

Operating Systems(24802)

Project #4

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2017011912
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<Thread Pool Algorithm>

enqueue()

enqueue 는 대기열에 새 작업을 넣는 데 쓰이는 함수입니다. 대기열의 상황은 대기열이 비어있는 경우, 넣을 공간이 있는 경우, 꽉 찬 경우의 세가지로 나뉩니다. 대기열이 비어있는 경우는 head 와 tail 을 0 으로 초기화하며 작업을 대기열에 넣고 수행할 작업이 추가되었으므로 sem 을 post 해주며 0 을 리턴합니다. 넣을 공간이 있을 경우에는 작업을 대기열에 넣어주며 tail 값을 한 칸 옮기며 sem 을 post 해주고 0 을 리턴합니다. 대기열이 꽉 찬 경우 enqueue 작업을 할 수 없으므로 1 을 리턴합니다.

dequeue()

dequeue 는 대기열에 대기중인 작업을 꺼내는 데 쓰이는 함수입니다. 대기열의 상황은 큐가 비어있는 경우, dequeue 를 진행했을때 큐가 비게 되는 경우, 그렇지 않은 경우의 세가지로 나뉩니다. 큐가 비어있을 경우에는 dequeue 를 해줄 수 없으므로 1 을 리턴합니다. 큐의 사이즈가 2 이상이여서 Dequeue 를 진행할 수 있을 경우 대기열의 head 를 t 에 저장하고 head 를 한칸 옮겨줍니다. 큐의 사이즈가 1 이라면 dequeue 를 하면 큐가 비게 되므로 head 와 tail 값을 -1 으로 초기화하며, queue 사이즈를 줄여줍니다.

worker()

worker 는 수행할 작업을 sem_wait(sem)을 통해 기다립니다. 수행할 작업이 enqueue 되어 post 되었다면 대기열에 접근해 mutex_lock 을 걸고 dequeue 를 해주어 성공했다면 수행할 작업을 받아온 후 mutex_unlock 을 해줍니다.

Pool_submit()

Mutex_lock 을 해주며 인자로 받은 f 와 p 를 갖는 task 구조체를 만들어 enqueue 를 시도하고 Mutex_unlock 을 해줍니다. 대기열이 꽉 차 enqueue 를 실패했다면 1 을 리턴하며, 성공했다면 0 을 리턴합니다.

pool_init()

mutex 를 초기화하며 named semaphore 인 sem 을 읽기-쓰기 권한을 주며 생성합니다. NUMBER_OF_BEES 만큼 worker 스레드를 생성합니다.

pool_shutdown()

NUMBER_OF_BEES 만큼의 모든 worker 스레드를 종료 시키고 mutex 와 semaphore 를 제거해줍니다.

<Compilation Process>

```
proj4 --zsh-- 153x67
(base) namjeonghun@songhae proj4 % make
gcc -v -Wall -c client.c
Apple clang version 12.0.5 (clang-1205.0.22.9)
Target: x86_64-apple-darwin20.4.0
Thread model: posix
InstalledDir: /Library/Developer/CommandLineTools/usr/bin
"/Library/Developer/CommandLineTools/usr/bin/clang" -cc1 -triple x86_64-apple-macosx11.0.0 -Wdeprecated-objc-isa-usage -Werror=deprecated-objc-isa-usage
-Werror=implicit-function-declaration -emit-obj -mrelax-all -disable-free -disable-llvm-verifier -discard-value-names -main-file-name client.c -mrelocat
ion-model pic -pic-level 2 -mframe-pointer=all -fno-strict-return -fno-rounding-math -munwind-tables -target-sdk-version=11.3 -fvisibility-inlines-hidden
-static-local-var -target-cpu penryn -debugger-tuning=lldb -target-linker-version 650.9 -v -resource-dir /Library/Developer/CommandLineTools/usr/lib/clan
g/12.0.5 -isysroot /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk -I/usr/local/include -internal-isystem /Library/Developer/CommandLineTools/SDKs/Ma
cOSX.sdk/usr/local/include -internal-isystem /Library/Developer/CommandLineTools/usr/lib/clang/12.0.5/include -internal-externc-isystem /Library/Develope
r/CommandLineTools/SDKs/MacOSX.sdk/usr/include -internal-externc-isystem /Library/Developer/CommandLineTools/usr/include -Wall -Wno-reorder-init-list -Wn
o-implicit-int-float-conversion -Wno-c99-designator -Wno-final-dtor-non-final-class -Wno-extra-semi-stmt -Wno-misleading-indentation -Wno-quoted-include
-in-framework-header -Wno-implicit-fallthrough -Wno-enum-enum-conversion -Wno-enum-float-conversion -Wno-elaborated-enum-base -fdebug-compilation-dir /Use
rs/namjeonghun/Desktop/운영 체제 /Operating_System_Project/proj4 -ferror-limit 19 -stack-protector 1 -fstack-check -mdarwin-stkchk-strong-link -fblocks -fe
ncode-extended-block-signature -fregister-global-dtors-with-atexit -fgnuc-version=4.2.1 -fmax-type-align=16 -fcommon -fcolor-diagnostics -clang-vendor-fe
ature=+disableNonDependentMemberExprInCurrentInstantiation -fno-odr-hash-protocols -mllvm -disable-aligned-alloc-awareness=1 -o client.o -x c client.c
clang -cc1 version 12.0.5 (clang-1205.0.22.9) default target x86_64-apple-darwin20.4.0
ignoring nonexistent directory "/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/local/include"
ignoring nonexistent directory "/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/Library/Frameworks"
#include "... search starts here:
#include <...> search starts here:
/usr/local/include
/Library/Developer/CommandLineTools/usr/lib/clang/12.0.5/include
/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include
/Library/Developer/CommandLineTools/usr/include
/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/System/Library/Frameworks (framework directory)
End of search list.
gcc -v -Wall -c threadpool.c
Apple clang version 12.0.5 (clang-1205.0.22.9)
Target: x86_64-apple-darwin20.4.0
Thread model: posix
InstalledDir: /Library/Developer/CommandLineTools/usr/bin
"/Library/Developer/CommandLineTools/usr/bin/clang" -cc1 -triple x86_64-apple-macosx11.0.0 -Wdeprecated-objc-isa-usage -Werror=deprecated-objc-isa-usage
-Werror=implicit-function-declaration -emit-obj -mrelax-all -disable-free -disable-llvm-verifier -discard-value-names -main-file-name threadpool.c -mrel
ocation-model pic -pic-level 2 -mframe-pointer=all -fno-strict-return -fno-rounding-math -munwind-tables -target-sdk-version=11.3 -fvisibility-inlines-hi
dden-static-local-var -target-cpu penryn -debugger-tuning=lldb -target-linker-version 650.9 -v -resource-dir /Library/Developer/CommandLineTools/usr/lib/cl
ang/12.0.5 -isysroot /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk -I/usr/local/include -internal-isystem /Library/Developer/CommandLineTools/SDK
s/MacOSX.sdk/usr/local/include -internal-isystem /Library/Developer/CommandLineTools/usr/lib/clang/12.0.5/include -internal-externc-isystem /Library/Deve
loper/CommandLineTools/SDKs/MacOSX.sdk/usr/include -internal-externc-isystem /Library/Developer/CommandLineTools/usr/include -Wall -Wno-reorder-init-list
-Wno-implicit-int-float-conversion -Wno-c99-designator -Wno-final-dtor-non-final-class -Wno-extra-semi-stmt -Wno-misleading-indentation -Wno-quoted-incl
ude-in-framework-header -Wno-implicit-fallthrough -Wno-enum-enum-conversion -Wno-enum-float-conversion -Wno-elaborated-enum-base -fdebug-compilation-dir
/Users/namjeonghun/Desktop/운영 체제 /Operating_System_Project/proj4 -ferror-limit 19 -stack-protector 1 -fstack-check -mdarwin-stkchk-strong-link -fblocks
-fencode-extended-block-signature -fregister-global-dtors-with-atexit -fgnuc-version=4.2.1 -fmax-type-align=16 -fcommon -fcolor-diagnostics -clang-vendo
r-feature=+disableNonDependentMemberExprInCurrentInstantiation -fno-odr-hash-protocols -mllvm -disable-aligned-alloc-awareness=1 -o threadpool.o -x c thr
eadpool.c
clang -cc1 version 12.0.5 (clang-1205.0.22.9) default target x86_64-apple-darwin20.4.0
ignoring nonexistent directory "/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/local/include"
ignoring nonexistent directory "/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/Library/Frameworks"
#include "... search starts here:
#include <...> search starts here:
/usr/local/include
/Library/Developer/CommandLineTools/usr/lib/clang/12.0.5/include
/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include
/Library/Developer/CommandLineTools/usr/include
/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/System/Library/Frameworks (framework directory)
End of search list.
gcc -v -Wall -o client client.o threadpool.o
Apple clang version 12.0.5 (clang-1205.0.22.9)
Target: x86_64-apple-darwin20.4.0
Thread model: posix
InstalledDir: /Library/Developer/CommandLineTools/usr/bin
"/Library/Developer/CommandLineTools/usr/bin/ld" -demangle -lto_library /Library/Developer/CommandLineTools/usr/lib/libLTO.dylib -dynamic -arch x86_64 -
platform_version macos 11.0.0 11.3 -syslibroot /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk -o client -L/usr/local/lib client.o threadpool.o -lSys
tem /Library/Developer/CommandLineTools/usr/lib/clang/12.0.5/lib/darwin/libclang_rt.osx.a
(base) namjeonghun@songhae proj4 %
```

```

(base) namjeonghun@songhae proj4 % make
gcc -v -Wall -c client.c
Apple clang version 12.0.5 (clang-1205.0.22.9)
Target: x86_64-apple-darwin20.4.0
Thread model: posix
InstalledDir: /Library/Developer/CommandLineTools/usr/bin
"/Library/Developer/CommandLineTools/usr/bin/clang" -cc1 -triple x86_64-apple-macosx11.0.0 -Wdeprecated-objc-isa-usage -Werror=deprecated-objc-isa-usage -Werror=implicit-function-declaration -emit-obj -mrelax-all -disable-free -disable-llvm-verifier -discard-value-names -main-file-name client.c -mrelocation-model pic -pic-level 2 -mframe-pointer=all -fno-strict-return -fno-rounding-math -munwind-tables -target-sdk-version=11.3 -fvisibility-inlines-hidden-static-local-var -target-cpu penryn -debugger-tuning=lldb -target-linker-version 650.9 -v -resource-dir /Library/Developer/CommandLineTools/usr/lib/clang/12.0.5 -isysroot /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk -I/usr/local/include -internal-isystem /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/local/include -internal-isystem /Library/Developer/CommandLineTools/usr/lib/clang/12.0.5/include -internal-externc-isystem /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include -internal-externc-isystem /Library/Developer/CommandLineTools/usr/include -Wall -Wno-reorder-init-list -Wno-implicit-int-float-conversion -Wno-c99-designator -Wno-final-dtor-non-final-class -Wno-extra-semi-stmt -Wno-misleading-indentation -Wno-quoted-include-in-framework-header -Wno-implicit-fallthrough -Wno-enum-enum-conversion -Wno-enum-float-conversion -Wno-elaborated-enum-base -fdebug-compilation-dir /Users/namjeonghun/Desktop/운영체제/Operating_System_Project/proj4 -ferror-limit 19 -stack-protector 1 -fstack-check -mdarwin-stkchk-strong-link -fblocks -fencode-extended-block-signature -fregister-global-dtors-with-atexit -fgnuc-version=4.2.1 -fmax-type-align=16 -fcommon -fcolor-diagnostics -clang-vendor-feature=+disableNonDependentMemberExprInCurrentInstantiation -fno-odr-hash-protocols -mllvm -disable-aligned-alloc-awareness=1 -o client.o -x c client.c
clang -cc1 version 12.0.5 (clang-1205.0.22.9) default target x86_64-apple-darwin20.4.0
ignoring nonexistent directory "/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/local/include"
ignoring nonexistent directory "/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/Library/Frameworks"
#include "...": search starts here:
#include <...> search starts here:
/usr/local/include
/Library/Developer/CommandLineTools/usr/lib/clang/12.0.5/include
/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include
/Library/Developer/CommandLineTools/usr/include
/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/System/Library/Frameworks (framework directory)
End of search list.
gcc -v -Wall -c threadpool.c
Apple clang version 12.0.5 (clang-1205.0.22.9)
Target: x86_64-apple-darwin20.4.0
Thread model: posix
InstalledDir: /Library/Developer/CommandLineTools/usr/bin
"/Library/Developer/CommandLineTools/usr/bin/clang" -cc1 -triple x86_64-apple-macosx11.0.0 -Wdeprecated-objc-isa-usage -Werror=deprecated-objc-isa-usage -Werror=implicit-function-declaration -emit-obj -mrelax-all -disable-free -disable-llvm-verifier -discard-value-names -main-file-name threadpool.c -mrelocation-model pic -pic-level 2 -mframe-pointer=all -fno-strict-return -fno-rounding-math -munwind-tables -target-sdk-version=11.3 -fvisibility-inlines-hidden-static-local-var -target-cpu penryn -debugger-tuning=lldb -target-linker-version 650.9 -v -resource-dir /Library/Developer/CommandLineTools/usr/lib/clang/12.0.5 -isysroot /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk -I/usr/local/include -internal-isystem /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/local/include -internal-isystem /Library/Developer/CommandLineTools/usr/lib/clang/12.0.5/include -internal-externc-isystem /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include -internal-externc-isystem /Library/Developer/CommandLineTools/usr/include -Wall -Wno-reorder-init-list -Wno-implicit-int-float-conversion -Wno-c99-designator -Wno-final-dtor-non-final-class -Wno-extra-semi-stmt -Wno-misleading-indentation -Wno-quoted-include-in-framework-header -Wno-implicit-fallthrough -Wno-enum-enum-conversion -Wno-enum-float-conversion -Wno-elaborated-enum-base -fdebug-compilation-dir /Users/namjeonghun/Desktop/운영체제/Operating_System_Project/proj4 -ferror-limit 19 -stack-protector 1 -fstack-check -mdarwin-stkchk-strong-link -fblocks -fencode-extended-block-signature -fregister-global-dtors-with-atexit -fgnuc-version=4.2.1 -fmax-type-align=16 -fcommon -fcolor-diagnostics -clang-vendor-feature=+disableNonDependentMemberExprInCurrentInstantiation -fno-odr-hash-protocols -mllvm -disable-aligned-alloc-awareness=1 -o threadpool.o -x c threadpool.c
clang -cc1 version 12.0.5 (clang-1205.0.22.9) default target x86_64-apple-darwin20.4.0
ignoring nonexistent directory "/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/local/include"
ignoring nonexistent directory "/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/Library/Frameworks"
#include "...": search starts here:
#include <...> search starts here:
/usr/local/include
/Library/Developer/CommandLineTools/usr/lib/clang/12.0.5/include
/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/usr/include
/Library/Developer/CommandLineTools/usr/include
/Library/Developer/CommandLineTools/SDKs/MacOSX.sdk/System/Library/Frameworks (framework directory)
End of search list.
gcc -v -Wall -o client client.o threadpool.o
Apple clang version 12.0.5 (clang-1205.0.22.9)
Target: x86_64-apple-darwin20.4.0
Thread model: posix
InstalledDir: /Library/Developer/CommandLineTools/usr/bin
"/Library/Developer/CommandLineTools/usr/bin/ld" -demangle -lto_library /Library/Developer/CommandLineTools/usr/lib/libLTO.dylib -dynamic -arch x86_64 -platform_version macos 11.0.0 11.3 -syslibroot /Library/Developer/CommandLineTools/SDKs/MacOSX.sdk -o client -L/usr/local/lib client.o threadpool.o -lSystem /Library/Developer/CommandLineTools/usr/lib/clang/12.0.5/lib/darwin/libclang_rt.osx.a

```

[illegible]

처음에는 `pool_init()`과 `pool_shutdown()` 이 잘 작동하는지 테스트를 한 후 작업을 시작합니다. `NTASK` 만큼의 스레드들이 `number` 함수를 실행하기 위해 `submit` 되려 하지만 `thread pool`의 대기열 용량이 `10` 이므로 을 그것을 넘는 요청은 오류메세지를 남기며 거절합니다. `10 msec` 동안 `thread pool`에 `submit`된 스레드들의 작업은 `3` 명의 `worker`들이 `concurrent`하게 수행하고 대기열을 비웁니다. 마지막으로 `donothing`, `donothing`, `pooh`를 수행하는 세 개의 스레드를 `submit` 해주어 방해 없이 `pooh` 함수가 잘 작동 해 공동이 푼 아스키아트가 잘 출력되는 것을 볼 수 있습니다.