ANALYSIS OF 2007 DFRWS FORENSIC CARVING CHALLENGE

The 07 smart carving approach

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1. Introduction

The DFRWS 2007 challenge is about data carving, which is a file recovery technique that is frequently used during digital investigations. Files are "carved" from the unallocated space using file type-specific information, such as headers, footers, and other internal structures.

The previous DFRWS 2006 challenge focused on carving basic file types in basic scenarios. The result was the development of new tools and techniques to carve files using more internal structure than only the header and footer values. The DFRWS 2007 challenge expands on the DFRWS 2006 challenge by introducing more file types and more complex fragmentation scenarios.

The goal of this challenge is to design and develop automated file carving algorithms that have high true positive and low false positive rates. The data should be analyzed using little or no human intervention, since attempts to recover data manually does not typically scale with realistic data sizes.

In this document the following definitions are used.

False positive
A file found by the carver that contains some of the characteristics of the specific (file) format, but is not considered as a complete valid file by applications that commonly process files of the specific (file) format.

False negative
A file that contains characteristics of the specific (file) format that is being carved, but was not considered a such by the carver, not considering embedded, encapsulated and fragments of the file.

Completed file
A file exported by the carver from the raw input and marked as a positive result.

Corrupted file
A file exported by the carver from the raw input and marked as a positive result. However the carver did detect corruption in the file format definition but was able to compensate.

Partial file
A file exported by the carver from the raw input and marked as a false positive result. The carver found the start of the format definition but was not able to complete the definition.

Fragment file
A file exported by the carver from the raw input and marked as a false positive result. The carver found a part of the file according to the format definition.

Validated file
A file that is validated by applications that commonly process files of the specific (file) format.

Note: some files which can be validated may contain additional data compared to the original file, like empty lines in HTML. This would cause the MD5 sum of the carved file to not match with the MD5 sum of the original file. In these cases a MD5 mismatch does not account for the file being a false positive.

```
Viewable file
A file that is a file that is viewable by applications that commonly process files of the specific
(file) format. Some of these applications compensate for errors.
```

Note: to determine if a file is viewable human intervention is required. Also it is highly debatable what the applications are that commonly process files of a specific format. For example, would a text editor be considered a valid viewer for formats like XML and mbox, since they are basically text files?

```
Embedded file
A contiguous file that is embedded within another file.
```

An example of an embedded file is a JPEG file within a PDF.

```
Encapsulated file
A non contiguous file that is embedded within another file.
```

An example of an encapsulated file is a MPEG video stream (file) within a MPEG program (system) stream file.

1.1. Approach

The following approach was used to design an automated approach to carve the DFRWS 2007 challenge data.

1. Analyze the possible file types present in the DFRWS 2007 challenge data.
2. Analyze and evaluate the DFRWS 2006 challenge, the tools and techniques as well as the scenarios.
3. Devise a carving approach that is useful for both the DFRWS 2007 challenge and realistic data sets. The carving approach should carve as much as possible in a single linear run.
4. Create additional tooling to handle the fragmentation scenarios which can not be handled in a single run. This tooling is referred to as post carving analysis.
5. Evaluate the findings and do some fine tuning.

And of course having fun and learning something while doing it.

2. Analysis of the DFRWS 2007 challenge data

An initial analysis of the evidence was performed using the following carving tools:

- revit 20061015-1
- scapel 1.6
- foremost 1.4
- FTK 1.6.2
- BadCopy Pro
- Recover My Files
- PhotoRec 6.6 (work in progress)

The results varied per carving tool but it provided information about the possible file formats present in the evidence data. A non-conclusive list of the file formats that need to be supported is: JPEG, AVI, ASF/WMV, MPEG, MOV/QT, PDF, OLE2, HTML, ZIP, MP3, MP4, ELF, MZ PE/COFF, FLV, mbox, plain text, and embedded file formats: XML, TIFF, PNG.

The scenarios could not be determined from the results of the different carving tools. The main problems are that the results are to variating and the amount of data too large. We considered looking for the scenarios when we had developed tooling that was able to provide us with the necessary information.

3. Carving tools, techniques and scenarios in a nutshell

Some of carving techniques introduced last year were quite inspirational. Last year we devised an approach we called 'deep carving'. The same technique was devised by S. Garfinkel which he called 'Semantic Carving'. To prevent misinterpretation of carving terminology a carving taxonomy was proposed [1]. See below.

Carving
General term for extracting data (files) out of undifferentiated blocks (raw data), like "carving" a sculpture out of soap stone.

Block Based Carving
Any carving method (algorithm) that analyzes the input on block-by-block basis to determine if a block is part of a possible output file. This method assumes that each block can only be part of a single file (or embedded file).

Characteristic Based Carving
Any carving method (algorithm) that analyzes the input on characteristic basis (for example, entropy) to determine if the input is part of a possible output file.

Header/Footer Carving
A method for carving files out of raw data using a distinct header (start of file marker) and footer (end of file marker).

Header/Maximum (file) size Carving
A method for carving files out of raw data using a distinct header (start of file marker) and a maximum (file) size. This approach works because many file formats (e.g. JPEG, MP3) do not care if

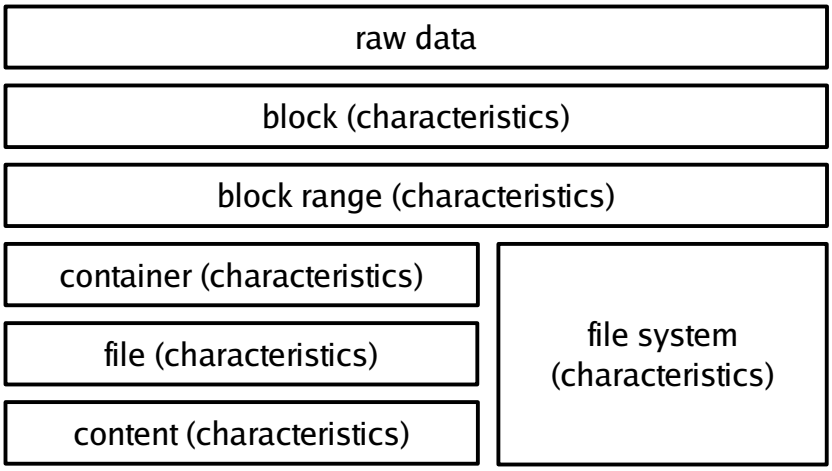
```
additional junk is appended to the end of a valid file.

Header/Embedded Length Carving
A method for carving files out of raw data using a distinct header and a file length (size) which
is embedded in the file format

File structure based carving
A method for carving files out of raw data using a certain level of knowledge of the internal
structure of file types. Garfinkel called this approach "Semantic Carving" in his DFRWS2006
carving challenge submission, while Metz and Mora called the approach "Deep Carving."

Semantic carving
A method for carving files based on a linguistic analysis of the files content. For example, a
semantic carver might conclude that six blocks of french in the middle of a long HTML file written
in English is a fragment left from a previous allocated file, and not from the English-language
HTML file.

Carving with Validation
A method for carving files out of raw data where the carved files are validated using a file type
specific validator.

Fragment Recovery Carving
A carving method in which two or more fragments are reassembled to form the original file or
object. Garfinkel previously called this approach "Split Carving."
```

File structure based carving proved to be a very powerful addition to header/footer based carving. However some file formats have large areas where there are little to no file structure characteristics. To improve carving results the carver needs to make sense of these areas.

A solution to this would be to have the carver process these areas, i.e. decompressing compressed data, etc. This would require very detailed knowledge of the file format and all its exotics. This is a problem for closed file formats. And even for open file formats this is a very time intensive solution.

Therefore we devised a concept we call block based 'smart carving'. Block based carving is a carving approach where the input is considered to be divided in to fixed size blocks, i.e. sectors of 512 bytes. The main assumption made is that every block can be part of at most one file (not considering embedded or encapsulated files) or not be part of a file at all, i.e. file system structures. A block can contain both file data and non file-related data, like slack space.

Smart carving is a carving approach where multiple carving techniques are combined. Smart carving uses different characteristics to determine whether data is part of a file. This technique can be used to improve carving results, by using certain collected characteristics of a (closed) file format. For example, using the knowledge that compressed areas have high entropy.



Content based carving
A generic term for carving files out of raw data using a certain level of knowledge of the content of file types, i.e. CRCs, semantics, content black lists, etc. A specific type of content based carving is semantic carving.

Block characteristics based carving
A method for carving files out of raw data using a certain level of knowledge of fixed size blocks, i.e. the amount of ASCII character values, the amount of zero values, if the block is empty, sliding entropy, etc.

Block range characteristics based carving
This method is actually a variant of Block characteristics based carving in which a range of fixed size blocks is used instead of single blocks.

In our smart carving approach we combined (ordered by significance):

1. *File structure based carving*
2. *Content based carving*
   This method is not very powerful by itself but is a powerful addition to file structure based carving.
3. *Block characteristics based carving*
   This method is not very powerful by itself, but is able to detect structureless files like ASCII or extended character set plain text files. It is also able to detect changes in the input data, for example by detecting sliding entropy drops.

3.1. Scenarios

Several scenarios that were used in the DFRWS 2006 challenge were:

1. non fragmented files
2. fragmenting files by inserting a file of a similar or different format
3. fragmenting files by intertwining a file of a similar or different format
4. fragmenting files by inserting random data
5. fragmenting files by inserting data similar to characteristics of the file
6. pre-pending files by a data similar to characteristics of the file (i.e. start of file)
7. inserting files larger than average file size maximum

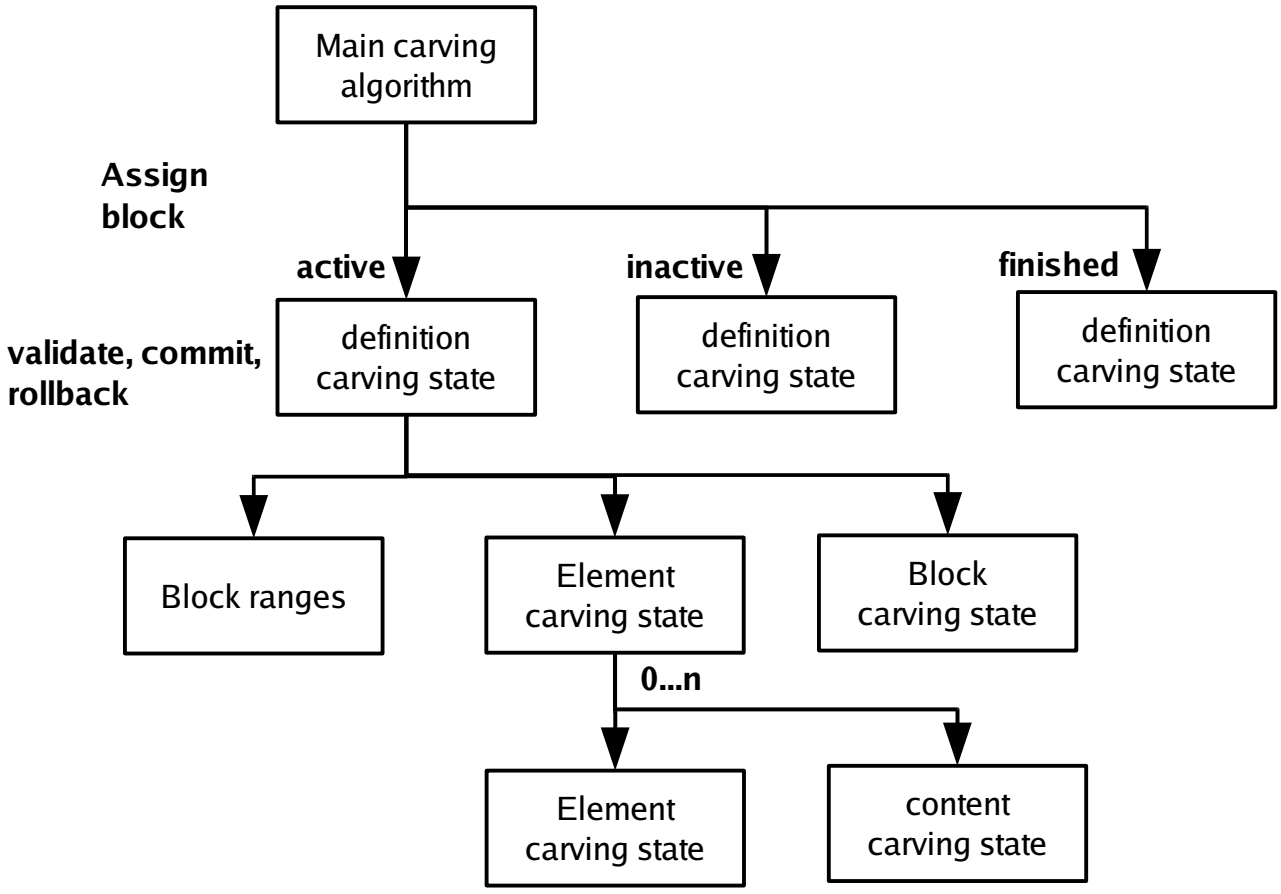
Other possible scenarios we considered might be in the DFRWS 2007 challenge

8. obfuscation of (part of) a file (Base64, ROT13, encryption, compression)
9. corruption of certain file characteristics
10. normal file with encapsulated files in it (i.e. uncompressed EWF)
11. non-linear fragmentation; a file split into 2 or more fragments and placed in the image in a different order.
12. a combination of one or more scenarios

3.2. The carving algorithm

Handling certain file formats using file format based carving is quite a challenge, even for non fragmented files. For example, some files contain embedded files or encapsulated files in packetized streams. To keep the carving approach as transparent as possible we decided to keep the evaluation of file formats separate from the main carving algorithm, by handling the file formats in `file definition states'.

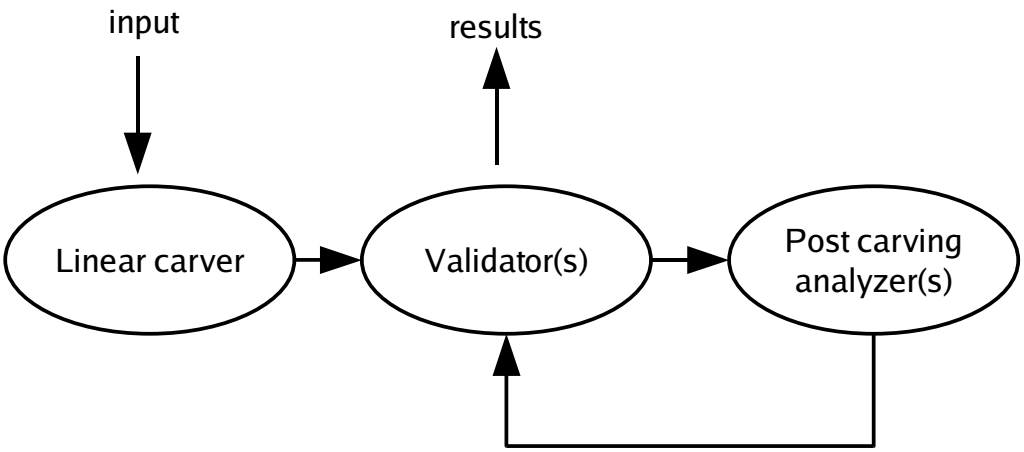
The main algorithm provides the file definition state with a block of raw data. The file definition state then tells the main algorithm whether this block of data is part of the file definition. In some cases the file definition state does not know if the block is part of its definition. Analyzing the other characteristics may provide for a conclusive answer.



To compensate for linear fragmentation the main carving algorithm needs to activate or deactivate file definition states. Using this approach the carver is able to handle the following scenarios:

- fragmentation by insertion (scenario 2, 4, 5), which can be detected in a linear run if the fragmented data is recognizable:
  - the inserted data does not match the file format (file characteristics)
  - the inserted data does not match content characteristics, like high entropy
  - the inserted data does not match block characteristics like those of intermediate, random or similar blocks
- fragmentation by intertwining (scenario 3), which can be detected in a linear run if the fragmented data is recognizable:
  - the intertwinement should be linear and the characteristics of the two files should clearly differ at the points where a switch between the files occurs.
- pre-pending files by a data similar to characteristics (scenario 6), which can be detected in a linear run if the pre-pended data is not validated as part of the file
- inserting files larger than average file size maximum (scenario 7) is not a problem, since a header/maximum (file) size carving approach is not used
- corruption of certain file characteristics (scenario 9) can be detected in a linear run if multiple file characteristics can be compared, i.e. a list can have a size and list elements. The carver could look for both and compensate for mismatches.

Some of the scenarios cannot be compensated for in a single linear carving run, but require post carving analysis. Therefore we devised the following carving approach:



3.3. Tools developed

The following tools were developed to be part of our carving approach (carving framework):

1. Revive It 2007 (revit07), a linear 'smart carving' tool
2. File validation (file-validation)
3. Experimental post carving analyzers

Some additional tools were developed to support in creating the linear carver to provide support for file formats and to determine the fragmentation scenarios and correct them in post carving analyzers:

4. Definition Tester (detest), analyzes if a file matches the revit07 file definition
5. Block Analyzer (banalyze), provides block based information about input, but does not carve files
6. Data visualization tool (visualize_image_topology.rb)
7. Random block range detection (random_ranges.rb), uses statistical data about blocks to try to find ranges of random blocks.
8. Empty block range detection (empty_ranges.rb), detects ranges of empty blocks.

The DFRWS 2007 challenge data does not contain a file system, therefore any file system support was left out of the tooling.

To be able to handle all different file formats, an initial version of a domain specific language for file format configuration was created. The file formats are stored in a single configuration file. This configuration file differs from the 2006 version of revit and is not interchangeable. The new format is more flexible and allows for more file formats to be specified. However this will not be the final version, yet.

The main carving algorithm used in revit07 is provided as a separate file.

Due to there size the tools were made available on the revit project site [3]

4. Findings

We continually tested our framework against multiple images to make the tooling and methods as generic as possible.

Evidence number:	1
Description:	Basic Data Carving Test #1 (Mar '05) (by Nick Mikus) Image containing files on a FAT file system • files are non fragmented • one file is corrupted
Filename:	11-carve-fat.dd
MD5:	0069813c892a462f88dc6d376624f7d9
Origin:	http://dftt.sourceforge.net/test11/index.html

Evidence number:	2
Description:	Basic Data Carving Test #2 (Mar '05) (by Nick Mikus) Image containing known files on an EXT2 file system • most files are linear fragmented by the indirect blocks of the EXT2 file system
Filename:	12-carve-ext2.dd
MD5:	6cbd2c5248fa7030d699eb6cde051623
Origin:	http://dftt.sourceforge.net/test12/index.html

Evidence number:	3
Description:	The DFRWS 2006 carving challenge data Image contains known files without a file system in random data • most files are linear fragmented using scenarios 2 to 7
Filename:	dfrws-2006-challenge.raw
MD5:	bd09d612fc8b3f92662b98f9456f2ada
Origin:	http://www.dfrws.org/2006/challenge/dfrws-2006-challenge.zip

Evidence number:	4
Description:	The DFRWS 2007 carving challenge data Image containing unknown data without a file system in random data • files are fragmented using unknown scenarios
Filename:	dfrws-2007-challenge.img
MD5:	8a501f3f525c85a50a3aa0bf698bffe7
Origin:	http://www.dfrws.org/2007/challenge/dfrws-2007-challenge.zip

4.1. Verify the evidence

The first step in the investigation was to verify the integrity hashes of the evidence images (only the verification of the the DFRWS 2007 carving challenge data is shown).

```
# md5sum dfrws-2007-challenge.img

8a501f3f525c85a50a3aa0bf698bffe7  dfrws-2007-challenge.img
```

4.2. Virus scan the evidence

The ClamAV virus scanner was used to determine if fragments of known viruses were present in

the raw file (only the scan of the the DFRWS 2007 carving challenge data is shown).

```
# clamscan -v dfrws-2007-challenge.img

Scanning dfrws-2007-challenge.img
dfrws-2007-challenge.img: OK

----------- SCAN SUMMARY -----------
Known viruses: 131350
Engine version: 0.90.2
Scanned directories: 0
Scanned files: 1
Infected files: 0
Data scanned: 330.89 MB
Time: 127.518 sec (2 m 7 s)
```

No known viruses were found.

4.3. Linear carving

The revit07 tool was used as the linear carver (only the command of the the DFRWS 2007 carving challenge data is shown):

```
#./revit -e -F -c etc/file_types.conf -t revived-dfrws2007 dfrws-2007-challenge.img 2>/dev/null

Analysis started at: Thu Jul  5 09:56:31 2007

This could take a while.

Status: at 0%.
        analyzed 512 B (512 bytes) of total 330 MB (346971136 bytes).
...


Status: at 100%.
        analyzed 330 MB (346971136 bytes) of total 330 MB (346971136 bytes).
        completion in 0 second(s) with 597 kB/s (611942 bytes/second).

Analysis of input successful at: Thu Jul  5 10:05:58 2007

Analyzed: 330 MB (346971136 bytes) in 9 minute(s) and 27 second(s) with 597 kB/s (611942
bytes/second).
Calculated MD5: 8a501f3f525c85a50a3aa0bf698bffe7
```

It was run with fragment detection (-F) which slows down the carving process significantly, about a factor 6. But currently will detect 21 known fragments and the reduce the amount of completed files.

```
Analyzed: 330 MB (346971136 bytes) in 2 minute(s) and 31 second(s) with 2.1 MB/s (2297822
bytes/second).
```

The linear 'smart carving' approach proved very powerful.

Evidence	Total	Partials	Completed	Validated	% positives
11-carve-fat.dd	15	1 partials 0 fragments	14	14	93.33
12-carve-ext2.dd	10	1 partials 0 fragments	9	7	70
dfrws-2006-challenge.raw	32	4 partials 0 fragments	29	25	78.13
dfrws-2007-challenge.img	unknown	176 partials 21 fragments	192	38	unknown

In the 11-carve-fat.dd the corrupted file was carved as partial. We experimented with a corruption tolerance technique by searching file format characteristics after the fragmentation within the same block. This allowed us to carve the corrupted file completely however the implementation of this technique still needs work in the current version of the linear carver (revit07).

In the 12-carve-ext2.dd most of the fragmentation by the EXT2 indirects blocks was detected:

fragmentation detected by:
sliding entropy

fragmentation detected by:
file format mismatch

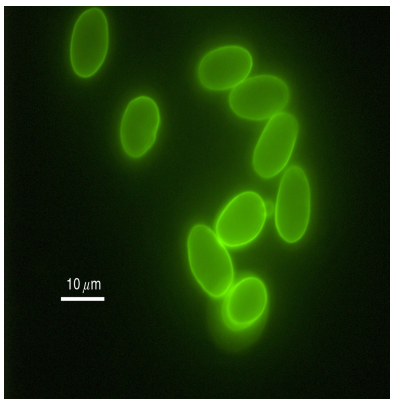
fragmentation detected by:
sliding entropy

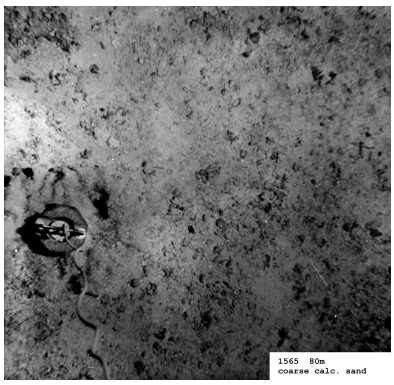
However 3 completed files were not validated:

- 1 partial ppt file
- 1 completed xls file
- 1 completed bmp file, however the file is viewable

The fragmentation by the indirect block was not detected by the carver. The carver was not able to distinguish between the indirect blocks and blocks relating to the file format specification.

In the dfrws-2006-challenge.raw most of the files fragmented by other files were carved correctly:





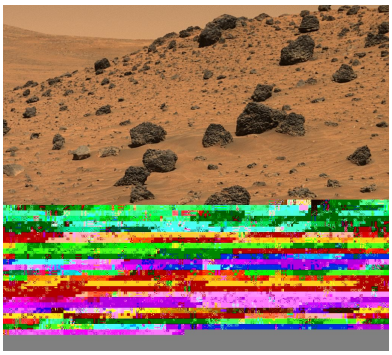
fragmentation detected by: change in characteristic

fragmentation detected by: file format mismatch

fragmentation detected by: file format mismatch

Even one additional text file was found not in the known files list (at the start of the image).

The intertwined files and files fragmented with file format specific data were not carved correctly:



intertwined with next image

intertwined with previous image

fragmented by special crafted block of data containing an end of file marker

The carver was not able to carve these files correctly. It was not able to distinguish the scenario data from the file format specification. However generic techniques could be build in to the linear carver to detect these problems areas. I.e. for a JPEG file the image size could be determined and tested if a valid file format element is present at that point. Another technique that could be useful is to use content based carving for the image data. The image data is encoded in a certain way and content test could be used to find fragmentation.

Some of the HTML files differ with those in the defined in the image contents because of additional end of line characters. Also the carver was not able to distinguish the random block within file formats like JPEG and ZIP, which contain data with some characteristics of random data.

In the dfrws-2007-challenge.img most of the files were severely fragmented. The results of the DFRWS 2007 challenge data are mentioned in the next chapter. Most of the fragmentation handling techniques in the linear carver do not work well in the DFRWS 2007 challenge data because of its

high amount of fragmentation.

In conclusion the linear carving run is powerful but is not able to handle every scenario. It is highly dependent on the file formats and other known characteristics of the files. It should be noted that some of the scenarios could be detected in the linear carving run, but further research is required.

4.4. Validation

To reduce the amount of false positives and provide candidates for post carving analysis a validation process was required.

Several key issues we were confronted with were that:

- the amount of good validators that can be automated is sparse.
- the amount good validators that can be automated and that provide the necessary information to pinpoint the problem is even more sparse.
- for some of the file formats it is difficult to validate if a file is partial or complete. In mp3 for example there is no clear start and end of file marker and the inner structure is the same throughout the entire file. Basically, as it says in the file specification, each mp3 frame is a full valid mp3. Humans can listen to mp3 files and tell if the music is the same, perhaps some kind of automated spectral analysis could provide for an educated guess. This technique would only be suitable for audio and video files.

Our solution was to create a framework in which different file formats are validated by checking them using a number of (console based) tools. The tools used are: catppt, convert, wine, eu-elflint, mp3check, mplayer, pdfinfo, pdftops, tidy, unzip, wvtext and xlhtml, link.exe. Together these tools can verify the following file formats: asf, avi, bmp, doc, elf, exe, flv, gif, html, jpg, mov, mp3, mp4, mpg, pdf, png, ppt, qt, tiff, wav, wmv, xls and zip.

These validations can never be completely foolproof, since they rely on the interpretation of the results of the tools. The results are interpreted in 3 basic ways:

- A tool may crash on invalid inputs.
- A tool may give (specific) output messages for invalid files.
- A conversion tool may only produce output for valid inputs.

The results of running the validator framework on the revit07 linear carver results are shown in the next chapter.

4.5. Post carving analysis

Non validated files could be corrected in the post analysis. The most simple approach of post carving analysis would be to use block and fragment depletion analysis.

Block and fragment depletion analysis
This technique tries all possible combinations of input blocks, fragments and/or partials and checks if the result is valid.

This approach takes too much time for realistic data sets. Also it is uncertain if other parts of the files are still within the raw data. The depletion technique is very unreliable if the validator is not restrictive enough. However the depletion method could be useful if the amount of suspect sectors can be limited.

The depletion analysis can be enhanced by:

- determining suspect areas, like ranges of (possibly) random or empty blocks and skipping these when trying to fix corrupted files or combine partial files.
- or by testing the join areas for known characteristics (if possible).

However good post analysis without having to resort to depletion relies on having tools that are able to detect and pinpoint errors in files. Information about the linear carving run is a useful source of pinpointing errors. Another technique that could be used is file structure backtracking analysis.

File structure backtracking analysis
This technique backtracks file structure data to find suspect areas and correct the carved files.

I.e. for ZIP it would be possible to check if the offsets in the central directory align with the location of the files and reduce the suspect area. Little of such tools seem to exist in the public domain thus building them would require detailed knowledge of the file formats and a considerable amount of time per file format.

Another approach was taken to try to correct fragmented results or reduce the amount of suspect areas using data similarity/dissimilarity analysis.

Data similarity/dissimilarity analysis
This technique collects statistical information about the file data and searches for similar or dissimilar data within the raw input.

In last years submission entropy and byte characteristics proved to be highly effective in finding suspect areas in certain file formats. We selected several criteria that could tell us something about the data:

- fragment detection by searching file format characteristics with a block
- random block detection by calculating the entropy, the chi^2 and the serial correlation coefficient
- similarity block detection by calculating similarity and dissimilarity metrics (Jaccard and Dice coefficient), mutual information

What we found is that the reliability of these characteristic vary a lot for file formats. Even sliding

entropy, which is a powerful technique, will not validate valid JPEG images. A lot more analysis and information about file formats is required to make educated guesses.

A technique appropriate for certain file format type is spectral analysis.

```
Spectral analysis
This technique uses spectral information about the suspect area and searches for data with the
same spectral distribution within the raw input.
```

I.e. some JPEG files contain a thumbnail, a spectral analysis of the thumbnail image data could provide for information about missing data in a JPEG and pinpointing the problem. Due to time constraint this techniques was not researched. It would be required to interpreted the file data in high detail. This technique could in theory also be used in MPEG and/or MP3.

5. Carving the DFRWS 2007 challenge image

5.1. Carving framework results

The results are categorize in the following tables:

- validated files
- partial files
- fragment files
- embedded validated files
- embedded partial files
- embedded fragment files

The output was generated by the carving framework

Table: validated files

MD5	Sectors	File Size	File Type	File Name
f33b2e628d209599fb67d0e74e795931	36851-53512	8530944	QT	011fe600.qt
c69c8b66d2df4539445110a8997b2605	72033-72627	304640	MP3	0232c200.mp3
34b1d1864c3aafee61e2263029bba3b5	148125-149059	478720	MP3	04853a00.mp3
9717e34ac087e6ea259d281652a65ea4	150266-152909	1353728	MP3	0495f400.mp3
0373afef43e8522497924357b86dae9a	156545-164098	3867648	MP3	04c70200.mp3
fcedfd868b09f09b371ad38aabf7f440	164138-165739	820224	MP3	05025400.mp3
ac15b319e1562a864a72e2be9ad84fb0	172059-173583	780800	MP3	05403600.mp3
982b2f257d319f5525267256a08110da	173744-174507	391168	MP3	054d6000.mp3
b42a32836be23347fd4b463c2e38dbfd	174508-176015	772096	MP3	05535800.mp3
94c7e419b92c7bfc6c2a06941f51d151	176274-182432	3153408	MP3	05612400.mp3
3440a0169740b80f5fcff4cb8641a210	201618-202231	314368	PDF	06272400.pdf
8a62656f1bc5e3556afcc9d6c346dd64	229424-231512	1069568	MP3	07006000.mp3
9ef3b71b37fd0a8a6c541e8273884755	242124-242319	100352	MP3	07639800.mp3
d084bd372016dfe2e6f71089d0541db6	242444-249256	3488256	MP3	07661800.mp3
f35fde08123993025326d94b7bad176f	249409-251894	1272832	MP3	079c8200.mp3

da056b55d5a65324b3cfc057255916fe	259227-270567	5806592	AVI	07e93600.avi
a624feb25dd3f916a8a9bf3aa100a913	302258-312443	5215232	MP3	09396400.mp3
e8b8f251a9bee0c761350183d4e520ff	315026-315860	427520	MP3	099d2400.mp3
6fb4d35d337ce3c8940ff26c4f6d6c2f	326874-331184	2207232	MP3	09f9b400.mp3
d49ab6f649605771f421c0d68f677730	332568-334932	1210880	MP3	0a263000.mp3
44aea11a5fba21218425068659def2d1	351153-352046	457728	FLV	0ab76200.flv
df57c932999606240d23d0c6cbde6e73	372760-373497	377856	MP3	0b603000.mp3
d9ef9586c6b243f2f3280e01eb529f78	373510-377164	1871360	MP3	0b660c00.mp3
0d7ce81407f0b3e282e341da25389e43	379964-390588	5440000	MP3	0b987800.mp3
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	440527-444541			
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2859538714dc3a14985ffaf6e18f919f	502897-508726	2984960	MP3	0f58e200.mp3
6bb75b6fd6eb8035922eb8ae29dc92cd	648613-648908	151552	JPG	13cb4a00.jpg
2c05ae41151b7de7132c0ddad47d1890	658805-661306	1281024	MP3	141aea00.mp3
3e664b723bc74e2bce6e4dc47936be1b	661345-662590	637952	MP3	142ec200.mp3

Table: partial files

MD5	Sectors	File Size	File Type	File Name
897dd77e265eafd58fc4a74d16e076cb	585-1004	215040	MPG	00049200.mpg
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eb9960df5809e1d1cfe50a65461c2857	3677-4980	667648	MPG	001cba00.mpg
c5e3420db555818f58d05697f4de802a	6317-6502,7143,7512	96256	MPG	00315a00.mpg
7fcbbbf75b53c81748debca07f53b82f	6503-7142	327680	MPG	0032ce00.mpg
6b139834fcc3c8a4c94f75ee8dd35211	7152-7511	184320	MPG	0037e000.mpg
283db32354f924fc8650f4550921005f	20014-36567	8475648	AVI	009c5c00.avi
5f4ff1480d425985addb6759b396504f	55812-56575	391168	MPG	01b40800.mpg
f24ecf5e76a36ffcbea2ab39d300ffc1	56577-57144	290816	MPG	01ba0200.mpg
7f7922028dd6983a22f12501543fd08f	57145-57499	181760	JPG	01be7200.jpg
77bb466b8159ec2b788f8a54cd0c9091	59473-61316	944128	MPG	01d0a200.mpg
ed4822cc15cdf8c033e2e1fe26ebdcf2	62500-64323	933888	MPG	01e84800.mpg
df250ed95eac0d6f5f9e9d7e654baa60	64327-64494	86016	MPG	01f68e00.mpg
f9ad1b6d59d6df5776242ce7dfab735f	70034-70518	248320	JPG	02232400.jpg
ac37a6721df795820f1d79dec57afcb2	79781-80115	171520	MPG	026f4a00.mpg
254072d42995958ef05fc7ba34f503c0	80352-80636	145920	MPG	0273c000.mpg
4ce08816537ddc94c9361690c253e1b7	87582-87677	49152	MPG	02ac3c00.mpg
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	88911-88952			
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767b3e129ef48bf244ea05956b82c71a	89029-90376	690176	JPG	02b78a00.jpg
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421a0d9230ba2222fb576a0c7994a350	93780-100449	3415040	JPG	02dca800.jpg
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742641127548cc0bb02bf6fe96b83209	145683-145805,145807	63488	MPG	04722600.mpg
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783e48a84c5319f179a218d60433f459	184200-185111	466944	MPG	059f1000.mpg
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	202232-202233			
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c40b9dd5ec4633ac9c1c8b5a6c0d0769	208031-210072	1045504	MPG	06593e00.mpg
f524939232cad78b77965e090381e4be	210073-212756	1374208	MPG	06693200.mpg
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	225971-226398			
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	229214-229215			
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	255874-255995			
	256070-256139			
	256194-256314			
	256583-256689			
	256835-256854			
	257314-257340			
	257742-257828			
	258059-258126			
	258426-258550			
	258779-258874			
	258954-259007			
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	335972-336082			
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	498171-498172			
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	498603-498605			
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	524872-524950			
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	595308-595347			
	595369-595373			
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	597836-597838			
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	601516-601517			
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	610347-610349			
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	629691-629694			
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	639492-639493			
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	639488-639489			
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7770412ad18be32f6d6f86fb93d7065f	675453-675952	256000	MPG	149cfa00.mpg
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	676497-676831			
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Table: fragment files

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	7144-7151,7513-18582			
	18588-18619,18624-18673			
	18678-18705,18710-18741			
	18747-18791,18796-18827			
	18833-18873,18878-18909			
	18914-18936,18942-18959			
	19091-20013			
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	57500-59472,61317-62499			
	64324-64326,64495-64534			

	64598-64602			
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	70519-72036,72628-74834			
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7a32348e895928ee4003bcab2ee937f5	78724	512	PDF	02670800.pdf
cc8eb2f844655b6f433ba10c3ca2d3de	78751-78752	1024	PDF	02673e78.pdf
9b8abe0f393332b7df41e7d986c6ee8e	83486-83621	69632	DOC	028c3c00.doc
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	184130-184140			
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	202422-202444			
	202449-208030			
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	241674-241707			
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	272728-272914			

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921662f192a3eef6e8a04ddf5e51dc23	617098-617148	26112	TXT	12d51400.txt
7d6d6edbe23c0abf4c1c3a4af8b89642	617152-617288	70144	TXT	12d58000.txt
2b352fd7332d4572a3d85b46cb4defe6	617291-617292	1024	TXT	12d69600.txt
fbd9461484c043bae9b4dfe241535fdc	617295-617413	60928	TXT	12d69e00.txt
a01b87232ccf77f0b68f2a2ca3adba4f	617418-617482	33280	TXT	12d79400.txt
9879d88eaa475a6d35715b712f69c3a6	617484-617547	32768	TXT	12d81800.txt
e31c34f412bb179a2b0b5ab484f91f2a	617548-617668	61952	TXT	12d89800.txt
18753397b3dc82be66ae3205361cc7ae	617671-617702	16384	TXT	12d98e00.txt
eece7350084dbee67409317f01c12fd4	617703-617726	12288	TXT	12d9ce00.txt
82b8e2fdbb95ec8585efd12bac5a7f36	617729-617810	41984	TXT	12da0200.txt
1de9e26fda7e46094441168b6e4b3fb5	617812-617841	15360	TXT	12daa800.txt
ffe735d079b550c249c5abbf2daf3e6a	617842-617895	27648	TXT	12dae400.txt
b0502e64467f9ebb962e6b1afe31cc1d	617900-617950	26112	TXT	12db5800.txt
307028362570c907821630f6633274ce	617952-617976	12800	TXT	12dbc000.txt
55385534a0989cb799034ac1e1ffe1d9	617983-617994	6144	TXT	12dbfe00.txt
264ce0d5e6fa0ace62e5e12c7bb5c6f9	617996-618007	6144	TXT	12dc1800.txt
45be0cb5f8c32007fd4d76b515663728	618009-618011	5120	TXT	12dc3200.txt
	618014-618020			
9341dd962f41f67ff677acbe03cd4249	618012-618013	1024	HTM	12dc3800.htm
dc1f2cbb7953863e42e364f6ae28eb94	618022-618128	54784	TXT	12dc4c00.txt
669988d0367235874ad604cfea83f2d9	618130-618380	128512	TXT	12dd2400.txt
02afa6065312f93f0b9f8ba2183918f3	618383-618443	31232	TXT	12df1e00.txt
9bb2ff85b2cce2e8e5c8dc671852f1bc	618444-618476	16896	TXT	12df9800.txt
e95a095945916200d070519b21a4ccac	618487-618490	2048	TXT	12dfee00.txt
5c126da4a0ade71c143201861cd11db8	618496-618608	57856	TXT	12e00000.txt

fe5e448df6fdebe99eccae70debb481a	618610-618629	10240	TXT	12e0e400.txt
e57ce4987fb78029ec1aee4ee0e1d10e	618631-618647	8704	TXT	12e10e00.txt
02f1a15cb3a28ffe46a763fafd8d87b6	618652-618656	2560	TXT	12e13800.txt
add49ee990429f796bdc45e114ec98e1	621153	512	HTM	12f4c200.htm
9300f2308d442d0db1bf85ef248f2903	624454-624460	3584	HTM	130e8c00.htm
80e2d2978796ab8fb0806802ca6e3cf8	624912	512	HTM	13122000.htm
0cd860d897f704116cb05ad39b2c3aa2	627126	512	HTM	13236c00.htm
c5a7ea2ca19910450d5b0d541512cb39	640613-640614	1024	TXT	138cca00.txt
9fc95d3340c28fa70272a4912a4a34e8	640620-641379	389120	EXE	138cd800.exe
a7e7f446e4cee2da0a295e8eb430f58a	641380-641849	358912	EXE	1392c800.exe
	642802-642993			
	643786-643790			
	644435-644447			
	644740-644743,645670			
	645791-645803,645860			
	646245-646246			
4b978b546fb3f0ec54c71aef62107771	641850-642801	487424	EXE	13967400.exe
5923f264ed41de5038c6a95f049b288d	644448-644568	63488	MPG	13aac000.mpg
	644738-644739,645669			
472a9b57f1c7148dd6d1757d1639c336	645804-645859	28672	MPG	13b55800.mpg
55ff6ba2a64b2303e8a99b3da2a8298d	646638-647077	519168	ELF	13bbdc00.elf
	647658-647697			
	648166-648252			
	648909-649203			
	650995-651146			
97bcd113ab12f739750d20f11b1c20b6	651147-654978	1961984	QT	13df1600.qt

Table: embedded validated files

MD5	Sectors	File Size	File Type	File Name
fcbbdd33492f7ddc8d688b7a62efe80e	57149-57154	3072	JPG	01be7a00.jpg
c2161255ee2fc1ee1f14cf1ef881c2b7	70098-70116	9728	JPG	0223a57a.jpg
8701567acfd850c0236e6b0ce31b0816	89039-89048	5120	JPG	02b79e00.jpg
43d9e17c27279f298811453996e3d579	90379-90396	9216	JPG	02c2177e.jpg
2825856d877826060c6210663b124502	93790-93800	5632	JPG	02dcbc00.jpg
d2ee5e3a5cbaed6d1afa7b1293cad43f	120072-120084	6656	JPG	03aa1121.jpg
523041ae955251ed95940603fe4766f9	120084-120139	28672	JPG	03aa29c1.jpg
9807cd1e4a5197e0d22bdc596baefaf6	201683-201797	58880	JPG	0627a61d.jpg
eae474bf687478b127a35f31d5c659de	284354-284361	4096	JPG	08ad84a3.jpg
bd0904bea39c7c30646d5d25109a2bd2	287352-287471	61440	JPG	08c4f0ac.jpg
e98f3c05adef49c86e826c544c763cb9	287482-287498	8704	JPG	08c5f534.jpg
9845e50283e23f784b35bad6b4552472	287498-287527	15360	JPG	08c615ff.jpg
36a8e000e68faff3b1a26361433f8be7	287528-287537	5120	JPG	08c6506a.jpg
04ed503c0731b4b894610f35d88a6d7b	287548-287553	3072	JPG	08c67943.jpg
4c34266e185b7b486e9de0751c33ecb5	287569-287581	6656	JPG	08c6a325.jpg
80003c23366e8d742b37a20843e24d38	287581-287583	1536	JPG	08c6bad2.jpg
b91e6932ceb2b0abc6dafc7fb4fbd768	287585-287587	1536	JPG	08c6c357.jpg
acd7e8ad8a8bfc0f82467e0622598b0a	287594-287601	4096	JPG	08c6d578.jpg
b6980fdb1aa134de0b2f832e1aea6e74	287602-287622	10752	JPG	08c6e439.jpg
f09c43b8efcf244a32fd0e7d02926216	287627-287654	14336	JPG	08c716f9.jpg
144c5fe55ba1315d46b2343871966fe3	287654-287676	11776	JPG	08c74dac.jpg
7a23b795eb08651e901a0a4eb1ff6e95	287685-287691	3584	JPG	08c78a58.jpg
7c0a110871fda2408bb4a3f350bcff59	287712-287772	31232	JPG	08c7c173.jpg
84989b6b7c6aca4cf90c3dbd62e1a899	287778-287827	25600	JPG	08c84526.jpg
6c49c273914516d0ea1e99eb7dd7cae1	287827-287840	7168	JPG	08c8a7ed.jpg
fea0b47aefdddcf3f4feaa78982bd5fc	287840-287855	8192	JPG	08c8c0cf.jpg
ae34dc6e6207c00c55f664ccb54f6ce9	287855-287872	9216	JPG	08c8def1.jpg
489ae0998a23605ebdac9ed16f3621d2	287878-287956	40448	JPG	08c90c03.jpg
e0b259298706f1790aa237ed32233714	287957-287966	5120	JPG	08c9aa02.jpg
11cded96e219f07949291dab1596d4fa	287967-287980	7168	JPG	08c9be2b.jpg
7b1a83fc40d0b53d1b4f9535c11a82cc	287980-287993	7168	JPG	08c9d8bc.jpg
d9f53900eae3db7a1f266b3d6853bbe9	287998-288035	19456	JPG	08c9fcd0.jpg
3ec1544a1d9e4b51c7242a9b24d0dedb	288035-288049	7680	JPG	08ca4760.jpg
1aeb507724b8046b8609c3c0a097950e	288049-288079	15872	JPG	08ca6332.jpg

a8eaca96a1d26e248fdcf2349a046b30	288080-288111	16384	JPG	08caa0a3.jpg
ea03647a1953a18d0a4eed06ee60c40c	288118-288155	19456	JPG	08caec6f.jpg
09833b368c632c3bfde29c4e318f3443	288155-288164	5120	JPG	08cb3768.jpg
9a65ad7dfedfc7906ba2796ae64adbce	288165-288196	16384	JPG	08cb4a5e.jpg
7bd66869a4d5e379188d57f07eda8637	288202-288290	45568	JPG	08cb94b0.jpg
e019ffea3db51b755ceeb95cbd499a5e	288297-288324	14336	JPG	08cc529b.jpg
cbf49d0b5be9a946d5ce2c606c7ce87d	288325-288349	12800	JPG	08cc8a43.jpg
3a402b9760ac1e722541978d0dc7ecf5	288349-288368	10240	JPG	08ccbbdc.jpg
0df7a37b97d32828bb4ca340d6f156f2	288369-288381	6656	JPG	08cce213.jpg
8d57e5488a61fb4e9166965cbe194411	288387-288446	30720	JPG	08cd069d.jpg
1180c320eda6992e59d68f83dbfcf098	288446-288457	6144	JPG	08cd7dfc.jpg
56eb94d34164324404c50eaf02dc4864	288457-288479	11776	JPG	08cd93b5.jpg
78f5a2aef6836c6c1369f8535626d901	288485-288513	14848	JPG	08cdca4c.jpg
e8b2d74d096136b835b1af0f4274e5f8	288514-288540	13824	JPG	08ce048f.jpg
16ae40889b7c1f125a8ac911503d1690	288540-288574	17920	JPG	08ce38e1.jpg
ddb2f18d0f1649a4d1587448ee312ab8	288580-288663	43008	JPG	08ce895e.jpg
d37db50d7b356060a9fa666e6408a761	288663-288680	9216	JPG	08cf2f41.jpg
0fc342397378004638d6c53334236c06	288687-288715	14848	JPG	08cf5fe0.jpg
d0502f98fd0d1cb80ed86a96de7e9c65	288715-288752	19456	JPG	08cf971c.jpg
bc7acf1425be8b5096190ff5c928577a	288758-288801	22528	JPG	08cfec20.jpg
0f8c1324ac041844dd6ff65693454a41	288809-288840	16384	JPG	08d053aa.jpg
6f900dc0e48b4253ed9b3e063376d1dc	288840-288854	7680	JPG	08d091c4.jpg
3a226a8112c4996fd92ddc99622eb28d	288865-288887	11776	JPG	08d0c2d8.jpg
80e4e737a539ac26f19f641cabff37a6	288892-288905	7168	JPG	08d0f828.jpg
e7126b927735612d382cc9cb711b1f99	288906-288966	31232	JPG	08d1148a.jpg
121904824f3fca11265f09ed1e11c9ba	288995-289035	20992	JPG	08d1c6d2.jpg
527fc4951dc66357cd784123bee7121e	289044-289069	13312	JPG	08d22831.jpg
d1b234bc9a8b45625d0d2cc420851080	289079-289098	10240	JPG	08d26f85.jpg
610f80f8e1fff7afa21d265d4a617d9a	289098-289112	7680	JPG	08d294b2.jpg
ca3b07bcab8f51cd8188aa65de6a765a	289119-289145	13824	JPG	08d2bf21.jpg
d2a6596732721471c4ad75be76ec9ee7	289146-289167	11264	JPG	08d2f45d.jpg
495f44791ba8d7acdff2c6156135211b	289200-289228	14848	JPG	08d361e2.jpg
7967386e42f72c70da301f337e874eea	289235-289284	25600	JPG	08d3a7d7.jpg
2d00c5098c4eedb1bd86b415ca1ad379	289284-289296	6656	JPG	08d4093a.jpg
f1b557c3220939072c0d30ace15937fa	289305-289316	6144	JPG	08d43223.jpg
36a2a86958e1e16217bcf2ae39f96eb2	289316-289332	8704	JPG	08d44927.jpg
c55e51c379d8ab64cac5bd291d0e9e7c	289340-289344	2560	JPG	08d47952.jpg
81a9938e1ffffce4431d709d14626a3a	289345-289349	2560	JPG	08d4825e.jpg
539d143ed3d03e99162999256470da46	289349-289353	2560	JPG	08d48b23.jpg
872e71c2c634e5c9e126ac511d354977	289354-289359	3072	JPG	08d49456.jpg
6cc026abd46c7c148964b1f135c75121	289359-289363	2560	JPG	08d49edb.jpg
32f0b37aa9e76cf626dcc1be85078f5e	289372-289377	3072	JPG	08d4b9ac.jpg
66f946b5bb08b90387e1e2b2703d12e1	289377-289382	3072	JPG	08d4c380.jpg
0f7b100f7d48097fbfb3f1b4ab5262e3	289382-289387	3072	JPG	08d4cd41.jpg
8048da2f9efc45221df46917daf20669	289396-289400	2560	JPG	08d4e821.jpg
c1e235fd9c5ad2c91227c55ee8bf7df9	289400-289405	3072	JPG	08d4f17f.jpg
e1d2908f2470e471702b499ee7e55155	289405-289409	2560	JPG	08d4fadf.jpg
eed38eb6bd9b4f08f489ed33199ee292	289409-289414	3072	JPG	08d503f2.jpg
b0ff112cbacc08b72ca6f86048e75a6a	289422-289426	2560	JPG	08d51c9a.jpg
29f85d6003f3ba624ab8fa9532862724	289428-289589	82944	JPG	08d5287b.jpg
19f3d1b52010ea1cdf435065c09db5a3	335097-335110	7168	JPG	0a39f398.jpg
a3ae42b7093f45d3a793c4432afef886	336433-336450	9216	JPG	0a446208.jpg
0ee334d03e7d47b00902aeca0670ac1e	341708-341715	4096	JPG	0a6d9800.jpg
45a941ab1cd6e0d70ad028c326f2d1e8	356069-356120	26624	JPG	0addca6a.jpg
850a1cd07023650b4dd984266fc1afd6	356136-356155	10240	JPG	0ade50e4.jpg
b835c4bfb055c63c17b640e7d1cfff13	356185-356277	47616	JPG	0adeb22a.jpg
b715c447cce97f70d8fe9bfc514a9738	356708-356913	105472	JPG	0ae2c828.jpg
018d8594f9b861fdd2fb28ac985165d4	356956-357102	75264	JPG	0ae4b8d6.jpg
b715c447cce97f70d8fe9bfc514a9738	357102-357307	105472	JPG	0ae5dd80.jpg
b5e2c5a64bdee6fb90f3ffda0e32af50	364337-364345	4608	JPG	0b1e62ef.jpg
1282f98b8f5290bc4fef8fd4306d38d7	444794-444806	6656	JPG	0d92f412.jpg
7dea3c656fe9770331da5e69a3dbf25d	520410-520415	3072	JPG	0fe1b400.jpg
824e2dea72be5fe4547413248de3cf8a	591263-591345	42496	JPG	120b3f4a.jpg
14c9f4f79068a441b2bd82c5547a3c70	591348-591402	28160	JPG	120be94e.jpg
4f05870fb99ea15701522fa6d8231f73	591723-591860	70656	JPG	120ed6d6.jpg
b13d401ed5374928ef0b5b5099043590	591867-592026	81920	JPG	120ff691.jpg
5452fafcc03063e96576c1b0b182cc92	592032-592157	64512	JPG	12114182.jpg
70fe433029d2488f2e89dae4969645ee	592159-592327	86528	JPG	12123f9c.jpg
6ea83857eab9adf1ddf823658b625587	592330-592413	43008	JPG	121395bc.jpg
12383efca1991e1230b22c65a8af3086	592413-592517	53760	JPG	12143b8a.jpg
2880fe41681367bdb8216ad97ed89816	592521-592651	67072	JPG	1215126d.jpg

7da433cd5adf808ccfe1380f88010965	592679-592756	39936	JPG	12164ec8.jpg
f6832fe2f2cb8498ffb719c0a61d7964	592756-592814	30208	JPG	1216e9ca.jpg
3ba6c20ae65dae89b7ea4eb998b4c0d9	592817-592863	24064	JPG	1217633a.jpg
6776f73d0277d5905619541b023c4cd3	592866-592982	59904	JPG	1217c473.jpg
dad8e31f32e896ca6e25fe8215cd9aef	592982-593029	24576	JPG	1218ad40.jpg
ed35161f87f8c62151de714fb4379cf9	593032-593075	22528	JPG	12191084.jpg
f5b11696a1ddad96321e0971569e0796	594630-594632	1536	JPG	12258cbf.jpg
3e942b38d39699ca3e93dbeb704b50b5	594633-594635	1536	JPG	1225927b.jpg
68422c75a15a5a33e254624236b32161	594699-594701	1536	JPG	1226163b.jpg
62a486385e2f2b7b7cd64eb4ad3b5a86	594791-594794	2048	JPG	1226cf54.jpg
70e5519c448b68e088f9c758d7f08368	595056-595086	15872	JPG	1228e15d.jpg
7a542c3b683b8570c8b7b02516980f0a	648622-648634	6656	JPG	13cb5dba.jpg
9ab05bd6bfaeadf48105e6d2577245b2	649208-649214	3584	JPG	13cff000.jpg

Table: embedded partial files

MD5	Sectors	File Size	File Type	File Name
34a44ed9195c6b962a07356f7579ad5e	102519-102602	43008	JPG	0320eee5.jpg
b8cf25ddfc7da87b52f9925c7ee9620a	236820-236931	619008	JPG	073a2988.jpg
	237028-237074			
	237653-237693			
	238277-238319			
	238857-238969			
	239010-239100			
	239379-239450			
	239487-239523			
	239726-239830			
	240497-240598			
	240700-240788			
	240879-240952			
	241235-241317			
	241346-241368			
	241566-241637			
	241674-241707			
	241932-242002			
a4e399eaf047840c6d55c73c2eba9cf3	289837-289874	92160	JPG	08d85b9a.jpg
	290411-290454			
	290822-290831			
	290837-290854			
	290859-290872			
	290878-290913			
	290918-290937			
a0e36bd2c7c027b7ed7394a3e1ae7dc5	356589-356701	57856	JPG	0ae1db08.jpg
f3b4d999f035d8de0097573022028a72	357358-357533	90112	JPG	0ae7dcc4.jpg
55b2af160e0b24e86b19b54c1976988a	362805-362902	67072	JPG	0b126ae1.jpg
	362904-362936			
d66553be1c1cc9e3e8c3978cf8aabfa8	433410-433435	13312	PNG	0d3a0437.png
deb84455bfce2b70070949aa6730f5b4	519161-519183	11776	JPG	0fd7f2ef.jpg
566aea1b5e0305b3afe0b6d3100ddaf7	591405-591428	31744	JPG	120c5b83.jpg
	591597-591634			

Table: embedded fragment files

MD5	Sectors	File Size	File Type	File Name
26dc093c3e9f0a8201932ef2926ebc9d	57145-57154	5120	TIF	01be720c.tif
0cc4bc2237500eb1b69a85283cc6c13b	70034-70116	42496	TIF	0223241e.tif

822629972ad5a283d4bb397eeef585a6	89029-89048	10240	TIF	02b78a0c.tif
c1b7d16b7022750cc366a9ae5036cec1	90377-90396	10240	TIF	02c2120c.tif
df3f78273acf266a81bc5c8f15fe9eb6	93780-93800	10752	TIF	02dca80c.tif
b6309db0f0ec02ec4a051ad1043017c1	335096-335110	7680	TIF	0a39f01e.tif
0f1b8e0edff8c00645a307777d9afdee	336372-336450	40448	TIF	0a43e80c.tif
97941c8f9fcba3748b6588ab0cc033e4	341698-341715	9216	TIF	0a6d840c.tif
cd034f69f09ad78ae73e4ab1afbf5a26	350010-351034	524800	TIF	0aae740c.tif
18597fb1dd2ea1f63dbbebf1fabe1fc8	444785-444806	11264	TIF	0d92e21e.tif
70817be6cd6e5d8616a8f343ff5fe2e2	520400-520415	8192	TIF	0fe1a00c.tif
bcaabdd6bd32db979f00d0efc8df9eb2	648613-648634	11264	TIF	13cb4a1e.tif
14256916202dd32ff83e51f19e9e97c2	649204-649214	5632	TIF	13cfe80c.tif

In total we have carved the following number of files from the image:

- 38 completed and validated files
- 147 partial (but viewable) files
- 203 fragments
- 18 completed and validated embedded files
- partial (but viewable) embedded files
- 13 embedded fragments

5.2. Additional notes

The file types defined by unknown are files fragments part of a container format in which no characteristic of a specific file format was found. I.e. the start of an OLE2 container was found but not the part that signifies it as a Microsoft Word file.

6. Notes on the DFRWS 2007 challenge

We enjoyed working on the DFRWS 2007 challenge and would like to thank the initiators for this master piece of fragmentation. However we have some side notes about it:

- We know that creating an image like the DFRWS 2007 takes a lot of time. But we would like to address that to truly test the effectiveness of the carving method or tooling would require a testing them on a second image that contains similar scenarios.
- Validating files by checking if the are viewable is an inherently human task, any automated validator will ultimately have to make tradeoffs.
- Using the MD5 to determine the carving results match with the original files is flawed. The carver could carve valid files, but add or remove additional white space. I.e. in file formats like MP3 and HTML.
- The DFRWS 2007 image just like the DFRWS 2006 image was created using random data. In theory this allows for a carving approach in which fragmentation can be detected by recognizing random blocks. We did not succeed in creating a reliable random block detector. However the random block tests allowed us to find non random data, like i386 assembly code. In a realistic dataset, random data will be much more scarce. And in realistic images, random

blocks could signify encrypted or wiped data.
- It's debatable if the fragmentation density and scenarios are realistic [2].

References

[1] Carving Taxonomy
URL: http://www.forensicswiki.org/wiki/Carving

[2] Carving contiguous and fragmented files with fast object validation
by Simson Garfinkel
URL: http://www.simson.net/clips/academic/2007.DFRWS.pdf

[3] Revit project page
URL: https://www.uitwisselplatform.nl/projects/revit/