

Fixity and checksums

Rachael MacGregor
Digital Preservation Officer
Modern Records Centre,
University of Warwick

www.anoldhanddigital.wordpress.com

@An_Old_Hand

Archives West Midlands
Library of Birmingham
Tuesday 21st January 2020



WARWICK

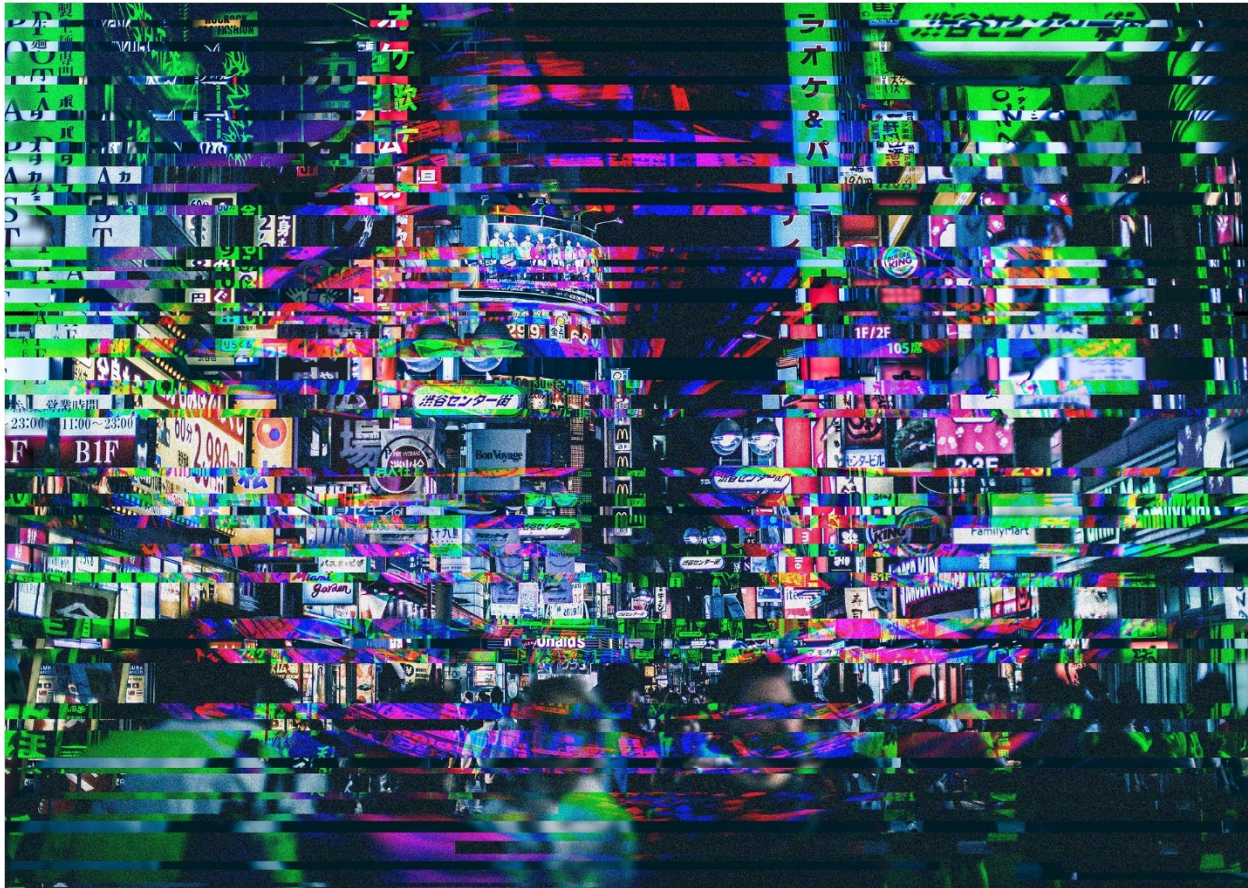
- Fixity and checksums:
- We will understand what fixity is
- We will understand what a checksum is
- We will know how checksums are used
- We will learn about some tools we can use to create these

- What is fixity?

“The condition of stability or permanence” (OED); the assurance that an item, thing or file is unchanged.

- A count of how many files or documents there are
- A condition report on a document

Corruption of digital data: bit flip



File.jpg	00	01	02	03	04	05	06	07	08	09	0a	0b	0c	0d	0e	0f	
00000000	ff	d8	ff	e0	00	10	4a	46	49	46	00	01	01	01	00	48	ÿøÿà..JFIF.....H
00000010	00	48	00	00	ff	db	00	43	00	03	02	02	03	02	02	03	.H..ÿÛ.C.....
00000020	03	03	03	04	03	03	04	05	08	05	05	04	04	05	0a	07	.....
00000030	07	06	08	0c	0a	0c	0c	0b	0a	0b	0b	0d	0e	12	10	0d	.....
00000040	0e	11	0e	0b	0b	10	16	10	11	13	14	15	15	15	0c	0f	.....
00000050	17	18	16	14	18	12	14	15	14	ff	db	00	43	01	03	04	.....ÿÛ.C...
00000060	04	05	04	05	09	05	05	09	14	0d	0b	0d	14	14	14	14	.....
00000070	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	.....
00000080	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	.....
00000090	14	14	14	14	14	14	14	14	14	14	14	14	14	14	ff	c0	.....ÿÀ
000000a0	00	11	08	05	83	05	83	03	01	22	00	02	11	01	03	11	....f.f..".
000000b0	01	ff	c4	00	1f	00	00	01	05	01	01	01	01	01	01	00	.ÿÀ.....
000000c0	00	00	00	00	00	00	00	01	02	03	04	05	06	07	08	09	.....
000000d0	0a	0b	ff	c4	00	b5	10	00	02	01	03	03	02	04	03	05	..ÿÀ.p.....
000000e0	05	04	04	00	00	01	7d	01	02	03	00	04	11	05	12	21}.....!
000000f0	31	41	06	13	51	61	07	22	71	14	32	81	91	a1	08	23	1A..Qa."q.2 `i. #
00000100	42	b1	c1	15	52	d1	f0	24	33	62	72	82	09	0a	16	17	B±Á.RNð\$3br,....
00000110	18	19	1a	25	26	27	28	29	2a	34	35	36	37	38	39	3a	...%&'()*456789:
00000120	43	44	45	46	47	48	49	4a	53	54	55	56	57	58	59	5a	CDEFGHIJSTUVWXYZ
00000130	63	64	65	66	67	68	69	6a	73	74	75	76	77	78	79	7a	cdefghijstuvwxyz
00000140	83	84	85	86	87	88	89	8a	92	93	94	95	96	97	98	99	f.....+~%\$'""-~
00000150	9a	a2	a3	a4	a5	a6	a7	a8	a9	aa	b2	b3	b4	b5	b6	b7	šc&fM¥!\$'°@~'µ¶·
00000160	b8	b9	ba	c2	c3	c4	c5	c6	c7	c8	c9	ca	d2	d3	d4	d5	,°ÀÀÀÀÆÇÈÉÊËÏÓÔÕ
00000170	d6	d7	d8	d9	da	e1	e2	e3	e4	e5	e6	e7	e8	e9	ea	f1	Ö×ØÙÚáâãäåæçèéêñ
00000180	f2	f3	f4	f5	f6	f7	f8	f9	fa	ff	c4	00	1f	01	00	03	óóóóó+øùúÿÿÀ.....
00000190	01	01	01	01	01	01	01	01	01	00	00	00	00	00	00	01	.....
000001a0	02	03	04	05	06	07	08	09	0a	0b	ff	c4	00	b5	11	00	.....ÿÀ.p..
000001b0	02	01	02	04	04	03	04	07	05	04	04	00	01	02	77	00	.....w.
000001c0	01	02	03	11	04	05	21	31	06	12	41	51	07	61	71	13	.....!1..AQ.aq.
000001d0	22	32	81	08	14	42	91	a1	b1	c1	09	23	33	52	f0	15	"2 ..B`j±Á.#3Rð.
000001e0	62	72	d1	0a	16	24	34	e1	25	f1	17	18	19	1a	26	27	brÑ..\$4â&ñ....&'
000001f0	28	29	2a	35	36	37	38	39	3a	43	44	45	46	47	48	49	()*56789:CDEFGHI
00000200	4a	53	54	55	56	57	58	59	5a	63	64	65	66	67	68	69	JSTUVWXYZcdefghi
00000210	6a	73	74	75	76	77	78	79	7a	82	83	84	85	86	87	88	jstuvwxyz,f.....+~
00000220	89	8a	92	93	94	95	96	97	98	99	9a	a2	a3	a4	a5	a6	%\$'""-~šc&fM¥!
00000230	a7	a8	a9	aa	b2	b3	b4	b5	b6	b7	b8	b9	ba	c2	c3	c4	\$'°@~'µ¶·,°ÀÀÀ
00000240	c5	c6	c7	c8	c9	ca	d2	d3	d4	d5	d6	d7	d8	d9	da	e2	ÀÆÇÈÉÊËÏÓÔÕÖ×ØÙÚá
00000250	e3	e4	e5	e6	e7	e8	e9	ea	f2	f3	f4	f5	f6	f7	f8	f9	âãäåæçèéêóóóóó+øù
00000260	fa	ff	da	00	0c	03	01	00	02	11	03	11	00	3f	00	f2	úÿÛ.....?..ð
00000270	86	21	63	1b	48	0c	a4	0c	63	19	c7	53	4e	dc	14	89	+!c.H.¤.c.ÇSNÜ.%
00000280	07	ca	ed	c6	3d	01	e0	d2	4a	c2	4d	ce	f8	2d	c6	08	.ÊiE-.àòJÂÎïø-E.
00000290	f4	a1	70	c7	24	64	01	c0	ea	32	3a	66	bf	75	d8	fc	ð;pÇ\$ð.Àê2:f;uøü
000002a0	f9	68	22	c6	23	5f	26	33	b0	0e	73	9c	64	8f	5a	6e	ùh"E#_&3°.sød Zn
000002b0	0b	64	11	f7	48	c1	ce	72	7d	45	38	a9	78	c8	3f	78	.d.+HÂÎr)E8øxÈ?x

fileflip1.jpg	00	01	02	03	04	05	06	07	08	09	0a	0b	0c	0d	0e	0f	
00000000	ff	d8	ff	e0	00	10	4a	46	49	46	00	01	01	01	00	48	ÿøÿà..JFIF.....H
00000010	00	48	00	00	ff	db	00	43	00	03	02	02	03	02	02	03	.H..ÿÛ.C.....
00000020	03	03	03	04	03	03	04	05	08	05	05	04	04	05	0a	07	.....
00000030	07	06	08	0c	0a	0c	0c	0b	0a	0b	0b	0d	0e	12	10	0d	.....
00000040	0e	11	0e	0b	0b	10	16	10	11	13	14	15	15	15	0c	0f	.....
00000050	17	18	16	14	18	12	14	15	14	ff	db	00	43	01	03	04	.....ÿÛ.C...
00000060	04	05	04	05	09	05	05	09	14	0d	0b	0d	14	14	14	14	.....
00000070	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	.....
00000080	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	.....
00000090	14	14	14	14	14	14	14	14	14	14	14	14	14	14	ff	c0	.....ÿÀ
000000a0	00	11	08	05	83	05	83	03	01	22	00	02	11	01	03	11	....f.f..".
000000b0	01	ff	c4	00	1f	00	00	01	05	01	01	01	01	01	01	00	.ÿÀ.....
000000c0	00	00	00	00	00	00	00	01	02	03	04	05	06	07	08	09	.....
000000d0	0a	0b	ff	c4	00	b5	10	00	02	01	03	03	02	04	03	05	..ÿÀ.p.....
000000e0	05	04	04	00	00	01	7d	01	02	03	00	04	11	05	12	21}.....!
000000f0	31	41	06	13	51	61	07	22	71	14	32	81	91	a1	08	23	1A..Qa."q.2 `i. #
00000100	42	b1	c1	15	52	d1	f0	24	33	62	72	82	09	0a	16	17	B±Á.RNð\$3br,....
00000110	18	19	1a	25	26	27	28	29	2a	34	35	36	37	38	39	3a	...%&'()*456789:
00000120	43	44	45	46	47	48	49	4a	54	54	55	56	57	58	59	5a	CDEFGHIJTUVWXYZ
00000130	63	64	65	66	67	68	69	6a	73	74	75	76	77	78	79	7a	cdefghijstuvwxyz
00000140	83	84	85	86	87	88	89	8a	92	93	94	95	96	97	98	99	f.....+~%\$'""-~
00000150	9a	a2	a3	a4	a5	a6	a7	a8	a9	aa	b2	b3	b4	b5	b6	b7	šc&fM¥!\$'°@~'µ¶·
00000160	b8	b9	ba	c2	c3	c4	c5	c6	c7	c8	c9	ca	d2	d3	d4	d5	,°ÀÀÀÀÆÇÈÉÊËÏÓÔÕ
00000170	d6	d7	d8	d9	da	e1	e2	e3	e4	e5	e6	e7	e8	e9	ea	f1	Ö×ØÙÚáâãäåæçèéêñ
00000180	f2	f3	f4	f5	f6	f7	f8	f9	fa	ff	c4	00	1f	01	00	03	óóóóó+øùúÿÿÀ.....
00000190	01	01	01	01	01	01	01	01	01	00	00	00	00	00	00	01	.....
000001a0	02	03	04	05	06	07	08	09	0a	0b	ff	c4	00	b5	11	00	.....ÿÀ.p..
000001b0	02	01	02	04	04	03	04	07	05	04	04	00	01	02	77	00	.....w.
000001c0	01	02	03	11	04	05	21	31	06	12	41	51	07	61	71	13	.....!1..AQ.aq.
000001d0	22	32	81	08	14	42	91	a1	b1	c1	09	23	33	52	f0	15	"2 ..B`j±Á.#3Rð.
000001e0	62	72	d1	0a	16	24	34	e1	25	f1	17	18	19	1a	26	27	brÑ..\$4â&ñ....&'
000001f0	28	29	2a	35	36	37	38	39	3a	43	44	45	46	47	48	49	()*56789:CDEFGHI
00000200	4a	53	54	55	56	57	58	59	5a	63	64	65	66	67	68	69	JSTUVWXYZcdefghi
00000210	6a	73	74	75	76	77	78	79	7a	82	83	84	85	86	87	88	jstuvwxyz,f.....+~
00000220	89	8a	92	93	94	95	96	97	98	99	9a	a2	a3	a4	a5	a6	%\$'""-~šc&fM¥!
00000230	a7	a8	a9	aa	b2	b3	b4	b5	b6	b7	b8	b9	ba	c2	c3	c4	\$'°@~'µ¶·,°ÀÀÀ
00000240	c5	c6	c7	c8	c9	ca	d2	d3	d4	d5	d6	d7	d8	d9	da	e2	ÀÆÇÈÉÊËÏÓÔÕÖ×ØÙÚá
00000250	e3	e4	e5	e6	e7	e8	e9	ea	f2	f3	f4	f5	f6	f7	f8	f9	âãäåæçèéêóóóóó+øù
00000260	fa	ff	da	00	0c	03	01	00	02	11	03	11	00	3f	00	f2	úÿÛ.....?..ð
00000270	86	21	63	1b	48	0c	a4	0c	63	19	c7	53	4e	dc	14	89	+!c.H.¤.c.ÇSNÜ.%
00000280	07	ca	ed	c6	3d	01	e0	d2	4a	c2	4d	ce	f8	2d	c6	08	.ÊiE-.àòJÂÎïø-E.
00000290	f4	a1	70	c7	24	64	01	c0	ea	32	3a	66	bf	75	d8	fc	ð;pÇ\$ð.Àê2:f;uøü

fileflip1.jpg																
00000000	00	01	02	03	04	05	06	07	08	09	0a	0b	0c	0d	0e	0f
00000000	ff	d8	ff	e0	00	10	4a	46	49	46	00	01	01	01	00	48
00000010	00	48	00	00	ff	db	00	43	00	03	02	02	03	02	02	03
00000020	03	03	03	04	03	03	04	05	08	05	05	04	04	05	0a	07
00000030	07	06	08	0c	0a	0c	0c	0b	0a	0b	0b	0d	0e	12	10	0d
00000040	0e	11	0e	0b	0b	10	16	10	11	13	14	15	15	15	0c	0f
00000050	17	18	16	14	18	12	14	15	14	ff	db	00	43	01	03	04
00000060	04	05	04	05	09	05	05	09	14	0d	0b	0d	14	14	14	14
00000070	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
00000080	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
00000090	14	14	14	14	14	14	14	14	14	14	14	14	14	14	ff	c0
000000a0	00	11	08	05	83	05	83	03	01	22	00	02	11	01	03	11
000000b0	01	ff	c4	00	1f	00	00	01	05	01	01	01	01	01	01	00
000000c0	00	00	00	00	00	00	00	01	02	03	04	05	06	07	08	09
000000d0	0a	0b	ff	c4	00	b5	10	00	02	01	03	03	02	04	03	05
000000e0	05	04	04	00	00	01	7d	01	02	03	00	04	11	05	12	21
000000f0	31	41	06	13	51	61	07	22	71	14	32	81	91	a1	08	23
00000100	42	b1	c1	15	52	d1	f0	24	33	62	72	82	09	0a	16	17
00000110	18	19	1a	25	26	27	28	29	2a	34	35	36	37	38	39	3a
00000120	43	44	45	46	47	48	49	4a	54	55	56	57	58	59	5a	5b
00000130	63	64	65	66	67	68	69	6a	72	73	75	76	77	78	79	7a
00000140	83	84	85	86	87	88	89	8a	92	93	94	95	96	97	98	99
00000150	9a	a2	a3	a4	a5	a6	a7	a8	a9	aa	b2	b3	b4	b5	b6	b7
00000160	b8	b9	ba	c2	c3	c4	c5	c6	c7	c8	c9	ca	d2	d3	d4	d5
00000170	d6	d7	d8	d9	da	e1	e2	e3	e4	e5	e6	e7	e8	e9	ea	f1
00000180	f2	f3	f4	f5	f6	f7	f8	f9	fa	ff	c4	00	1f	01	00	03
00000190	01	01	01	01	01	01	01	01	01	00	00	00	00	00	00	01
000001a0	02	03	04	05	06	07	08	09	0a	0b	ff	c4	00	b5	11	00
000001b0	02	01	02	04	04	03	04	07	05	04	04	00	01	02	77	00
000001c0	01	02	03	11	04	05	21	31	06	12	41	51	07	61	71	13
000001d0	22	32	81	08	14	42	91	a1	b1	c1	09	23	33	52	f0	15
000001e0	62	72	d1	0a	16	24	34	e1	25	f1	17	18	19	1a	26	27
000001f0	28	29	2a	35	36	37	38	39	3a	43	44	45	46	47	48	49
00000200	4a	53	54	55	56	57	58	59	5a	63	64	65	66	67	68	69
00000210	6a	73	74	75	76	77	78	79	7a	82	83	84	85	86	87	88
00000220	89	8a	92	93	94	95	96	97	98	99	9a	a2	a3	a4	a5	a6
00000230	a7	a8	a9	aa	b2	b3	b4	b5	b6	b7	b8	b9	ba	c2	c3	c4
00000240	c5	c6	c7	c8	c9	ca	d2	d3	d4	d5	d6	d7	d8	d9	da	e2
00000250	e3	e4	e5	e6	e7	e8	e9	ea	f2	f3	f4	f5	f6	f7	f8	f9
00000260	fa	ff	da	00	0c	03	01	00	02	11	03	11	00	3f	00	f2
00000270	86	21	63	1b	48	0c	a4	0c	63	19	c7	53	4e	dc	14	89
00000280	07	ca	ed	c6	3d	01	e0	d2	4a	c2	4d	ce	f8	2d	c6	08
00000290	f4	a1	70	c7	24	64	01	c0	ea	32	3a	66	bf	75	d8	fc
000002a0	f9	68	22	c6	23	5f	26	33	b0	0e	73	9c	64	8f	5a	6e
000002b0	0b	64	11	f7	48	c1	ce	72	7d	45	38	a9	78	c8	3f	78
000002c0	93	9f	c7	1f	a5	2f	dd	c6	30	b1	81	c0	fe	74	74	15





Checksums

- A unique number created computationally
- A file if unchanged will always return the same checksum
- Renaming the file will not alter the checksum
- Changing even one bit will!

Using DROID to create and compare checksums





What can fixity checking do for me?

- Support the repair of altered digital files
- Monitor hardware degradation
- Help diagnose possible systemic or human error in lifecycle management
- Assure confidence when providing someone with a copy
- Document provenance and history
- Meet requirements or best practice guidelines such as the NDSA Levels
- Support the monitoring of digitization processes
- Help with deduplication work

When do I do use the fixity information?

- On ingest
- On transfer
- At regular intervals
- In storage systems
- On segments/portions of files

Some considerations about fixity checking

- Running checks takes time/resource
- Running fixity on certain types of media may lead to its life being shortened
- Will it lead to a choke point and mean you process less stuff?
- Do you need to perform fixity checks on your redundant copies?

Where do we keep our fixity information

- In the object metadata record
- Alongside the content (eg in a Bag)
- In a separate database or log
- In the collections management system

Fixity and checksums



- We will understand what fixity is
- We will understand what a checksum is
- We will know how checksums are used
- We will know learn about some tools we can use to create these

Fixity and checksums

Rachael MacGregor

Digital Preservation Officer
Modern Records Centre,
University of Warwick

www.anoldhanddigital.wordpress.com

@An_Old_Hand

Archives West Midlands
Library of Birmingham
Tuesday 21st January 2020



WARWICK