3.
```
bash-5.1$ make
flex scan.l
mv lex.yy.c scan.c
bison -d -y parse.y
mv y.tab.c parse.c
gcc -g -Wall -std=c99 --verbose -c parse.c
Using built-in specs.
COLLECT_GCC=gcc
OFFLOAD_TARGET_NAMES=nvptx-none
OFFLOAD_TARGET_DEFAULT=1
Target: x86_64-redhat-linux
Configured with: ../configure --enable-bootstrap --enable-languages=c,c++,fortran,objc,obj-c++,ada,go,d,lto --prefix=/usr --
mandir=/usr/share/man --infodir=/usr/share/info --with-bugurl=http://bugzilla.redhat.com/bugzilla --enable-shared --enable-
threads=posix --enable-checking=release --enable-multilib --with-system-zlib --enable-__cxa_atexit --disable-libunwind-exceptions --
enable-gnu-unique-object --enable-linker-build-id --with-gcc-major-version-only --enable-libstdcxx-backtrace --with-linker-hash-
style=gnu --enable-plugin --enable-initfini-array --with-isl=/builddir/build/BUILD/gcc-12.2.1-20220819/obj-x86_64-redhat-linux/isl-
install --enable-offload-targets=nvptx-none --without-cuda-driver --enable-offload-defaulted --enable-gnu-indirect-function --enable-
cet --with-tune=generic --with-arch_32=i686 --build=x86_64-redhat-linux --with-build-config=bootstrap-lto --enable-link-serialization=1
Thread model: posix
Supported LTO compression algorithms: zlib zstd
gcc version 12.2.1 20220819 (Red Hat 12.2.1-1) (GCC)
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-mtune=generic' '-march=x86-64'
 /usr/libexec/gcc/x86_64-redhat-linux/12/cc1 -quiet -v parse.c -quiet -dumpbase parse.c -dumpbase-ext .c -mtune=generic -march=x86-64 -
g -Wall -std=c99 -version -o /tmp/cckdPJBh.s
GNU C99 (GCC) version 12.2.1 20220819 (Red Hat 12.2.1-1) (x86_64-redhat-linux)
        compiled by GNU C version 12.2.1 20220819 (Red Hat 12.2.1-1), GMP version 6.2.1, MPFR version 4.1.0-p13, MPC version 1.2.1, isl
version isl-0.18-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
ignoring nonexistent directory "/usr/lib/gcc/x86_64-redhat-linux/12/include-fixed"
ignoring nonexistent directory "/usr/lib/gcc/x86_64-redhat-linux/12/../../../../x86_64-redhat-linux/include"
#include "..." search starts here:
#include <...> search starts here:
 /usr/lib/gcc/x86_64-redhat-linux/12/include
 /usr/local/include
 /usr/include
End of search list.
GNU C99 (GCC) version 12.2.1 20220819 (Red Hat 12.2.1-1) (x86_64-redhat-linux)
        compiled by GNU C version 12.2.1 20220819 (Red Hat 12.2.1-1), GMP version 6.2.1, MPFR version 4.1.0-p13, MPC version 1.2.1, isl
version isl-0.18-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
Compiler executable checksum: 7a7e4425228392cc6cc9a11c55f9c2b9
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-mtune=generic' '-march=x86-64'
 as -v --gdwarf-5 --64 -o parse.o /tmp/cckdPJBh.s
GNU assembler version 2.37 (x86_64-redhat-linux) using BFD version version 2.37-27.fc36
COMPILER_PATH=/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-
linux/:/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-linux/
LIBRARY_PATH=/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-
linux/12/../../../../lib64/:/lib/../lib64/:/usr/lib/../lib64/:/usr/lib/gcc/x86_64-redhat-linux/12/../../../:/lib/:/usr/lib/
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-mtune=generic' '-march=x86-64'
gcc -g -Wall -std=c99 --verbose    -c -o scan.o scan.c
Using built-in specs.
COLLECT_GCC=gcc
OFFLOAD_TARGET_NAMES=nvptx-none
OFFLOAD_TARGET_DEFAULT=1
Target: x86_64-redhat-linux
Configured with: ../configure --enable-bootstrap --enable-languages=c,c++,fortran,objc,obj-c++,ada,go,d,lto --prefix=/usr --
mandir=/usr/share/man --infodir=/usr/share/info --with-bugurl=http://bugzilla.redhat.com/bugzilla --enable-shared --enable-
threads=posix --enable-checking=release --enable-multilib --with-system-zlib --enable-__cxa_atexit --disable-libunwind-exceptions --
enable-gnu-unique-object --enable-linker-build-id --with-gcc-major-version-only --enable-libstdcxx-backtrace --with-linker-hash-
style=gnu --enable-plugin --enable-initfini-array --with-isl=/builddir/build/BUILD/gcc-12.2.1-20220819/obj-x86_64-redhat-linux/isl-
install --enable-offload-targets=nvptx-none --without-cuda-driver --enable-offload-defaulted --enable-gnu-indirect-function --enable-
cet --with-tune=generic --with-arch_32=i686 --build=x86_64-redhat-linux --with-build-config=bootstrap-lto --enable-link-serialization=1
Thread model: posix
Supported LTO compression algorithms: zlib zstd
gcc version 12.2.1 20220819 (Red Hat 12.2.1-1) (GCC)
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'scan.o' '-mtune=generic' '-march=x86-64'
 /usr/libexec/gcc/x86_64-redhat-linux/12/cc1 -quiet -v scan.c -quiet -dumpbase scan.c -dumpbase-ext .c -mtune=generic -march=x86-64 -g
-Wall -std=c99 -version -o /tmp/ccCahExE.s
GNU C99 (GCC) version 12.2.1 20220819 (Red Hat 12.2.1-1) (x86_64-redhat-linux)
        compiled by GNU C version 12.2.1 20220819 (Red Hat 12.2.1-1), GMP version 6.2.1, MPFR version 4.1.0-p13, MPC version 1.2.1, isl
version isl-0.18-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
ignoring nonexistent directory "/usr/lib/gcc/x86_64-redhat-linux/12/include-fixed"
ignoring nonexistent directory "/usr/lib/gcc/x86_64-redhat-linux/12/../../../../x86_64-redhat-linux/include"
#include "..." search starts here:
#include <...> search starts here:
 /usr/lib/gcc/x86_64-redhat-linux/12/include
 /usr/local/include
 /usr/include
End of search list.
GNU C99 (GCC) version 12.2.1 20220819 (Red Hat 12.2.1-1) (x86_64-redhat-linux)
        compiled by GNU C version 12.2.1 20220819 (Red Hat 12.2.1-1), GMP version 6.2.1, MPFR version 4.1.0-p13, MPC version 1.2.1, isl
version isl-0.18-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
Compiler executable checksum: 7a7e4425228392cc6cc9a11c55f9c2b9
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'scan.o' '-mtune=generic' '-march=x86-64'
 as -v --gdwarf-5 --64 -o scan.o /tmp/ccCahExE.s
GNU assembler version 2.37 (x86_64-redhat-linux) using BFD version version 2.37-27.fc36
COMPILER_PATH=/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-
linux/:/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-linux/
LIBRARY_PATH=/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-
linux/12/../../../../lib64/:/lib/../lib64/:/usr/lib/../lib64/:/usr/lib/gcc/x86_64-redhat-linux/12/../../../:/lib/:/usr/lib/
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'scan.o' '-mtune=generic' '-march=x86-64' '-dumpdir' 'scan.'
gcc -g -Wall -std=c99 --verbose    -c -o main.o main.c
Using built-in specs.
COLLECT_GCC=gcc
OFFLOAD_TARGET_NAMES=nvptx-none
```

```
OFFLOAD_TARGET_DEFAULT=1
Target: x86_64-redhat-linux
Configured with: ../configure --enable-bootstrap --enable-languages=c,c++,fortran,objc,obj-c++,ada,go,d,lto --prefix=/usr --
mandir=/usr/share/man --infodir=/usr/share/info --with-bugurl=http://bugzilla.redhat.com/bugzilla --enable-shared --enable-
threads=posix --enable-checking=release --enable-multilib --with-system-zlib --enable-__cxa_atexit --disable-libunwind-exceptions --
enable-gnu-unique-object --enable-linker-build-id --with-gcc-major-version-only --enable-libstdcxx-backtrace --with-linker-hash-
style=gnu --enable-plugin --enable-initfini-array --with-isl=/builddir/build/BUILD/gcc-12.2.1-20220819/obj-x86_64-redhat-linux/isl-
install --enable-offload-targets=nvptx-none --without-cuda-driver --enable-offload-defaulted --enable-gnu-indirect-function --enable-
cet --with-tune=generic --with-arch_32=i686 --build=x86_64-redhat-linux --with-build-config=bootstrap-lto --enable-link-serialization=1
Thread model: posix
Supported LTO compression algorithms: zlib zstd
gcc version 12.2.1 20220819 (Red Hat 12.2.1-1) (GCC)
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'main.o' '-mtune=generic' '-march=x86-64'
 /usr/libexec/gcc/x86_64-redhat-linux/12/cc1 -quiet -v main.c -quiet -dumpbase main.c -dumpbase-ext .c -mtune=generic -march=x86-64 -g
-Wall -std=c99 -version -o /tmp/cc3uC5Az.s
GNU C99 (GCC) version 12.2.1 20220819 (Red Hat 12.2.1-1) (x86_64-redhat-linux)
        compiled by GNU C version 12.2.1 20220819 (Red Hat 12.2.1-1), GMP version 6.2.1, MPFR version 4.1.0-p13, MPC version 1.2.1, isl
version isl-0.18-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
ignoring nonexistent directory "/usr/lib/gcc/x86_64-redhat-linux/12/include-fixed"
ignoring nonexistent directory "/usr/lib/gcc/x86_64-redhat-linux/12/../../../../x86_64-redhat-linux/include"
#include "..." search starts here:
#include <...> search starts here:
 /usr/lib/gcc/x86_64-redhat-linux/12/include
 /usr/local/include
 /usr/include
End of search list.
GNU C99 (GCC) version 12.2.1 20220819 (Red Hat 12.2.1-1) (x86_64-redhat-linux)
        compiled by GNU C version 12.2.1 20220819 (Red Hat 12.2.1-1), GMP version 6.2.1, MPFR version 4.1.0-p13, MPC version 1.2.1, isl
version isl-0.18-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
Compiler executable checksum: 7a7e4425228392cc6cc9a11c55f9c2b9
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'main.o' '-mtune=generic' '-march=x86-64'
 as -v --gdwarf-5 --64 -o main.o /tmp/cc3uC5Az.s
GNU assembler version 2.37 (x86_64-redhat-linux) using BFD version version 2.37-27.fc36
COMPILER_PATH=/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-
linux/:/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-linux/
LIBRARY_PATH=/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-
linux/12/../../../../lib64/:/lib/../lib64/:/usr/lib/../lib64/:/usr/lib/gcc/x86_64-redhat-linux/12/../../../:/lib/:/usr/lib/
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'main.o' '-mtune=generic' '-march=x86-64' '-dumpdir' 'main.'
gcc -g -Wall -std=c99 --verbose   -c -o message.o message.c
Using built-in specs.
COLLECT_GCC=gcc
OFFLOAD_TARGET_NAMES=nvptx-none
OFFLOAD_TARGET_DEFAULT=1
Target: x86_64-redhat-linux
Configured with: ../configure --enable-bootstrap --enable-languages=c,c++,fortran,objc,obj-c++,ada,go,d,lto --prefix=/usr --
mandir=/usr/share/man --infodir=/usr/share/info --with-bugurl=http://bugzilla.redhat.com/bugzilla --enable-shared --enable-
threads=posix --enable-checking=release --enable-multilib --with-system-zlib --enable-__cxa_atexit --disable-libunwind-exceptions --
enable-gnu-unique-object --enable-linker-build-id --with-gcc-major-version-only --enable-libstdcxx-backtrace --with-linker-hash-
style=gnu --enable-plugin --enable-initfini-array --with-isl=/builddir/build/BUILD/gcc-12.2.1-20220819/obj-x86_64-redhat-linux/isl-
install --enable-offload-targets=nvptx-none --without-cuda-driver --enable-offload-defaulted --enable-gnu-indirect-function --enable-
cet --with-tune=generic --with-arch_32=i686 --build=x86_64-redhat-linux --with-build-config=bootstrap-lto --enable-link-serialization=1
Thread model: posix
Supported LTO compression algorithms: zlib zstd
gcc version 12.2.1 20220819 (Red Hat 12.2.1-1) (GCC)
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'message.o' '-mtune=generic' '-march=x86-64'
 /usr/libexec/gcc/x86_64-redhat-linux/12/cc1 -quiet -v message.c -quiet -dumpbase message.c -dumpbase-ext .c -mtune=generic -march=x86-
64 -g -Wall -std=c99 -version -o /tmp/ccj3qFHt.s
GNU C99 (GCC) version 12.2.1 20220819 (Red Hat 12.2.1-1) (x86_64-redhat-linux)
        compiled by GNU C version 12.2.1 20220819 (Red Hat 12.2.1-1), GMP version 6.2.1, MPFR version 4.1.0-p13, MPC version 1.2.1, isl
version isl-0.18-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
ignoring nonexistent directory "/usr/lib/gcc/x86_64-redhat-linux/12/include-fixed"
ignoring nonexistent directory "/usr/lib/gcc/x86_64-redhat-linux/12/../../../../x86_64-redhat-linux/include"
#include "..." search starts here:
#include <...> search starts here:
 /usr/lib/gcc/x86_64-redhat-linux/12/include
 /usr/local/include
 /usr/include
End of search list.
GNU C99 (GCC) version 12.2.1 20220819 (Red Hat 12.2.1-1) (x86_64-redhat-linux)
        compiled by GNU C version 12.2.1 20220819 (Red Hat 12.2.1-1), GMP version 6.2.1, MPFR version 4.1.0-p13, MPC version 1.2.1, isl
version isl-0.18-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
Compiler executable checksum: 7a7e4425228392cc6cc9a11c55f9c2b9
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'message.o' '-mtune=generic' '-march=x86-64'
 as -v --gdwarf-5 --64 -o message.o /tmp/ccj3qFHt.s
GNU assembler version 2.37 (x86_64-redhat-linux) using BFD version version 2.37-27.fc36
COMPILER_PATH=/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-
linux/:/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-linux/
LIBRARY_PATH=/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-
linux/12/../../../../lib64/:/lib/../lib64/:/usr/lib/../lib64/:/usr/lib/gcc/x86_64-redhat-linux/12/../../../:/lib/:/usr/lib/
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'message.o' '-mtune=generic' '-march=x86-64' '-dumpdir' 'message.'
gcc -g -Wall -std=c99 --verbose   -c -o assemble.o assemble.c
Using built-in specs.
COLLECT_GCC=gcc
OFFLOAD_TARGET_NAMES=nvptx-none
OFFLOAD_TARGET_DEFAULT=1
Target: x86_64-redhat-linux
Configured with: ../configure --enable-bootstrap --enable-languages=c,c++,fortran,objc,obj-c++,ada,go,d,lto --prefix=/usr --
mandir=/usr/share/man --infodir=/usr/share/info --with-bugurl=http://bugzilla.redhat.com/bugzilla --enable-shared --enable-
threads=posix --enable-checking=release --enable-multilib --with-system-zlib --enable-__cxa_atexit --disable-libunwind-exceptions --
enable-gnu-unique-object --enable-linker-build-id --with-gcc-major-version-only --enable-libstdcxx-backtrace --with-linker-hash-
style=gnu --enable-plugin --enable-initfini-array --with-isl=/builddir/build/BUILD/gcc-12.2.1-20220819/obj-x86_64-redhat-linux/isl-
install --enable-offload-targets=nvptx-none --without-cuda-driver --enable-offload-defaulted --enable-gnu-indirect-function --enable-
cet --with-tune=generic --with-arch_32=i686 --build=x86_64-redhat-linux --with-build-config=bootstrap-lto --enable-link-serialization=1
Thread model: posix
Supported LTO compression algorithms: zlib zstd
```

```
gcc version 12.2.1 20220819 (Red Hat 12.2.1-1) (GCC)
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'assemble.o' '-mtune=generic' '-march=x86-64'
 /usr/libexec/gcc/x86_64-redhat-linux/12/cc1 -quiet -v assemble.c -quiet -dumpbase assemble.c -dumpbase-ext .c -mtune=generic -
march=x86-64 -g -Wall -std=c99 -version -o /tmp/ccZp3WSg.s
GNU C99 (GCC) version 12.2.1 20220819 (Red Hat 12.2.1-1) (x86_64-redhat-linux)
        compiled by GNU C version 12.2.1 20220819 (Red Hat 12.2.1-1), GMP version 6.2.1, MPFR version 4.1.0-p13, MPC version 1.2.1, isl
version isl-0.18-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
ignoring nonexistent directory "/usr/lib/gcc/x86_64-redhat-linux/12/include-fixed"
ignoring nonexistent directory "/usr/lib/gcc/x86_64-redhat-linux/12/../../../../x86_64-redhat-linux/include"
#include "..." search starts here:
#include <...> search starts here:
 /usr/lib/gcc/x86_64-redhat-linux/12/include
 /usr/local/include
 /usr/include
End of search list.
GNU C99 (GCC) version 12.2.1 20220819 (Red Hat 12.2.1-1) (x86_64-redhat-linux)
        compiled by GNU C version 12.2.1 20220819 (Red Hat 12.2.1-1), GMP version 6.2.1, MPFR version 4.1.0-p13, MPC version 1.2.1, isl
version isl-0.18-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
Compiler executable checksum: 7a7e4425228392cc6cc9a11c55f9c2b9
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'assemble.o' '-mtune=generic' '-march=x86-64'
 as -v --gdwarf-5 --64 -o assemble.o /tmp/ccZp3WSg.s
GNU assembler version 2.37 (x86_64-redhat-linux) using BFD version version 2.37-27.fc36
COMPILER_PATH=/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-
linux/:/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-linux/
LIBRARY_PATH=/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-
linux/12/../../../../lib64/:/lib/../lib64/:/usr/lib/../lib64/:/usr/lib/gcc/x86_64-redhat-linux/12/../../../:/lib/:/usr/lib/
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'assemble.o' '-mtune=generic' '-march=x86-64' '-dumpdir' 'assemble.'
gcc -g -Wall -std=c99 --verbose   -c -o symtab.o symtab.c
Using built-in specs.
COLLECT_GCC=gcc
OFFLOAD_TARGET_NAMES=nvptx-none
OFFLOAD_TARGET_DEFAULT=1
Target: x86_64-redhat-linux
Configured with: ../configure --enable-bootstrap --enable-languages=c,c++,fortran,objc,obj-c++,ada,go,d,lto --prefix=/usr --
mandir=/usr/share/man --infodir=/usr/share/info --with-bugurl=http://bugzilla.redhat.com/bugzilla --enable-shared --enable-
threads=posix --enable-checking=release --enable-multilib --with-system-zlib --enable-__cxa_atexit --disable-libunwind-exceptions --
enable-gnu-unique-object --enable-linker-build-id --with-gcc-major-version-only --enable-libstdcxx-backtrace --with-linker-hash-
style=gnu --enable-plugin --enable-initfini-array --with-isl=/builddir/build/BUILD/gcc-12.2.1-20220819/obj-x86_64-redhat-linux/isl-
install --enable-offload-targets=nvptx-none --without-cuda-driver --enable-offload-defaulted --enable-gnu-indirect-function --enable-
cet --with-tune=generic --with-arch_32=i686 --build=x86_64-redhat-linux --with-build-config=bootstrap-lto --enable-link-serialization=1
Thread model: posix
Supported LTO compression algorithms: zlib zstd
gcc version 12.2.1 20220819 (Red Hat 12.2.1-1) (GCC)
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'symtab.o' '-mtune=generic' '-march=x86-64'
 /usr/libexec/gcc/x86_64-redhat-linux/12/cc1 -quiet -v symtab.c -quiet -dumpbase symtab.c -dumpbase-ext .c -mtune=generic -march=x86-64
-g -Wall -std=c99 -version -o /tmp/ccoIxYcS.s
GNU C99 (GCC) version 12.2.1 20220819 (Red Hat 12.2.1-1) (x86_64-redhat-linux)
        compiled by GNU C version 12.2.1 20220819 (Red Hat 12.2.1-1), GMP version 6.2.1, MPFR version 4.1.0-p13, MPC version 1.2.1, isl
version isl-0.18-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
ignoring nonexistent directory "/usr/lib/gcc/x86_64-redhat-linux/12/include-fixed"
ignoring nonexistent directory "/usr/lib/gcc/x86_64-redhat-linux/12/../../../../x86_64-redhat-linux/include"
#include "..." search starts here:
#include <...> search starts here:
 /usr/lib/gcc/x86_64-redhat-linux/12/include
 /usr/local/include
 /usr/include
End of search list.
GNU C99 (GCC) version 12.2.1 20220819 (Red Hat 12.2.1-1) (x86_64-redhat-linux)
        compiled by GNU C version 12.2.1 20220819 (Red Hat 12.2.1-1), GMP version 6.2.1, MPFR version 4.1.0-p13, MPC version 1.2.1, isl
version isl-0.18-GMP

GGC heuristics: --param ggc-min-expand=100 --param ggc-min-heapsize=131072
Compiler executable checksum: 7a7e4425228392cc6cc9a11c55f9c2b9
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'symtab.o' '-mtune=generic' '-march=x86-64'
 as -v --gdwarf-5 --64 -o symtab.o /tmp/ccoIxYcS.s
GNU assembler version 2.37 (x86_64-redhat-linux) using BFD version version 2.37-27.fc36
COMPILER_PATH=/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-
linux/:/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-linux/
LIBRARY_PATH=/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-
linux/12/../../../../lib64/:/lib/../lib64/:/usr/lib/../lib64/:/usr/lib/gcc/x86_64-redhat-linux/12/../../../:/lib/:/usr/lib/
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-c' '-o' 'symtab.o' '-mtune=generic' '-march=x86-64' '-dumpdir' 'symtab.'
gcc -g -Wall -std=c99 --verbose scan.o main.o parse.o message.o assemble.o symtab.o -o asx20
Using built-in specs.
COLLECT_GCC=gcc
COLLECT_LTO_WRAPPER=/usr/libexec/gcc/x86_64-redhat-linux/12/lto-wrapper
OFFLOAD_TARGET_NAMES=nvptx-none
OFFLOAD_TARGET_DEFAULT=1
Target: x86_64-redhat-linux
Configured with: ../configure --enable-bootstrap --enable-languages=c,c++,fortran,objc,obj-c++,ada,go,d,lto --prefix=/usr --
mandir=/usr/share/man --infodir=/usr/share/info --with-bugurl=http://bugzilla.redhat.com/bugzilla --enable-shared --enable-
threads=posix --enable-checking=release --enable-multilib --with-system-zlib --enable-__cxa_atexit --disable-libunwind-exceptions --
enable-gnu-unique-object --enable-linker-build-id --with-gcc-major-version-only --enable-libstdcxx-backtrace --with-linker-hash-
style=gnu --enable-plugin --enable-initfini-array --with-isl=/builddir/build/BUILD/gcc-12.2.1-20220819/obj-x86_64-redhat-linux/isl-
install --enable-offload-targets=nvptx-none --without-cuda-driver --enable-offload-defaulted --enable-gnu-indirect-function --enable-
cet --with-tune=generic --with-arch_32=i686 --build=x86_64-redhat-linux --with-build-config=bootstrap-lto --enable-link-serialization=1
Thread model: posix
Supported LTO compression algorithms: zlib zstd
gcc version 12.2.1 20220819 (Red Hat 12.2.1-1) (GCC)
COMPILER_PATH=/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-linux/12/:/usr/libexec/gcc/x86_64-redhat-
linux/:/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-linux/
LIBRARY_PATH=/usr/lib/gcc/x86_64-redhat-linux/12/:/usr/lib/gcc/x86_64-redhat-
linux/12/../../../../lib64/:/lib/../lib64/:/usr/lib/../lib64/:/usr/lib/gcc/x86_64-redhat-linux/12/../../../:/lib/:/usr/lib/
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-o' 'asx20' '-mtune=generic' '-march=x86-64' '-dumpdir' 'asx20.'
 /usr/libexec/gcc/x86_64-redhat-linux/12/collect2 -plugin /usr/libexec/gcc/x86_64-redhat-linux/12/liblto_plugin.so -plugin-
opt=/usr/libexec/gcc/x86_64-redhat-linux/12/lto-wrapper -plugin-opt=-fresolution=/tmp/cc8SCTOo.res -plugin-opt=-pass-through=-lgcc -
plugin-opt=-pass-through=-lgcc_s -plugin-opt=-pass-through=-lc -plugin-opt=-pass-through=-lgcc -plugin-opt=-pass-through=-lgcc_s --
build-id --no-add-needed --eh-frame-hdr --hash-style=gnu -m elf_x86_64 -dynamic-linker /lib64/ld-linux-x86-64.so.2 -o asx20
```

```
/usr/lib/gcc/x86_64-redhat-linux/12/../../../../lib64/crt1.o /usr/lib/gcc/x86_64-redhat-linux/12/../../../../lib64/crti.o
/usr/lib/gcc/x86_64-redhat-linux/12/crtbegin.o -L/usr/lib/gcc/x86_64-redhat-linux/12 -L/usr/lib/gcc/x86_64-redhat-
linux/12/../../../../lib64 -L/lib/../lib64 -L/usr/lib/../lib64 -L/usr/lib/gcc/x86_64-redhat-linux/12/../../.. scan.o main.o parse.o
message.o assemble.o symtab.o -lgcc --push-state --as-needed -lgcc_s --pop-state -lc -lgcc --push-state --as-needed -lgcc_s --pop-state
/usr/lib/gcc/x86_64-redhat-linux/12/crtend.o /usr/lib/gcc/x86_64-redhat-linux/12/../../../../lib64/crtn.o
COLLECT_GCC_OPTIONS='-g' '-Wall' '-std=c99' '-v' '-o' 'asx20' '-mtune=generic' '-march=x86-64' '-dumpdir' 'asx20.'
```

4.
```asm
                .file   "factorial.c"
                .text
                .globl  factorial
                .type   factorial, @function
        factorial:
        .LFB0:
                .cfi_startproc
                pushq   %rbp
                .cfi_def_cfa_offset 16
                .cfi_offset 6, -16
                movq    %rsp, %rbp
                .cfi_def_cfa_register 6
                pushq   %rbx
                subq    $24, %rsp
                .cfi_offset 3, -24
                movl    %edi, -20(%rbp)
                cmpl    $0, -20(%rbp)
                jne     .L2
                movl    $1, %eax
                jmp     .L3
        .L2:
                movl    -20(%rbp), %eax
                movslq  %eax, %rbx
                movl    -20(%rbp), %eax
                subl    $1, %eax
                movl    %eax, %edi
                call    factorial
                imulq   %rbx, %rax
        .L3:
                movq    -8(%rbp), %rbx
                leave
                .cfi_def_cfa 7, 8
                ret
                .cfi_endproc
        .LFE0:
                .size   factorial, .-factorial
                .section        .rodata
        .LC0:
                .string "%ld\n"
                .text
                .globl  main
                .type   main, @function
        main:
        .LFB1:
                .cfi_startproc
                pushq   %rbp
                .cfi_def_cfa_offset 16
                .cfi_offset 6, -16
                movq    %rsp, %rbp
                .cfi_def_cfa_register 6
                subq    $16, %rsp
                movl    $9, -4(%rbp)
                movl    -4(%rbp), %eax
                movl    %eax, %edi
                call    factorial
                movq    %rax, %rsi
                movl    $.LC0, %edi
                movl    $0, %eax
                call    printf
                nop
                leave
                .cfi_def_cfa 7, 8
                ret
                .cfi_endproc
        .LFE1:
                .size   main, .-main
                .ident  "GCC: (GNU) 12.2.1 20220819 (Red Hat 12.2.1-1)"
                .section        .note.GNU-stack,"",@progbits
```

5.
```c
        #include <stdio.h>

        char *mygets(char *s)
        {
            int c;
            char *dest = s;
            int gotchar = 0;
            while ((c = getchar()) != '\n' && c != EOF)
            {
                *dest++ = c;
                gotchar = 1;
            }
            *dest++ = '\0';
            if (c == EOF && !gotchar)
            {
                return NULL;
            }
            return s;
        }

        int main()
        {
            char buf[8];
            mygets(buf);
            printf("string is: %s\n", buf);
        }
```

Program returns text inputted on the command line. For example, if you enter 'seven', 'string is: seven' will be output by the program. If you input a file containing: 'one two three', the program will output: 'string is: one two three'.
Other examples:

```
bash-5.1$ ./a.out
ebsggbdgrb
string is: ebsggbdgrb
bash-5.1$ ./a.out
0123456789
string is: 0123456789
```

6.

ELF stands for "Executable and Linkable Format" and is a standard format for executable and object code.

```
bash-5.1$ readelf -h mygets
ELF Header:
  Magic:   7f 45 4c 46 02 01 01 00 00 00 00 00 00 00 00 00
  Class:                             ELF64
  Data:                              2's complement, little endian
  Version:                           1 (current)
  OS/ABI:                            UNIX - System V
  ABI Version:                       0
  Type:                              EXEC (Executable file)
  Machine:                           Advanced Micro Devices X86-64
  Version:                           0x1
  Entry point address:               0x401050
  Start of program headers:          64 (bytes into file)
  Start of section headers:          23080 (bytes into file)
  Flags:                             0x0
  Size of this header:               64 (bytes)
  Size of program headers:           56 (bytes)
  Number of program headers:         13
  Size of section headers:           64 (bytes)
  Number of section headers:         31
  Section header string table index: 30

bash-5.1$ readelf -h mygets.o
ELF Header:
  Magic:   7f 45 4c 46 02 01 01 00 00 00 00 00 00 00 00 00
  Class:                             ELF64
  Data:                              2's complement, little endian
  Version:                           1 (current)
  OS/ABI:                            UNIX - System V
  ABI Version:                       0
  Type:                              REL (Relocatable file)
  Machine:                           Advanced Micro Devices X86-64
  Version:                           0x1
  Entry point address:               0x0
  Start of program headers:          0 (bytes into file)
  Start of section headers:          920 (bytes into file)
  Flags:                             0x0
  Size of this header:               64 (bytes)
  Size of program headers:           0 (bytes)
  Number of program headers:         0
  Size of section headers:           64 (bytes)
  Number of section headers:         14
  Section header string table index: 13

bash-5.1$ readelf -a mygets
ELF Header:
  Magic:   7f 45 4c 46 02 01 01 00 00 00 00 00 00 00 00 00
  Class:                             ELF64
  Data:                              2's complement, little endian
  Version:                           1 (current)
  OS/ABI:                            UNIX - System V
  ABI Version:                       0
  Type:                              REL (Relocatable file)
  Machine:                           Advanced Micro Devices X86-64
  Version:                           0x1
  Entry point address:               0x0
  Start of program headers:          0 (bytes into file)
  Start of section headers:          912 (bytes into file)
  Flags:                             0x0
  Size of this header:               64 (bytes)
  Size of program headers:           0 (bytes)
  Number of program headers:         0
  Size of section headers:           64 (bytes)
  Number of section headers:         14
  Section header string table index: 13

Section Headers:
  [Nr] Name              Type            Address          Offset
       Size              EntSize         Flags  Link  Info  Align
  [ 0]                   NULL            0000000000000000 00000000
       0000000000000000  0000000000000000        0      0     0
  [ 1] .text             PROGBITS        0000000000000000 00000040
       00000000000000a2  0000000000000000  AX     0      0     1
  [ 2] .rela.text        RELA            0000000000000000 00000288
       0000000000000060  0000000000000018  I     11      1     8
  [ 3] .data             PROGBITS        0000000000000000 000000e2
       0000000000000000  0000000000000000  WA     0      0     1
  [ 4] .bss              NOBITS          0000000000000000 000000e2
       0000000000000000  0000000000000000  WA     0      0     1
  [ 5] .rodata           PROGBITS        0000000000000000 000000e2
       000000000000000f  0000000000000000  A      0      0     1
  [ 6] .comment          PROGBITS        0000000000000000 000000f1
       000000000000002f  0000000000000001  MS     0      0     1
  [ 7] .note.GNU-stack   PROGBITS        0000000000000000 00000120
       0000000000000000  0000000000000000        0      0     1
  [ 8] .note.gnu.pr[...] NOTE            0000000000000000 00000120
       0000000000000030  0000000000000000  A      0      0     8
  [ 9] .eh_frame         PROGBITS        0000000000000000 00000150
       0000000000000058  0000000000000000  A      0      0     8
  [10] .rela.eh_frame    RELA            0000000000000000 000002e8
```

```
              000000000000030  0000000000000018   I      11     9     8
  [11] .symtab           SYMTAB           0000000000000000  000001a8
       00000000000000c0  0000000000000018         12     4     8
  [12] .strtab           STRTAB           0000000000000000  00000268
       0000000000000020  0000000000000000          0     0     1
  [13] .shstrtab         STRTAB           0000000000000000  00000318
       0000000000000074  0000000000000000          0     0     1
Key to Flags:
  W (write), A (alloc), X (execute), M (merge), S (strings), I (info),
  L (link order), O (extra OS processing required), G (group), T (TLS),
  C (compressed), x (unknown), o (OS specific), E (exclude),
  D (mbind), l (large), p (processor specific)

There are no section groups in this file.

There are no program headers in this file.

There is no dynamic section in this file.

Relocation section '.rela.text' at offset 0x288 contains 4 entries:
  Offset          Info           Type           Sym. Value    Sym. Name + Addend
000000000036  000500000004 R_X86_64_PLT32    0000000000000000 getchar - 4
000000000081  000400000004 R_X86_64_PLT32    0000000000000000 mygets - 4
00000000008d  00030000000a R_X86_64_32       0000000000000000 .rodata + 0
000000000097  000700000004 R_X86_64_PLT32    0000000000000000 printf - 4

Relocation section '.rela.eh_frame' at offset 0x2e8 contains 2 entries:
  Offset          Info           Type           Sym. Value    Sym. Name + Addend
000000000020  000200000002 R_X86_64_PC32     0000000000000000 .text + 0
000000000040  000200000002 R_X86_64_PC32     0000000000000000 .text + 71
No processor specific unwind information to decode

Symbol table '.symtab' contains 8 entries:
   Num:    Value          Size Type    Bind   Vis      Ndx Name
     0: 0000000000000000     0 NOTYPE  LOCAL  DEFAULT  UND
     1: 0000000000000000     0 FILE    LOCAL  DEFAULT  ABS 5.c
     2: 0000000000000000     0 SECTION LOCAL  DEFAULT    1 .text
     3: 0000000000000000     0 SECTION LOCAL  DEFAULT    5 .rodata
     4: 0000000000000000   113 FUNC    GLOBAL DEFAULT    1 mygets
     5: 0000000000000000     0 NOTYPE  GLOBAL DEFAULT  UND getchar
     6: 0000000000000071    49 FUNC    GLOBAL DEFAULT    1 main
     7: 0000000000000000     0 NOTYPE  GLOBAL DEFAULT  UND printf

No version information found in this file.

Displaying notes found in: .note.gnu.property
  Owner                Data size       Description
  GNU                  0x00000020      NT_GNU_PROPERTY_TYPE_0
      Properties: x86 ISA used:
        x86 feature used: x86

bash-5.1$ readelf -a mygets.o
ELF Header:
  Magic:   7f 45 4c 46 02 01 01 00 00 00 00 00 00 00 00 00
  Class:                             ELF64
  Data:                              2's complement, little endian
  Version:                           1 (current)
  OS/ABI:                            UNIX - System V
  ABI Version:                       0
  Type:                              REL (Relocatable file)
  Machine:                           Advanced Micro Devices X86-64
  Version:                           0x1
  Entry point address:               0x0
  Start of program headers:          0 (bytes into file)
  Start of section headers:          920 (bytes into file)
  Flags:                             0x0
  Size of this header:               64 (bytes)
  Size of program headers:           0 (bytes)
  Number of program headers:         0
  Size of section headers:           64 (bytes)
  Number of section headers:         14
  Section header string table index: 13

Section Headers:
  [Nr] Name              Type             Address           Offset
       Size              EntSize          Flags  Link  Info  Align
  [ 0]                   NULL             0000000000000000  00000000
       0000000000000000  0000000000000000          0     0     0
  [ 1] .text             PROGBITS         0000000000000000  00000040
       00000000000000a2  0000000000000000  AX      0     0     1
  [ 2] .rela.text        RELA             0000000000000000  00000290
       0000000000000060  0000000000000018   I     11     1     8
  [ 3] .data             PROGBITS         0000000000000000  000000e2
       0000000000000000  0000000000000000  WA      0     0     1
  [ 4] .bss              NOBITS           0000000000000000  000000e2
       0000000000000000  0000000000000000  WA      0     0     1
  [ 5] .rodata           PROGBITS         0000000000000000  000000e2
       000000000000000f  0000000000000000   A      0     0     1
  [ 6] .comment          PROGBITS         0000000000000000  000000f1
       000000000000002f  0000000000000001  MS      0     0     1
  [ 7] .note.GNU-stack   PROGBITS         0000000000000000  00000120
       0000000000000000  0000000000000000          0     0     1
  [ 8] .note.gnu.pr[...] NOTE             0000000000000000  00000120
       0000000000000030  0000000000000000   A      0     0     8
  [ 9] .eh_frame         PROGBITS         0000000000000000  00000150
       0000000000000058  0000000000000000   A      0     0     8
  [10] .rela.eh_frame    RELA             0000000000000000  000002f0
       0000000000000030  0000000000000018   I     11     9     8
  [11] .symtab           SYMTAB           0000000000000000  000001a8
       00000000000000c0  0000000000000018         12     4     8
  [12] .strtab           STRTAB           0000000000000000  00000268
       0000000000000025  0000000000000000          0     0     1
  [13] .shstrtab         STRTAB           0000000000000000  00000320
```

```
              0000000000000074  0000000000000000          0     0     1
      Key to Flags:
        W (write), A (alloc), X (execute), M (merge), S (strings), I (info),
        L (link order), O (extra OS processing required), G (group), T (TLS),
        C (compressed), x (unknown), o (OS specific), E (exclude),
        D (mbind), l (large), p (processor specific)

      There are no section groups in this file.

      There are no program headers in this file.

      There is no dynamic section in this file.

      Relocation section '.rela.text' at offset 0x290 contains 4 entries:
          Offset          Info           Type           Sym. Value    Sym. Name + Addend
      000000000036  000500000004 R_X86_64_PLT32    0000000000000000 getchar - 4
      000000000081  000400000004 R_X86_64_PLT32    0000000000000000 mygets - 4
      00000000008d  00030000000a R_X86_64_32       0000000000000000 .rodata + 0
      000000000097  000700000004 R_X86_64_PLT32    0000000000000000 printf - 4

      Relocation section '.rela.eh_frame' at offset 0x2f0 contains 2 entries:
          Offset          Info           Type           Sym. Value    Sym. Name + Addend
      000000000020  000200000002 R_X86_64_PC32     0000000000000000 .text + 0
      000000000040  000200000002 R_X86_64_PC32     0000000000000000 .text + 71
      No processor specific unwind information to decode

      Symbol table '.symtab' contains 8 entries:
         Num:    Value          Size Type    Bind   Vis      Ndx Name
           0: 0000000000000000     0 NOTYPE  LOCAL  DEFAULT  UND
           1: 0000000000000000     0 FILE    LOCAL  DEFAULT  ABS mygets.c
           2: 0000000000000000     0 SECTION LOCAL  DEFAULT    1 .text
           3: 0000000000000000     0 SECTION LOCAL  DEFAULT    5 .rodata
           4: 0000000000000000   113 FUNC    GLOBAL DEFAULT    1 mygets
           5: 0000000000000000     0 NOTYPE  GLOBAL DEFAULT  UND getchar
           6: 0000000000000071    49 FUNC    GLOBAL DEFAULT    1 main
           7: 0000000000000000     0 NOTYPE  GLOBAL DEFAULT  UND printf

      No version information found in this file.

      Displaying notes found in: .note.gnu.property
        Owner                Data size        Description
        GNU                  0x00000020       NT_GNU_PROPERTY_TYPE_0
            Properties: x86 ISA used:
                x86 feature used: x86
```
They are not any noticeable differences.

7.

This implementation is almost the same as program 4's histogram.c. The difference now is that each file's threads would have to lock the global sum table before it adds to it and then unlock it once it's finished.