# [301] Program I/O

Tyler Caraza-Harter

# Learning Objectives

TODO:

# Today's Topics

Program Input/Output

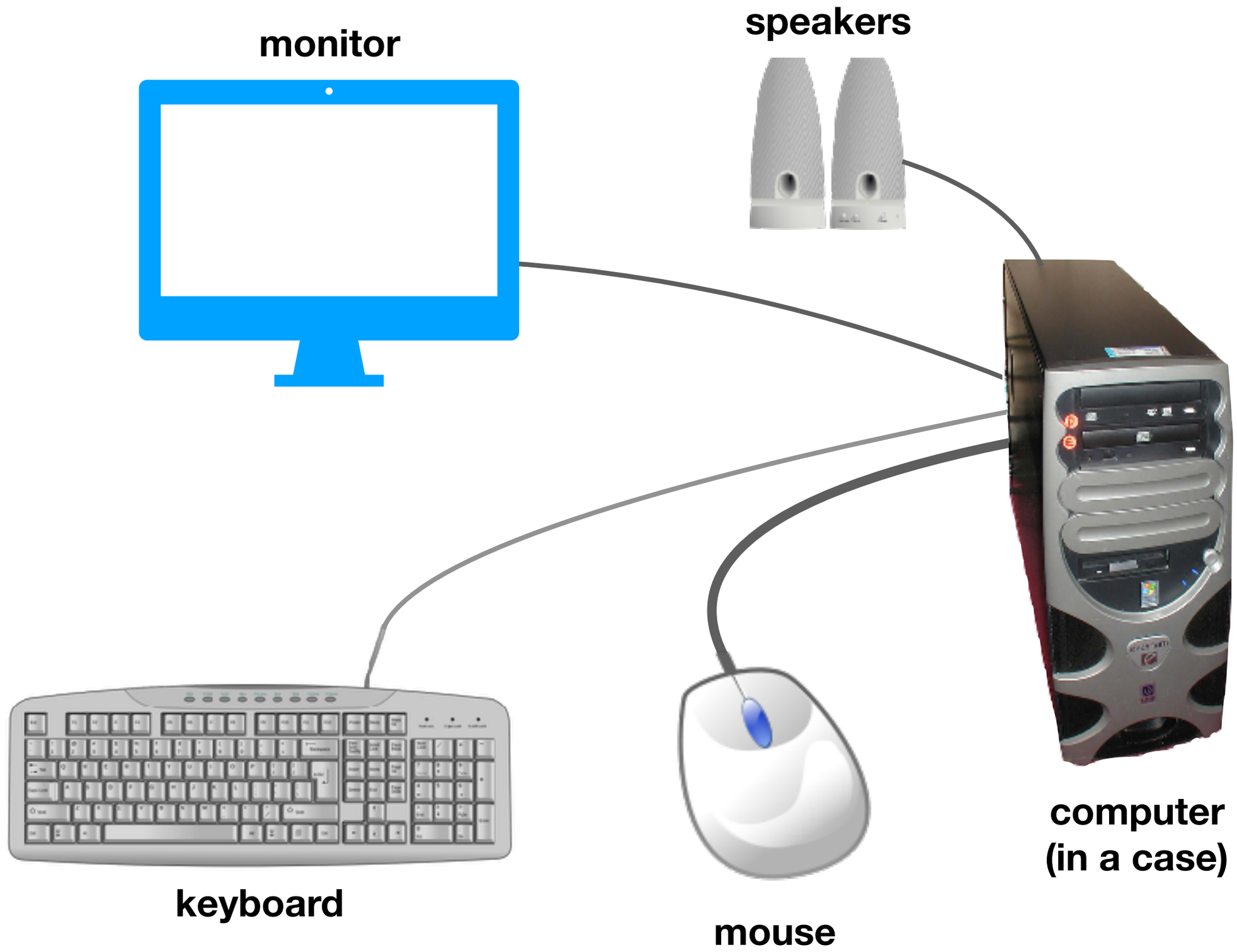
- Review Computer I/O
- Program I/O and the Operating System

File Systems

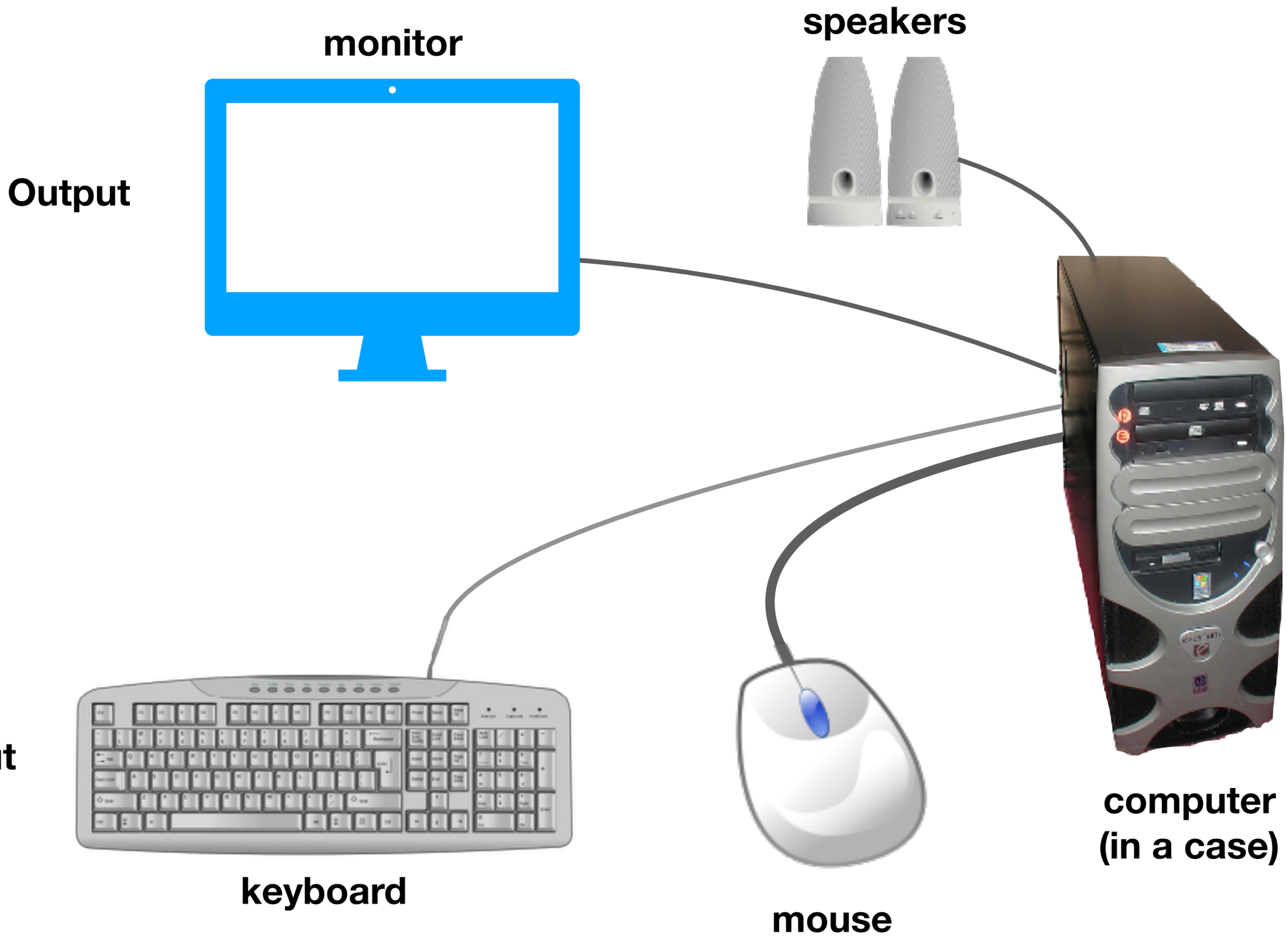
Terminal Emulators and Shells

Tutorials

# Computer Input/Output



# Computer Input/Output



# Computer Input/Output

**Are NICs and storage drives input devices or output devices?**


**computer (in a case)**

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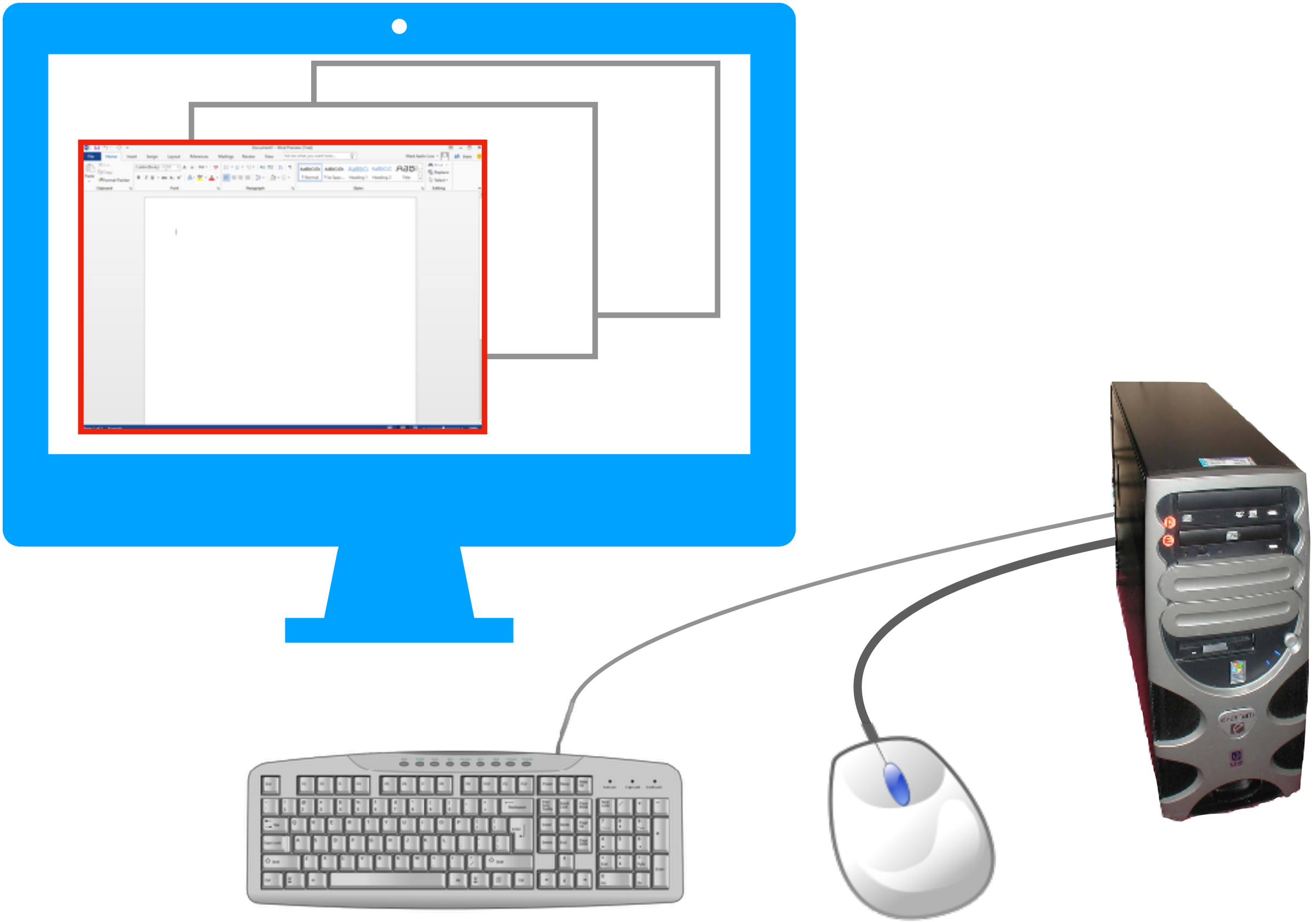
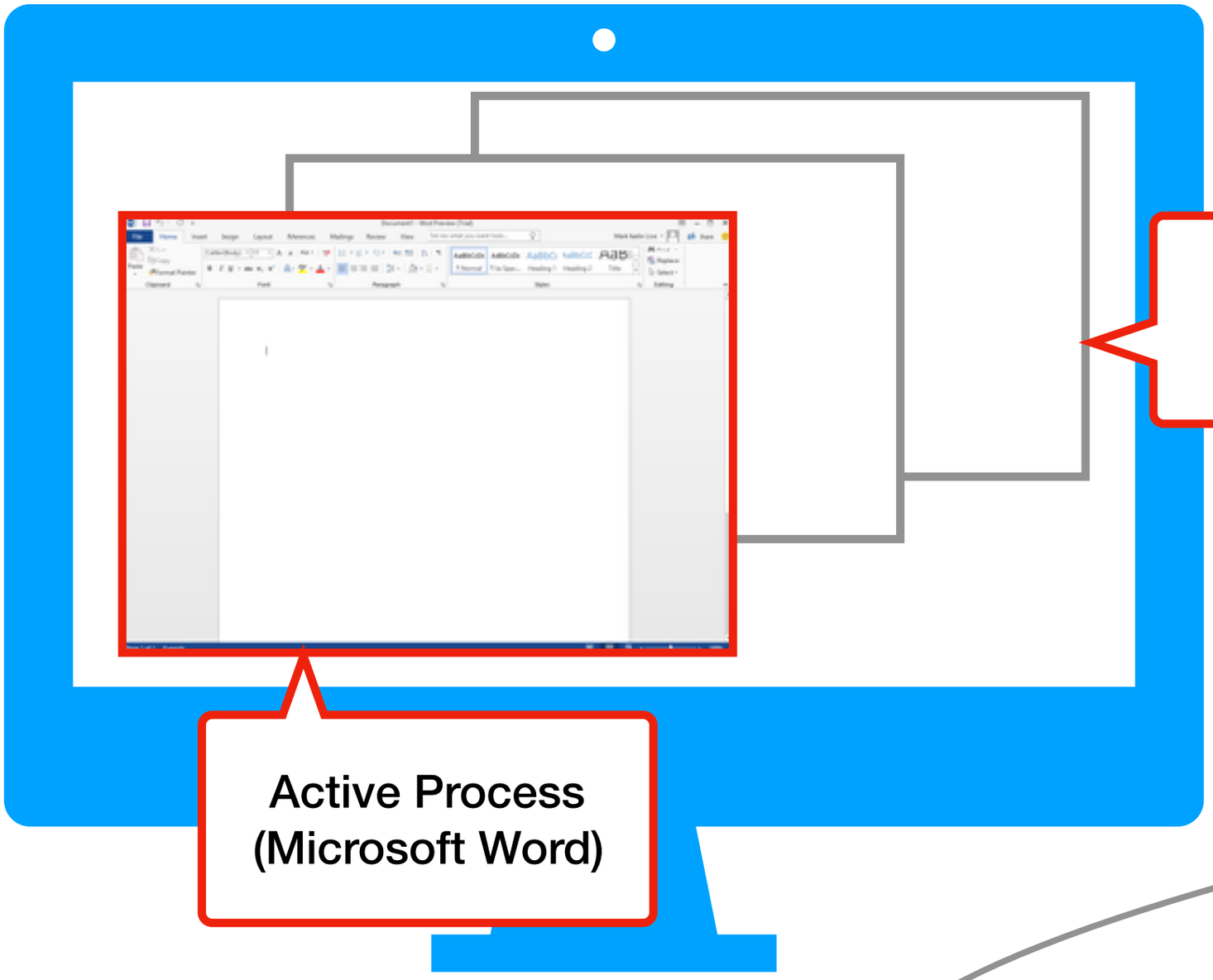
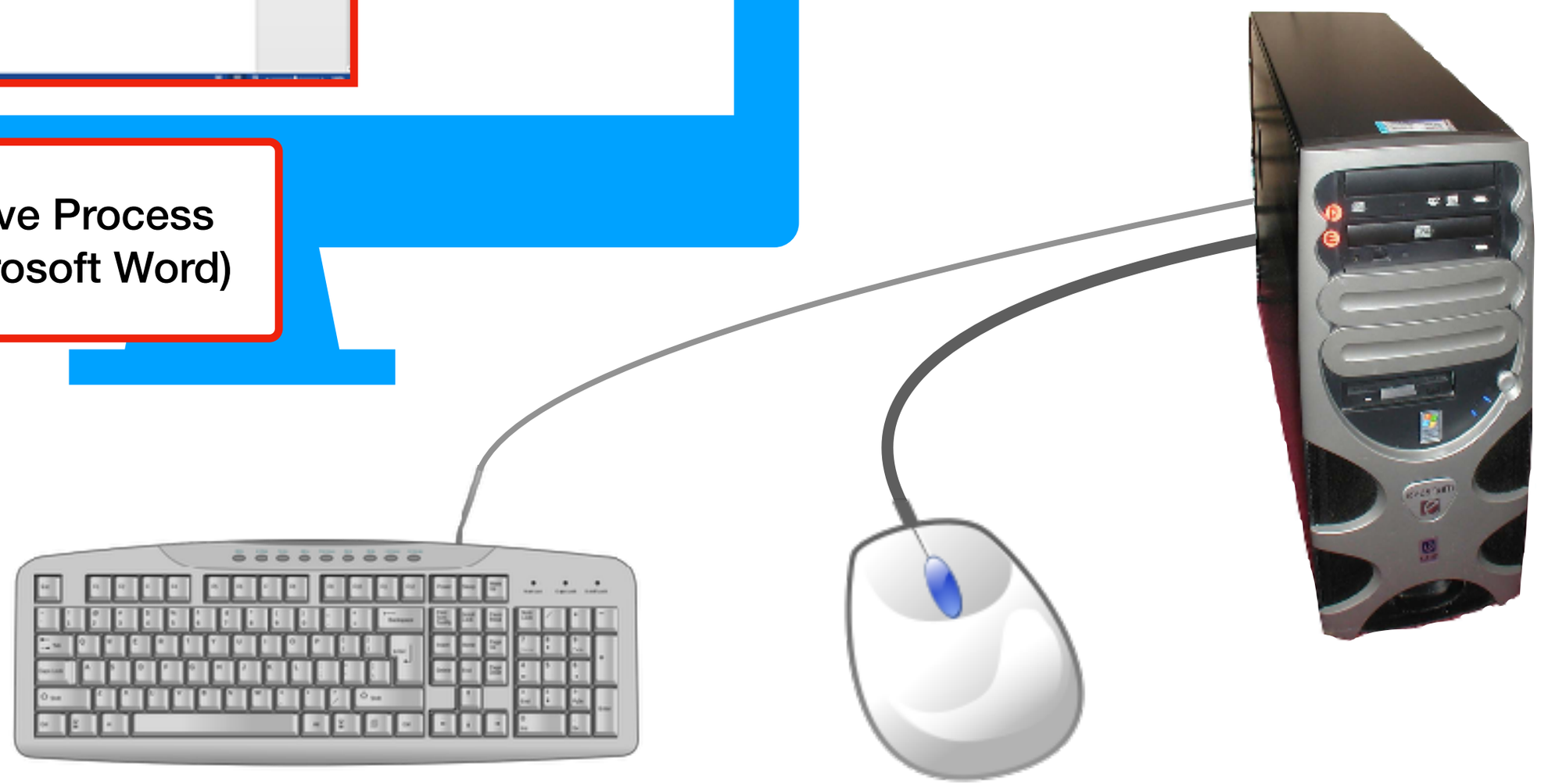
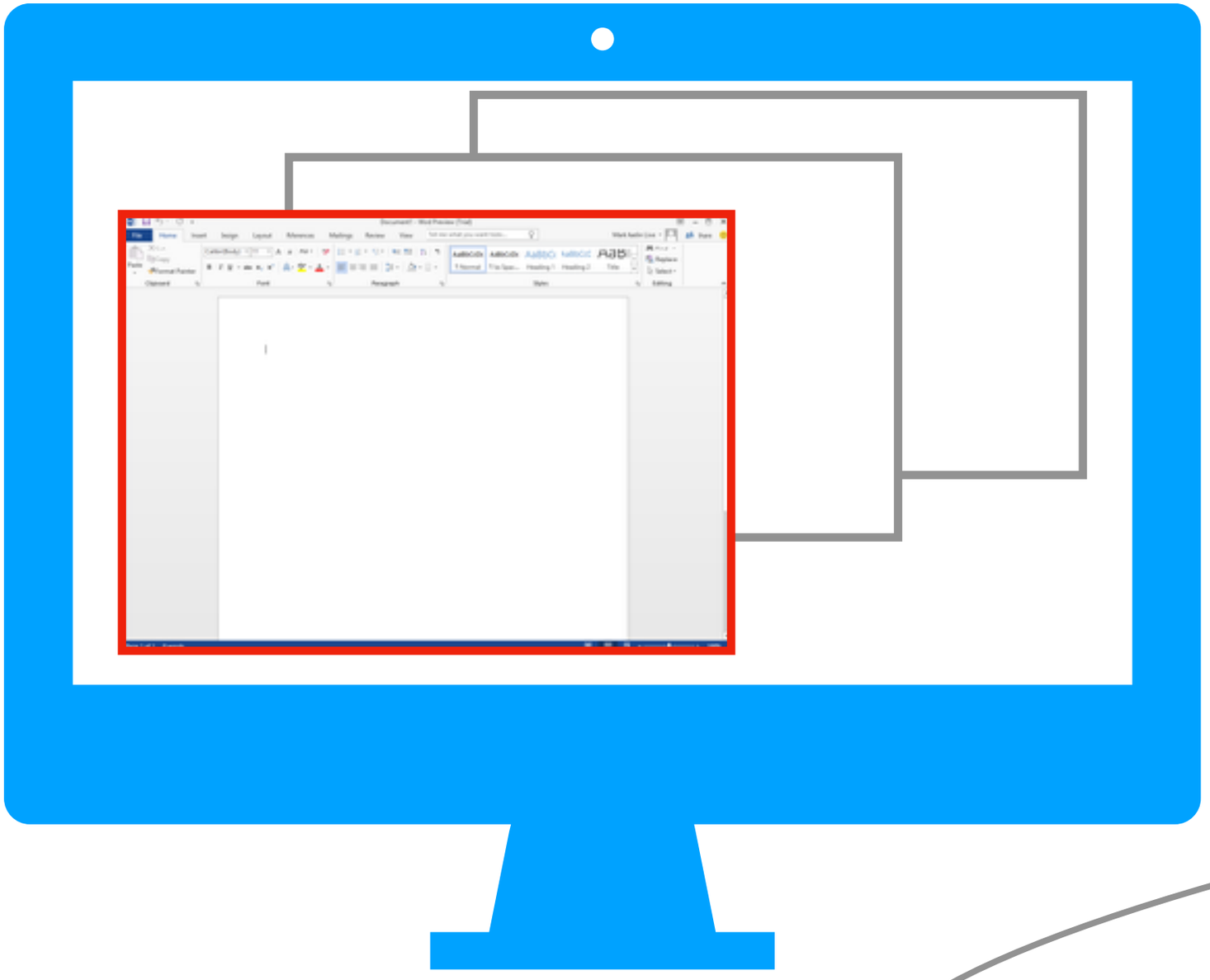
Tutorial



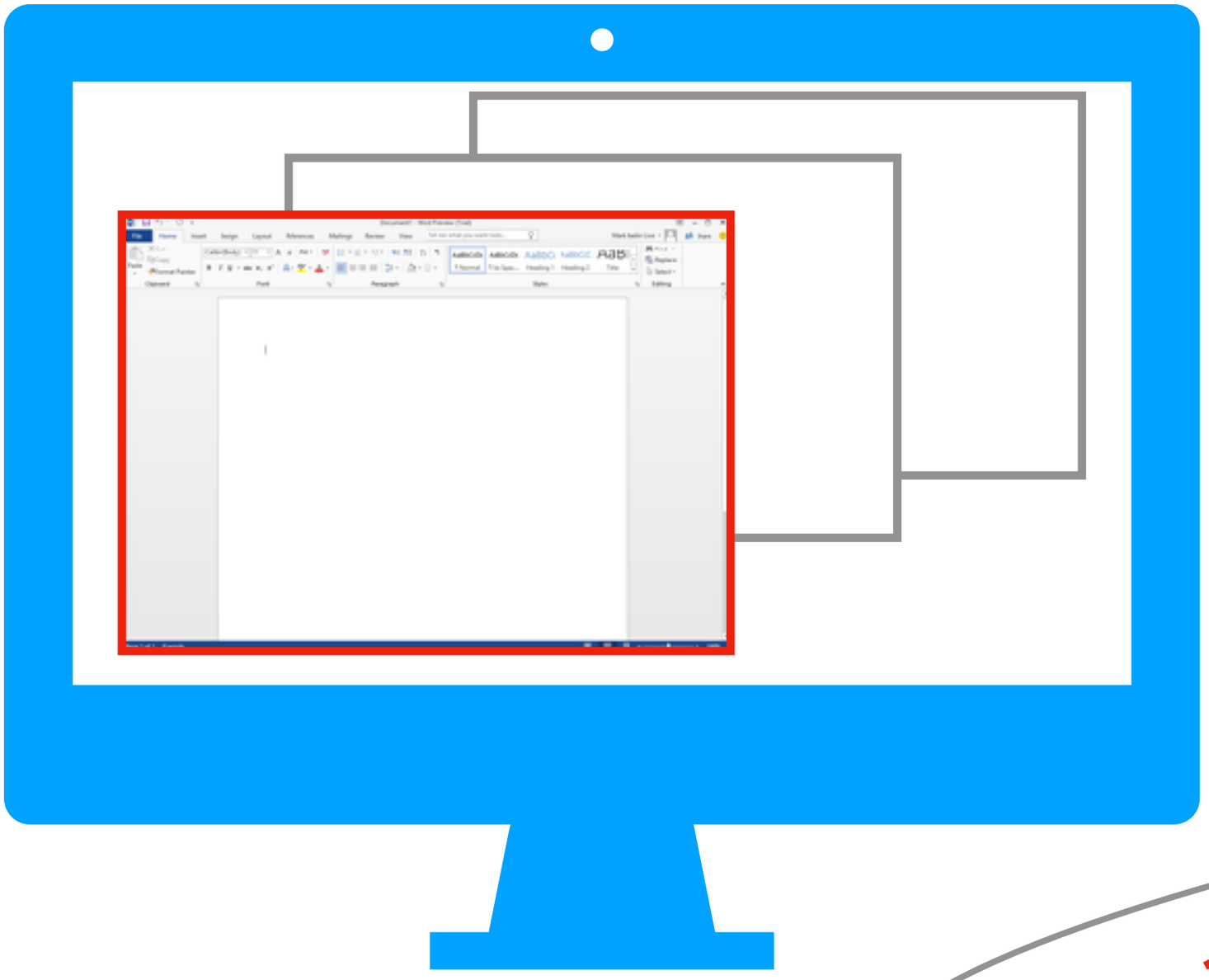
# Terminology: a “process” is just a running “program”





Operating System



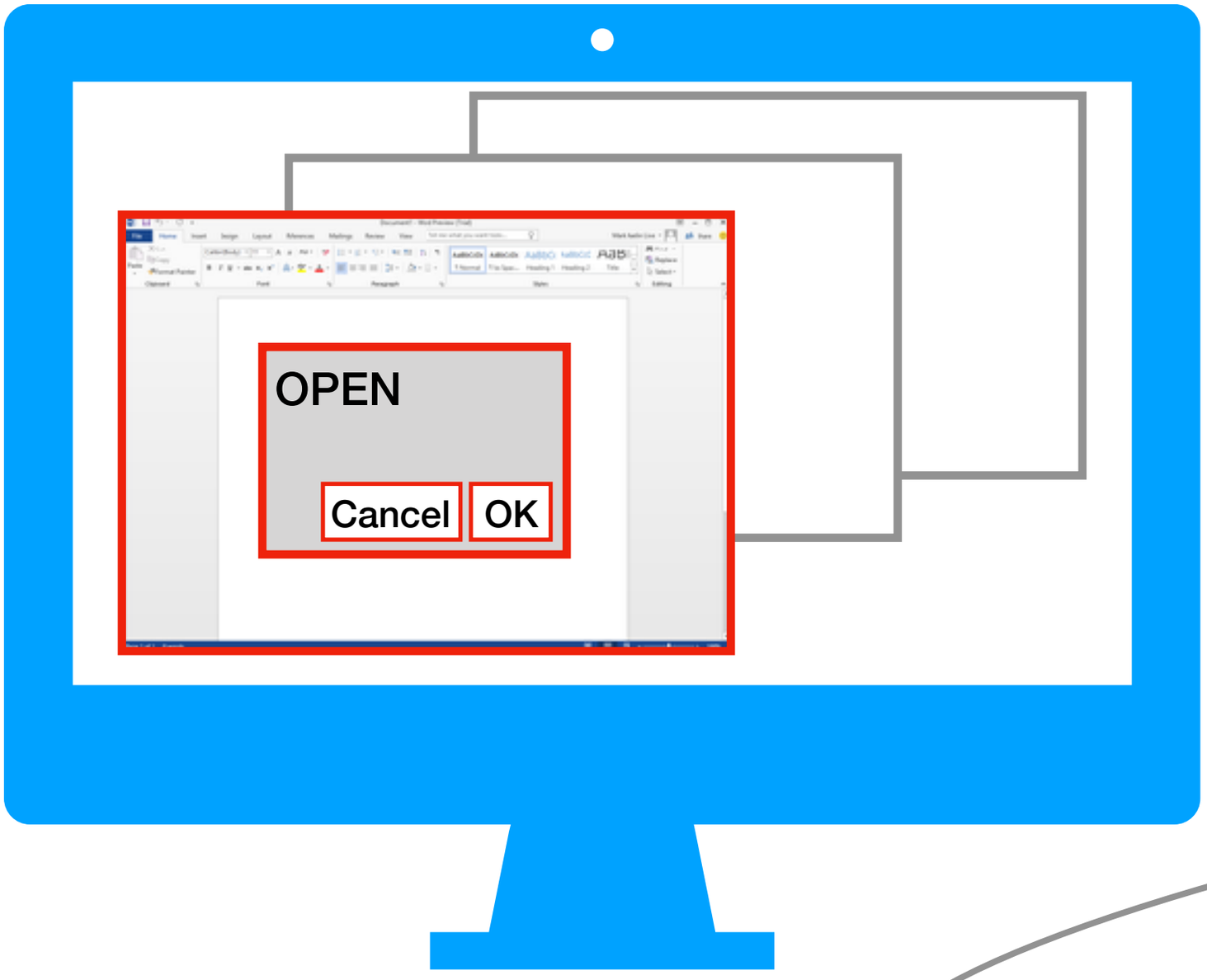
**Operating System**

**Click!**
**(input)**

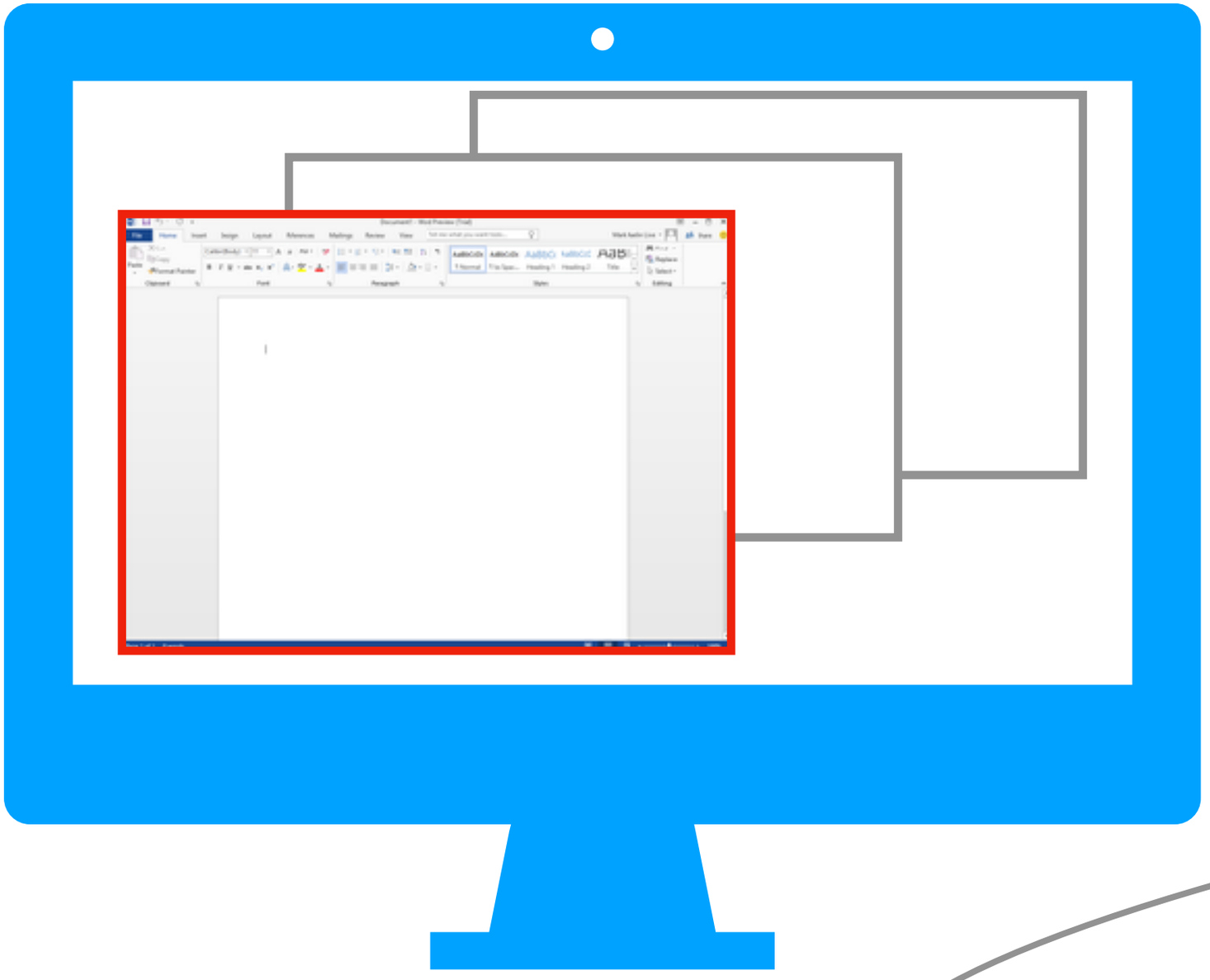
Click!
(input)

Operating System

Click!
(input)

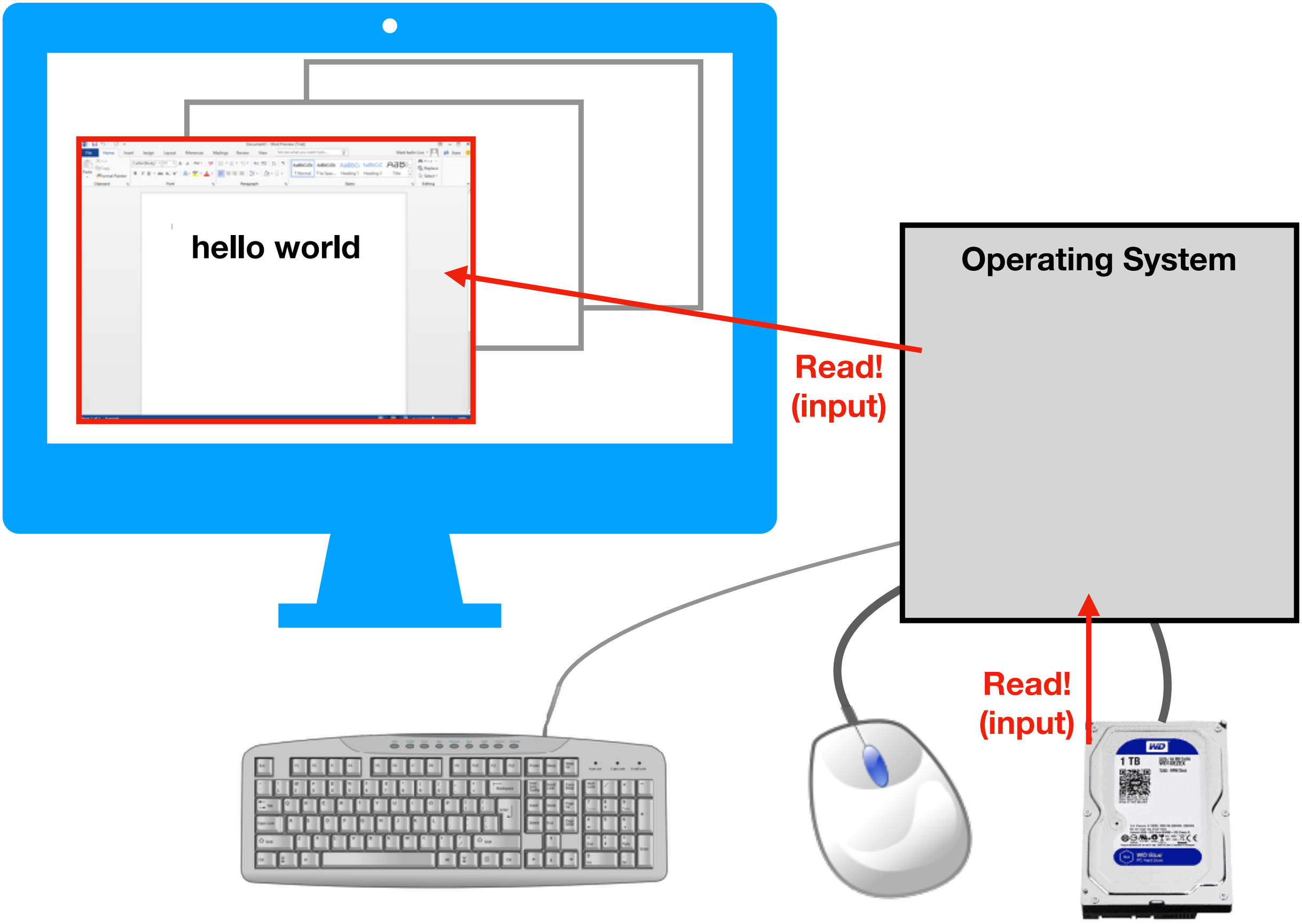


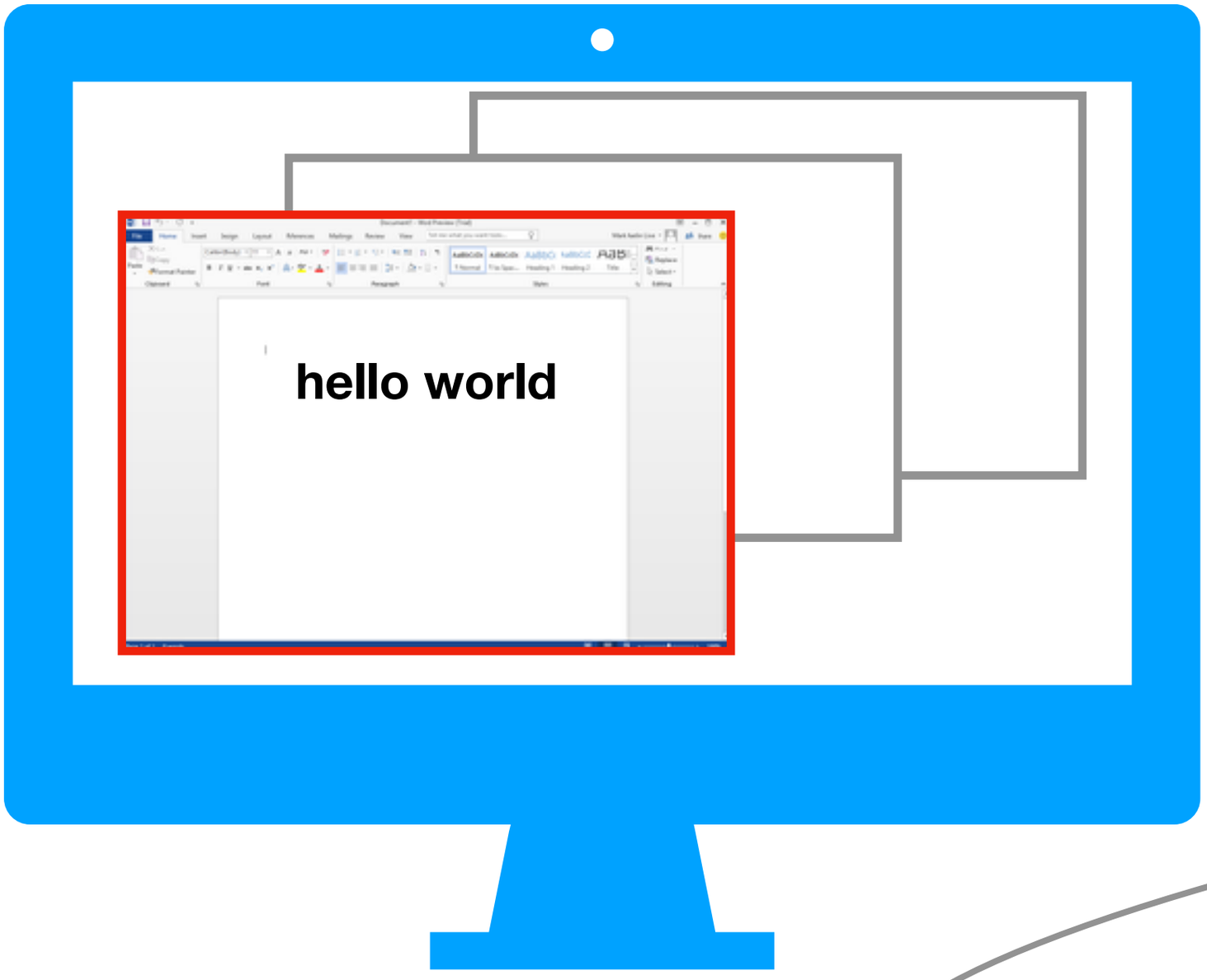

Operating System



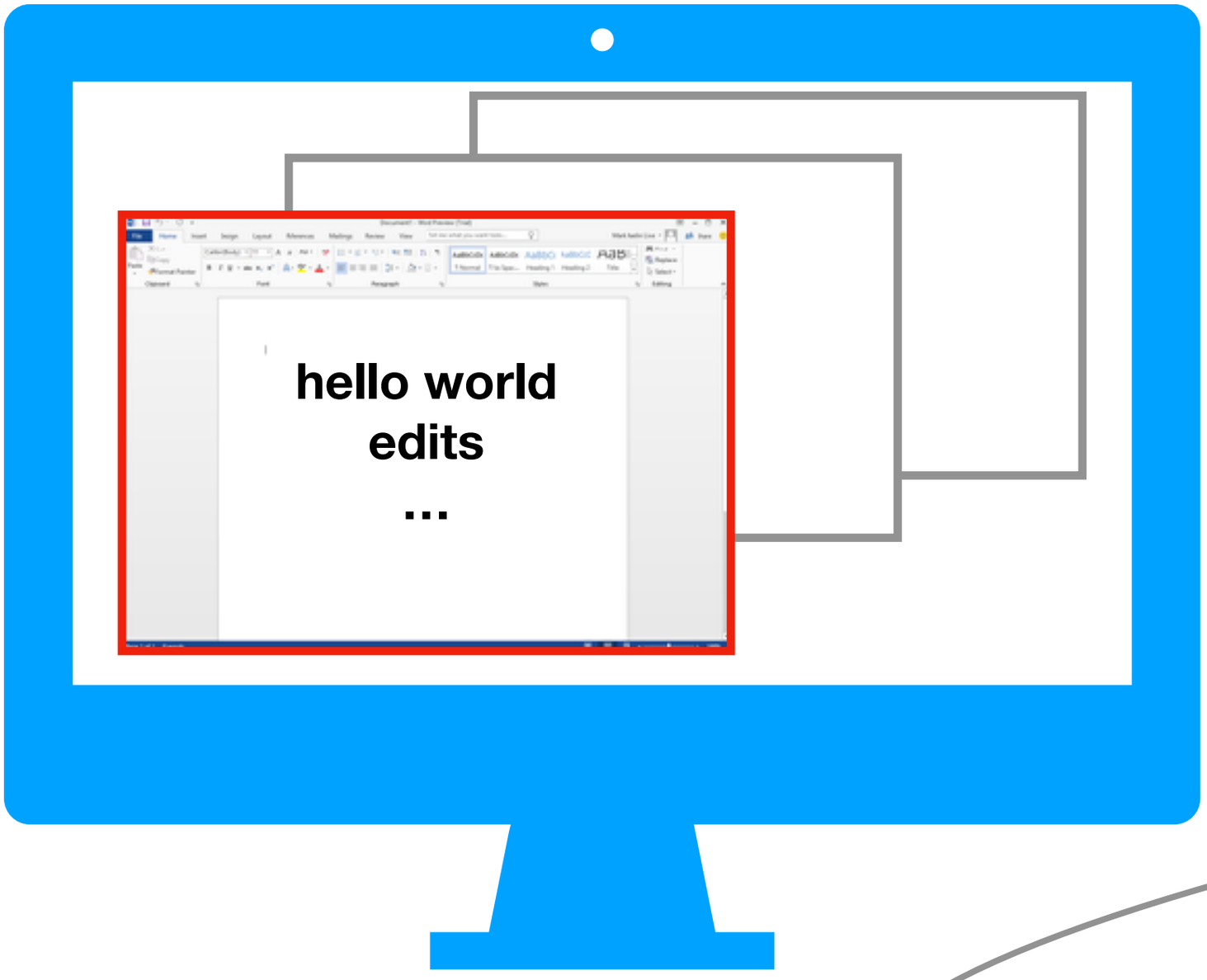
**Operating System**

**Read!**
**(input)**


hello world
Read!
(input)
Operating System
Read!
(input)
1 TB




Operating System

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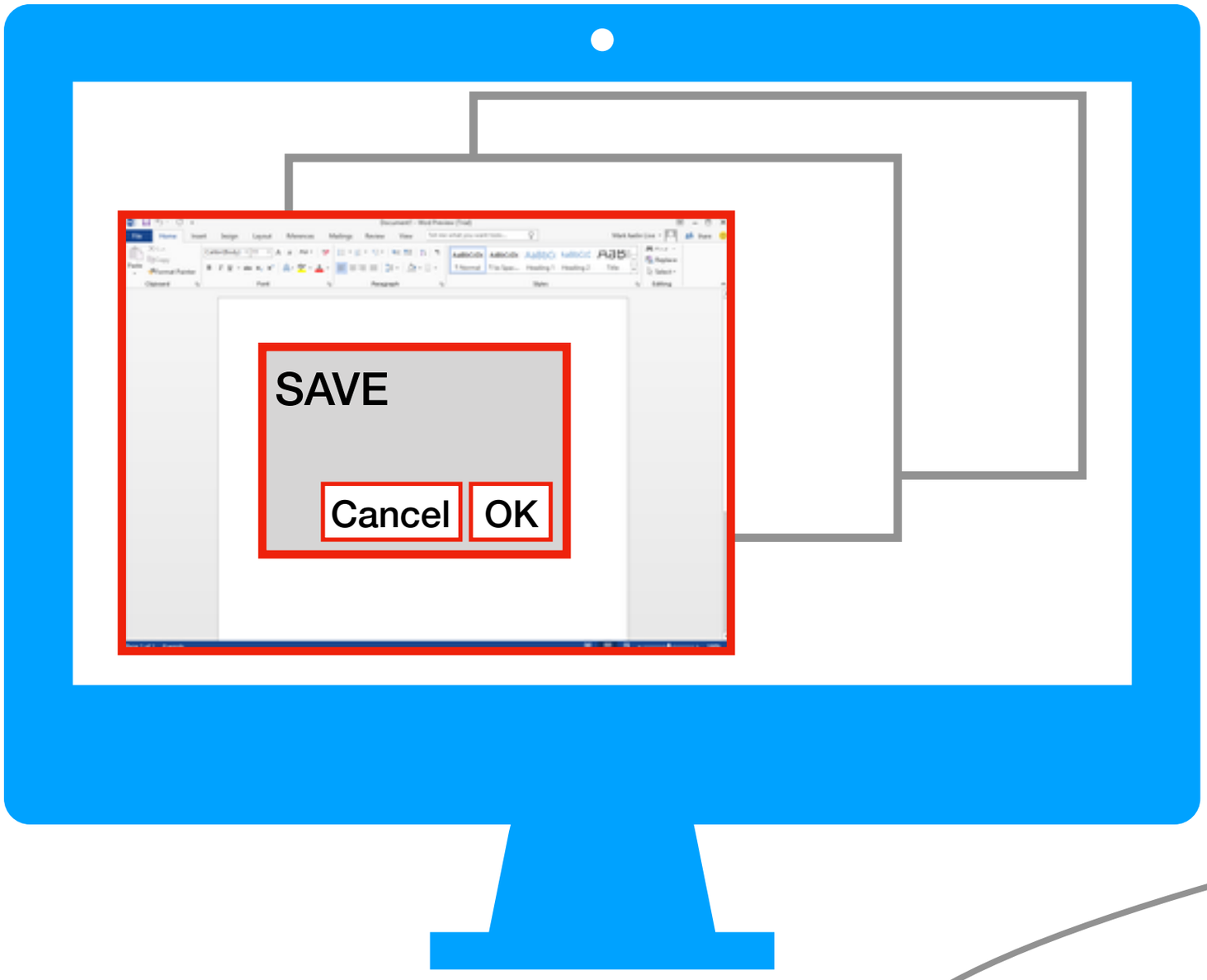



Operating System

SAVE

Cancel

OK

Write!
(output)

Operating System

1 TB

SAVE

Cancel

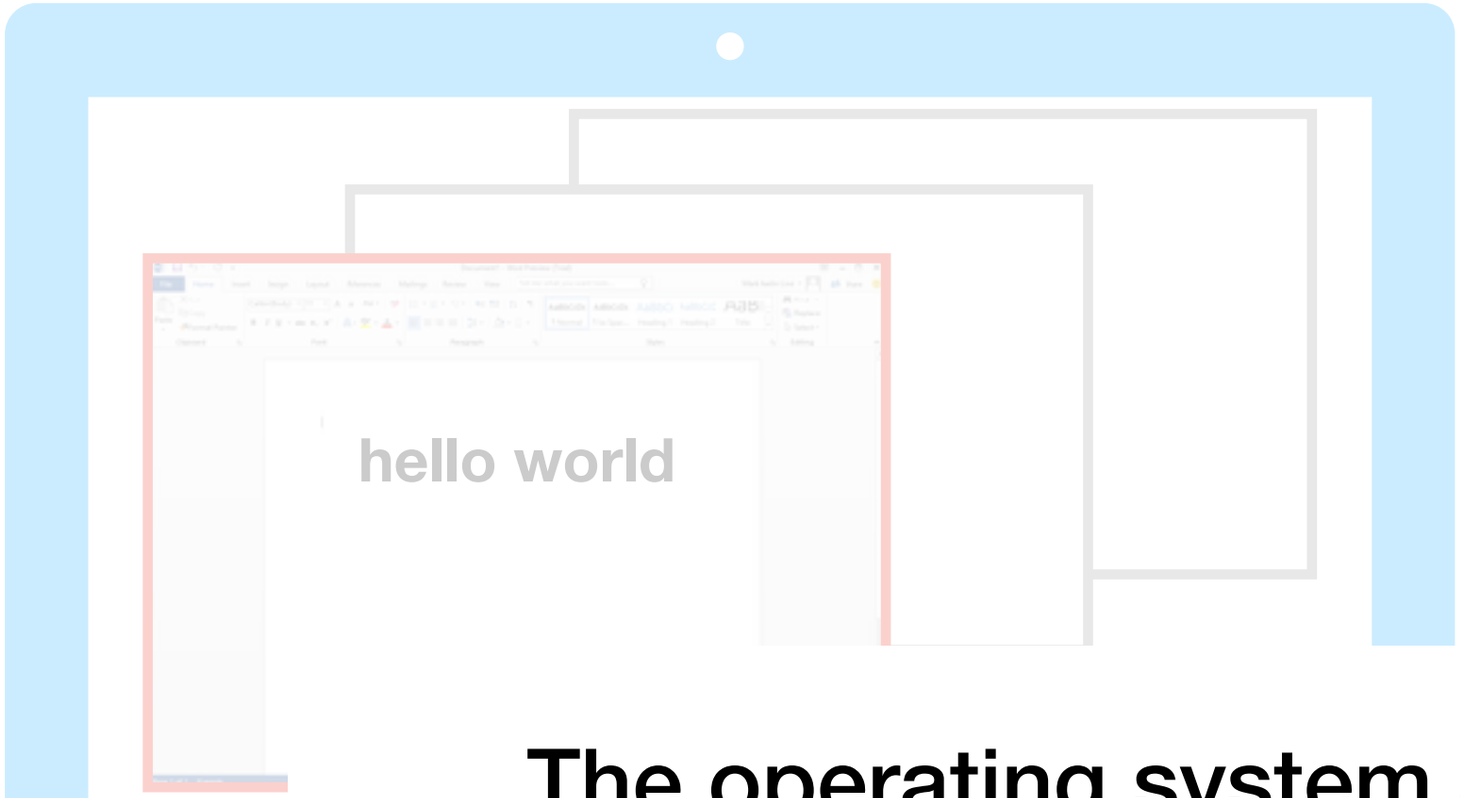
OK

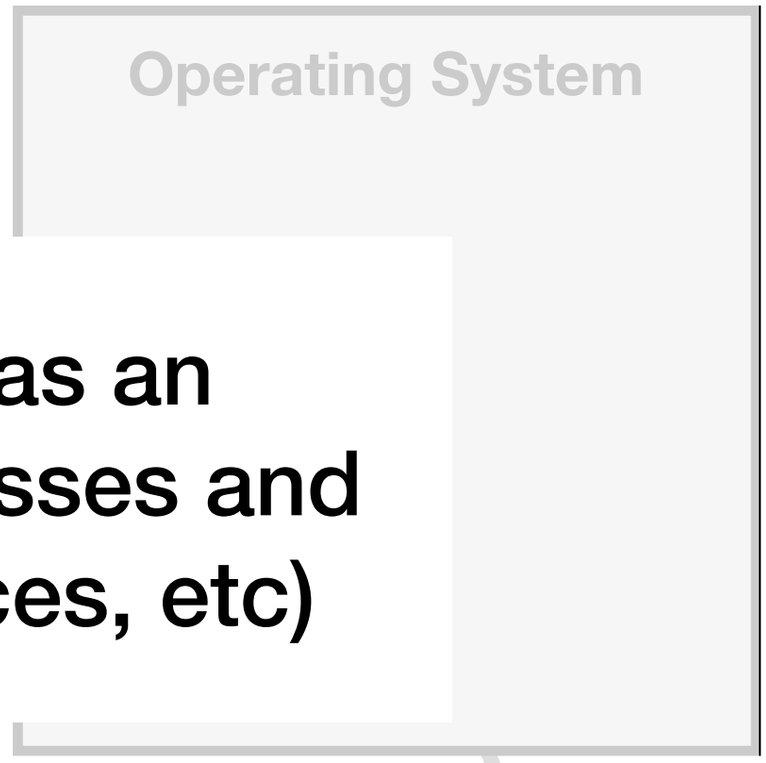
Write!
(output)

Operating System

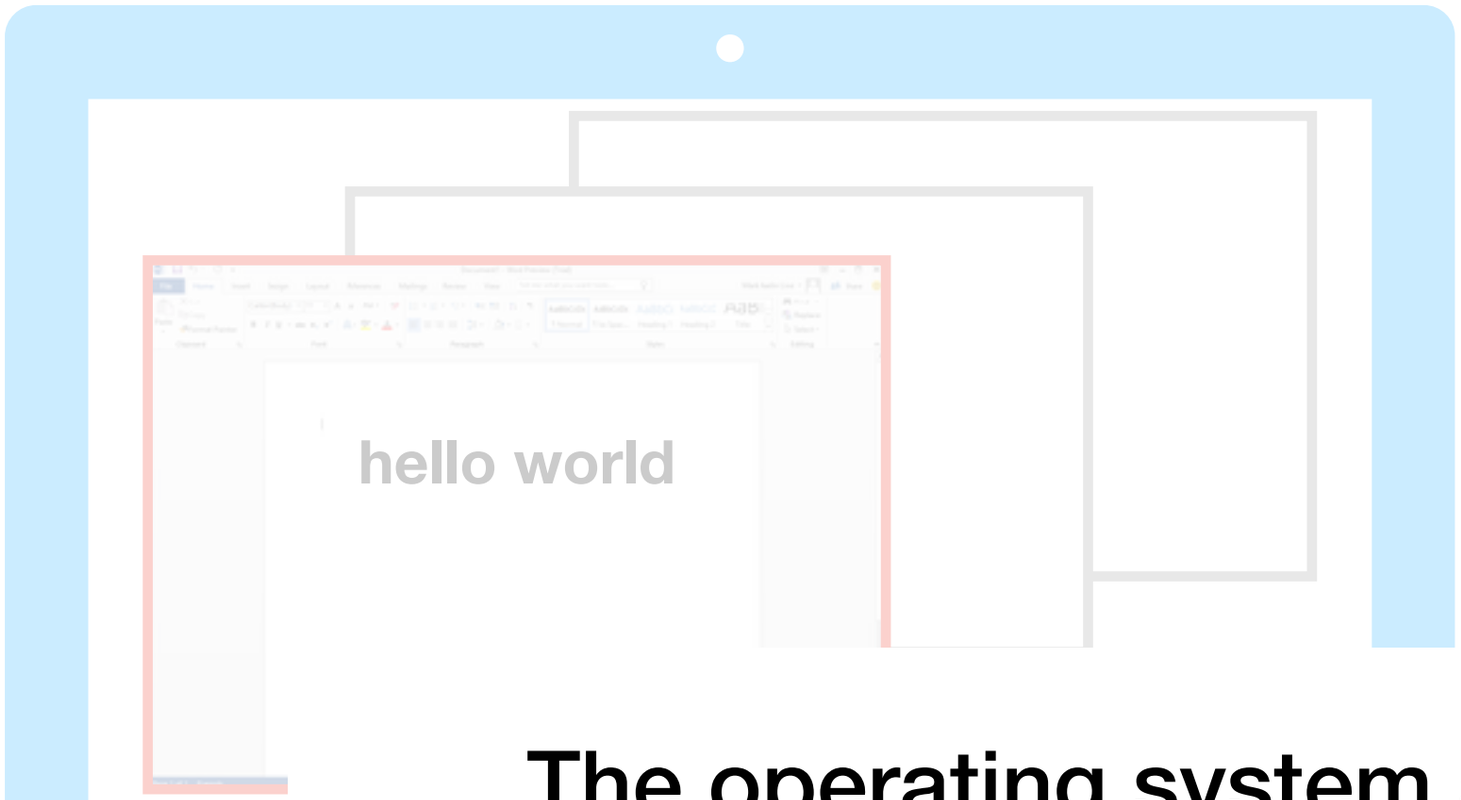
Write!
(output)

1 TB




The operating system acts as an **I/O middleman** between processes and hardware (NICs, storage devices, etc)




Operating System

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# Today's Topics

Program Input/Output

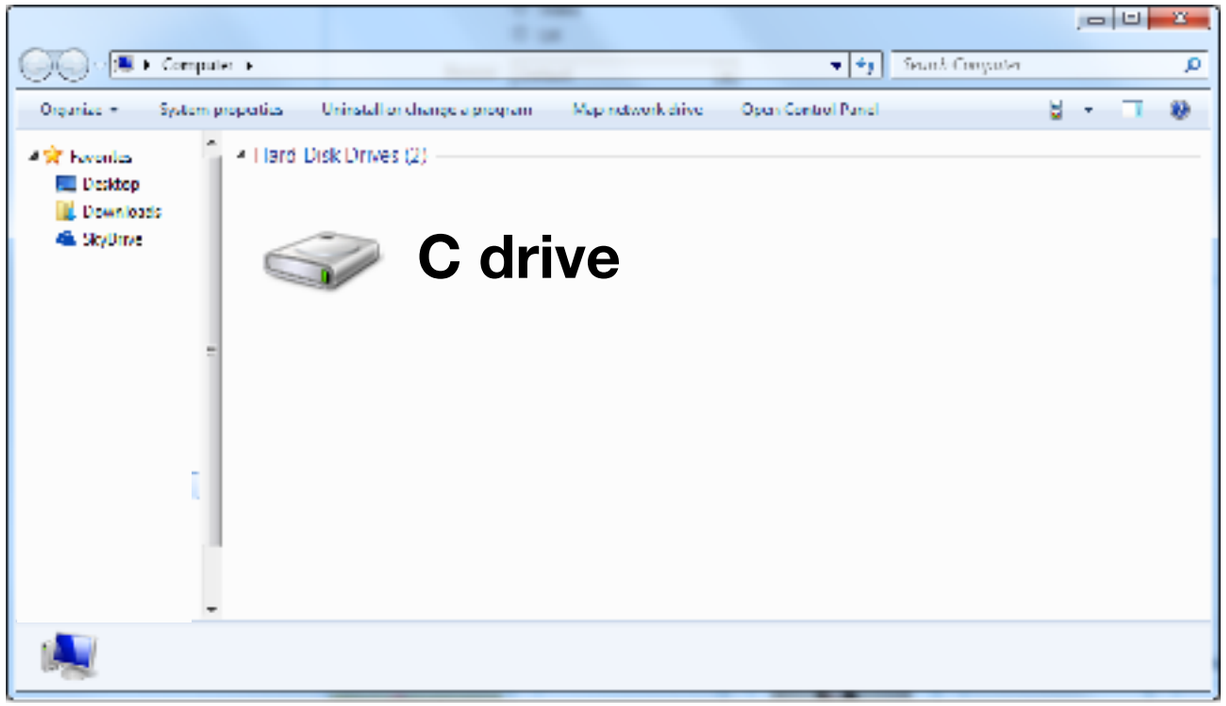
File Systems

- Storage Devices in Windows
- File I/O
- Organizing with Folders/Directories
- Storage Devices in Mac+Linux

Terminal Emulators and Shells

Tutorial

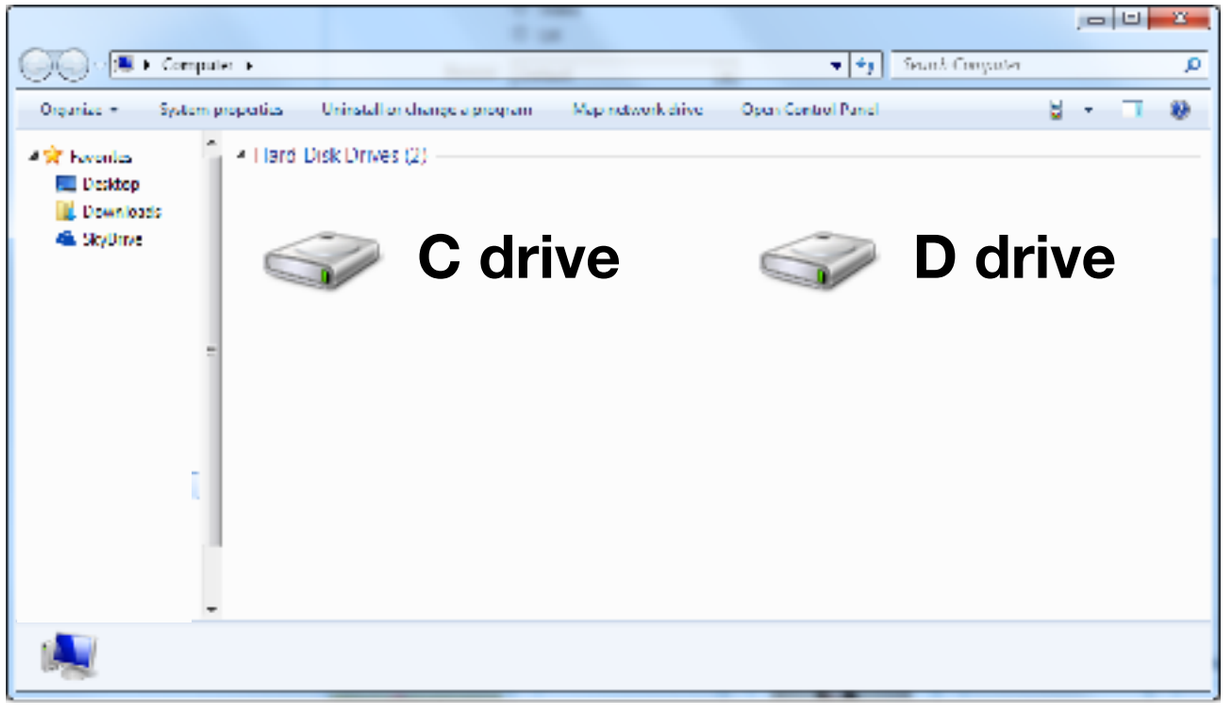
# Windows Storage Drives





**Each added drive is given its own drive letter**

# Windows Storage Drives





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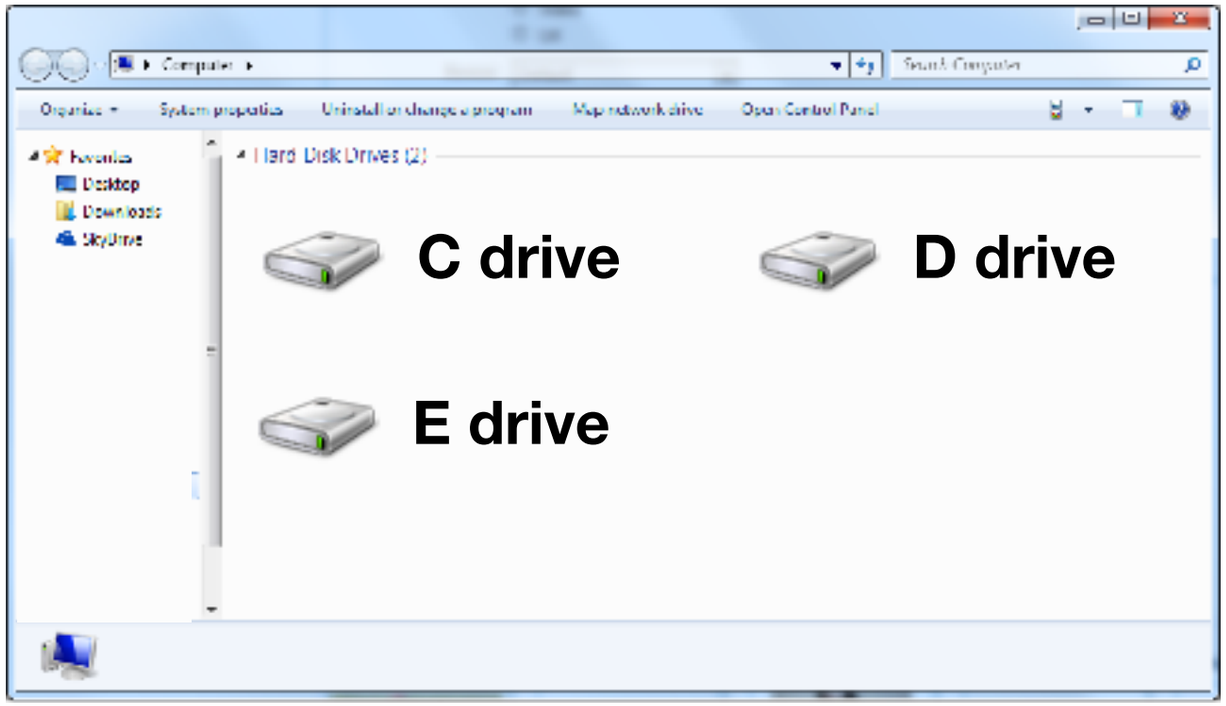



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Tutorial

# File I/O

Each file has a name, called a “path name”

**c:\README.txt**

**c:\hw.docx**

**d:\page.html**

**e:\main.py**

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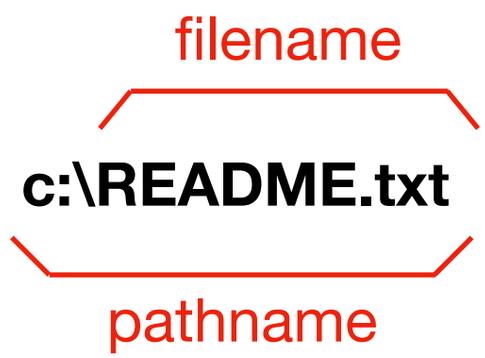


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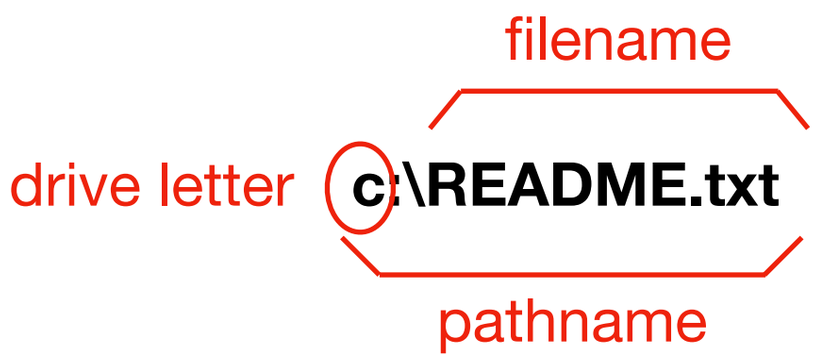


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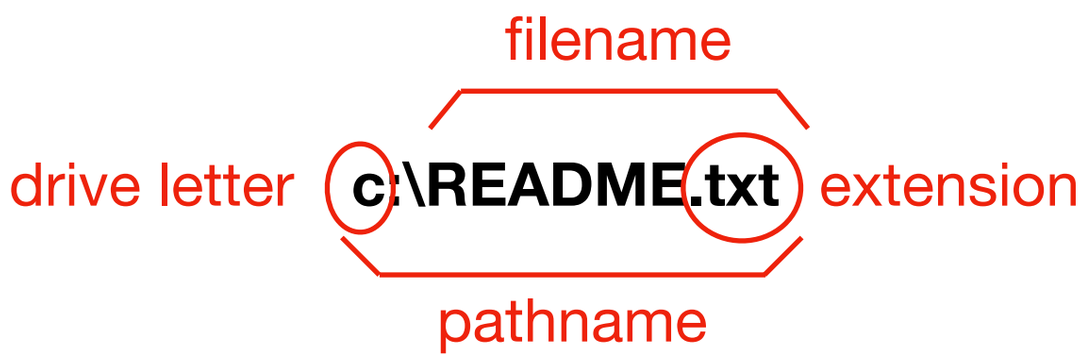


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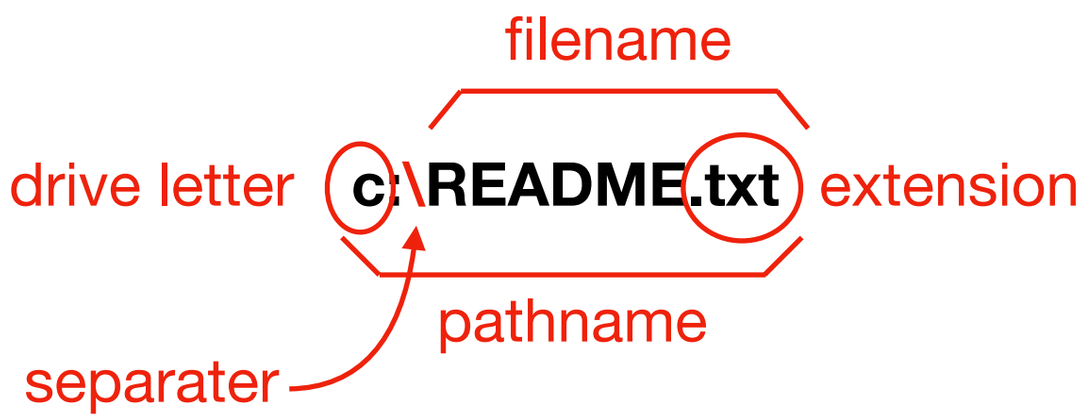


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# File I/O

Files are sources of input and destinations for output for processes.

Files are managed by a part of the operating system called the “file system”

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**Processes:** Word | Email Program

**File System:** c:\template.docx

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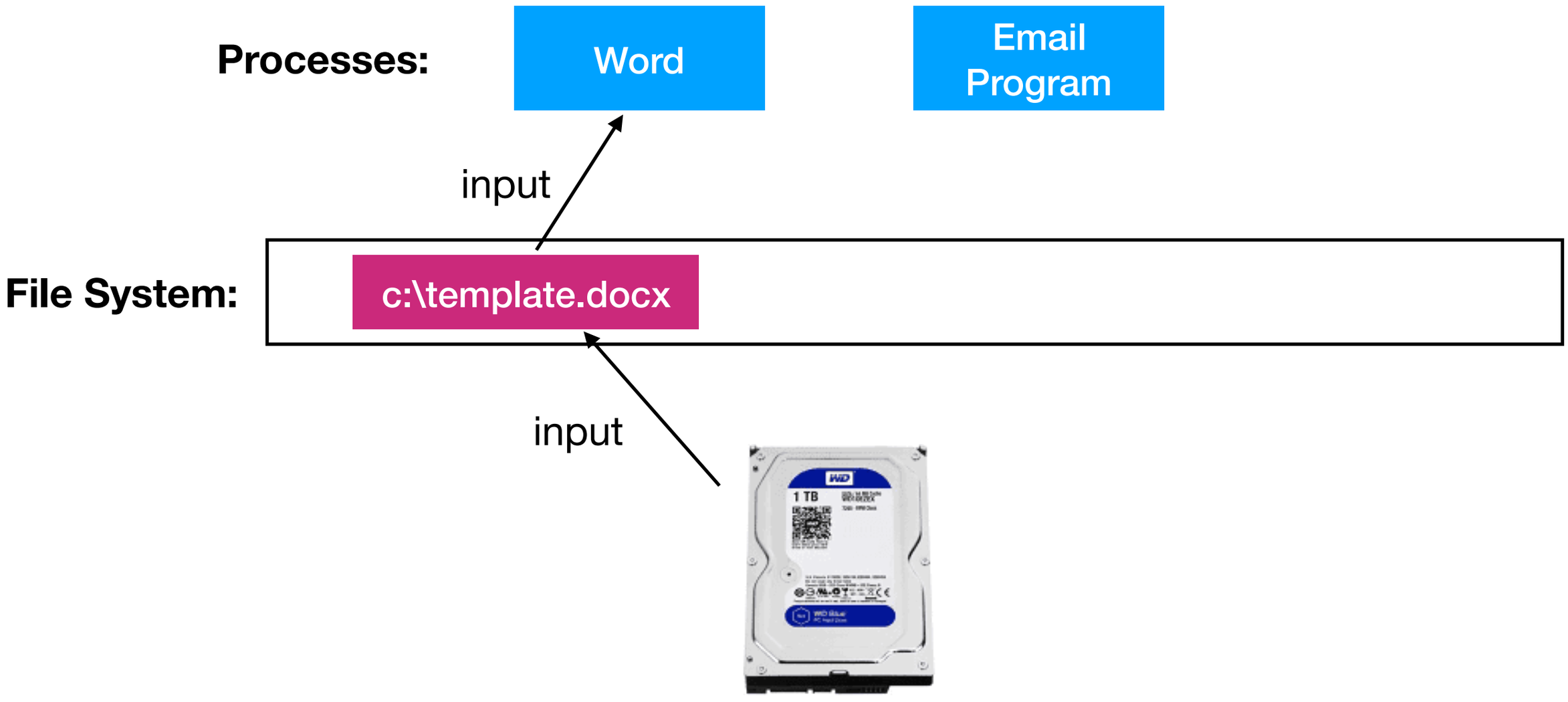

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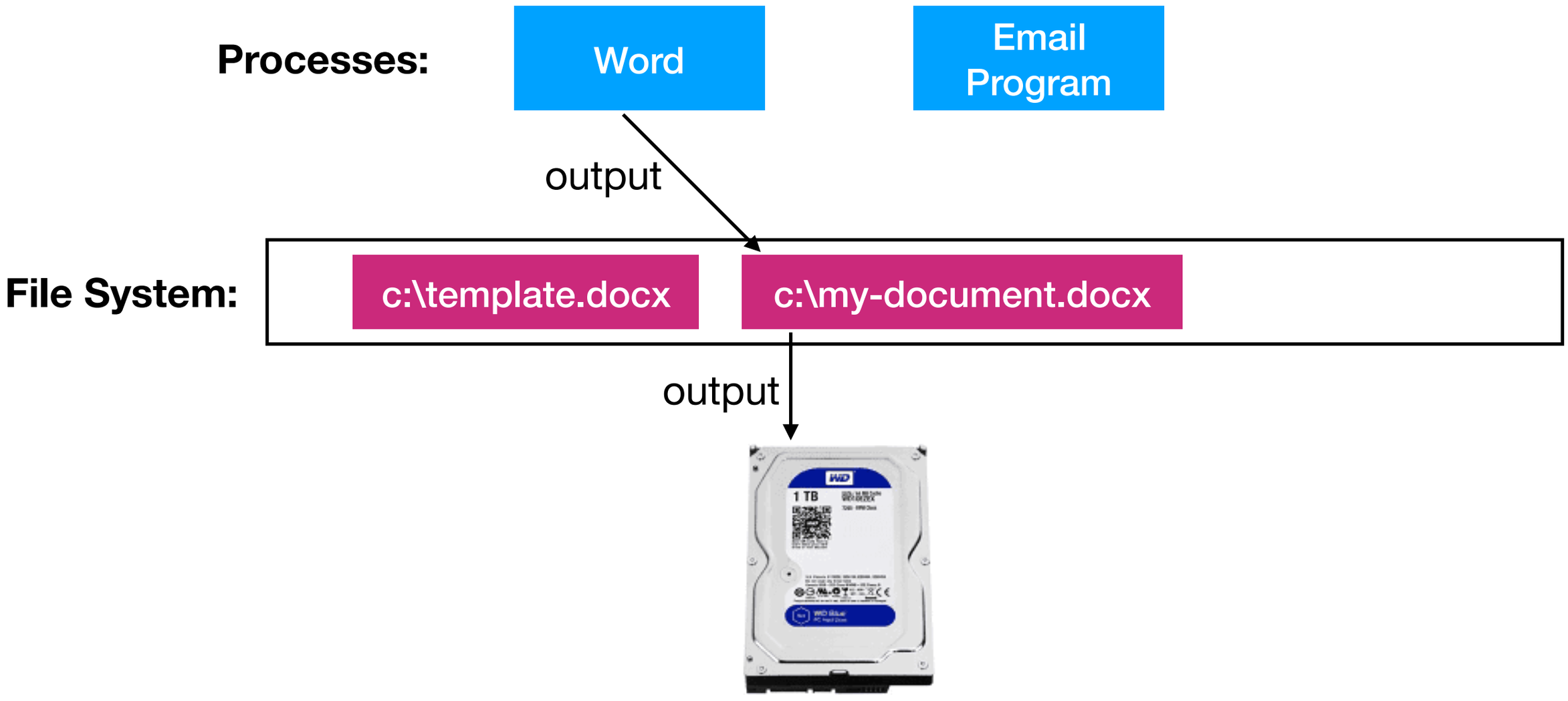

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Files are managed by a part of the operating system called the “file system”

**Processes:** Word, Email Program

**File System:** c:\template.docx, c:\my-document.docx

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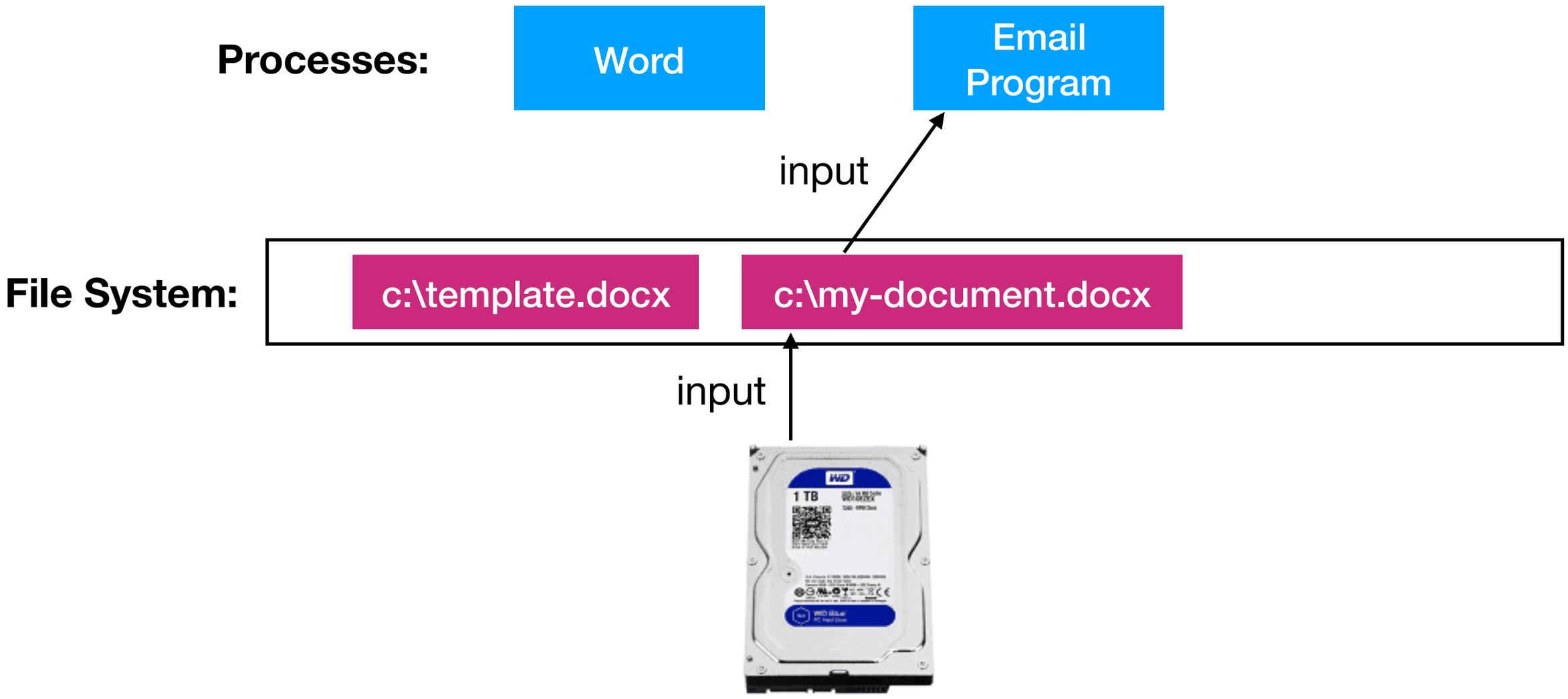

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Tutorial

# Directories

Directories are used to organize files

- Also called “folders”
- A directory also has pathname
- Each directory may contain other directories and files

Example paths:

- c:\my-directory\file1.docx
- c:\my-directory\file2.docx
- c:\my-directory\file3.docx
- c:\directory1\directory2\file1.docx
- c:\same-dir\same-dir\readme.txt

# Relative Paths

*Where is the Computer Science building?*

- Answer 1: 1210 W Dayton St, Madison, WI 53706
- Answer 2: on the other side of Johnson street

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When is Answer 2 appropriate?

- When you're in the psychology building
- It may be more convenient

# Relative Paths

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Pathnames are absolute (answer 1) or relative (answer 2)

- Absolute paths: always possible
- Relative paths: if current location is known

# Relative Paths

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When is Answer 2 appropriate?

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Pathnames are absolute (answer 1) or relative (answer 2)

- Absolute paths: always possible
- Relative paths: if current location is known
- Current location/directory is called "working directory" or "current working directory"

# Absolute vs. Relative

| Absolute Path | Working Directory | Relative Path |
|---|---|---|
| c:\test.txt | c:\ | test.txt |
| c:\x\y\z\my.docx | c:\x\y\z | |
| c:\x\y\z\my.docx | c:\x\y | |
| c:\x\y\z | c:\x | |

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| c:\x\y\z\my.docx | c:\x\y | z\my.docx |
| c:\x\y\z | c:\x | |

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| c:\x\y\z\my.docx | c:\x\y | z\my.docx |
| c:\x\y\z | c:\x | y\z |

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| c:\x\y\z\my.docx | c:\x\y | z\my.docx |
| c:\x\y\z | c:\x | y\z |

Two special directory names

- “..” means up a directory
- “.” means current directory

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| c:\x\y\z\my.docx | c:\x\y | z\my.docx |
| c:\x\y\z | c:\x | y\z |
| c:\test.txt | c:\ | .\test.txt |
| c:\x\y\z | c:\x | |
| c:\x | c:\x\y\z | |

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| c:\x\y\z | c:\x | y\z |
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| c:\x\y\z | c:\x | .\y\z |
| c:\x | c:\x\y\z | ..\.. |

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| c:\x\y\z | c:\x | y\z |
| c:\test.txt | c:\ | .\test.txt |
| c:\test.txt | c:\ | .\.\test.txt |
| c:\x\y\z | c:\x | .\y\z |
| c:\x | c:\x\y\z | ..\.. |
| c:\B\file.txt | c:\A | |

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| c:\test.txt | c:\ | .\.\test.txt |
| c:\x\y\z | c:\x | .\y\z |
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| c:\test.txt | c:\ | .\test.txt |
| c:\x\y\z | c:\x | .\y\z |
| c:\x | c:\x\y\z | ..\.. |
| c:\B\file.txt | c:\A | ..\B\file.txt |

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**more examples in tutorial later…**

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Tutorials

# Multiple Drives in Linux

Windows

- Generally, every absolute pathname starts with “c:\” or “d:\” or similar
- Name indicates which drive stores the file

UNIX

- Every absolute pathname starts with “/”
- For example, /home/tyler/my-file.docx (note forward slash)
- Name does not indicate on which drive a file lives

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- Generally, every absolute pathname starts with “c:\” or “d:\” or similar
- Name indicates which drive stores the file

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- Every absolute pathname starts with “/”
- For example, /home/tyler/my-file.docx (note forward slash)
- Name does not indicate on which drive a file lives

**How can we use multiple drives if every file paths starts the same, with “/” ???**

# Multiple Drives in Linux

Windows

- Generally, every absolute pathname starts with “c:\” or “d:\” or similar
- Name indicates which drive stores the file

UNIX

- Every absolute pathname starts with “/”
- For example, /home/tyler/my-file.docx (note forward slash)
- Name does not indicate on which drive a file lives

**How can we use multiple drives if every file paths starts the same, with “/” ???**

**Answer: different drives feel like different directories in UNIX systems**

# Comparison

| Windows | Mac | UNIX | Drives |
|---|---|---|---|
| c:\Users\tyler\file.txt | /Users/tyler | /home/tyler |  |
| c:\Program Files | /usr/local/bin | /usr/local/bin | |
| c:\Windows\…\Logs | /var/log | /var/log | |
| d:\ | /Volumes | /mnt/backup |  |
| d:\aug | /Volumes/backup/aug | /mnt/backup/aug | |
| e:\movies | /Volumes/movies | /home/tyler/movies |  |

# Comparison

| Windows | Mac | Linux | Drives |
|---|---|---|---|
| c:\Users\tyler\file.txt | /Users/tyler | /home/tyler |  |
| c:\Program Files | /usr/local/bin | /usr/local/bin | |
| c:\Windows\…\Logs | /var/log | /var/log | |
| d:\ | /Volumes | /mnt/backup |  |
| d:\aug | /Volumes/backup/aug | /mnt/backup/aug | |
| e:\movies | /Volumes/movies | /home/tyler/movies |  |

On Mac, extra drives often appear under /Volumes.
On Linux, extra drives often appear under /mnt (for mount).

# Today's Topics

Program Input/Output

File Systems

Terminal Emulators and Shells

Tutorials

- PowerShell
- bash
- scripts

# Conclusion

Today we covered

- TODO

Action steps for you:

- TODO