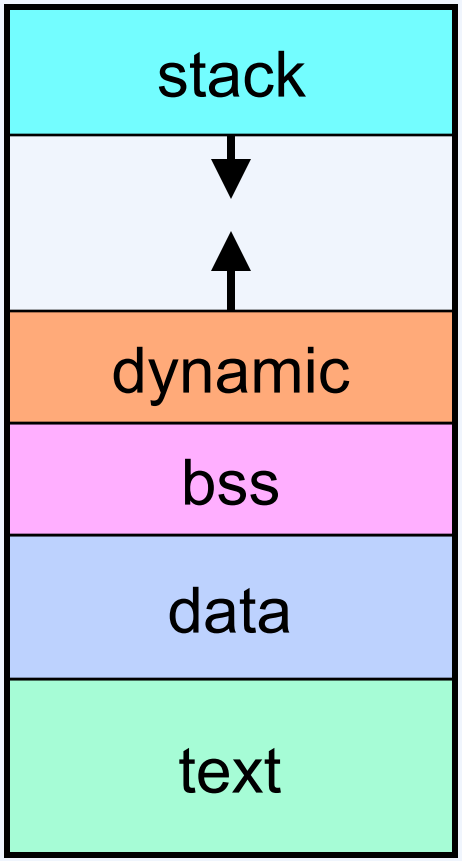
# A Program

```
const int nprimes = 100;
int prime[nprimes];
int main() {
   int i;
   int current = 2;
   prime[0] = current;
   for (i=1; i<nprimes; i++) {
      int j;
   NewCandidate:
      current++;
      for (j=0; prime[j]*prime[j] <= current; j++) {
         if (current % prime[j] == 0)
            goto NewCandidate;
      }
      prime[i] = current;
   }
   return(0);
}
```

# The Unix Address Space



# Modified Program

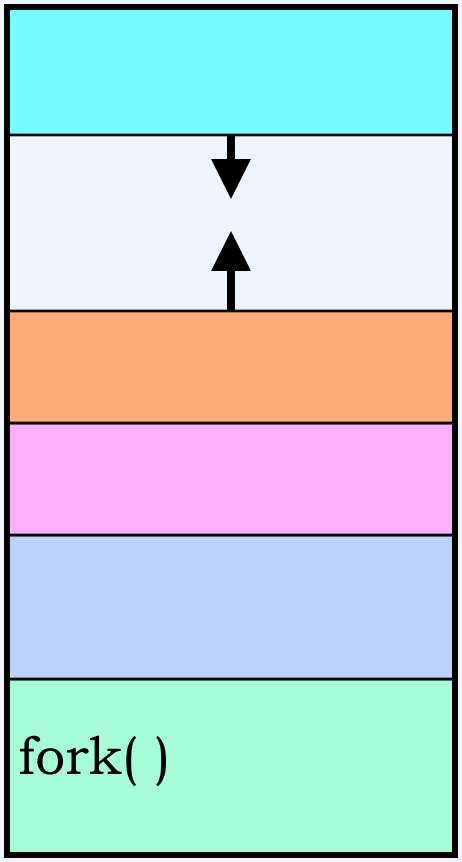
```
const int nprimes = 100;
int *prime;
int main(int argc, char *argv[]) {
   int i;
   int current = 2;
   nprimes = atoi(argv[1]);
   prime = (int *)malloc(nprimes*sizeof(int))
   prime[0] = current;
   for (i=1; i<nprimes; i++) {

      …

   }
   return(0);
}
```

# System Calls

- **Sole interface between user and kernel**
- **Implemented as library routines**
- **Errors indicated by returns of –1; error code is in *errno***

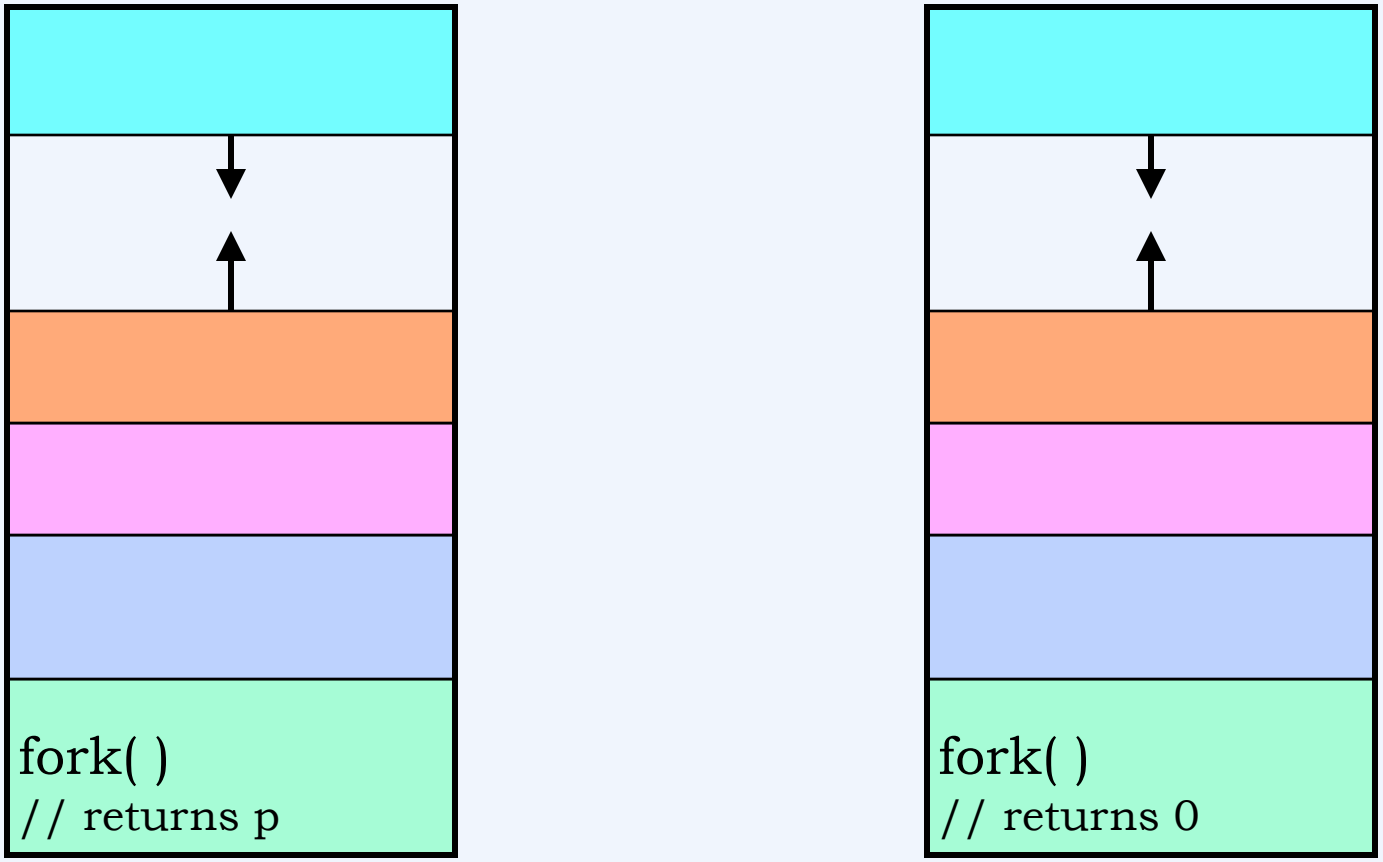
```
if (write(fd, buffer, bufsize) == –1) {
    // error!
    printf("error %d\n", errno);
    // see perror
}
```

# Creating a Process: Before




parent process

# Creating a Process: After




parent process

child process
(pid = p)

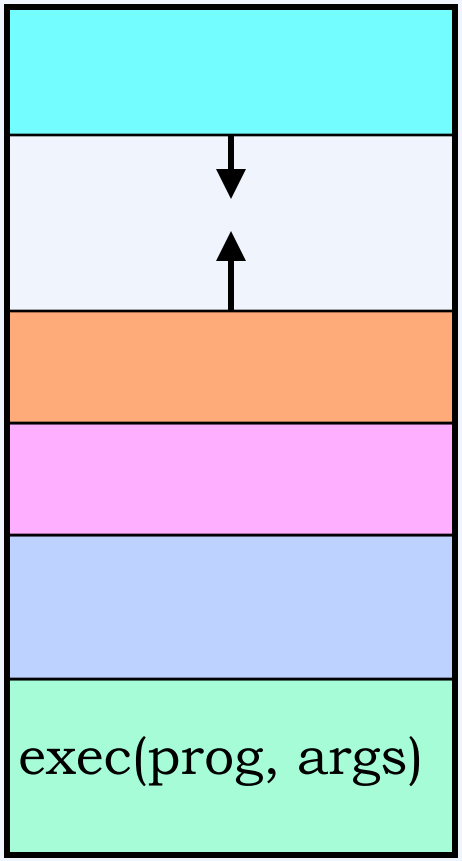
# Fork and Wait

```
short pid;
if ((pid = fork()) == 0) {
   /* some code is here for the child to execute */
   exit(n);
} else {
   int ReturnCode;
   while(pid != wait(&ReturnCode))
      ;
   /* the child has terminated with ReturnCode as its
      return code */
}
```

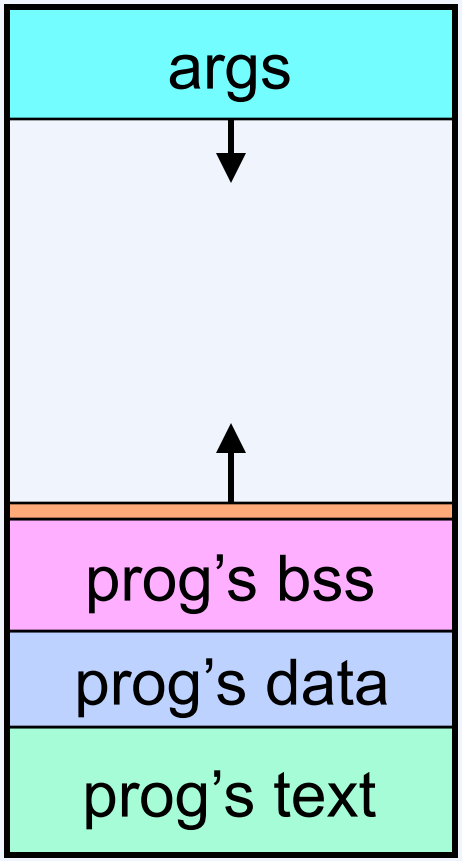
# Exec

```
int pid;
if ((pid = fork()) == 0) {
   /* we'll soon discuss what might take place before exec
      is called */
   execl("/home/twd/bin/primes", "primes", "300", 0);
   exit(1);
}

/* parent continues here */

while(pid != wait(0))      /* ignore the return code */
   ;
```

# Loading a New Image




Before




After

# Standard File Descriptors

```
main( ) {
  char buf[BUFSIZE];
  int n;
  const char* note = "Write failed\n";

  while ((n = read(0, buf, sizeof(buf))) > 0)
    if (write(1, buf, n) != n) {
          (void)write(2, note, strlen(note));
          exit(EXIT_FAILURE);
    }
  return(EXIT_SUCCESS);
}
```

# Back to Primes …

```
int nprimes;
int *prime;
int main(int argc, char *argv[]) {
   …
   for (i=1; i<nprimes; i++) {
      …
   }
   if (write(1, prime, nprimes*sizeof(int)) == -1) {
      perror("primes output");
      exit(1);
   }
   return(0);
}
```

# Human-Readable Output

```
int nprimes;
int *prime;
int main(int argc, char *argv[]) {
   …
   for (i=1; i<nprimes; i++) {
      …
   }
   for (i=0; i<nprimes; i++) {
      printf("%d\n", prime[i]);
   }
   return(0);
}
```

# Open

```
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
int open(const char *path, int options [, mode_t mode])
```

- **options**
  - **O_RDONLY** — **open for reading only**
  - **O_WRONLY** — **open for writing only**
  - **O_RDWR** — **open for reading and writing**
  - **O_APPEND** — **set the file offset to *end of file* prior to each *write***
  - **O_CREAT** — **if the file does not exist, then create it, setting its mode to *mode* adjusted by *umask***
  - **O_EXCL** — **if O_EXCL and O_CREAT are set, then *open* fails if the file exists**
  - **O_TRUNC** — **delete any previous contents of the file**
  - **O_NONBLOCK** — **don't wait if I/O can't be done immediately**

# Running It

```
if (fork() == 0) {
   /* set up file descriptor 1 in the child process */
   close(1);
   if (open("/home/twd/Output", O_WRONLY) == -1) {
      perror("/home/twd/Output");
      exit(1);
   }
   execl("/home/twd/bin/primes", "primes", "300", 0);
   exit(1);
}

/* parent continues here */

while(pid != wait(0))      /* ignore the return code */
   ;
```