Goals	Accounting	[De]coding	Takeaways	References
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Accounting Approach to Climate Change Statistics and Indicators

Data Visualization [Good] Practices



Goals	Accounting	[De]coding	Takeaways	References
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How many "3" in that sequence?

Goals	Accounting	[De]coding	Takeaways	References
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How many "3" in that sequence?

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How many "3" in that sequence?

Goals	Accounting	[De]coding	Takeaways	References
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How many "3" in that sequence?

from Ware (2012)

Goals	Accounting	[De]coding	Takeaways	References
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What can you say from this graphic?



Goals	Accounting	[De]coding	Takeaways	References
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[- WHY VISUALIZING DATA? -]
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What can you say from this graphic?





What can you say from this graphic?



Goals	Accounting	[De]coding	Takeaways	References
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What does this curve tells you ?

Goals	Accounting	[De]coding	Takeaways	References
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Source: Global Carbon Budget 2018

Goals	Accounting	[De]coding	Takeaways	References
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We compare: Surfaces...



Goals	Accounting	[De]coding	Takeaways	References
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Lines...

Number of out-of-school children of primary school age, selected regions, 1990-2015 (million)



Source: UNDP

Goals	Accounting	[De]coding	Takeaways	References
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Source: Meera Umasankar

Goals	Accounting	[De]coding	Takeaways	References
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source: Datawrapper

Goals	Accounting	[De]coding	Takeaways	References
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Color intensity!



source: Datawrapper

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Goals of Data Visualisation

Goals	Accounting	[De]coding	Takeaways	References
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Data visualisation serves *at least* two main purposes:

Goals	Accounting	[De]coding	Takeaways	References
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Data visualisation serves *at least* two main purposes:Data exploration

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Data visualisation serves at least two main purposes:

► Data exploration

Graphics as visual tests, comparisons

Goals	Accounting	[De]coding	Takeaways	References
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Data visualisation serves at least two main purposes:

Data exploration

Graphics as visual tests, comparisons

 \rightarrow **short** time to built, **short** time to read

Goals	Accounting	[De]coding	Takeaways	References
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Data visualisation serves at least two main purposes:

Data exploration

Graphics as visual tests, comparisons

 \rightarrow **short** time to built, **short** time to read

Data representation

Goals	Accounting	[De]coding	Takeaways	References
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Data visualisation serves at least two main purposes:

Data exploration

Graphics as visual tests, comparisons

 \rightarrow **short** time to built, **short** time to read

Data representation

Summaries, comparisons, storytelling

Goals	Accounting	[De]coding	Takeaways	References
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Data visualisation serves at least two main purposes:

Data exploration

Graphics as visual tests, comparisons

 \rightarrow **short** time to built, **short** time to read

Data representation

Summaries, comparisons, storytelling

 \rightarrow long time to build, short time to read

Goals	Accounting	[De]coding	Takeaways	References
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Ecosystem Accounts

[- NATIONAL RIVER ECOSYSTEM ACCOUNTS -] What can you say from this table?

Table E: Ecosystem condition account for rivers based on the aggregated ecological condition category, for main rivers, tributaries and all rivers

		Degree of mo	dification fro	om natural		
Kilometres	Natural	Moderately modified	Heavily modified	Unaccept- ably modified	No Data	Total
MAIN RIVERS						
Opening stock 1999	46 541	22 315	2 791	1 026	3 637	76 310
Opening stock as a % total river length	61	29	4	1	5	100
Increase/decreases	-24 100	9 467	13 168	1 465		
Increases/decreases as % opening stock	-52	42	472	143		
Opening stock 2011	22 441	31 782	15 960	2 492	3 637	76 310
Opening stock as a % total river length	29	42	21	3	5	100
TRIBUTARIES						
Opening stock 1999	40 294	7 470	2 084	328	37 047	87 223
Opening stock as a % total river length	46	9	2		42	100
Increase/decreases	-17 062	11 339	4 766	957		
Increases/decreases as % opening stock	-42	152	229	292		
Opening stock 2011	23 232	18 809	6 850	1 285	37 047	87 223
Opening stock as a % total river length	27	22	8	1	42	100
ALL RIVERS						
Opening stock 1999	86 835	29 784	4 875	1 354	40 684	163 533
Opening stock as a % total river length	53	18	3	1	25	100
Increase/decreases	-41 163	20 806	17 935	2 422		
Increases/decreases as % opening stock	-47	70	368	179		
Opening stock 2011	45 673	50 591	22 810	3 776	40 684	163 533
Opening stock as a % total river length	28	31	14	2	25	100

Goals	Accounting	[De]coding	Takeaways	References
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[- NATIONAL RIVER ECOSYSTEM ACCOUNTS -]

What can you say from this graphic?



Figure C: Change in the extent of river length in each aggregated ecological condition category, for main rivers, tributaries and all rivers, 1999 – 2011

Source: National River Ecosystem Accounts for South Africa (2015

Goals	Accounting	[De]coding	Takeaways	References
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Decoding visual Information

Goals	Accounting	[De]coding	Takeaways	References
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Source: Knowable magazine

Goals	Accounting	[De]coding	Takeaways	References
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Which is the third largest segment in the pie chart?

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Goals	Accounting	[De]coding	Takeaways	References
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Which is the third largest segment in the pie chart?



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Goals	Accounting	[De]coding	Takeaways	References
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[Good?] Practices & Takeaways

Goals 00	Accounting 00	[De]coding 0000	Takeaways o●o	References

- KISS: Keep It Simple Stupid!



Ed Hawkins



- Facilitate comparisons



 \hookrightarrow Can you see the evolution of electricity?

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- Not all graphics are born equal



Source: Munzner (2014)

Goals	Accounting	[De]coding	Takeaways	References
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- Tables can be graphics

Goal Target Indicator esCode SeriesDescription 3 3.1 3.1.1 _STA_MIMaternal mortality ratio

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Algeria	161	155	148	145	134	127	108.6	119	117	117	115	116	116	105.8	114	114	113	112
Angola	827	766	690	628	574	519	473	239.2	395	359	326	300	281	269	258	251	146.3	241
Antigua and Barbuda	71.95	72	43	71.5	70.5	69.95	72.95	74	75	72.5	72	43	72	71.5	71	71.5	43	71
Argentina	82.55	82.7	81.95	81.85	80.05	79.05	78.2	77.7	73.9	76.95	73	72.55	72.6	70.5	70.8	70.3	69.2	66.45
Armenia	69.9	70.2	68.9	68.6	67.75	66.4	67.85	65.95	67.95	66	65.75	65	65	63	63.5	28	62.9	26
Australia	53.15	52.65	52.65	52.65	52.15	52.2	52.15	52.1	52.05	52.05	52.05	52.55	52.6	52.65	52.85	52.85	51.5	51.35
Bahamas	87	76	88.5	89	88	77	88.5	88	88	78	88.5	88.5	78	88	88.45	86	85.5	70
Bahrain	62.35	58.25	61.3	59.4	59.35	58.25	60.75	56.7	57.75	59.2	58.65	57.3	58.9	58.4	57.4	57.45	57.35	56.95
Barbados	74	48	73.5	72.5	71.5	71	70.5	70	69.5	38	36	67.5	66.45	65.3	65.4	65	64.55	27
Belarus	60.95	59.45	58.95	57.45	56.45	55.5	54.45	53.45	52.95	52.95	52.45	52.4	52	51.4	51.4	3	3	2
Belize	89	88	82	80	75	70	80.4	75.85	76.95	75.25	74	74.1	50	71.1	46	66	67.9	65
Botswana	180.25	181.5	187.25	187.05	180.65	166.5	160.15	151.8	150.7	144.25	139.05	137.9	134.9	131.95	129.75	127.85	125.35	121.9
Brazil	83.8	83.15	83.75	84.2	84.8	84.8	84.5	84.8	84.4	83.95	81.95	80	79.5	80.05	80.55	81.05	80.55	79.55
Brunel Darussalam	63.6	63.85	64.2	64.7	64.7	64.3	63.8	63.45	63.35	63.4	63.9	63.8	64.4	63.85	64.45	65	65.5	65.4
Bulgaria	59.4	58.45	58.1	57.6	57.7	57.2	56.7	56.3	56.3	55.8	55.75	12	11	54.85	55.35	54.9	10	10
Burkina Faso	516	501	486	254.4	454	437	237.75	410	401	393	225.45	377	369	362	353	211.4	331	320

Goals Acc	ounting [De	e]coding Ta	akeaways	References
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- Tables can be graphics

Goal Target Indicator esCode SeriesDescription 3 3.1 3.1.1 STA_M Maternal mortality ratio

Country		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Algeria		161	155	148	145	134	127	108.6	119	117	117	115	116	116	105.8	114	114	113	112
Angola		827	766	690	628	574	519	473	239.2	395	359	326	300	281	269	258	251	146.3	241
Antigua and Barbuda	88_88×88 8 88_8888_	71.95	72	43	71.5	70.5	69.95	72.95	74	75	72.5	72	43	72	71.5	71	71.5	43	71
Argentina	IIIIIIII	82.55	82.7	81.95	81.85	80.05	79.05	78.2	77.7	73.9	76.95	73	72.55	72.6	70.5	70.8	70.3	69.2	66.45
Armenia		69.9	70.2	68.9	68.6	67.75	66.4	67.85	65.95	67.95	66	65.75	65	65	63	63.5	28	62.9	26
Australia		53.15	52.65	52.65	52.65	52.15	52.2	52.15	52.1	52.05	52.05	52.05	52.55	52.6	52.65	52.85	52.85	51.5	51.35
Bahamas	8.181.000.00.00m	87	76	88.5	89	88	77	88.5	88	88	78	88.5	88.5	78	88	88.45	86	85.5	70
Bahrain	I.I.B.B.B.B.S.B.B.B.B.B.B.B.B.B.B.B.B.B.	62.35	58.25	61.3	59.4	59.35	58.25	60.75	56.7	57.75	59.2	58.65	57.3	58.9	58.4	57.4	57.45	57.35	56.95
Barbados	8.8888888	74	48	73.5	72.5	71.5	71	70.5	70	69.5	38	36	67.5	66.45	65.3	65.4	65	64.55	27
Belarus		60.95	59.45	58.95	57.45	56.45	55.5	54.45	53.45	52.95	52.95	52.45	52.4	52	51.4	51.4	3	3	2
Belize		89	88	82	80	75	70	80.4	75.85	76.95	75.25	74	74.1	50	71.1	46	66	67.9	65
Botswana		180.25	181.5	187.25	187.05	180.65	166.5	160.15	151.8	150.7	144.25	139.05	137.9	134.9	131.95	129.75	127.85	125.35	121.9
Brazil		83.8	83.15	83.75	84.2	84.8	84.8	84.5	84.8	84.4	83.95	81.95	80	79.5	80.05	80.55	81.05	80.55	79.55
Brunei Darussalam		63.6	63.85	64.2	64.7	64.7	64.3	63.8	63.45	63.35	63.4	63.9	63.8	64.4	63.85	64.45	65	65.5	65.4
Bulgaria		59.4	58.45	58.1	57.6	57.7	57.2	56.7	56.3	56.3	55.8	55.75	12	11	54.85	55.35	54.9	10	10
Burkina Faso		516	501	486	254.4	454	437	237.75	410	401	393	225.45	377	369	362	353	211.4	331	320

Goals	Accounting	[De]coding	Takeaways	References
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- Tables can be graphics

| | Goal | Goal Target Indicator esCode | | | SeriesDescription
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 | 2017 |
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 | 119 | 117 | 117 | 115
 | 116 | 116 | 105.8 | 114 | 114 | 113
 | 112 |
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 | 473
 | 239.2 | 395 | 359 | 326
 | 300 | 281 | 269 | 258 | 251 | 146.3
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| + | 82.55 | 82.7 | 81.95 | 81.85 | 80.05
 | 79.05
 | 78.2
 | 77.7 | 73.9 | 76.95 | 73
 | 72.55 | 72.6 | 70.5 | 70.8 | 70.3 | 69.2
 | 66.45 |
| + | 69.9 | 70.2 | 68.9 | 68.6 | 67.75
 | 66.4
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 | 137.9 | 134.9 | 131.95 | 129.75 | 127.85 | 125.35
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 | 12 | 11 | 54.85 | 55.35 | 54.9 | 10
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 | 377 | 369 | 362 | 353 | 211.4 | 331
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- Tables can be graphics

		Goal	Target	Indicator	esCode	SeriesD	escriptio	on											
		3	3.1	3.1.1	STA_M	Materna	al morta	lity ratio											
Country		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Algeria		- 161	155	148	145	134	127	108.6	119	117	117	115	116	116	105.8	114	114	113	112
Angola		827	766	690	628	574	519	473	239.2	395	359	326	300	281	269	258	251	146.3	241
Antigua and Barbuda	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	71.95	72	43	71.5	70.5	69.95	72.95	74	75	72.5	72	43	72	71.5	71	71.5	43	71
Argentina	+	- 82.55	82.7	81.95	81.85	80.05	79.05	78.2	77.7	73.9	76.95	73	72.55	72.6	70.5	70.8	70.3	69.2	66.45
Armenia	+	69.9	70.2	68.9	68.6	67.75	66.4	67.85	65.95	67.95	66	65.75	65	65	63	63.5	28	62.9	26
Australia		- 53.15	52.65	52.65	52.65	52.15	52.2	52.15	52.1	52.05	52.05	52.05	52.55	52.6	52.65	52.85	52.85	51.5	51.35
Bahamas	~~~~~	87	76	88.5	89	88	77	88.5	88	88	78	88.5	88.5	78	88	88.45	86	85.5	70
Bahrain	~~~~	62.35	58.25	61.3	59.4	59.35	58.25	60.75	56.7	57.75	59.2	58.65	57.3	58.9	58.4	57.4	57.45	57.35	56.95
Barbados	~~~~	74	48	73.5	72.5	71.5	71	70.5	70	69.5	38	36	67.5	66.45	65.3	65.4	65	64.55	27
Belarus		. 60.95	59.45	58.95	57.45	56.45	55.5	54.45	53.45	52.95	52.95	52.45	52.4	52	51.4	51.4	3	3	2
Belize		89	88	82	80	75	70	80.4	75.85	76.95	75.25	74	74.1	50	71.1	46	66	67.9	65
Botswana		. 180.25	181.5	187.25	187.05	180.65	166.5	160.15	151.8	150.7	144.25	139.05	137.9	134.9	131.95	129.75	127.85	125.35	121.9
Brazil		- 83.8	83.15	83.75	84.2	84.8	84.8	84.5	84.8	84.4	83.95	81.95	80	79.5	80.05	80.55	81.05	80.55	79.55
Brunei Darussalam		63.6	63.85	64.2	64.7	64.7	64.3	63.8	63.45	63.35	63.4	63.9	63.8	64.4	63.85	64.45	65	65.5	65.4
Bulgaria	·	- 59.4	58.45	58.1	57.6	57.7	57.2	56.7	56.3	56.3	55.8	55.75	12	11	54.85	55.35	54.9	10	10
Burkina Faso		- 516	501	486	254.4	454	437	237.75	410	401	393	225.45	377	369	362	353	211.4	331	320
Burundi		517.6	956	925	890	844	422.9	785	756	733	698	362.65	635	608	591	576	568	558	316.55

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- Good practices & Guidance



Wong (2013) & Financial Times Visual Vocabulary

- Be careful of "visual Lies"

How [Not] To Lie with Graphics A practitioner guide

An exclusion is one of the ly-down on a balance with one of statistic sources (b). By the statistical statistical

Data visualization as visual test

Following the work of Baja et al. (2009), we consider data visualization as a visual statistical tost aimed a detecting structural information in a given data set. More precisely, the null hypothesis tested by looking ant a graphic lo:

 $H_0: \{\text{There is ``nothing''} \} = \{\text{No relation} \}$

H₁: { There is "something" } = { There is some relation }



When the data visualization is well designed to unambiguously reveal the intrusic properties of the data, this visual test would help the practitioner to choose a pocific hypothesis and statistical test. Bad grapphic design many bias the visual test?

1 Rule #1: Modify Axes

One of the most common problem is the truncation of the vertical axe in bar charts, inducing an exaggerating effect.



Figure 1: Transaction exagonating effect (left), small absolute variation/sight) Interestingly Correll et al. (2019) experimentally showed that this exaggerating effects is also found in line charts (Figure 1b). This powe the question of when it is appropriate to start line chart at the origin, in particular when the origin is seen of the range of the data set (set: Earth temperature in a Fubernheid).



Figure the Trancation serves to exaggence effect sizes in both line and har charts.

Christophe Bontemps Statistical Institute for Asia and the Pacific Christophe.Bontemps@un.org



Figure 4: A complete exchange rate (left) "wide-I" within a declining period tright

Rule #5: Use Several Pie Charts

Pie charts are among the most popular and most used graphics although they are not suited for fair comparisons (Cleveland and McGill (1984))



Figure 5: Comparing pie charts can be a difficult visual test and should be avoided

Rule #6: Use Areas

Our perception of areas is very had but area-based comparisons sti flourishing in publication, in particular in statistical maps where bub maps are one of the most popular encoding (see rule #10).



 $\label{eq:Asym} Asym} = \pi (18/2)^2 - 254 \ {\rm in}^2 \qquad Asym} = 2\pi (12/2)^2 - 229 \ {\rm in}^2$

Rule #7: Use unaligned bars

Stacked bars are a good example of unaligned visual variables that an difficult to compare. In the example below, it is difficult to test whethe the red category is steadily increasing or not.



Figure 7: In simple situations, ordering the categories may solve the problem

Rule #8: Cross The Lines

This is probably the most challenging as plotting several crossing lines is likely to produce a graphic where not clear pattern emerges as illutrated by Schwabish (2014). Alternative design using small multiples graphics, where only one line is highlighted while others are grayed for global reference, holps displaying clear information.





Figure 8: In simple situations, ordering the categories may solve the problem

Rule #9: Use Radar Plots

Comparing individuals in many dimension is challenging, even when the sample in small. Using a data set of 4 individuals Bontemps (2017) illustrated that he area representing the overall performance is highly dependent of the cedering of the axes. This underirable feature is a major undecumented drawback of radar boto.



Figure 9: The order of the axes changes the areas representing global pedormance

Rule #10: Use Maps

Maps are probably the most complex graphical objects and are prone to many issues as documented by Monemonier (2018) and others. Statistical maps use all the visual encoding described here, and thus concurrate all the problems bindering fair visual tests.



Figure 18: 4 ways of representing statistical information on a map, and many ione

Conclusion

Since the publications of Bierrici (1977), a lot has been learned on the design of statistical information and on the use of data visualization as a visual language, with a clear waveledgy. Many publications have highlighted good practices for quite a long time (see the "old" Hinten (1974), but despite this abundant Bizentare, very few articles have dimensional theorem of any story books and popular graphics. We should not let these useful visual some he biased by software default attings, miscoarcived designs or utilizations.

Figure 2: The perception of a time strice increase is afficiently the faming Hist the faming, and space (aff around data points can subtly affect our perception of combutation Circulard et al. (1982).



Rule #2: Modify the Framing Design

Figure 2b: The correlation between Xs and Ys is the same in the two data sets.

Rule #3: Use Double Axes

Plotting two times series with different units on two axis (left and right) is a tempting practice that results in a sparious visual correlation. This has been well illustrated in Math (2018) (see also Vigen (2015)).



Figure & Playing with left and right axes (source: Math (2018))

Rule #4: Select Your Scope

Cherry-picking the data through as (is)appropriate choice of the range in any time series, is alsovery midetading. This is particularly true for time serie and scatter plots but can also change the roprosentation of maps when only a part of the world is selected as illustrated in Baboken and Lamber(2023).

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- Train with SIAP!

Statistical Institute for Asia and the Pacific



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Personnel working in the field of statistics, whose main responsibilities include data collection, exploration, analysis or dissemination of SDG indicators and related statistics.

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Self-Paced course SIAP e-learning platform

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