Hello Dolly

Forks, zombies, orphans, pipes, exec...

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With credit to Isabel Ghourchian who's slide text from last year was used for this presentation
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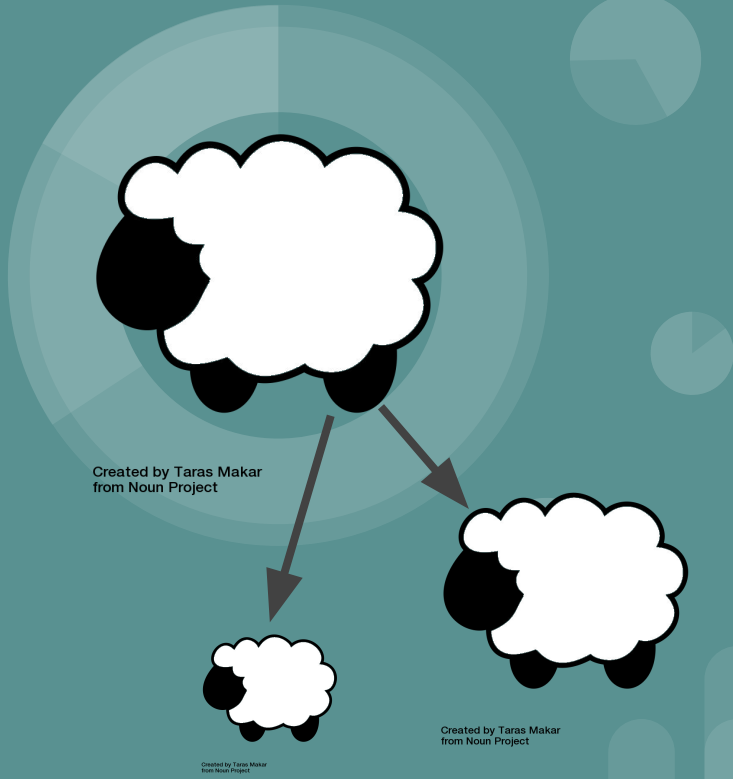

Read about the (not strictly related) sheep Dolly here:
https://en.wikipedia.org/wiki/Dolly_(sheep)

Intro - processes

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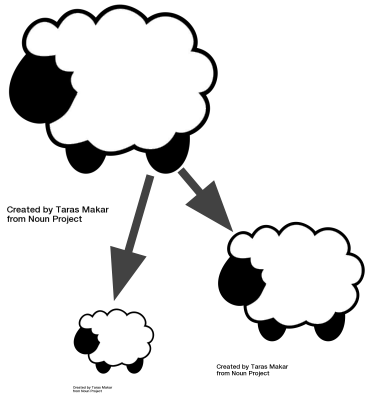
- A process is a running program, an execution of instructions and a set of resources
- A process can be represented by a unique number called process id (pid)

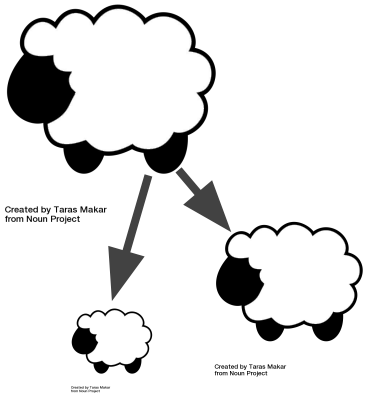
fork()

- Function that creates a new process
- Creates a copy (child process) of the current process (parent process)
- Returns twice
  - child's pid to the parent
  - 0 to the child
- The processes have separate address spaces ...
- ... but they share some things, such as references to open files

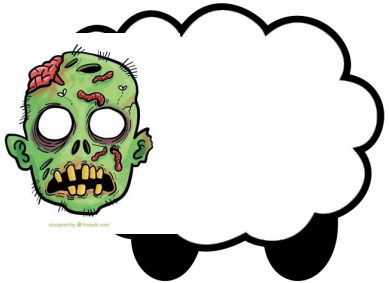


Example – fork()

```
int pid = fork();
if (pid == 0) {
    printf("I'm the child");
}
else {
    printf("I'm the parent ");
}
```



Zombie



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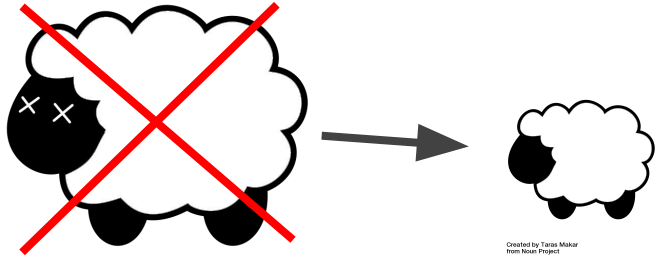
- Child process that has finished executing but still exists in the process table
- Happens if parent does not call wait()

```
else {                          //parent process
    printf("I'm the parent");
    wait(NULL);                 //wait for child process to terminate, prevent zombie
}
```

image from FreePik

Orphans

- Child process that is still running but the parent process has finished executing or terminated
- Will be ”adopted” by another process, get a new parent process
- In UNIX the new parent process is the init or systemd process
  - parent of all processes
  - process id 1



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Groups and Sessions

- The child and parent belong to the same group
- getpgid() gives the group leader’s pid

- A session consists of several groups and a session leader
- getsid() gives the session leader’s pid
- When a session terminates, all processes belonging to the session terminate

Daemon

- Process that runs in the background instead of under direct control of a user
- Has its own session
- Performs operations at predefined times or in response to events
- Runs most of the tasks in a system

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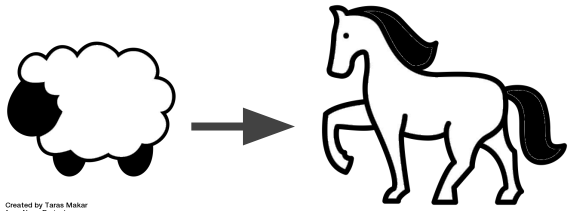
exec()

- Runs an executable file in the context of an existing process, replacing the previous execution context
- execlp(”ls”, ”ls”, NULL);
  - check if ’ls’ exists
  - run it with the rest of the arguments
- exec functions do not return when successful



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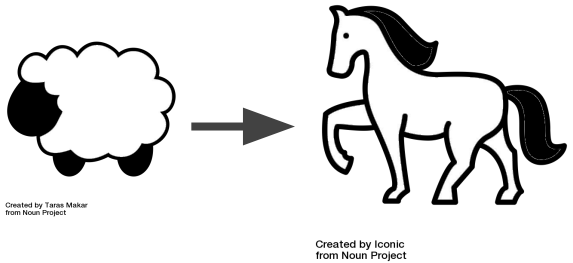
exec() family of functions

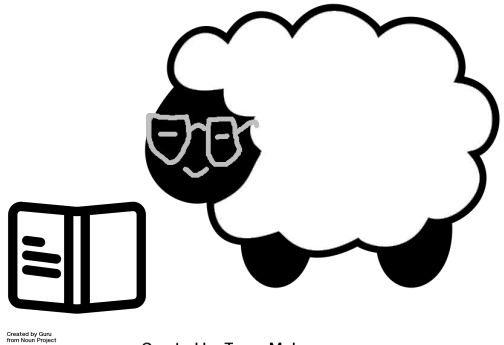
- execl, execlp, execle, execv, execvp, execvpe
  - e: pass an array of pointers to environment variables
  - l: arguments are passed individually to the function
  - v: arguments are passed as an array of strings
  - p: uses PATH environment variable to find the file that is to be executed



Pipes

- Sends the output of one program to another programs input
- Denoted by symbol ’|’
- Piping in the shell: combine several commands
    - Ex: cat countries.txt | grep a | sort
    - Displays all countries that start with an ’a’ and sorts them in alphabetical order

Exam question



1.3 Arghhh! [2 points]

Assume that we have a program `boba` that writes "Don't get in my way" to `stdout`. What will the result be if we run the program below and why is this the result? (the procedure `dprintf()` takes a file descriptor as argument)

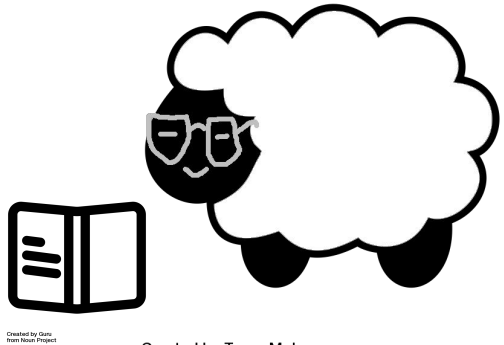
```
int main() {

  int fd = open("quotes.txt", O_RDWR | O_CREAT, S_IRUSR | S_IWUSR);

  int pid = fork();

  if(pid == 0) {
    dup2(fd, 1);
    close(fd);
    execl("boba", "boba", NULL);
  } else {
    dprintf(fd, "Arghhh!");
    close(fd);
  }
  return 0;
}
```

Exam question



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    execl("boba", "boba", NULL);
  } else {
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    close(fd);
  }
  return 0;
}
```

Answer: In `dup2(fd,1)` we redirect `stdout` to the opened file. Boba will write its line to the file `quites.txt`. At the same time the mother process will write "Arghhh!" to the same file. The two processes will share the file current position and combine the write oprations. The result is a mixture of the two texts in the file `quotes.txt` i.e. the texts will not overwrite each other.

Exam question: What is the value of count after?

```
#include <stdio.h>
#include <unistd.h>
#include <sys/wait.h>
#include <sys/types.h>

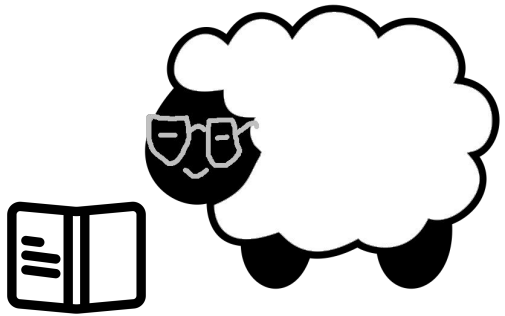
int count = 0;

int main() {

  int *status;

  int pid = fork();

  if( pid == 0) {
    for (int i = 0; i < 10; i++) {
      count += 1;
    }
    return 0;
  } else {
    for (int i = 0; i < 10; i++) {
      count += 1;
    }
    wait(status);
  }
  printf("count = %d\n", count);
  return 0;
}
```



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Exam question: What is the value of count after?

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    }
    wait(status);
  }
  printf("count = %d\n", count);
  return 0;
}
```
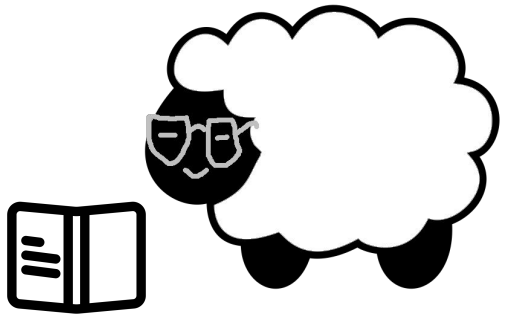

As both processes have their own virtual memory which means that the value of count will be **10** for both of them.



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Exam question: How does pipe work?

2.2 pipes [2 points]

If we have two processes, one producer and one consumer, that are communicating through a so called *pipe*. How can we then prevent that the producer sends more information than the consumer is ready to receive and thereby crash the system.

Exam question: How does pipes work?

2.2 pipes [2 points]

If we have two processes, one producer and one consumer, that are communicating through a so called *pipe*. How can we then prevent that the producer sends more information than the consumer is ready to receive and thereby crash the system.

Answer: Pipes have built-in flow controll. If the consumer does not read from the pipe the producer will be suspended when it tries to write the filled pipe.