 1 atie atie 518395 Dec 24 2. 2023 configure    ./configure --prefix=/usr/local/leptonica
-rw-r--r--. 1 atie atie   9373 Sep  1  2023 configure.ac
-rw-r--r--. 1 atie atie 106620 Dec 24  2023 Doxyfile
-rw-r--r--. 1 atie atie 132996 Dec 24  2023 doxygen.log
-rw-r--r--. 1 atie atie   1521 Jul 30  2020 leptonica-license.txt
-rw-r--r--. 1 atie atie    414 Mar  2  2023 lept.pc.cmake
-rw-r--r--. 1 atie atie    425 Jun 30  2019 lept.pc.in
-rw-r--r--. 1 atie atie   3473 Sep  5  2018 lok.lua
drwxr-xr-x. 2 atie atie    131 Dec 24  2023 m4
-rw-r--r--. 1 atie atie   2322 Sep 24  2022 Makefile.am
-rw-r--r--. 1 atie atie  32545 Dec 24  2023 Makefile.in
-rwxr-xr-x. 1 atie atie    178 Sep  5  2018 make-for-auto
-rwxr-xr-x. 1 atie atie    165 Sep  5  2018 make-for-local
-rw-r--r--. 1 atie atie   9610 Sep  5  2018 moller52.jpg
drwxr-xr-x. 5 atie atie  20480 Dec 24  2023 prog
-rw-r--r--. 1 atie atie  57775 Dec 24  2023 README.html
-rw-r--r--. 1 atie atie   6319 Feb  6  2023 README.md
drwxr-xr-x. 2 atie atie   8192 Dec 24  2023 src
-rw-r--r--. 1 atie atie   8518 Aug  6  2020 style-guide.txt
-rw-r--r--. 1 atie atie  17604 Aug 29  2023 sw.cpp
-rw-r--r--. 1 atie atie  91780 Dec 24  2023 version-notes.html
[atie@localhost ~/AtieSpace/install_leptonica-1.84.0/leptonica-1.84.0]
```

```
[atie@localhost ~/AtieSpace/install_leptonica-1.84.0/leptonica-1.84.0]
$ make
(CDPATH="${ZSH_VERSION+.}:" && cd . && /bin/sh '/home/atie/AtieSpace/install_leptonica-1.84.0/lep
rm -f stamp-h1
touch config/config.h.in
cd . && /bin/sh ./config.status config_auto.h
config.status: creating config_auto.h
config.status: config_auto.h is unchanged
make  all-recursive
make[1]: Entering directory '/home/atie/AtieSpace/install_leptonica-1.84.0/leptonica-1.84.0'
Making all in src
make[2]: Entering directory '/home/atie/AtieSpace/install_leptonica-1.84.0/leptonica-1.84.0/src'
  CC       adaptmap.lo
```

```
[atie@localhost ~/AtieSpace/install_leptonica-1.84.0/leptonica-1.84.0]
$ sudo make install
[sudo] password for atie:
Making install in src
make[1]: Entering directory '/home/atie/AtieSpace/install_leptonica-1.84.0/leptonica-1.84.0/src'
make[2]: Entering directory '/home/atie/AtieSpace/install_leptonica-1.84.0/leptonica-1.84.0/src'
 /usr/bin/mkdir -p '/usr/local/leptonica/lib'
```

Check the Letonica installation.

```
[atie@localhost ~/AtieSpace/install_leptonica-1.84.0/leptonica-1.84.0]
$ ls -l /usr/local/leptonica/
total 4
drwxr-xr-x. 2 root root 4096 Sep 19 18:23 bin
drwxr-xr-x. 3 root root   23 Sep 19 18:23 include
drwxr-xr-x. 4 root root  158 Sep 19 18:23 lib
[atie@localhost ~/AtieSpace/install_leptonica-1.84.0/leptonica-1.84.0]
```

Confirm the Leptonica version use by Tesseract with below method.

$ wget https://github.com/tesseract-ocr/tesseract/archive/refs/tags/5.4.1.tar.gz

$ tar -xf tesseract-5.4.1.tar.gz -C install_tesseract/

$ ./autogen

$ ./configure –enable-debug --prefix=/usr/local/tesseract

```
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$ ./configure --enable-debug
checking for g++... g++
checking whether the C++ compiler works... yes
checking for C++ compiler default output file name... a.out
checking for suffix of executables...
checking whether we are cross compiling... no
checking for suffix of object files... o

.....

checking for brew... false
checking for asciidoc... false
checking for xsltproc... true
checking for wchar_t... yes
checking for long long int... yes
checking for pkg-config... /usr/bin/pkg-config
checking pkg-config is at least version 0.9.0... yes
checking for libcurl... no
checking for lept >= 1.74... no
configure: error: Leptonica 1.74 or higher is required. Try to install libleptonica-dev package.
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$
```

After finish installation, don't forget append Leptonica paths to /etc/profile file below variables, which used by Tesseract OCR.

```
###########################################################
#########################Atie ADD##########################
###########################################################
PKG_CONFIG_PATH=$PKG_CONFIG_PATH:/usr/local/leptonica/lib/pkgconfig
export PKG_CONFIG_PATH
CPLUS_INCLUDE_PATH=$CPLUS_INCLUDE_PATH:/usr/local/leptonica/include/leptonica
export CPLUS_INCLUDE_PATH
C_INCLUDE_PATH=$C_INCLUDE_PATH:/usr/local/leptonica/include/leptonica
export C_INCLUDE_PATH
LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/usr/local/leptonica/lib
export LD_LIBRARY_PATH
LIBRARY_PATH=$LIBRARY_PATH:/usr/local/leptonica/lib
export LIBRARY_PATH
LIBLEPT_HEADERSDIR=/usr/local/leptonica/include/leptonica
export LIBLEPT_HEADERSDIR
###########################################################
#########################Atie END##########################
###########################################################
```

```
###########################################################
#########################Atie ADD##########################
###########################################################
PKG_CONFIG_PATH=$PKG_CONFIG_PATH:/usr/local/leptonica/lib/pkgconfig
export PKG_CONFIG_PATH
CPLUS_INCLUDE_PATH=$CPLUS_INCLUDE_PATH:/usr/local/leptonica/include/leptonica
export CPLUS_INCLUDE_PATH
C_INCLUDE_PATH=$C_INCLUDE_PATH:/usr/local/leptonica/include/leptonica
export C_INCLUDE_PATH
LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/usr/local/leptonica/lib
export LD_LIBRARY_PATH
LIBRARY_PATH=$LIBRARY_PATH:/usr/local/leptonica/lib
export LIBRARY_PATH
LIBLEPT_HEADERSDIR=/usr/local/leptonica/include/leptonica
export LIBLEPT_HEADERSDIR
###########################################################
#########################Atie END##########################
###########################################################
```

Tesseract Compile & Install


```
$ wget https://github.com/tesseract-ocr/tesseract/archive/refs/tags/5.4.1.tar.gz
$ tar -xf tesseract-5.4.1.tar.gz -C install_tesseract/
$ ./autogen
$ ./configure –enable-debug --prefix=/usr/local/tesseract
$ make
$ sudo make install
$ sudo make ldconfig
```

```
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$ ./autogen.sh
Running aclocal
Running /usr/bin/libtoolize
libtoolize: putting auxiliary files in AC_CONFIG_AUX_DIR, 'config'.
libtoolize: copying file 'config/ltmain.sh'
libtoolize: putting macros in AC_CONFIG_MACRO_DIRS, 'm4'.
libtoolize: copying file 'm4/libtool.m4'
libtoolize: copying file 'm4/ltoptions.m4'
libtoolize: copying file 'm4/ltsugar.m4'
libtoolize: copying file 'm4/ltversion.m4'
libtoolize: copying file 'm4/lt~obsolete.m4'
Running aclocal
Running autoconf
Running autoheader
Running automake --add-missing --copy
configure.ac:379: installing 'config/compile'
configure.ac:27: installing 'config/missing'
Makefile.am: installing 'config/depcomp'

All done.
To build the software now, do something like:

$ ./configure [--enable-debug] [...other options]
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
```

```
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$ ./configure --enable-debug --prefix=/usr/local/tesseract
checking for g++... g++
checking whether the C++ compiler works... yes
checking for C++ compiler default output file name... a.out
checking for suffix of executables...
checking whether we are cross compiling... no
checking for suffix of object files... o
checking whether the compiler supports GNU C++... yes
checking whether g++ accepts -g... yes
checking for g++ option to enable C++11 features... none needed
checking for a BSD-compatible install... /usr/bin/install -c
checking whether build environment is sane... yes
```

```
config.status: creating include/config_auto.h
config.status: executing depfiles commands
config.status: executing libtool commands

Configuration is done.
You can now build and install tesseract by running:

$ make
$ sudo make install
$ sudo ldconfig

Documentation will not be built because asciidoc or xsltproc is missing.

You cannot build training tools because of missing dependency.
Check configure output for details.

[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$
```

```
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$ make
Making all in .
make[1]: Entering directory '/home/atie/AtieSpace/install_tesseract/tesseract-5.4.1'
  CXX      src/tesseract-tesseract.o
  CXX      src/api/libtesseract_la-baseapi.lo
  CXX      src/api/libtesseract_la-altorenderer.lo
  CXX      src/api/libtesseract_la-pagerenderer.lo
  CXX      src/api/libtesseract_la-capi.lo
  CXX      src/api/libtesseract_la-hocrrenderer.lo
  CXX      src/api/libtesseract_la-lstmboxrenderer.lo
  CXX      src/api/libtesseract_la-pdfrenderer.lo
  CXX      src/api/libtesseract_la-renderer.lo
  CXX      src/api/libtesseract_la-wordstrboxrenderer.lo
```

```
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$ sudo make install
[sudo] password for atie:
Making install in .
make[1]: Entering directory '/home/atie/AtieSpace/install_tesseract/tesseract-5.4.1'
make[2]: Entering directory '/home/atie/AtieSpace/install_tesseract/tesseract-5.4.1'
 /usr/bin/mkdir -p '/usr/local/tesseract/lib'
 /bin/sh ./libtool   --mode=install /usr/bin/install -c   libtesseract.la '/usr/local/tesseract/lib'
libtool: install: /usr/bin/install -c .libs/libtesseract.so.5.0.4 /usr/local/tesseract/lib/libtesser
libtool: install: (cd /usr/local/tesseract/lib && { ln -s -f libtesseract.so.5.0.4 libtesseract.so.5
libtool: install: (cd /usr/local/tesseract/lib && { ln -s -f libtesseract.so.5.0.4 libtesseract.so |
libtool: install: /usr/bin/install -c .libs/libtesseract.lai /usr/local/tesseract/lib/libtesseract.l
libtool: install: /usr/bin/install -c .libs/libtesseract.a /usr/local/tesseract/lib/libtesseract.a
libtool: install: chmod 644 /usr/local/tesseract/lib/libtesseract.a
libtool: install: ranlib /usr/local/tesseract/lib/libtesseract.a
libtool: finish: PATH="/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/var/lib/snapd/s
```

```
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$ sudo ldconfig
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$
```

Check the Tesseract installation.

```
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$ ls -l /usr/local/tesseract/
total 0
drwxr-xr-x. 2 root root  23 Sep 19 19:38 bin
drwxr-xr-x. 3 root root  23 Sep 19 19:38 include
drwxr-xr-x. 3 root root 145 Sep 19 19:38 lib
drwxr-xr-x. 3 root root  22 Sep 19 19:38 share
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$ tree /usr/local/tesseract/
/usr/local/tesseract/
├── bin
│   └── tesseract
├── include
│   └── tesseract
│       ├── baseapi.h
│       ├── capi.h
│       ├── export.h
│       ├── ltrresultiterator.h
│       ├── ocrclass.h
│       ├── osdetect.h
│       ├── pageiterator.h
│       ├── publictypes.h
│       ├── renderer.h
│       ├── resultiterator.h
│       ├── unichar.h
│       └── version.h
├── lib
│   ├── libtesseract.a
│   ├── libtesseract.la
│   ├── libtesseract.so -> libtesseract.so.5.0.4
│   ├── libtesseract.so.5 -> libtesseract.so.5.0.4
│   ├── libtesseract.so.5.0.4
│   └── pkgconfig
│       └── tesseract.pc
└── share
    └── tessdata
        ├── configs
        │   ├── alto
        │   ├── ambigs.train
        │   ├── api_config
        │   ├── bigram
```

Add Tesseract binary into PATH direct.

```
 83 ##########################################################
 84 #######################Atie ADD###########################
 85 ##########################################################
 86
 87 # ------------------------------------------------------------
 88 # For Leptonica
 89 PKG_CONFIG_PATH=$PKG_CONFIG_PATH:/usr/local/leptonica/lib/pkgconfig
 90 export PKG_CONFIG_PATH
 91 CPLUS_INCLUDE_PATH=$CPLUS_INCLUDE_PATH:/usr/local/leptonica/include/leptonica
 92 export CPLUS_INCLUDE_PATH
 93 C_INCLUDE_PATH=$C_INCLUDE_PATH:/usr/local/leptonica/include/leptonica
 94 export C_INCLUDE_PATH
 95 LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/usr/local/leptonica/lib
 96 export LD_LIBRARY_PATH
 97 LIBRARY_PATH=$LIBRARY_PATH:/usr/local/leptonica/lib
 98 export LIBRARY_PATH
 99 LIBLEPT_HEADERSDIR=/usr/local/leptonica/include/leptonica
100 export LIBLEPT_HEADERSDIR
101
102 # ------------------------------------------------------------
103 # For Tesseract
104 export PATH=$PATH:/usr/local/tesseract/bin
105
106 ##########################################################
107 #######################Atie END###########################
108 ##########################################################
109
```

Create soft link for Tesseract command for easy use.

```
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$ sudo ln -sf /usr/local/tesseract/bin/tesseract /usr/local/bin/tesseract
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$ ll /usr/local/bin/tesseract
lrwxrwxrwx. 1 root root 34 Sep 19 19:45 /usr/local/bin/tesseract -> /usr/local/tesseract/bin/tesseract
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$ tesseract -v
tesseract 5.4.1
 leptonica-1.84.0
  libjpeg 6b (libjpeg-turbo 2.1.4) : libpng 1.6.37 : libtiff 4.4.0 : zlib 1.2.13
 Found AVX2
 Found AVX
 Found FMA
 Found SSE4.1
 Found OpenMP 201511
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$
[atie@localhost ~/AtieSpace/install_tesseract/tesseract-5.4.1]
$
```

---

4   Tesseract Training

4.1   Training for Tesseract5 Windows

Training outline

1. Install "jTessBoxEditor" tools.

   This tool is helpful another image format converts into TIF file (*.tif), OR TIF image packet format (*.tif), and edit Box format file to correct and adjust the Box file Orientation and Segmentation result.

2. Get target image and merge into a TIF image packets.

3. Generate Box file (*.box).

4. Open TIF image packet and adjust the Box file character Orientation and Segmentation result.

5. Create image character FONT metadata file.

6. Run bat file generate trained data (*. traineddata).

   If Tesseract before on Tesseract-4.x (exclude), until here all the training procedure finish. So, as long as the (. traineddata) generated, go to use it.*

7. LSTM training.

   From Tesseract-4.x (include) also need another training: LSTM training procedure.

8. Run bat file generate trained data (*. traineddata).

Train data Preparation

1) Download a uig.traineddata from https://github.com/tesseract-ocr/tessdata for use LSTM training.

   ⬜ uig.traineddata

2) Download a jTessBoxEditor from https://sourceforge.net/projects/vietocr/files/jTessBoxEditor/.
   For edit, correct & check character recognition.

   jTessBoxEditorFX-2.6.0.zip
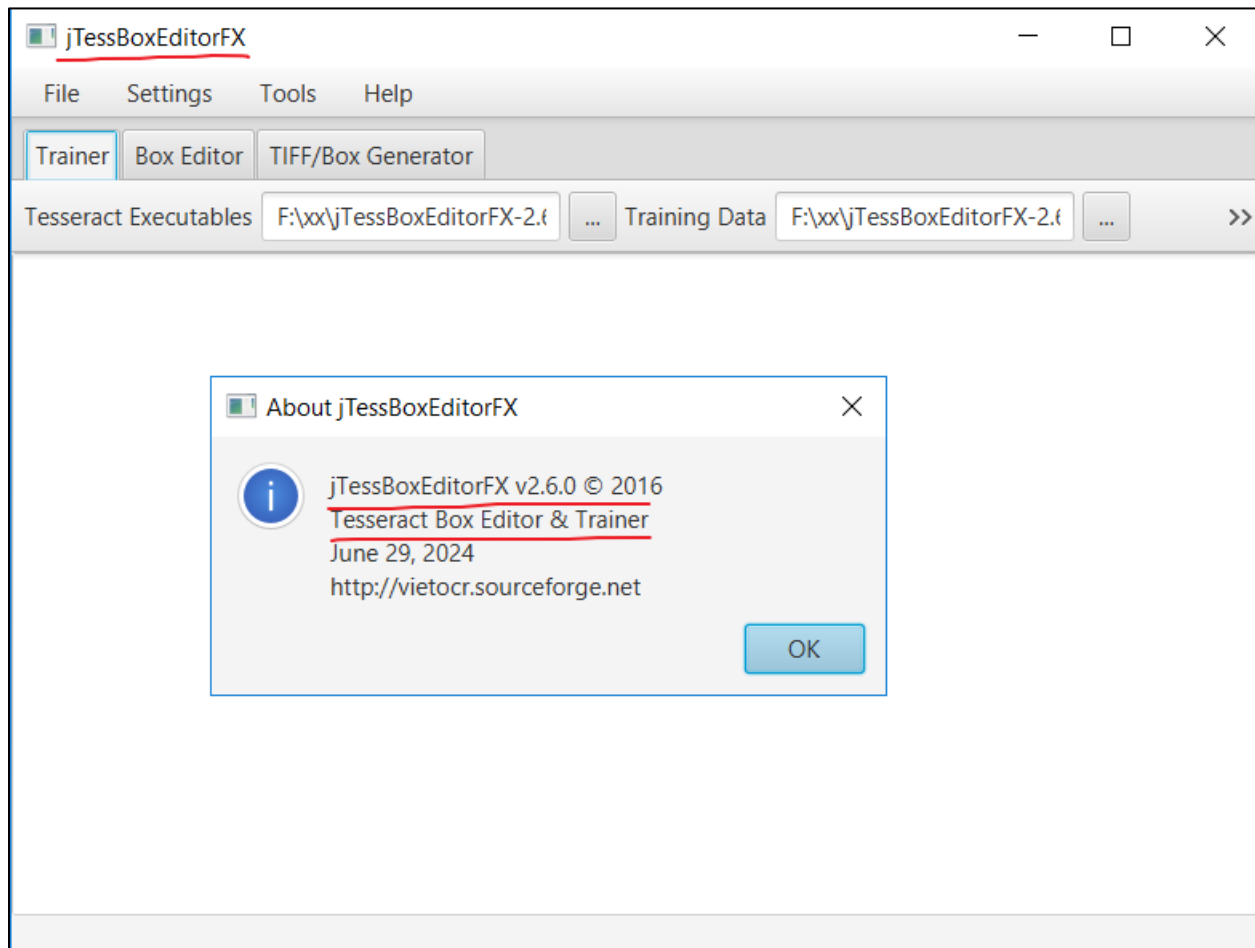
   This tool developed by Java, so need JRE 8+.

Do train steps

1.Image convert into TIFF format.

If use jTessBoxEditor DON'T need convert into TIF format, while packet into TIF image format the tool automatic convert it to TIF format.

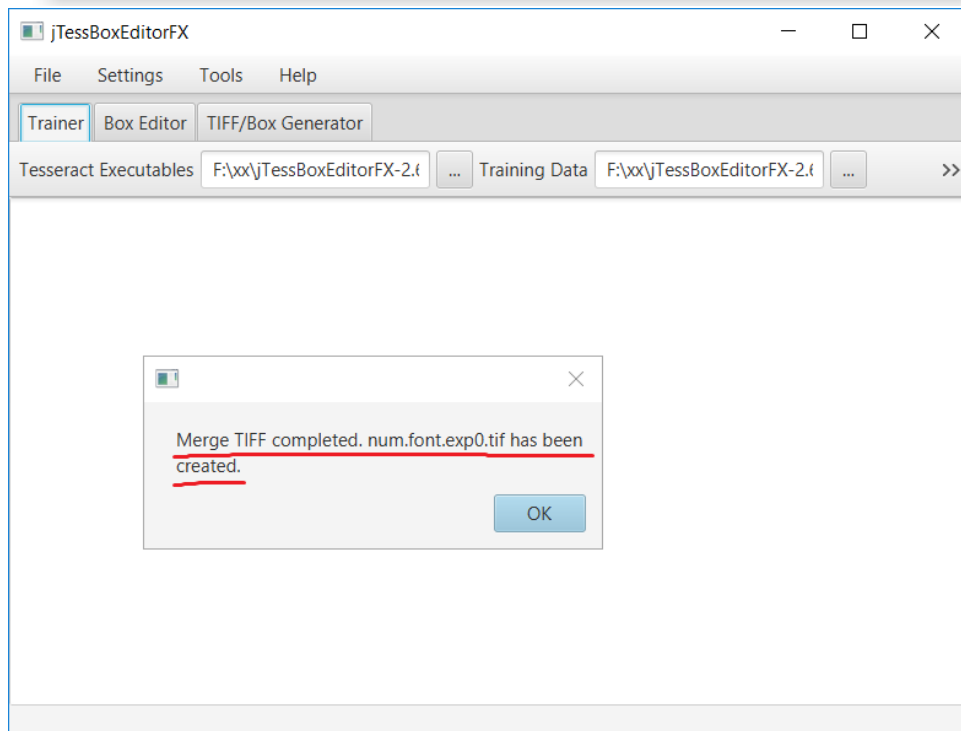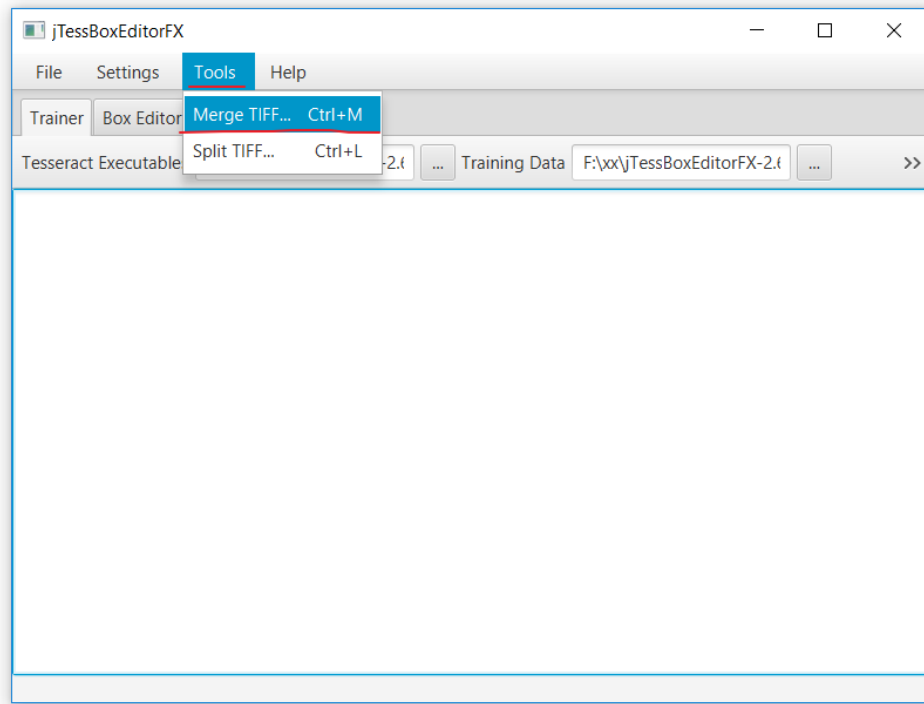**2.Material image packet into a TIF image.**

Use jTessBoxEditor tools to combine all material images into a compound TIFF packet file.

train_img1.png   train_img2.png   train_img3.png   train_img4.png   train_img5.png

Merge TIFF completed. num.font.exp0.tif has been created.

num.font.exp0.tif

How to pick a name for generated TIF image packet, this all MUST obey Tesseract rules. The rule says that:

TIF image packet name: [language].[font name].exp[num].tif . A demo name " num.font.exp0.tif ".

#	Item	Profile
1	language	The TIF image contained language name like "uig";
2	font name	Font name like UKIJ, Alkatip etc.;
3	num	Experiment/Exercise/Train Seq. number

3.Generate BOX file

In the Windows command line, change to directory to current working directory and type below command to generate *.box file.

$ tesseract num.font.exp0.tif num.font.exp0 batch.nochop makebox   // generate num.font.exp0.box file

Make Box File command:

$ tesseract [tif packet image] [box file name] batch.nochop makebox   // generate "box_name.box" file

Note that the *.tif and *.box file picked name rule is the same. The rule shown above. And the both should the same directory.

TIF image packet file vs. BOX file

1.TIF image packet file stores lots of images page by page.

2.BOX file stores the characters location information (every character's X, Y quadrant and height, width) in TIF image packet file.

```
F:\xx\Train Tesseract 5.x>tesseract5 num.font.exp0.tif num.font.exp0 batch.nochop makebox
Page 1
Page 2
Page 3
Page 4
Page 5

F:\xx\Train Tesseract 5.x>
```

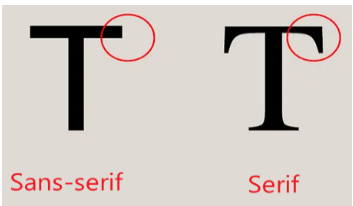After run above command would generate a *.box file based on commpond *.tif.

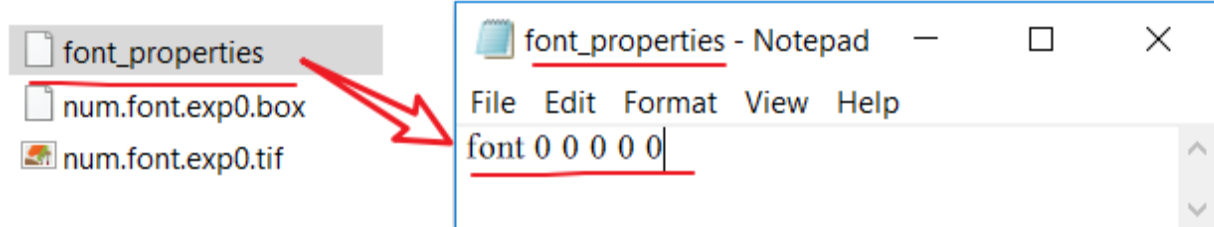num.font.exp0.tif   Generate   num.font.exp0.box

4.Check & Correct chars

This is what we really do work on the whole training process.

Open jTessBoxEditor, click Box Editor -> Open，and open num.font.exp0.tif generated above procedure. And will see some of characters recognition is wrong, so need to check and correct them one by one for all images.

That window could correct character, even change the character X, Y, width, height metadata. And if don't need, also can delete OR add even a character node etc. No forget to save of course.

Until here, the jTessBoxEditor tool mission is finished.

5.Create FONT metadata file: font_properties

In the work directory, create a file named "font_properties**", and write "font 0 0 0 0 0".**

[Syntax] : `<fontname> <italic> <bold> <fixed> <serif> <fraktur>`

Argument		
#	**Item**	**Value**	**Profile**
1	fontname	font name	
2	italic	specify font italic OR NOT	
3	bold	specify font bold OR NOT	
4	fixed	Default font name	
5	serif	Serif OR NOT T (Sans-serif) T (Serif)	0: Not existed 1: existed
6	fraktur	German bold	

6.Generate *. traineddata

Run below bat file to generate *. traineddata.

```
1  echo Run Tesseract for Training ...
2  tesseract5.exe num.font.exp0.tif num.font.exp0 nobatch box.train
3                          1                  2
4  echo Compute the Character Set.. 3
5  unicharset_extractor.exe num.font.exp0.box
6  mftraining –F font_properties –U unicharset –O num.unicharset num.font.exp0.tr
7
8  echo Clustering..                    [1] *.tif: compound TIF file
9  cntraining.exe num.font.exp0.tr
10                                       [2]
11 echo Rename Files ...                 [3] *.box: box file
12 rename normproto num.normproto
13 rename inttemp num.inttemp
14 rename pffmtable num.pffmtable
15 rename shapetable num.shapetable
16
17 echo Create Tessdata..
18 combine_tessdata.exe num.
19
20 set /p input= Type any key to end ...
21
```

echo Run Tesseract for Training ... tesseract5.exe num.font.exp0.tif num.font.exp0 nobatch box.train echo Compute the Character Set.. unicharset_extractor.exe num.font.exp0.box mftraining -F font_properties -U unicharset -O num.unicharset num.font.exp0.tr echo Clustering.. cntraining.exe num.font.exp0.tr echo Rename Files ... rename normproto num.normproto rename inttemp num.inttemp rename pffmtable num.pffmtable rename shapetable num.shapetable echo Create Tessdata.. combine_tessdata.exe num. set /p input= Type any key to end ...	**gen_traineddata.bat**

If lower than Tesseract 4.x (exclude), until here the train finished. But begins with Tesseract 4.x (include), also need more train with LSTM.

6. LSTM training

Use *.tif and *.box file generate *. lstmf file for training LSTM.

$ tesseract num.font.exp0.tif num.font.exp0 -l uig--psm 6 lstm.train // generate num.font.exp0.lstmf file

Argument		
#	**Item**	**Value**	**Profile**
1	num.font.exp0.tif	TIF packet image name	
2	num.font.exp0	Output *.lstmf file name	
3	-l lang	LSTF train language	
4	--psm NO	Recognition mode	The mode 6 is better

After the command finish, would generate a file named "num.font.exp0.lstmf ".

```
F:\xx\Train Tesseract 5.x - Copy>tesseract5 num.font.exp0.tif num.font.exp0 --psm 6 lstm.train
Page 1
Page 2
Page 3
Loaded 2/2 lines (1-2) of document num.font.exp0.lstmf        generate num.font.exp0.lstmf file
Page 4
Loaded 3/3 lines (1-3) of document num.font.exp0.lstmf
Page 5
Loaded 4/4 lines (1-4) of document num.font.exp0.lstmf

F:\xx\Train Tesseract 5.x - Copy>
```

Generated file: num.font.exp0.lstmf

7. Extract LSTM data from already LSTM traineddata file

The file *. traineddata MUST get from https://github.com/tesseract-ocr/tessdata_best repository.

$ combine_tessdata -e uig.traineddata uig.lstm // generate uig.lstm file

```
F:\xx\Train Tesseract 5.x - Copy>combine_tessdata -e uig.traineddata uig.lstm
Extracting tessdata components from uig.traineddata
Wrote uig.lstm
Version:4.00.00alpha:uig:synth20170629
17:lstm:size=11779387, offset=192
18:lstm-punc-dawg:size=4506, offset=11779579
19:lstm-word-dawg:size=1249010, offset=11784085        generate uig.lstm
20:lstm-number-dawg:size=32242, offset=13033095
21:lstm-unicharset:size=8037, offset=13065337
22:lstm-recoder:size=1201, offset=13073374
23:version:size=30, offset=13074575

F:\xx\Train Tesseract 5.x - Copy>
```
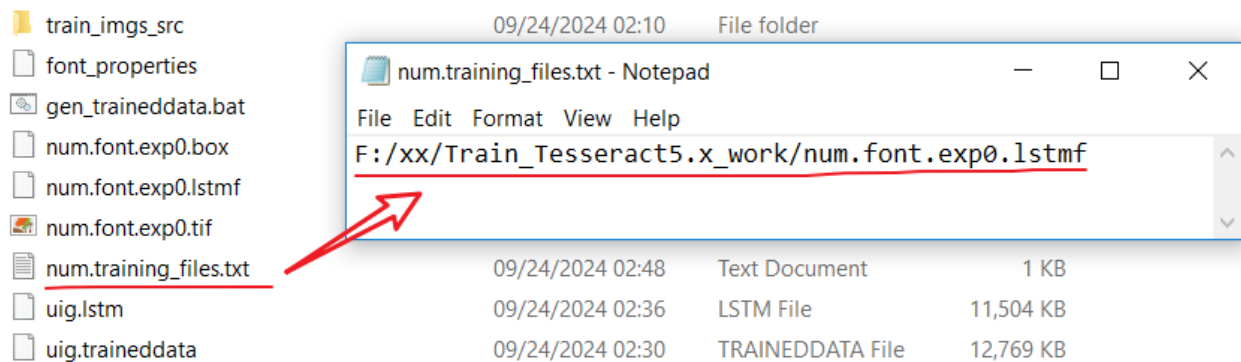
Generated file: uig.lstm

8.Touch num.training_files.txt and specify *. lstmf file

$ echo "F:/xx/Train Tesseract 5.x/num.font.exp0.lstmf" > num.training_files.txt // generate
num.training_files.txt

9.LSTM train

In working directory, create an output file, and working directory execute below command.

```
$ lstmtraining \
   --model_output="F:/Train_Tesseract5.x_Work/output" \
   --continue_from="F:/Train_Tesseract5.x_Work/uig.lstm" \
   --train_listfile="F:/Train_Tesseract5.x_Work/num.training_files.txt"
   --traineddata="F:/Train_Tesseract5.x_Work/uig.traineddata" \
   --debug_interval -1 \
   --max_iterations 800
```

Argument			
#	Item	Value	Profile
1	--modeloutput DIR	Directory	LSTM trained data file output directory; in other word, "output_*.checkpoint " file directory.
2	--continue_from DIR	LSTM File name	LSTM module data extract from LSTM *.traineddata
3	--train_listfile DIR	File name	
4	--traineddata DIR	LSTM *. Traineddata file name	LSTM *. Traineddata file name
5	--debug_interval NO		-1 means verbose
6	--max_iterations NO	Training times with integer	

This command would generate multiple output_*.checkpoint and output_checkpoint files.

```
F:\xx\Train_Tesseract5.x_work>
F:\xx\Train_Tesseract5.x_work>lstmtraining --model_output="F:/xx/Train_Tesseract5.x_work/output" --continue_from="F:/xx/
Train_Tesseract5.x_work/uig.lstm" --train_listfile="F:/xx/Train_Tesseract5.x_work/num.training_files.txt" --traineddata=
"F:/xx/Train_Tesseract5.x_work/uig.traineddata" --debug_interval -1 --max_iterations 800
Loaded file F:/xx/Train_Tesseract5.x_work/uig.lstm, unpacking...
Warning: LSTMTrainer deserialized an LSTMRecognizer!
Continuing from F:/xx/Train_Tesseract5.x_work/uig.lstm
Loaded 5/5 lines (1-5) of document F:/xx/Train_Tesseract5.x_work/num.font.exp0.lstmf
Iteration 0: GROUND  TRUTH : |234567390
Iteration 0: ALIGNED TRUTH : |23456739390
Iteration 0: BEST OCR TEXT : | 23┼º É567  05
File num.font.exp0.lstmf line 0 :
Mean rms=4.312%, delta=31.579%, train=90%(100%), skip ratio=0%
Iteration 1: GROUND  TRUTH : |234.567890
Iteration 1: ALIGNED TRUTH : |234.5678990
Iteration 1: BEST OCR TEXT : |25┼º5660
File num.font.exp0.lstmf line 0 :
Mean rms=3.861%, delta=27.039%, train=85.909%(100%), skip ratio=0%
Iteration 2: GROUND  TRUTH : 1234567890
Iteration 2: ALIGNED TRUTH : 12345567890
Iteration 2: BEST OCR TEXT : | 2ᴶ¢ᴶÅ70
File num.font.exp0.lstmf line 2 :
Mean rms=3.973%, delta=28.443%, train=90.606%(100%), skip ratio=0%
Iteration 3: GROUND  TRUTH : [234567890
Iteration 3: BEST OCR TEXT : |235670
File num.font.exp0.lstmf line 0 :
Mean rms=3.745%, delta=25.355%, train=80.455%(100%), skip ratio=0%
Iteration 4: GROUND  TRUTH : 1234567890
Iteration 4: ALIGNED TRUTH : 12345678990
Iteration 4: BEST OCR TEXT : 1234 56 7 0
```

```
Iteration 793: GROUND  TRUTH : [234567890
File num.font.exp0.lstmf line 0 (Perfect):
Mean rms=0.413%, delta=1.01%, train=3.994%(15.491%), skip ratio=0%
Iteration 794: GROUND  TRUTH : 1234567890
File F:/xx/Train_Tesseract5.x_work/num.font.exp0.lstmf line 4 (Perfect):
Mean rms=0.413%, delta=1.008%, train=3.989%(15.472%), skip ratio=0%
Iteration 795: GROUND  TRUTH : |234567390
File num.font.exp0.lstmf line 0 (Perfect):
Mean rms=0.412%, delta=1.007%, train=3.984%(15.452%), skip ratio=0%
Iteration 796: GROUND  TRUTH : |234.567890
File num.font.exp0.lstmf line 0 (Perfect):
Mean rms=0.412%, delta=1.006%, train=3.979%(15.433%), skip ratio=0%
Iteration 797: GROUND  TRUTH : 1234567890
File num.font.exp0.lstmf line 2 (Perfect):
Mean rms=0.411%, delta=1.005%, train=3.974%(15.414%), skip ratio=0%
Iteration 798: GROUND  TRUTH : [234567890
File num.font.exp0.lstmf line 0 (Perfect):
Mean rms=0.411%, delta=1.003%, train=3.969%(15.394%), skip ratio=0%
Iteration 799: GROUND  TRUTH : 1234567890
File F:/xx/Train_Tesseract5.x_work/num.font.exp0.lstmf line 4 (Perfect):
Mean rms=0.41%, delta=1.002%, train=3.964%(15.375%), skip ratio=0%
2 Percent improvement time=0, best error was 6.342 @ 113
At iteration 113/800/800, Mean rms=0.410000%, delta=1.002000%, BCER train=3.964000%, BWER train=15.375000%, skip ratio=0
.000000%,  New best BCER = 3.964000 wrote best model:F:/xx/Train_Tesseract5.x_work/output_3.964000_113_800.checkpoint wr
ote checkpoint.

Finished! Selected model with minimal training error rate (BCER) = 3.964

F:\xx\Train_Tesseract5.x_work>
```

output_3.663000_74_800.checkpoint	09/26/2024 20:16	CHECKPOINT File	34,548 KB
output_4.186000_74_700.checkpoint	09/26/2024 20:16	CHECKPOINT File	34,548 KB
output_4.883000_74_600.checkpoint	09/26/2024 20:16	CHECKPOINT File	34,548 KB
output_5.860000_74_500.checkpoint	09/26/2024 20:15	CHECKPOINT File	34,548 KB
output_7.325000_74_400.checkpoint	09/26/2024 20:15	CHECKPOINT File	34,548 KB
output_9.733000_73_300.checkpoint	09/26/2024 20:15	CHECKPOINT File	34,548 KB
output_14.600000_73_200.checkpoint	09/26/2024 20:14	CHECKPOINT File	34,548 KB
output_28.500000_69_100.checkpoint	09/26/2024 20:14	CHECKPOINT File	34,548 KB
output_checkpoint	09/26/2024 20:16	File	69,096 KB

10.Generate LSTM mode traineddata

Use last command generated "output_checkpoint" file and old LSTM "uig. traineddata", combine

together and generate new LSTM " num.traineddata" file.

```
$ lstmtraining \
   --stop_training \
   --continue_from="F:/Train_Tesseract5.x_Work/output_checkpoint" \
   --traineddata="F:/Train_Tesseract5.x_Work/uig.traineddata" \
   --model_output="F:/Train_Tesseract5.x_Work/num.traineddata"
```

Argument			
#	Item	Value	Profile
1	--stop_training	NA	Default needs
2	--continue_from FILE	Output_checkout file name with direcotry	
3	--traineddata FILE	Mother *.traineddata File name	
4	--model_output DIR	Output *.traineddata File name	Target LSTM *. Traineddata file name

The command would generate LSTM *.traineddata file.

```
F:\xx\Train_Tesseract5.x_work>
F:\xx\Train_Tesseract5.x_work>lstmtraining --stop_training --continue_from="F:/xx/Train_Tesseract5.x_work/output_checkpo
int" --traineddata="F:/xx/Train_Tesseract5.x_work/uig.traineddata" --model_output="F:/xx/Train_Tesseract5.x_work/num.tra
ineddata"
Loaded file F:/xx/Train_Tesseract5.x_work/output_checkpoint, unpacking...      Generate num.traineddata
F:\xx\Train_Tesseract5.x_work>
```

Generate

num.traineddata

The generated LSTM *.traineddata copy to {TESSERACT_INSTALL_PATH}/tessdata. Until here all mission is done.

Appendix I: Leptonica

Leptonica is an open source library containing software that is broadly useful for image processing and image analysis applications.

#	Item	Value
1	Leptonica official website	http://www.leptonica.org/
2	Leptonica official Repository	https://github.com/DanBloomberg/leptonica
3	GitHub repository Info	Languages ● C 97.9% ● HTML 0.8% ● C++ 0.6% ● CMake 0.3% ● Shell 0.2% ● Makefile 0.1% ○ Other 0.1%

Open Source Projects that use Leptonica:

- tesseract (optical character recognition)

- OpenCV (computer vision library)

- jbig2enc (encodes multipage binary image documents with jbig2 compression)