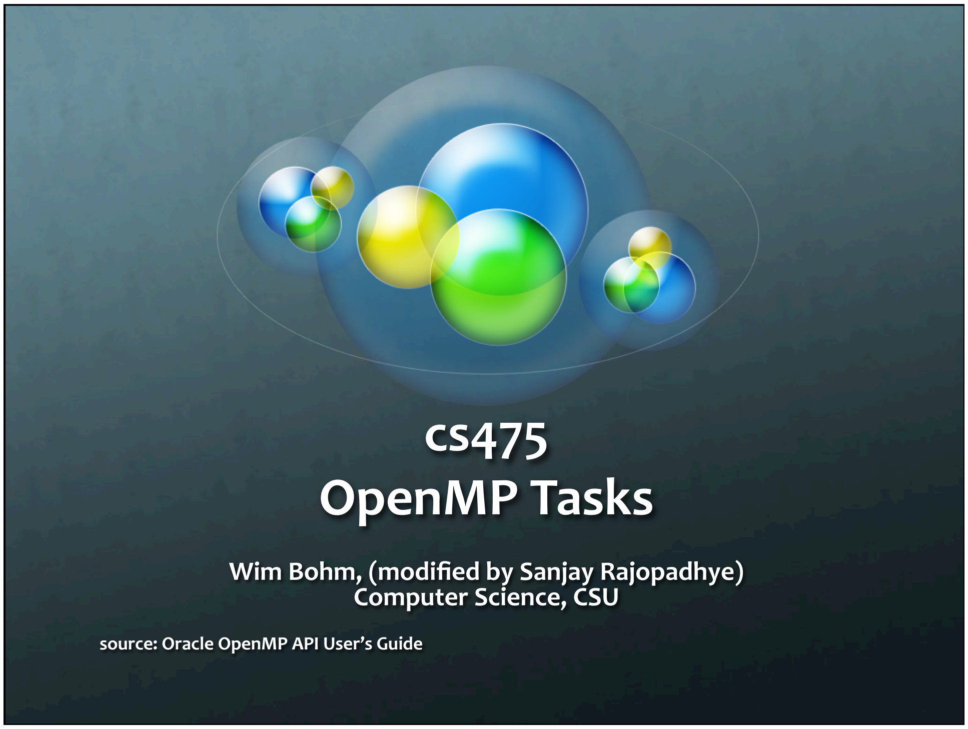

cs475
OpenMP Tasks

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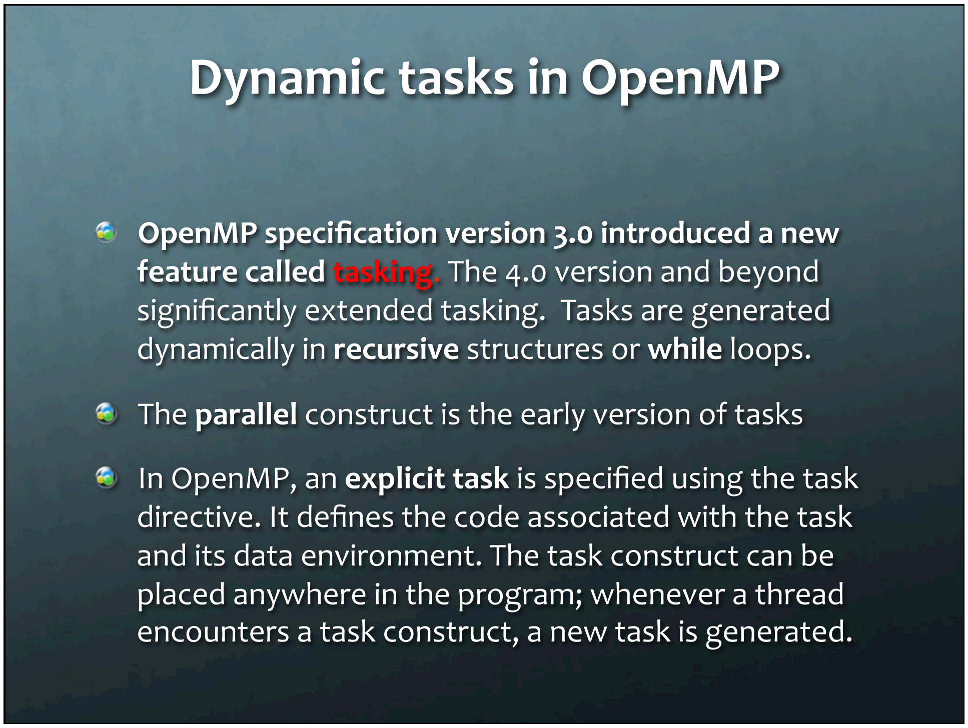
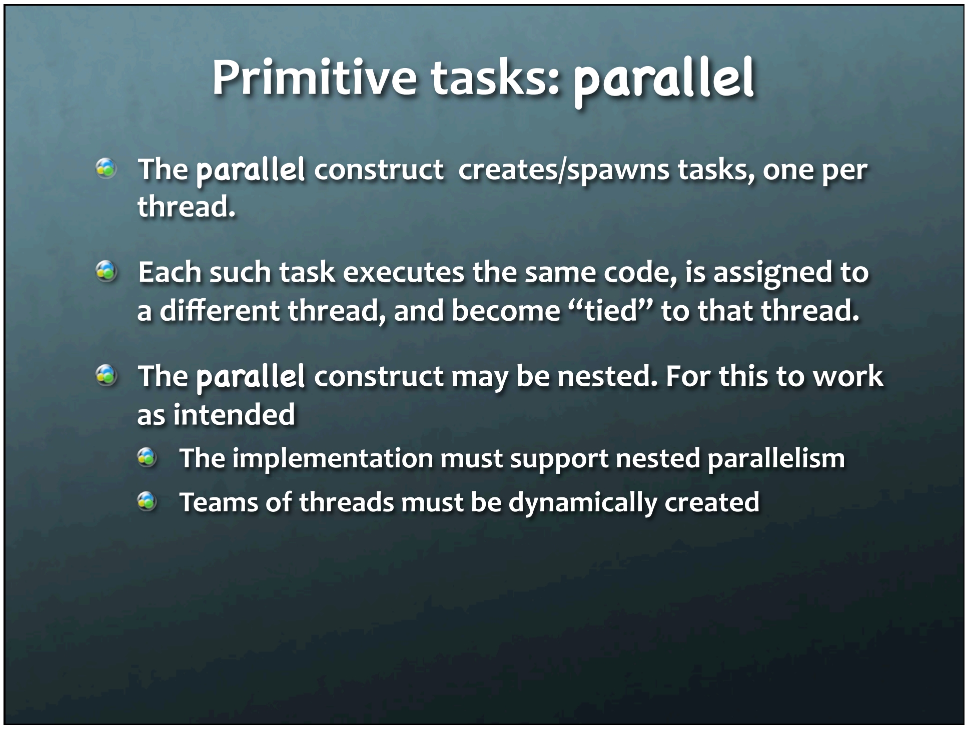
source: Oracle OpenMP API User's Guide



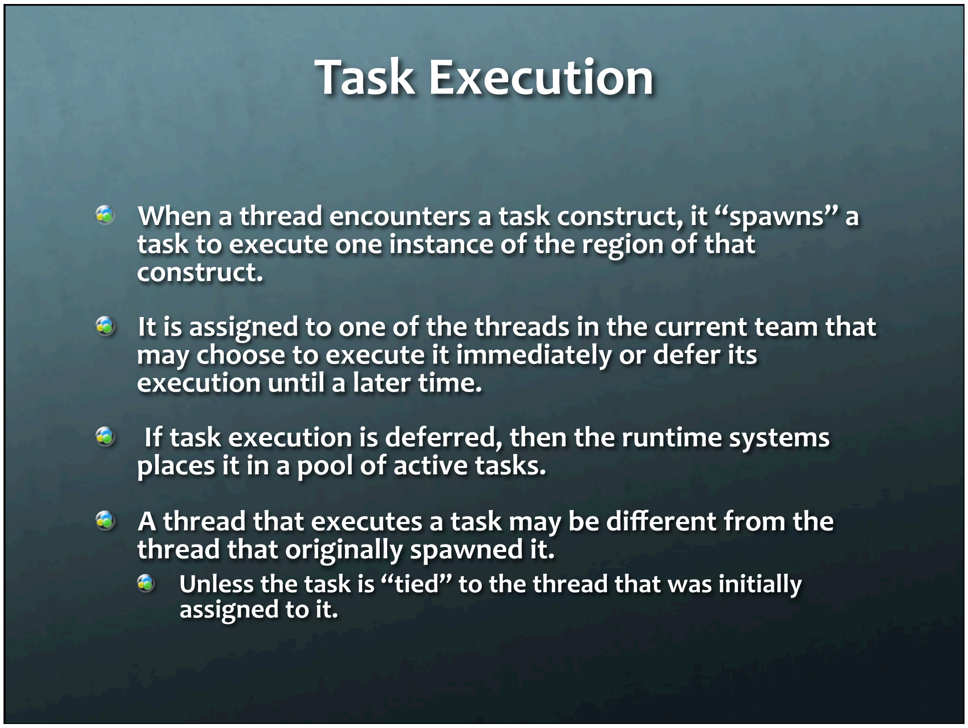
Dynamic tasks in OpenMP

- **OpenMP specification version 3.0 introduced a new feature called tasking.** The 4.0 version and beyond significantly extended tasking. Tasks are generated dynamically in **recursive** structures or **while** loops.
- The **parallel** construct is the early version of tasks
- In OpenMP, an **explicit task** is specified using the task directive. It defines the code associated with the task and its data environment. The task construct can be placed anywhere in the program; whenever a thread encounters a task construct, a new task is generated.



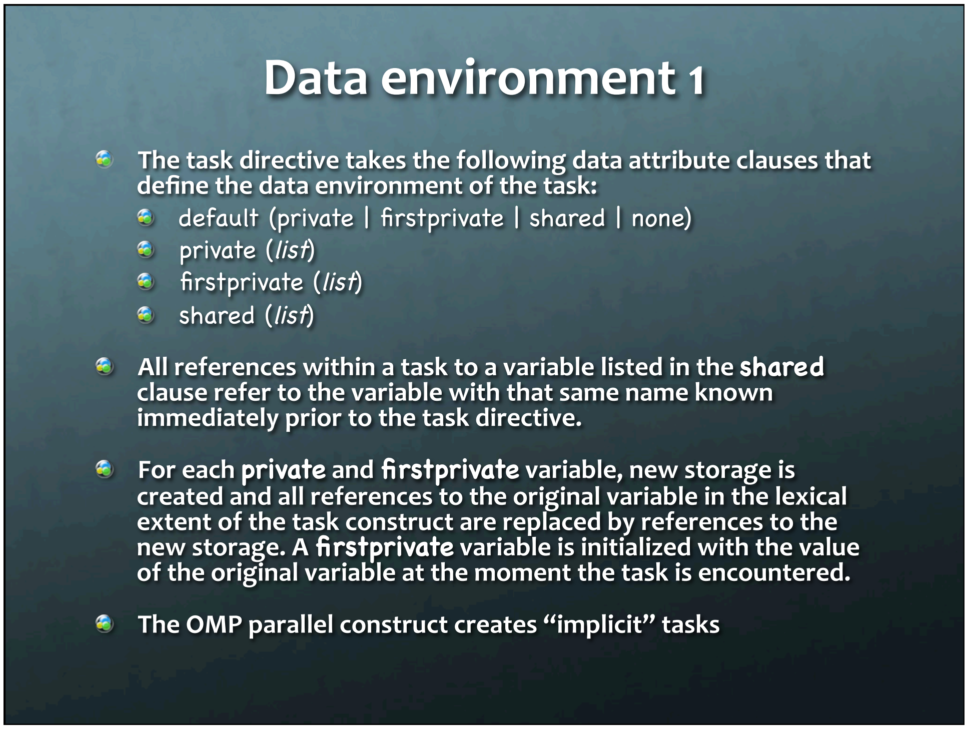
Primitive tasks: parallel

- The **parallel** construct creates/spawns tasks, one per thread.
- Each such task executes the same code, is assigned to a different thread, and become “tied” to that thread.
- The **parallel** construct may be nested. For this to work as intended
  - The implementation must support nested parallelism
  - Teams of threads must be dynamically created



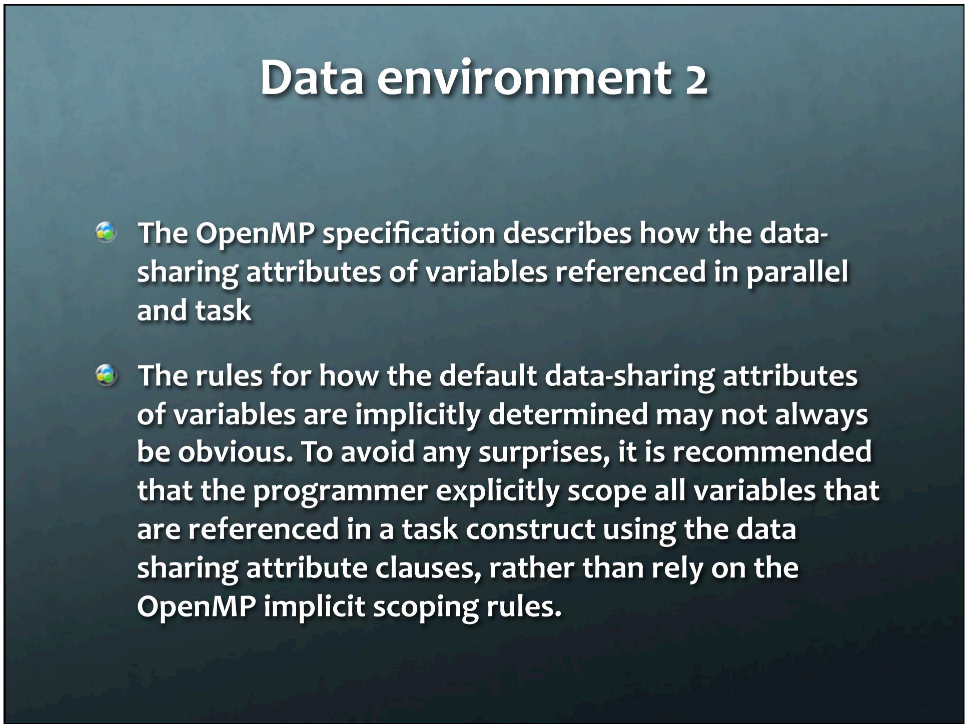
Task Execution

- When a thread encounters a task construct, it “spawns” a task to execute one instance of the region of that construct.
- It is assigned to one of the threads in the current team that may choose to execute it immediately or defer its execution until a later time.
- If task execution is deferred, then the runtime systems places it in a pool of active tasks.
- A thread that executes a task may be different from the thread that originally spawned it.
  - Unless the task is “tied” to the thread that was initially assigned to it.



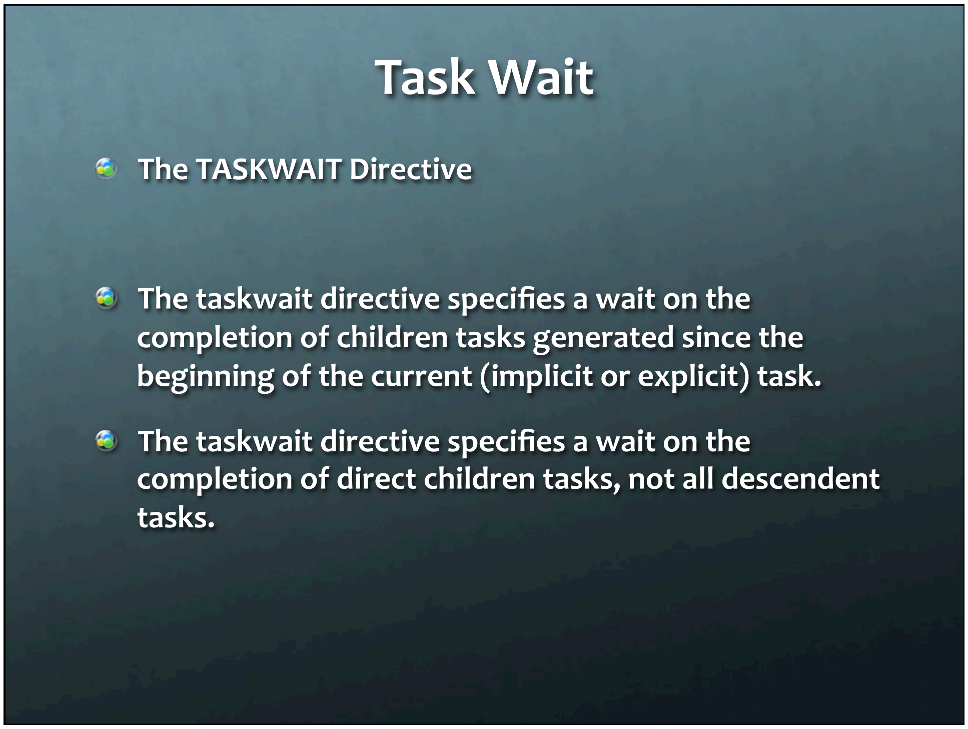
Data environment 1

- The task directive takes the following data attribute clauses that define the data environment of the task:
  - default (private | firstprivate | shared | none)
  - private (*list*)
  - firstprivate (*list*)
  - shared (*list*)
- All references within a task to a variable listed in the **shared** clause refer to the variable with that same name known immediately prior to the task directive.
- For each **private** and **firstprivate** variable, new storage is created and all references to the original variable in the lexical extent of the task construct are replaced by references to the new storage. A **firstprivate** variable is initialized with the value of the original variable at the moment the task is encountered.
- The OMP parallel construct creates "implicit" tasks



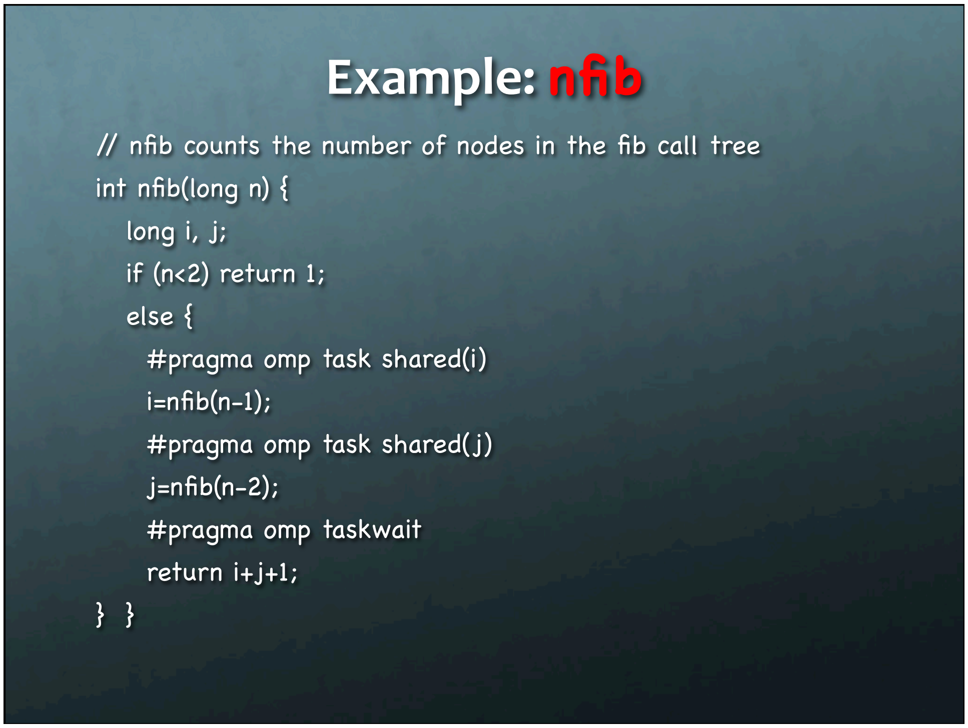
Data environment 2

- The OpenMP specification describes how the data-sharing attributes of variables referenced in parallel and task
- The rules for how the default data-sharing attributes of variables are implicitly determined may not always be obvious. To avoid any surprises, it is recommended that the programmer explicitly scope all variables that are referenced in a task construct using the data sharing attribute clauses, rather than rely on the OpenMP implicit scoping rules.



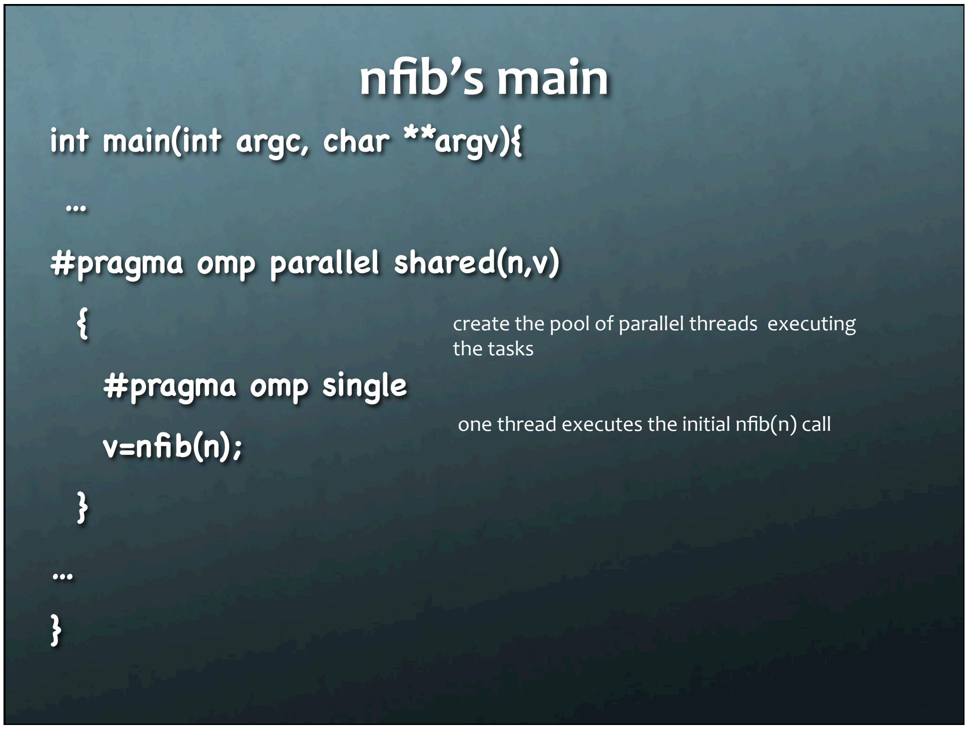
Task Wait

- The TASKWAIT Directive
- The taskwait directive specifies a wait on the completion of children tasks generated since the beginning of the current (implicit or explicit) task.
- The taskwait directive specifies a wait on the completion of direct children tasks, not all descendent tasks.



Example: nfib

```
// nfib counts the number of nodes in the fib call tree
int nfib(long n) {
   long i, j;
   if (n<2) return 1;
   else {
     #pragma omp task shared(i)
     i=nfib(n-1);
     #pragma omp task shared(j)
     j=nfib(n-2);
     #pragma omp taskwait
     return i+j+1;
} }
```

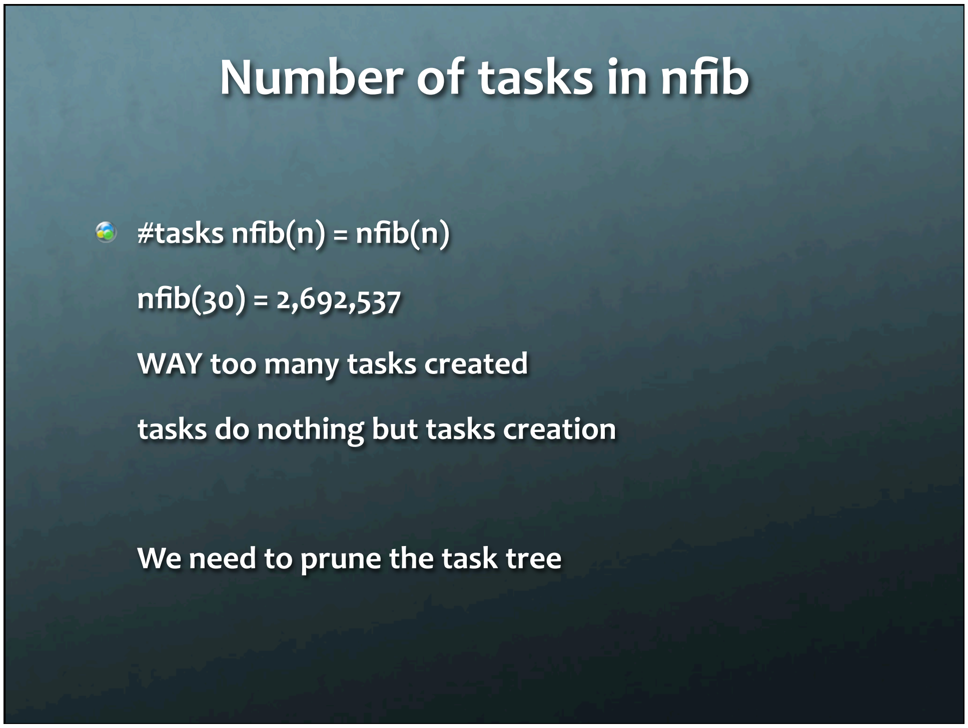


nfib's main

```
int main(int argc, char **argv){
 ...
#pragma omp parallel shared(n,v)
  {
     #pragma omp single
     v=nfib(n);
  }
...
}
```

create the pool of parallel threads executing the tasks

one thread executes the initial nfib(n) call



Number of tasks in nfib

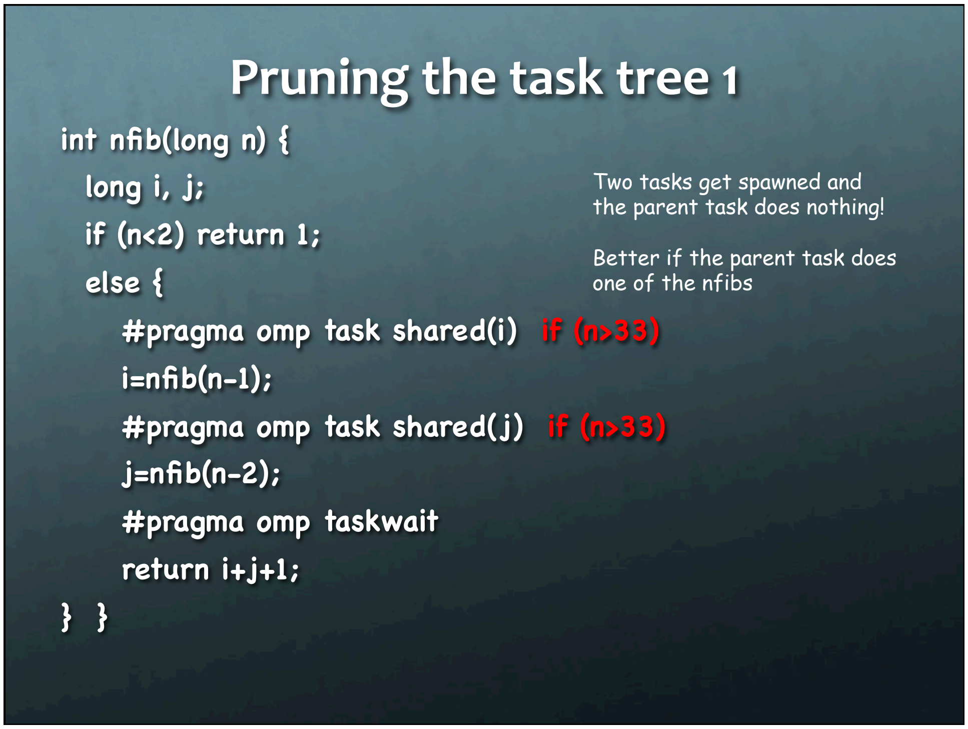
- #tasks nfib(n) = nfib(n)

  nfib(30) = 2,692,537

  WAY too many tasks created

  tasks do nothing but tasks creation

  We need to prune the task tree

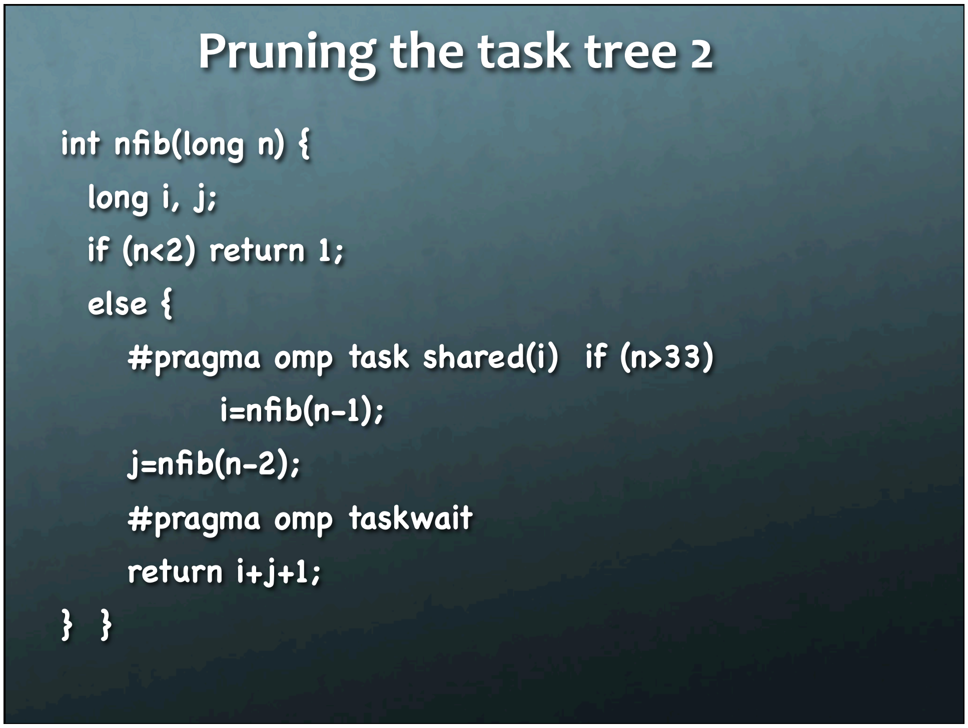


Pruning the task tree 1

```
int nfib(long n) {
  long i, j;
  if (n<2) return 1;
  else {
     #pragma omp task shared(i)  if (n>33)
     i=nfib(n-1);
     #pragma omp task shared(j)  if (n>33)
     j=nfib(n-2);
     #pragma omp taskwait
     return i+j+1;
} }
```

Two tasks get spawned and the parent task does nothing!

Better if the parent task does one of the nfibs



Pruning the task tree 2

```
int nfib(long n) {
  long i, j;
  if (n<2) return 1;
  else {
     #pragma omp task shared(i)  if (n>33)
            i=nfib(n-1);
     j=nfib(n-2);
     #pragma omp taskwait
     return i+j+1;
} }
```