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.DS_Stores: Like Shellbags but for Macs

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Who am I

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Importance

- Additional artifact source for folder accesses
- Reveals how a folder was accessed
- Requires Finder GUI interaction
- Currently underutilized

Agenda

- Introduction to .DS_Stores
- Parsing .DS_Stores
- Understanding parsed data
- Limitations and caveats

Introduction to .DS_Stores

Introduction to .DS_Stores

- Desktop Services Store
- MacOS Finder GUI application
- Around since OSX Tiger 10.4
- Contains custom view settings on a per folder basis
- On a fresh install of MacOS, only three of these exist by default:
  - /.DS_Store
  - /Applications/.DS_Store
  - /Applications/Utilities/.DS_Store

Introduction to .DS_Stores
Where are they located?

- Can be found in any folder on any File System
- Accessed using Finder
- A user has write permissions to
- Can include:
  - Internal drives
  - External drives
  - Network shares

Introduction to .DS_Stores
Why are they created?

- Various ways these files can be created and/or modified.
- All require user interaction. Some examples include:
  - The view style was changed
  - The Finder window size/location/scroll position has change
  - A folder is double-clicked in Finder
  - A folder is expanded while in “List View”
  - A folder is right-clicked and “Open in new Tab” is selected

Introduction to .DS_Stores
What do they Contain?

- Each .DS_Store can have multiple records
- A file/folder can have multiple entries in a .DS_Store
- Data is stored in b-tree format

Name	• The name in unicode of the file/folder the record pertains to.
Record Type	• A four letter string code indicating the record entry type.
Data Format	• A four letter string code indicating the format of the record data.
Record Data	• The record data. Used by Finder to display customized view settings.

- The file format is covered here: https://metacpan.org/pod/distribution/Mac-Finder-DSStore/DSStoreFormat.pod#FILE-FORMAT

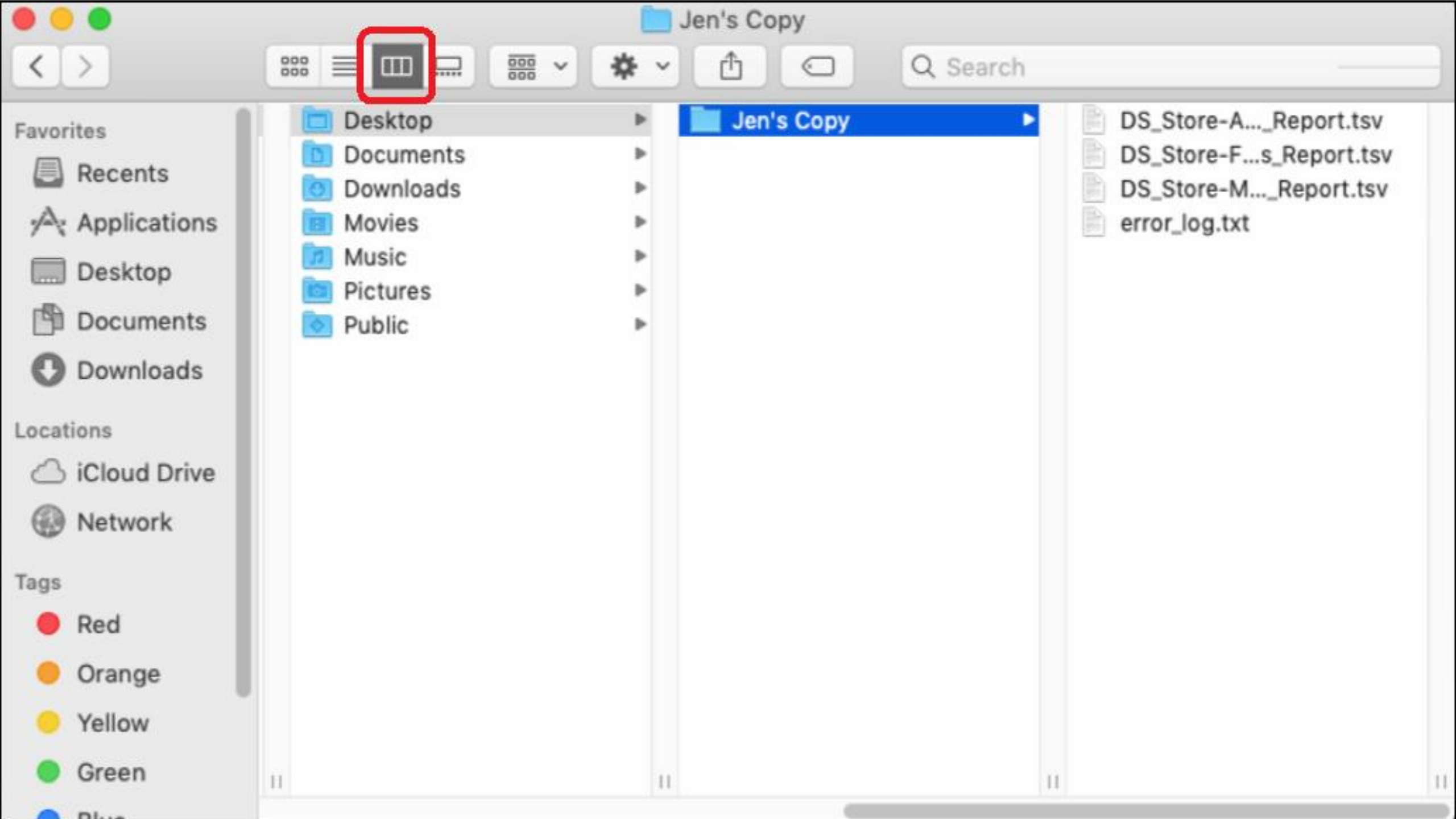
Introduction to .DS_Stores

.DS_Stores and Finder Views

.DS_Stores and Finder Views

“columns” View

- Does NOT create/modify .DS_Stores
- A user can navigate through folders with no effect to .DS_Stores


Jen's Copy
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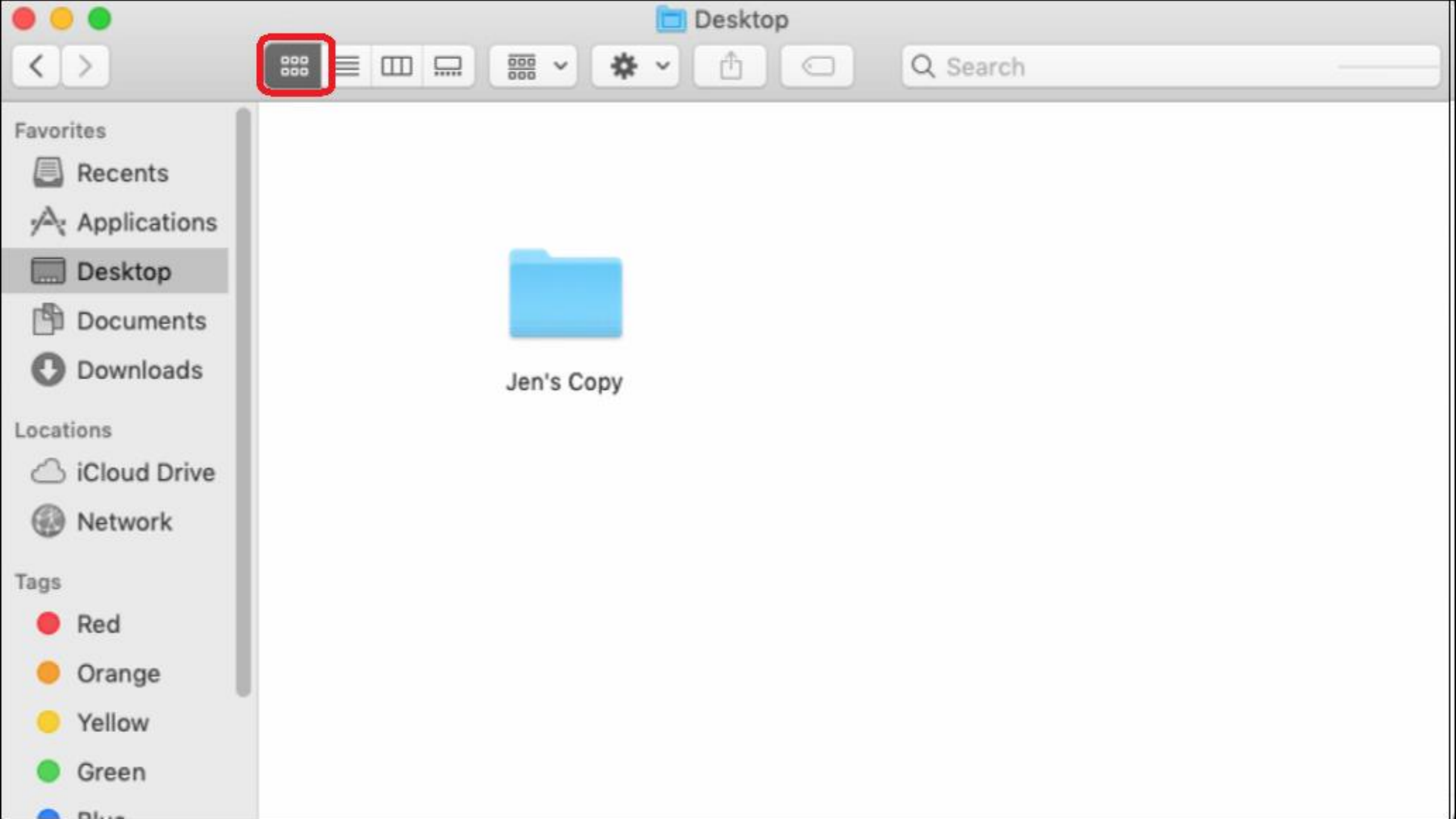
Movies
Music
Pictures
Public
Jen's Copy
DS_Store-A..._Report.tsv
DS_Store-F...s_Report.tsv
DS_Store-M..._Report.tsv
error_log.txt

.DS_Stores and Finder Views

"icon" View

- Creates/modifies a .DS_Store
- Parent folder's .DS_Store contains
  - The view setting for the folder: Icon View
- .DS_Store of folder contains
  - Location of icons
  - Selected index of files (OS versions prior to MacOS Sierra)


Desktop
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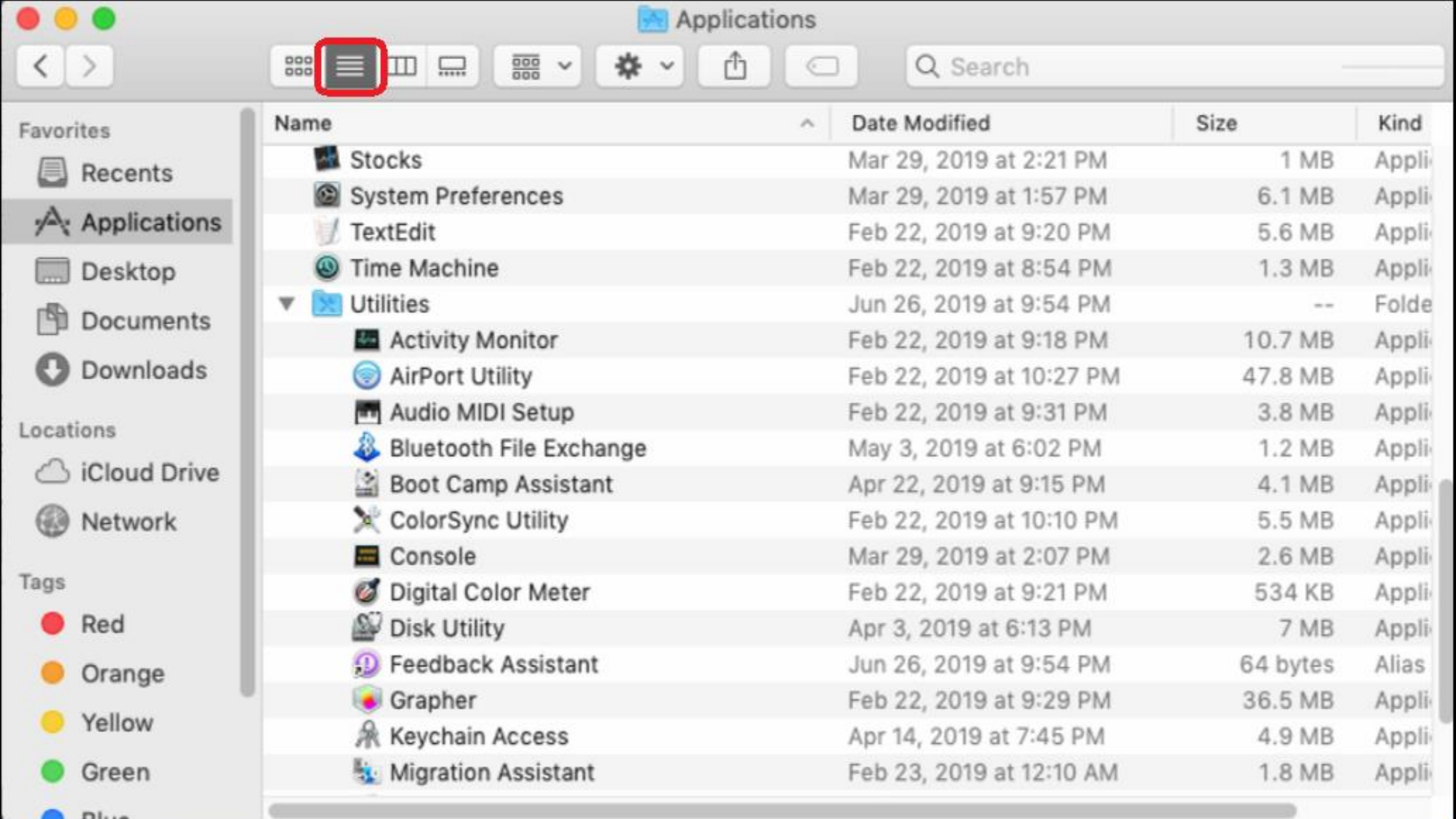
Jen's Copy

.DS_Stores and Finder Views

"list" View

- Creates/modifies a .DS_Store
- Parent folder's .DS_Store contains
  - The view setting for the folder: List View
- Folder's .DS_Store contains
  - The disclosure (dscl) status of a sub-folder
    - 0 = False, the folder is not currently disclosed (but previously was)
    - 1 = True, the folder is currently disclosed


Applications
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Applications
Desktop
Documents
Downloads
Locations
iCloud Drive
Network
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Name
Date Modified
Size
Kind
Stocks Mar 29, 2019 at 2:21 PM 1 MB Appli
System Preferences Mar 29, 2019 at 1:57 PM 6.1 MB Appli
TextEdit Feb 22, 2019 at 9:20 PM 5.6 MB Appli
Time Machine Feb 22, 2019 at 8:54 PM 1.3 MB Appli
Utilities Jun 26, 2019 at 9:54 PM -- Folde
Activity Monitor Feb 22, 2019 at 9:18 PM 10.7 MB Appli
AirPort Utility Feb 22, 2019 at 10:27 PM 47.8 MB Appli
Audio MIDI Setup Feb 22, 2019 at 9:31 PM 3.8 MB Appli
Bluetooth File Exchange May 3, 2019 at 6:02 PM 1.2 MB Appli
Boot Camp Assistant Apr 22, 2019 at 9:15 PM 4.1 MB Appli
ColorSync Utility Feb 22, 2019 at 10:10 PM 5.5 MB Appli
Console Mar 29, 2019 at 2:07 PM 2.6 MB Appli
Digital Color Meter Feb 22, 2019 at 9:21 PM 534 KB Appli
Disk Utility Apr 3, 2019 at 6:13 PM 7 MB Appli
Feedback Assistant Jun 26, 2019 at 9:54 PM 64 bytes Alias
Grapher Feb 22, 2019 at 9:29 PM 36.5 MB Appli
Keychain Access Apr 14, 2019 at 7:45 PM 4.9 MB Appli
Migration Assistant Feb 23, 2019 at 12:10 AM 1.8 MB Appli

Parsing .DS_Stores

- Open source and free python based tool DSStoreParser:
  - https://github.com/nicoleibrahim/DSStoreParser
- Compiled builds are available here:
  - https://github.com/nicoleibrahim/DSStoreParser/releases
- Outputs three reports in tsv format:
  - DS_Store-Folder_Access_Report
  - DS_Store-Miscellaneous_Info_Report
  - DS_Store-All_Parsed_Report

Parsing .DS_Stores
DSStoreParser Usage

```
usage: DSStoreParser.py [-h] -s SOURCE -o OUTDIR [-f]

DSStoreParser CLI tool. v0.2.1

Search for .DS_Store files in the path provided and parse them.

optional arguments:
  -h, --help            show this help message and exit
  -s SOURCE, --source SOURCE
                        The source path to search recursively for .DS_Store
                        files to parse.
  -o OUTDIR, --out OUTDIR
```

Parsing .DS_Stores
DSStoreParser Reports

DS_Store-Folder_Access_Report

Record types related to folder access:

- dscl/fdsc: Directory disclosure status
- bRsV: Browse in selected view
- bwsp: Browser window properties
- icgo/icsp/ICVO/icvo/icvp/icvt: Icon view properties
- lsvC/LSVO/lsvo/lsvt/lsvP/lsvp/lssp: List view properties
- vSrn: Opened in new tab
- vstl: View style selected
- glvp: Gallery view properties
- fwi0/fwsw/fwvh/info: Finder properties
- pBB0/pBBk/pict/BKGD: Background picture settings

DS_Store-Miscellaneous_Info_Report

Other record types:

- clip: Text clipping
- cmmt: Finder comments
- dilc/Iloc: Icon locations
- extn: File extension
- lg1S/logS: Logical size
- modD/moDD: Modified date
- ph1S/phyS: Physical size
- ptbL/ptbN: Trash Put Back information

Interesting Correlations
Window Bounds

- bwsp: Browser Window Settings
- This record type contains the window bounds (location of the Finder window)
- Double-clicking on folders while in Icon view
- Provides the ability to correlate folder accesses
- As a user navigates through folders, each .DS_Store entry is updated with the current bounds.

Interesting Correlations
Window Bounds

generated_path	record_filename	record_type	record_format	record_data
/Users/Niko/Desktop/My_Images	My_Images	bwsp	blob (PlistCodec)	{'ShowStatusBar': False, 'WindowBounds': '{{433, 148}, {925, 673}}', 'ContainerShowSidebar': True, 'SidebarWidth': 192, 'ShowTabView': False, 'PreviewPaneVisibility': False, 'ShowToolbar': True, 'ShowSidebar': True, 'ShowPathbar': False}
/Users/Niko/Desktop/My_Images/2017-Images	2017-Images	bwsp	blob (PlistCodec)	{'ShowStatusBar': False, 'WindowBounds': '{{433, 148}, {925, 673}}', 'ContainerShowSidebar': True, 'SidebarWidth': 192, 'ShowTabView': False, 'PreviewPaneVisibility': False, 'ShowToolbar': True, 'ShowSidebar': True, 'ShowPathbar': False}

Interesting Correlations
Window Bounds

generated_path	record_type	record_data
/Users/neiko/Desktop/knowC/Private/Knowledge	bwsp (Browser	{'ShowStatusBar': True, 'WindowBounds': '{{230, 335}, {1145, 436}}', 'ContainerShowSidebar': True, 'ShowTabView': True, 'ShowToolbar': True, 'ShowPathbar': True, 'ShowSidebar': True}
/Users/neiko/Desktop/knowC/Private	bwsp (Browser	{'ShowStatusBar': True, 'WindowBounds': '{{230, 335}, {1145, 436}}', 'ContainerShowSidebar': True, 'ShowTabView': True, 'ShowToolbar': True, 'ShowPathbar': True, 'ShowSidebar': True}
/Users/neiko/Desktop/knowC/nikki	bwsp (Browser	{'ShowStatusBar': True, 'WindowBounds': '{{230, 335}, {1145, 436}}', 'ContainerShowSidebar': True, 'ShowTabView': True, 'ShowToolbar': True, 'ShowPathbar': True, 'ShowSidebar': True}
/Users/nikki/Development/04-KnowledgeC/26-SQLiteDB_to_TSV/parsed/20190324	bwsp (Browser	{'ShowStatusBar': True, 'WindowBounds': '{{230, 335}, {1145, 436}}', 'ContainerShowSidebar': True, 'ShowTabView': True, 'ShowToolbar': True, 'ShowPathbar': True, 'ShowSidebar': True}
/Users/nikki/Development/04-KnowledgeC/26-SQLiteDB_to_TSV/parsed	bwsp (Browser	{'ShowStatusBar': True, 'WindowBounds': '{{230, 335}, {1145, 436}}', 'ContainerShowSidebar': True, 'ShowTabView': True, 'ShowToolbar': True, 'ShowPathbar': True, 'ShowSidebar': True}
/Users/nikki/Development/04-KnowledgeC/26-SQLiteDB_to_TSV	bwsp (Browser	{'ShowStatusBar': True, 'WindowBounds': '{{230, 335}, {1145, 436}}', 'ContainerShowSidebar': True, 'ShowTabView': True, 'ShowToolbar': True, 'ShowPathbar': True, 'ShowSidebar': True}

Interesting Correlations
Scroll Positions

- icvp: Icon view properties
- lsvC: List view columns
- lsvp: List view properties
- Contains both vertical and horizontal scroll positions
- Provides insight about the last visible area the user was viewing

Interesting Correlations
Scroll Positions

generated_path	record_type	record_data
/.	lsvp (List View	{'sortColumn': 'name', 'textSize': 12.0, 'viewOptionsVersion': 1, 'calculateAllSizes': False, 'iconSize': 16.0, 'showIconPreview': True, 'scrollPositionY': 91.0, 'scrollPositionX': 0.0, 'useRelativeDates': True, 'columns': {'kind': {'index': 4, 'ascending': True, 'visible': True, 'width': 115}, 'name': {'visible': True, 'ascending': True, 'index': 0, 'width': 816}, 'dateLastOpened': {'index': 8, 'ascending': False, 'visible': False, 'width': 200}, 'comments': {'index': 7, 'ascending': True, 'visible': False, 'width': 300}, 'label': {'index': 5, 'ascending': True, 'visible': False, 'width': 100}, 'version': {'index': 6, 'ascending': True, 'visible': False, 'width': 75}, 'dateCreated': {'index': 2, 'ascending': False, 'visible': False, 'width': 181}, 'dateModified': {'index': 1, 'ascending': False, 'visible': True, 'width': 181}, 'size': {'index': 3, 'ascending': False, 'visible': True, 'width': 97}}}
/.fseventsd	lsvp (List View	{'sortColumn': 'dateModified', 'textSize': 12.0, 'viewOptionsVersion': 1, 'calculateAllSizes': False, 'iconSize': 16.0, 'showIconPreview': True, 'scrollPositionY': 0.0, 'scrollPositionX': 0.0, 'useRelativeDates': True, 'columns': {'kind': {'index': 4, 'ascending': True, 'visible': True, 'width': 115}, 'name': {'visible': True, 'ascending': True, 'index': 0, 'width': 252}, 'dateLastOpened': {'index': 8, 'ascending': False, 'visible': False, 'width': 200}, 'comments': {'index': 7, 'ascending': True, 'visible': False, 'width': 300}, 'label': {'index': 5, 'ascending': True, 'visible': False, 'width': 100}, 'version': {'index': 6, 'ascending': True, 'visible': False, 'width': 75}, 'dateCreated': {'index': 2, 'ascending': False, 'visible': False, 'width': 181}, 'dateModified': {'index': 1, 'ascending': False, 'visible': True, 'width': 181}, 'size': {'index': 3, 'ascending': False, 'visible': True, 'width': 97}}}
/Applications	lsvp (List View	{'sortColumn': 'name', 'textSize': 12.0, 'viewOptionsVersion': 1, 'calculateAllSizes': False, 'iconSize': 16.0, 'showIconPreview': True, 'scrollPositionY': 1185.0, 'scrollPositionX': 3.0, 'useRelativeDates': True, 'columns': {'kind': {'visible': True, 'ascending': True, 'index': 4, 'width': 115}, 'name': {'visible': True, 'ascending': True, 'index': 0, 'width': 356}, 'dateLastOpened': {'visible': False, 'ascending': False, 'index': 8, 'width': 200}, 'comments': {'visible': False, 'ascending': True, 'index': 7, 'width': 300}, 'label': {'visible': False, 'ascending': True, 'index': 5, 'width': 100}, 'version': {'visible': False, 'ascending': True, 'index': 6, 'width': 75}, 'dateCreated': {'visible': False, 'ascending': False, 'index': 2, 'width': 181}, 'dateModified': {'visible': True, 'ascending': False, 'index': 1, 'width': 181}, 'size': {'visible': True, 'ascending': False, 'index': 3, 'width': 97}}}

Interesting Correlations
Trash Put Backs

- ptbN: Trash Put Back Name
- ptbL: Trash Put Back Location
- Contains the original filename and location of a file/folder sent to the Trash
- Follows the file even if restored, renamed, or moved
- Provides insight about the original name/location of files that were sent to the Trash

Interesting Correlations
Trash Put Backs

generated_path	record_type	record_data
/Users/neiko/.Trash/000000000194adf1	ptbL (Trash Put Back Location)	Users/neiko/Desktop/
/Users/neiko/.Trash/000000000194adf1	ptbN (Trash Put Back Name)	000000000194adf1
/Users/neiko/.Trash/osxpmem.app	ptbL (Trash Put Back Location)	/
/Users/neiko/.Trash/osxpmem.app	ptbN (Trash Put Back Name)	osxpmem.app
/Users/neiko/Desktop/DS_Store/ds_store-bash.ad1.txt	ptbL (Trash Put Back Location)	Users/neiko/Desktop/DS_Store/
/Users/neiko/Desktop/DS_Store/ds_store-bash.ad1.txt	ptbN (Trash Put Back Name)	ds_store-bash.ad1.txt
/Users/neiko/Desktop/New folder/knowC_rename_test	ptbL (Trash Put Back Location)	Users/neiko/Desktop/KnowledgeC/
/Users/neiko/Desktop/New folder/knowC_rename_test	ptbN (Trash Put Back Name)	knowC
/Users/other/Desktop/Script.sh	ptbL (Trash Put Back Location)	Users/lilly/Desktop/
/Users/other/Desktop/Script.sh	ptbN (Trash Put Back Name)	Script.sh

Interesting Correlations
Selected Indexes

- Iloc: Icon location
- Contains an index number if a file or folder was selected
- Provides insight into files/folders the user selected/clicked on
- Unfortunately, deprecated as of MacOS 10.12 Sierra

Interesting Correlations
Selected Indexes

generated_path	record_type	record_data
/Users/nikki/Development/.DS_Store	Iloc (Icon Location)	Location: (472, 40), Selected Index: 9, Unknown: ffff0000
/Users/nikki/Development/ds_store_parser.py	Iloc (Icon Location)	Location: (204, 264), Selected Index: 26, Unknown: ffff0000
/Users/nikki/Development/FSEventWatcher	Iloc (Icon Location)	Location: (338, 40), Selected Index: 2, Unknown: ffff0000
/Users/nikki/Development/FSEventWatcher.zip	Iloc (Icon Location)	Location: (204, 40), Selected Index: 1, Unknown: ffff0000
/Users/nikki/Development/logs	Iloc (Icon Location)	Location: (338, 264), Selected Index: 20, Unknown: ffff0000
/Users/nikki/Development/logs.dmg	Iloc (Icon Location)	Location: (70, 376), Selected Index: Null, Unknown: ffff0000
/Users/nikki/Development/M1-Test-Shared_Folder_Desktop	Iloc (Icon Location)	Location: (275, 159), Selected Index: 21, Unknown: ffff0000
/Users/nikki/Development/original.txt	Iloc (Icon Location)	Location: (204, 488), Selected Index: Null, Unknown: ffff0000
/Users/nikki/Development/Parallels Shared Folders	Iloc (Icon Location)	Location: (70, 40), Selected Index: Null, Unknown: ffff0000
/Users/nikki/Development/test.txt	Iloc (Icon Location)	Location: (338, 488), Selected Index: 25, Unknown: ffff0000
/Users/nikki/Development/Tests_output	Iloc (Icon Location)	Location: (70, 264), Selected Index: 27, Unknown: ffff0000
/Users/nikki/Development/untitled folder	Iloc (Icon Location)	Location: (472, 264), Selected Index: 24, Unknown: ffff0000

Caveats

- .DS_Stores are portable
- No full paths
- No stored timestamps
- Data is volatile

Caveats
.DS_Stores are Portable

Problem:

- .DS_Stores can be archived in a container file such as a ZIP, then unzipped on another computer.
- Copying folders also copies hidden .DS_stores

Solution:

- This solution does not apply to files parsed on Windows systems
- Check permissions
  - Expected: -rw-r--r--
  - Only the owner has r/w access by default
  - The three files that exist by default on a fresh install are an exception
- Check extended attributes
  - Expected: “com.apple.finderinfo”

Caveats
No Full Paths

Problem:

- Full paths are not stored in .DS_Stores

Solution:

- The DSStoreParser tool builds the full path using the path to the .DS_Store file

Caveats
No Stored Timestamps

Problem:

- There are no stored timestamps that indicate when a record was added or changed

Solution:

- None
- The created/modified timestamps of the .DS_Store file provides a time range at best

Caveats
Record Data is Volatile

Problem:

- .DS_Stores do not retain previous records
- When an item is deleted or moved all associated records are purged
- When items are renamed all associated records are updated with the new name

Solution:

- Carving for .DS_Store files
- Check local snapshots
- Check Time Machine backups

Conclusion

- .DS_Stores are created as a result of user interaction
- They provide evidence of folder accesses
- They provide insight into how the user interacted with files/folders
- Original file names and locations can be identified using Trash Put Backs
- Some caveats, can be overcome

Questions?

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