System Programming: Communication through pipes

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https://gforgeron.gitlab.io/progsys/

The concept of pipe

- Major mechanism used by the shell
  - ls | grep pattern
  - ./prog | cat -n | less
  - Etc.

- Some operating systems (MS-DOS) implement pipes using files
  - Example: ls | grep pattern
    - The output of “ls” is redirected to a temporary file
    - The system waits for the termination of “ls”
    - “grep pattern” is executed, with its input redirected from the file

    - No parallelism
    - Max file size limit can be reached

The concept of pipe

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  - FIFO ordering
  - Fixed capacity

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    - One for reading (fildes[0]) and one for writing (fildes[1])

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  - Creates a pipe and returns two file descriptors
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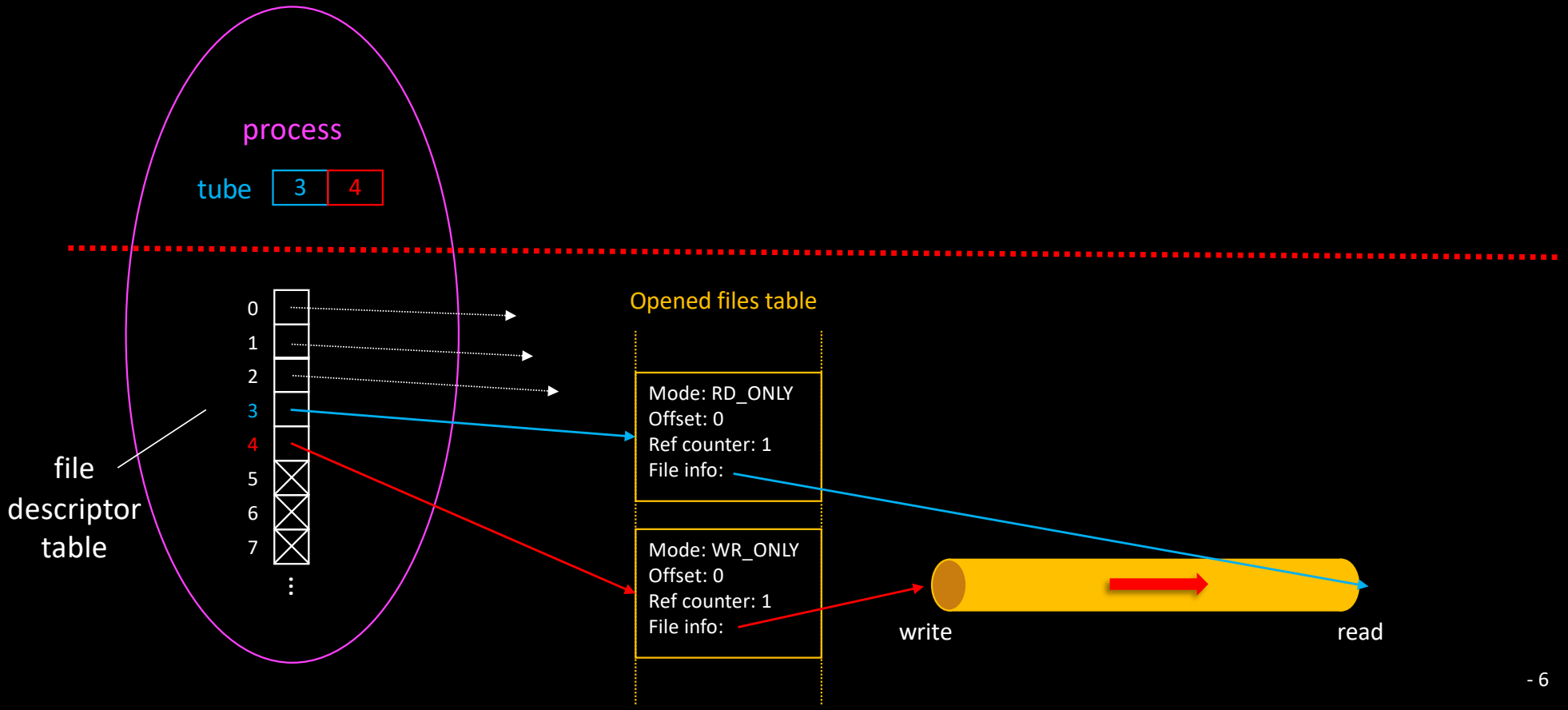
- Reading and writing are done using usual read/write
  - No lseek

int tube[2];
pipe (tube);



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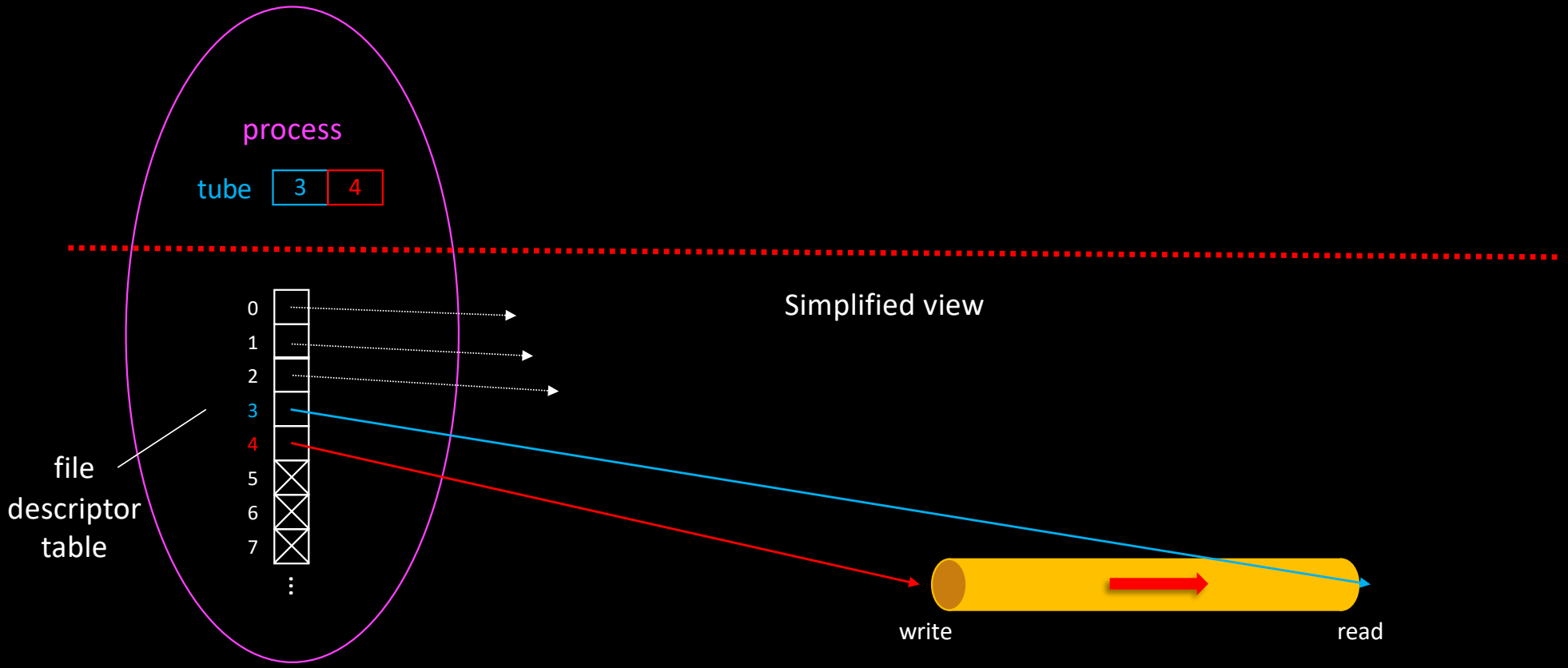


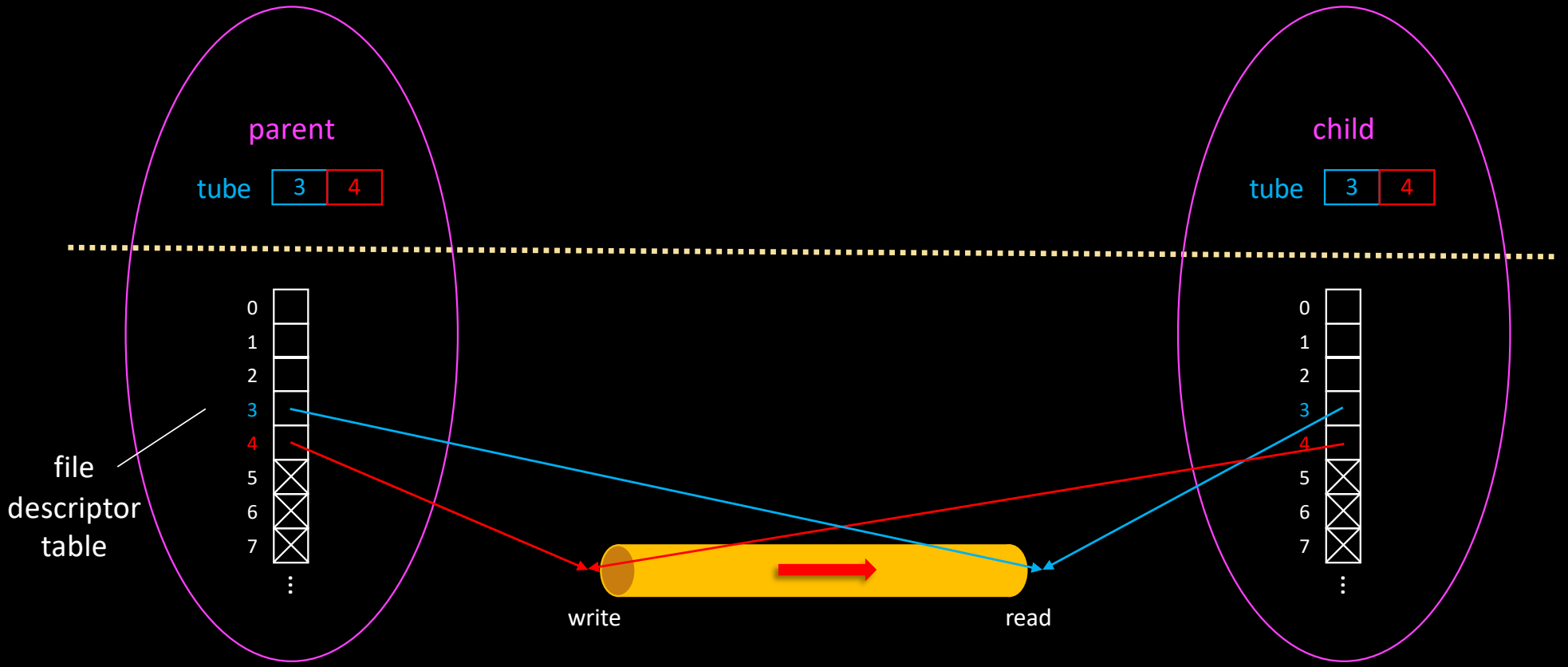
Trying out our first pipe

- pipe.c

Pipe are intended to allow communication between processes

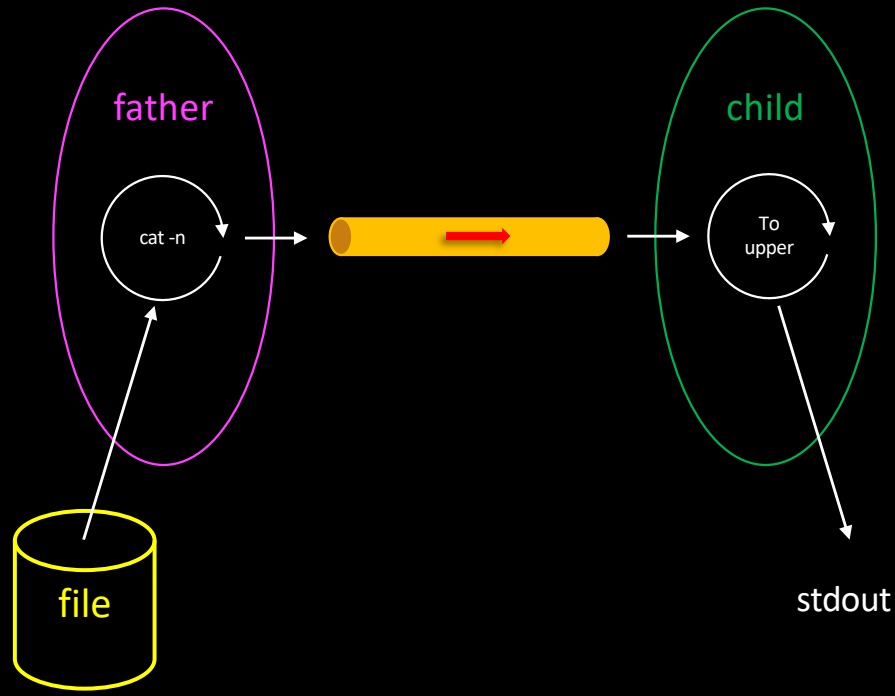
- But pipes created with “pipe” are anonymous
  - No way to share their name
    - Look at `mkfifo` if named pipes are really what you need
- Fortunately, pipes are inherited when forking new processes…

int tube[2];
pipe (tube); fork();



Sending characters through a pipe

- Hand-made implementation of
  - Line numbering + to upper case
- pipe-n-fork.c



The concept of pipe

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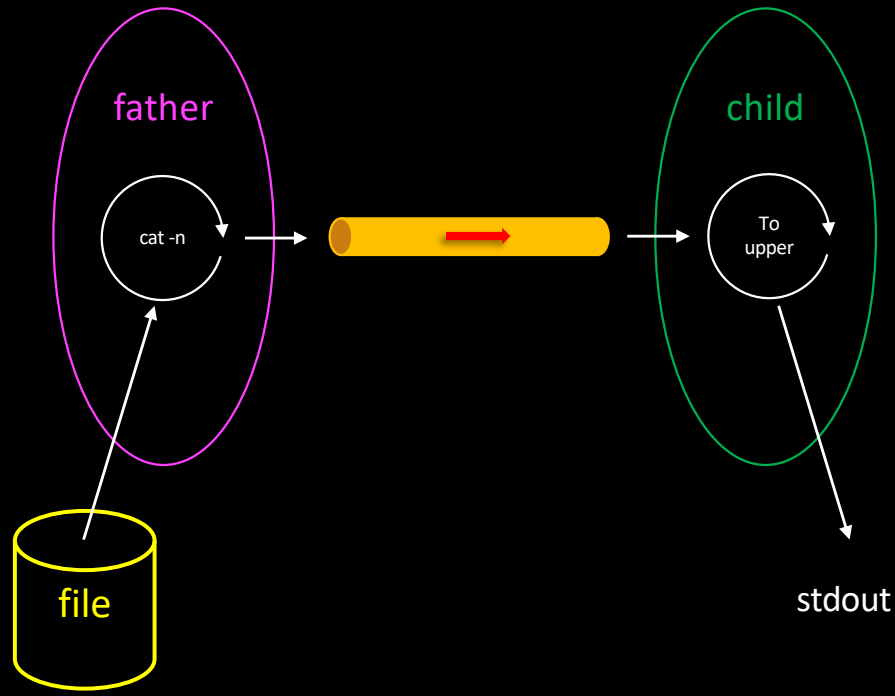
  - `read` is blocking if the pipe is empty
  - `write` is blocking if the pipe is full
- Pipe closed on the write side
  - `read` returns 0 (end of file)
- Pipe closed on the read side
  - `write` raises an exception (“Broken pipe”)

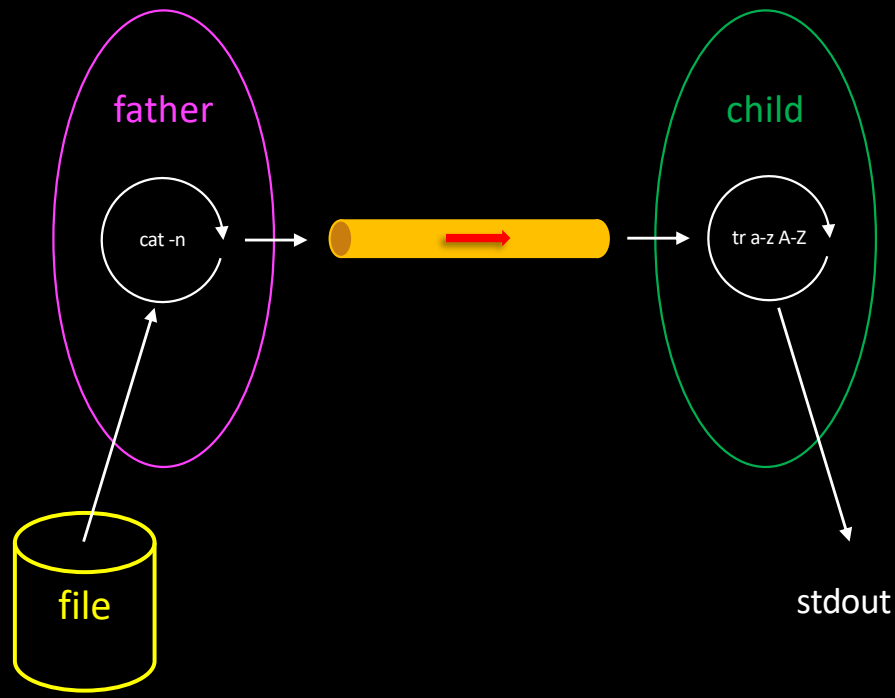
Sending characters through a pipe

- Redirections to only use STDIN/STDOUT
- pipe-n-redir.c



Sending characters through a pipe

- Redirections to only use STDIN/STDOUT
- Exec to use legacy
  - cat -n
  - tr a-z A-Z
- pipe-n-exec.c



Sending characters through a pipe

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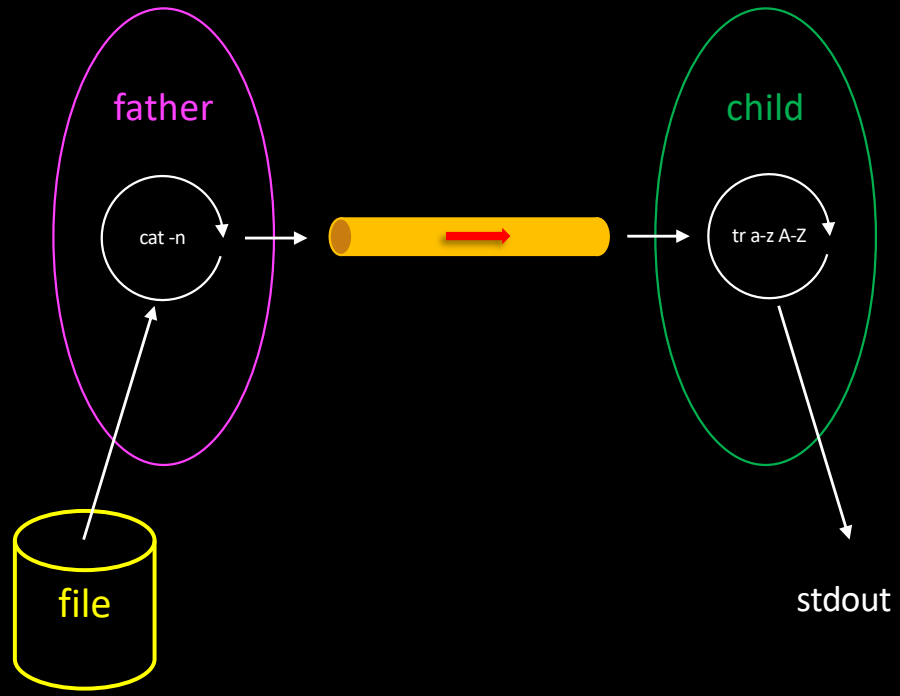
  - Child still output characters after shell prompt



Sending characters through a pipe

- Problem:
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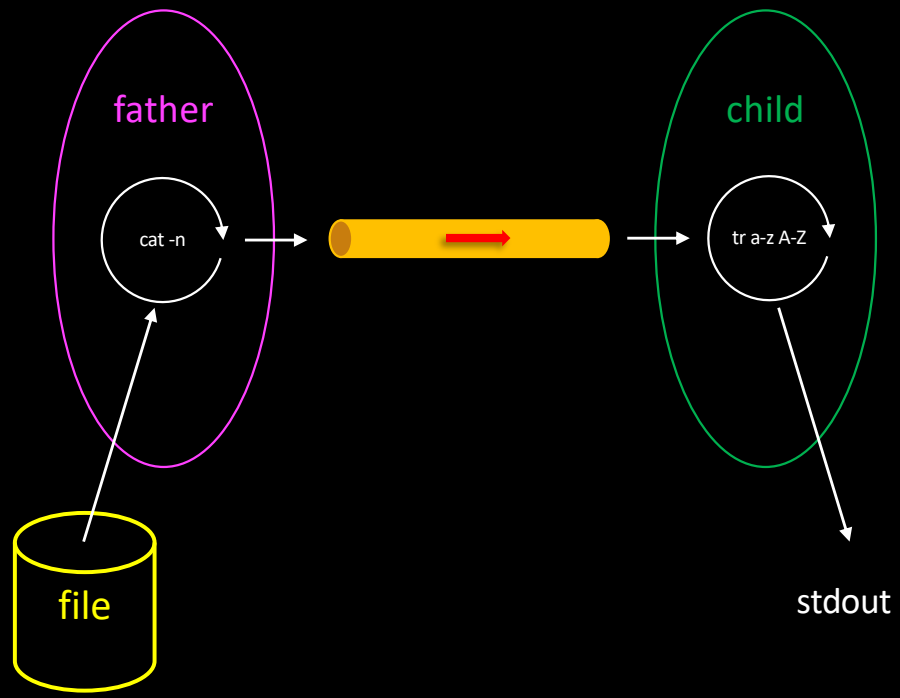
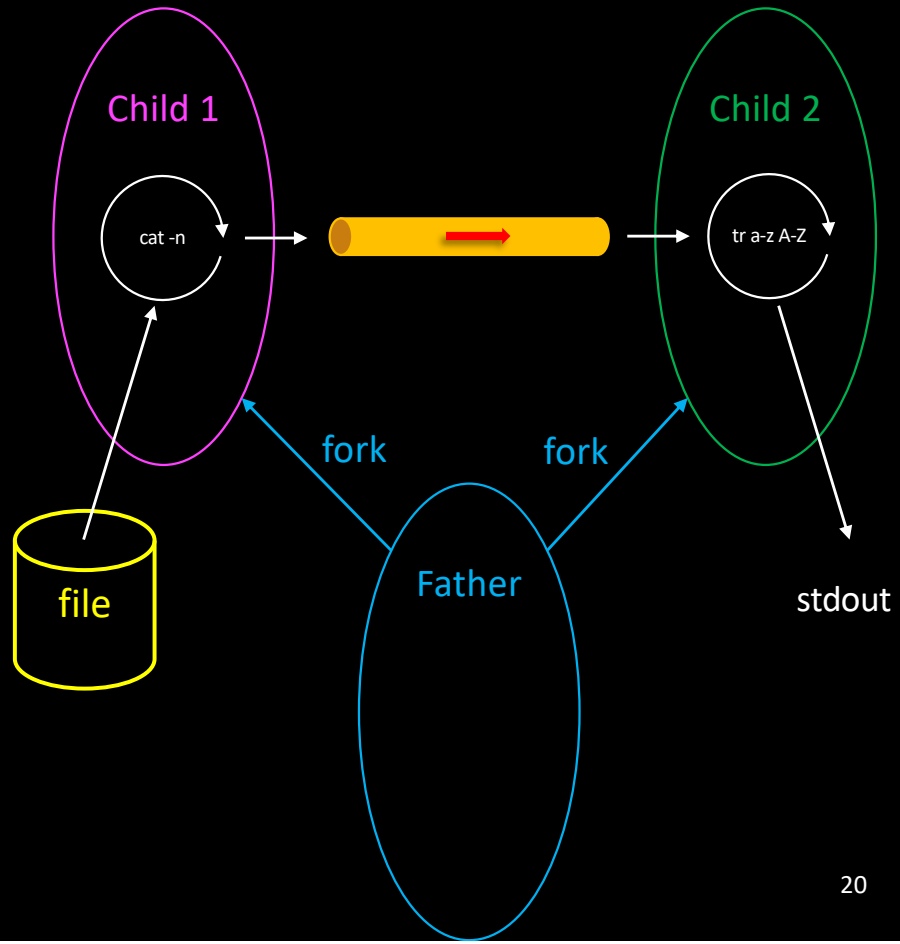
- One solution would be to swap roles of father & child…



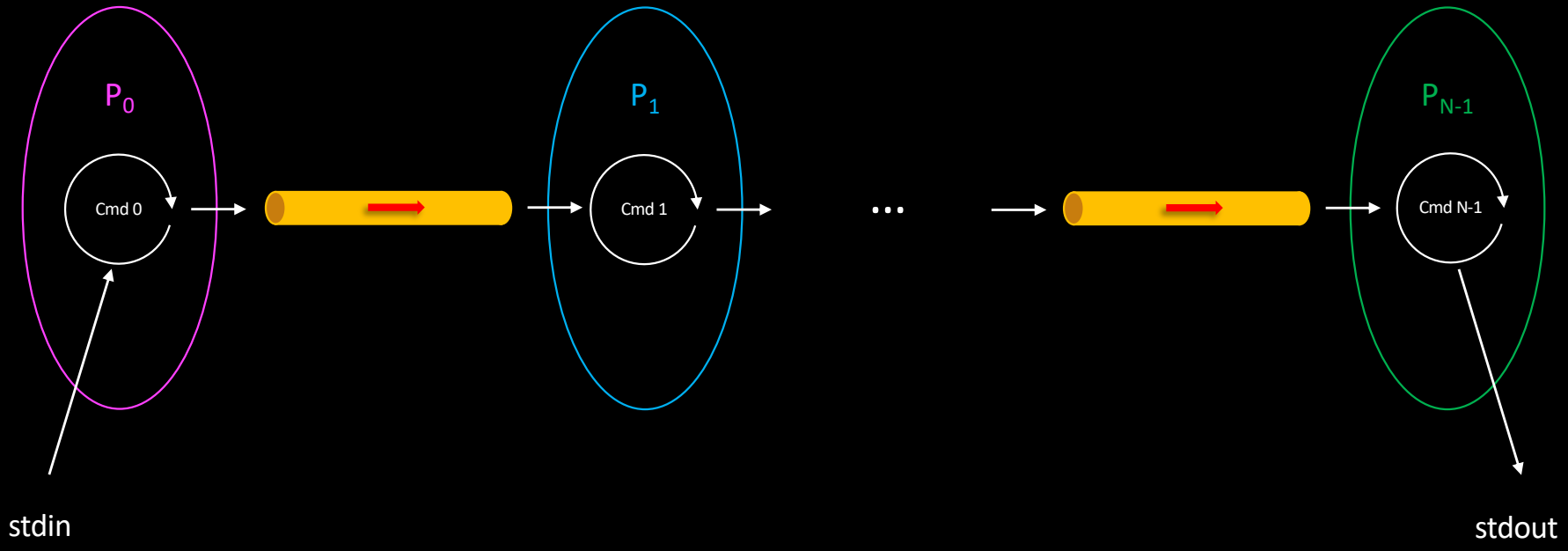
Sending characters through a pipe

- Problem:
  - Child still output characters after shell prompt
- But the shell acts differently: it creates two children!
- ultimate-pipe.c



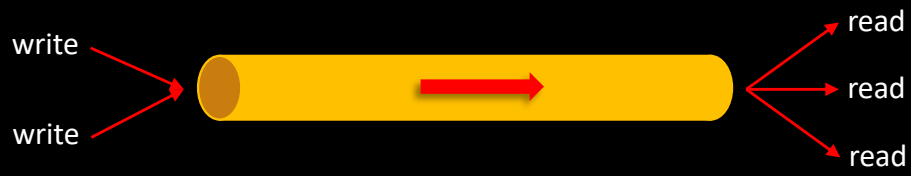
Setting up a chain of processes

- chain.c



Atomicity of read/write

- What happens if multiple processes simultaneously write into (or read from) the same pipe?
  - Atomic if size < PIPE_BUF
    - (typically 512 bytes)



Additional resources
available on
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