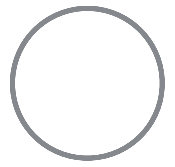
making poetic discoveries with computational interpolation

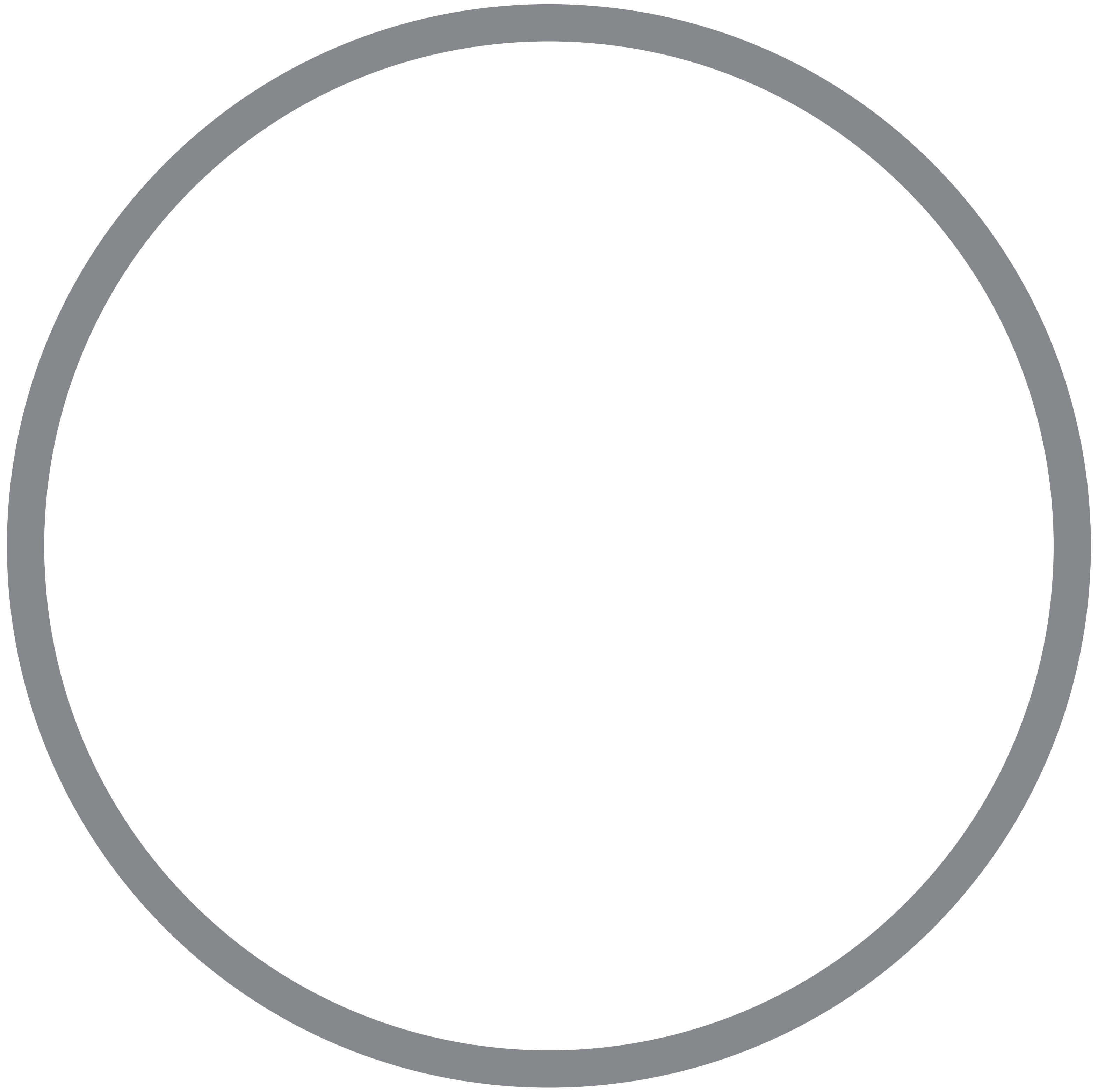
Allison Parrish
New York University, Interactive Telecommunications Program



idea

synthesis

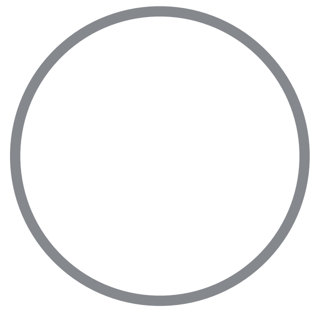
research



idea

synthesis

research



idea

synthesis

research

idea

research

?

synthesis

how do I make language
malleable

I just sorta think that writing a poem should feel like this

A typewriter?–why shd it only make use of the tips of the fingers as contact points of flowing multi directional creativity. If I invented a word placing machine, an “expression-scriber,” if you will, then I would have a kind of instrument into which I could step & sit or sprawl or hang & use not only my fingers to make words express feelings but elbows, feet, head, behind, and all the sounds I wanted, screams, grunts, taps, itches. [...] A typewriter is corny!!

Baraka, Amiri. “Technology & Ethos.” Raise, Race, Rays, Raze; Essays since 1965, Random House, 1972, pp. 155–58.

Laurie Spiegel, "Manipulations of musical patterns"

"The process of creating music involves not only the ability to design... patterns of sound, but a working knowledge of all the processes of transformation which can aesthetically be applied to them. [...] [I]t seems like a good idea... to look at plain old fashioned non-electronic music and to try to extract a basic 'library'... of the most elemental transformations which have consistently been successfully used on musical patterns..." (continued)

(From Spiegel, Laurie. “Manipulations of Musical Patterns.” Proceedings of the Symposium on Small Computers and the Arts, IEEE Computer Society Catalog, vol. 393, 1981, pp. 19–22, http://retiary.org/ls/writings/musical_manip.html.)

- TRANSPOSITION
- REVERSAL
- ROTATION
- PHASE OFFSET
- RESCALING
- INTERPOLATION
- EXTRAPOLATION
- FRAGMENTATION
- SUBSTITUTION
- COMBINATION
- SEQUENCING
- REPETITION
- THE GREAT UNKNOWN

(From Spiegel, Laurie. “Manipulations of Musical Patterns.” Proceedings of the Symposium on Small Computers and the Arts, IEEE Computer Society Catalog, vol. 393, 1981, pp. 19–22, http://retiary.org/ls/writings/musical_manip.html.)

6. INTERPOLATION

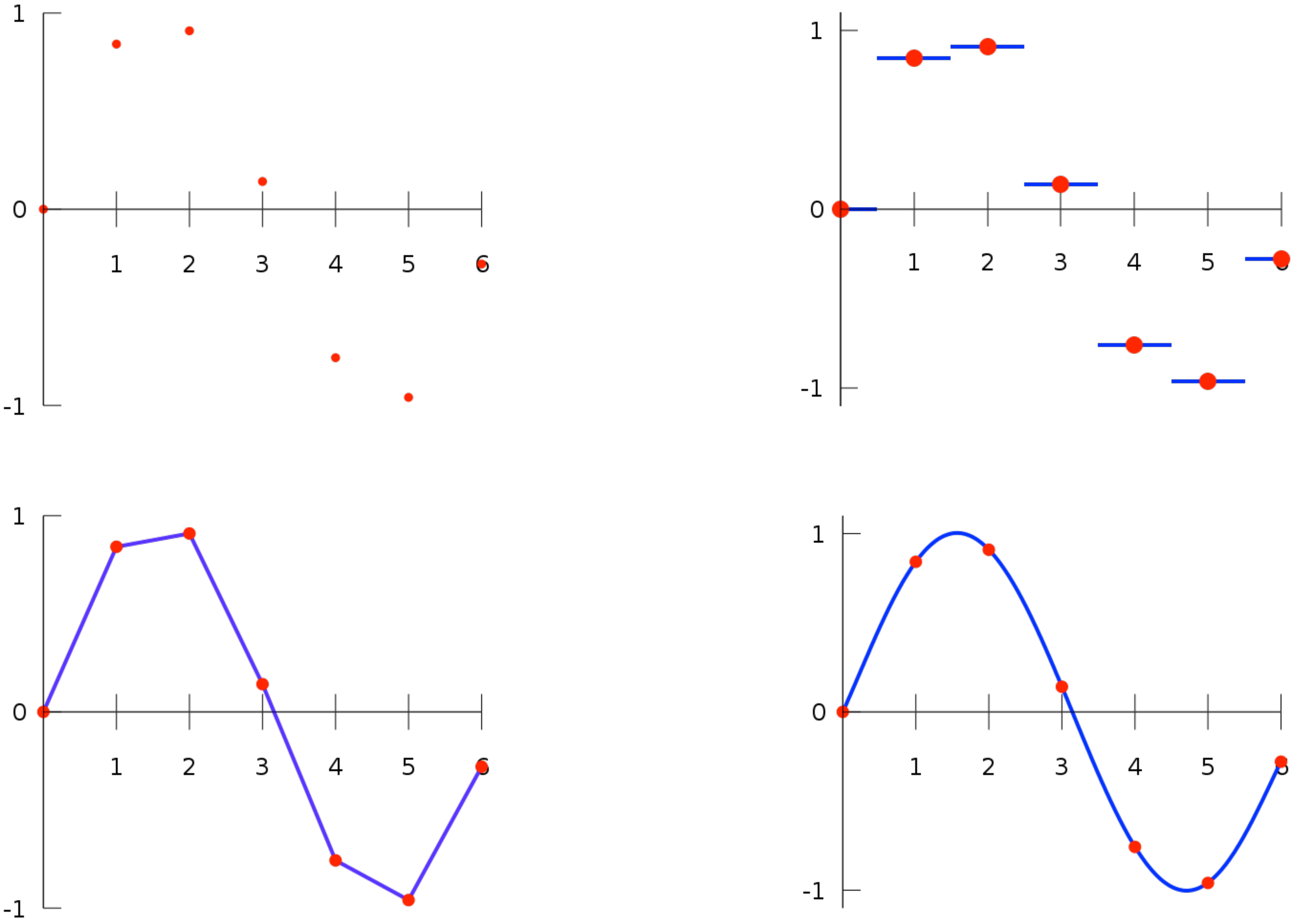
Filling in between previously established points. Inserting a smooth ramp between discretely separated values, a fast-moving melody added over slow-moving chords, or additional chords put between given chords, embellishing with trills or other such ornamentation. The renaissance practice of "divisions playing" (improvising variations on a theme) was a method of extending shorter patterns into longer compositions by means of melodic interpolation (see also medieval trope and melisma).

(From Spiegel, Laurie. “Manipulations of Musical Patterns.” Proceedings of the Symposium on Small Computers and the Arts, IEEE Computer Society Catalog, vol. 393, 1981, pp. 19–22, http://retiary.org/ls/writings/musical_manip.html, my emphasis)

"filling in between previously established points"

- yes, whoa, I like this, I think this is kinda what I've been doing and it's good to have a word for it!
- what are other examples of interpolation? who else is interpolating. are *you* interpolating? let me know.
- but wait just how *specifically* does this apply to poetry? how do you "establish points" in language?

interpolation for discovery in the arts
and sciences throughout the ages,
an opinionated and whirlwind tour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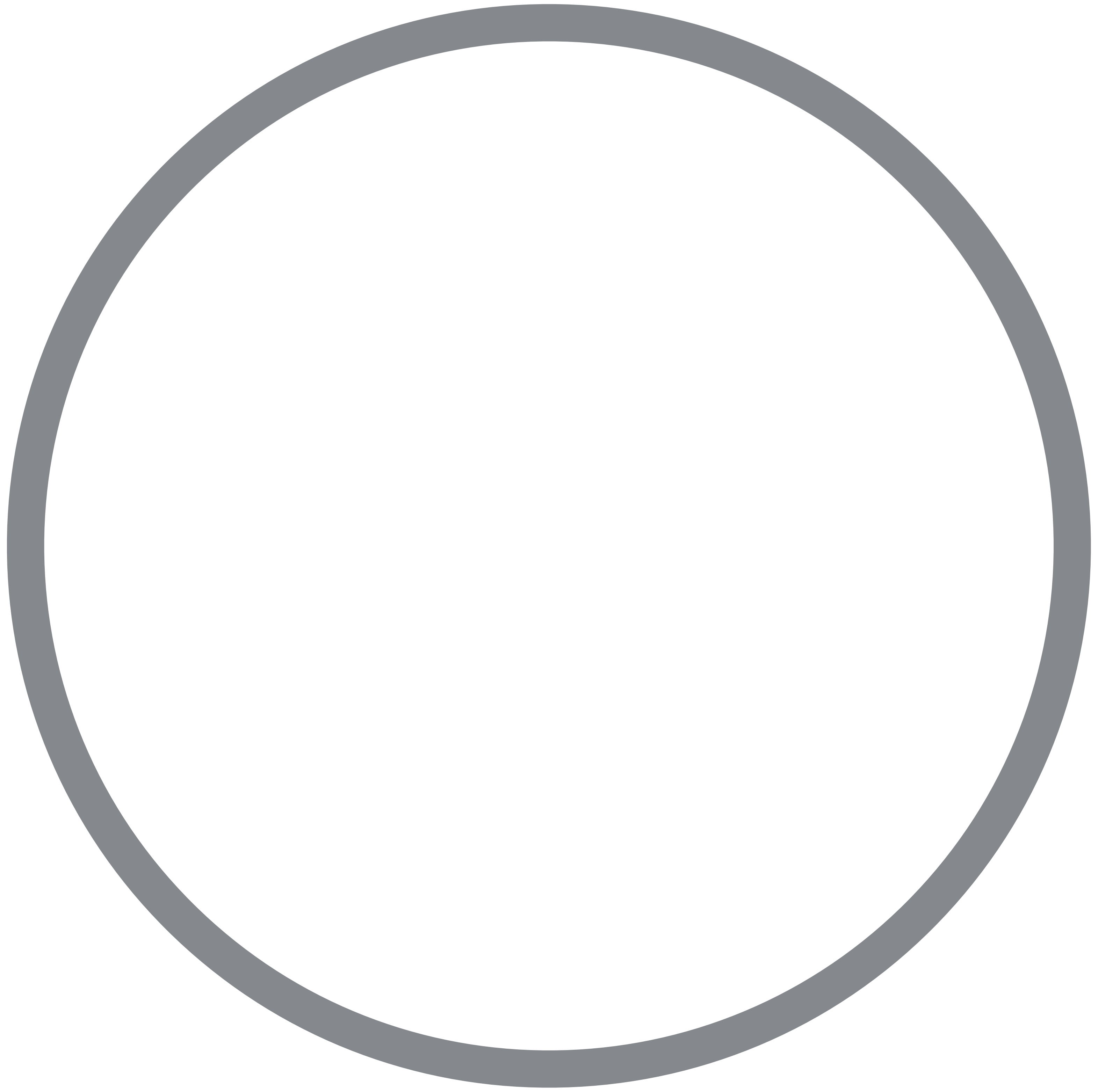
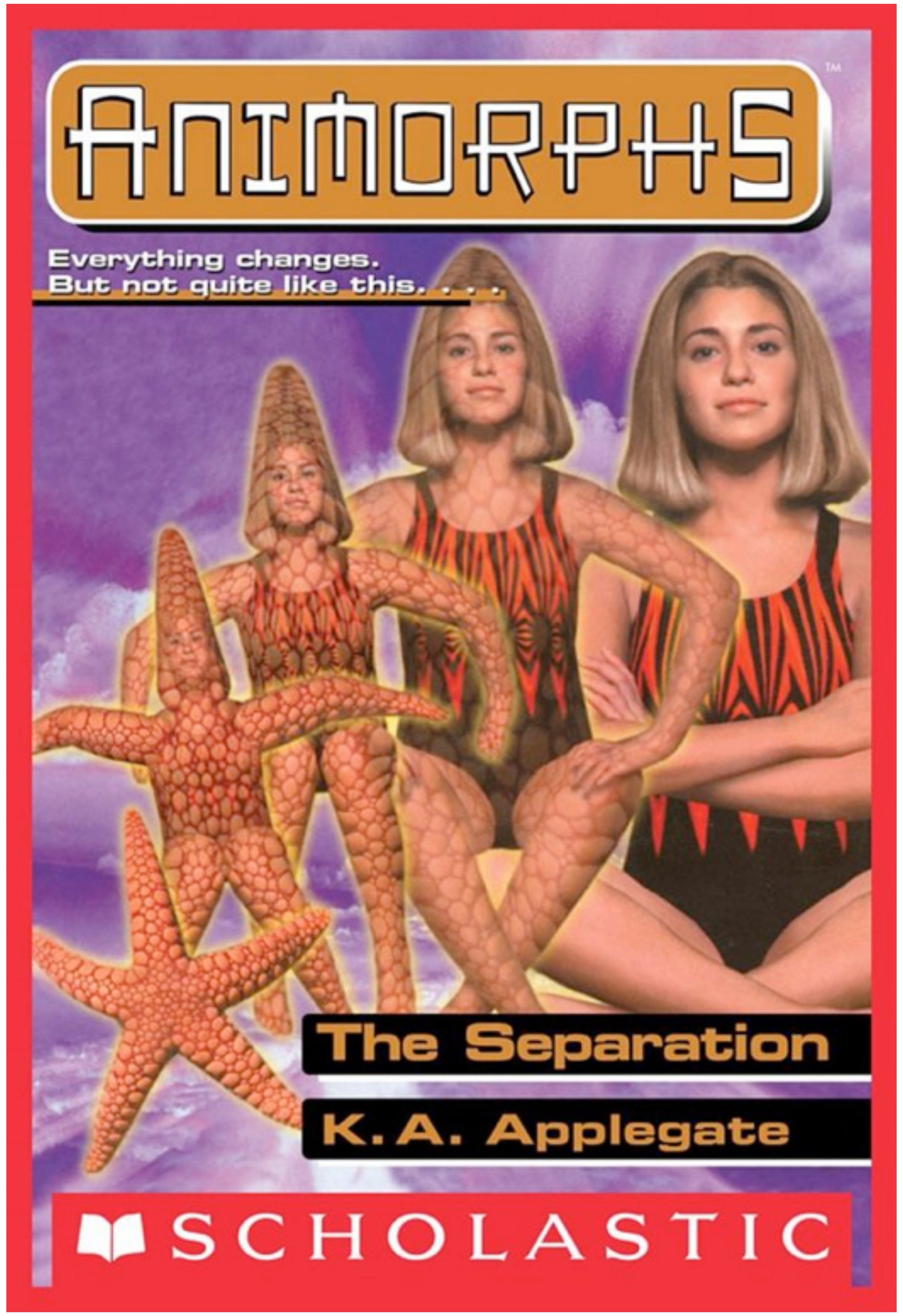
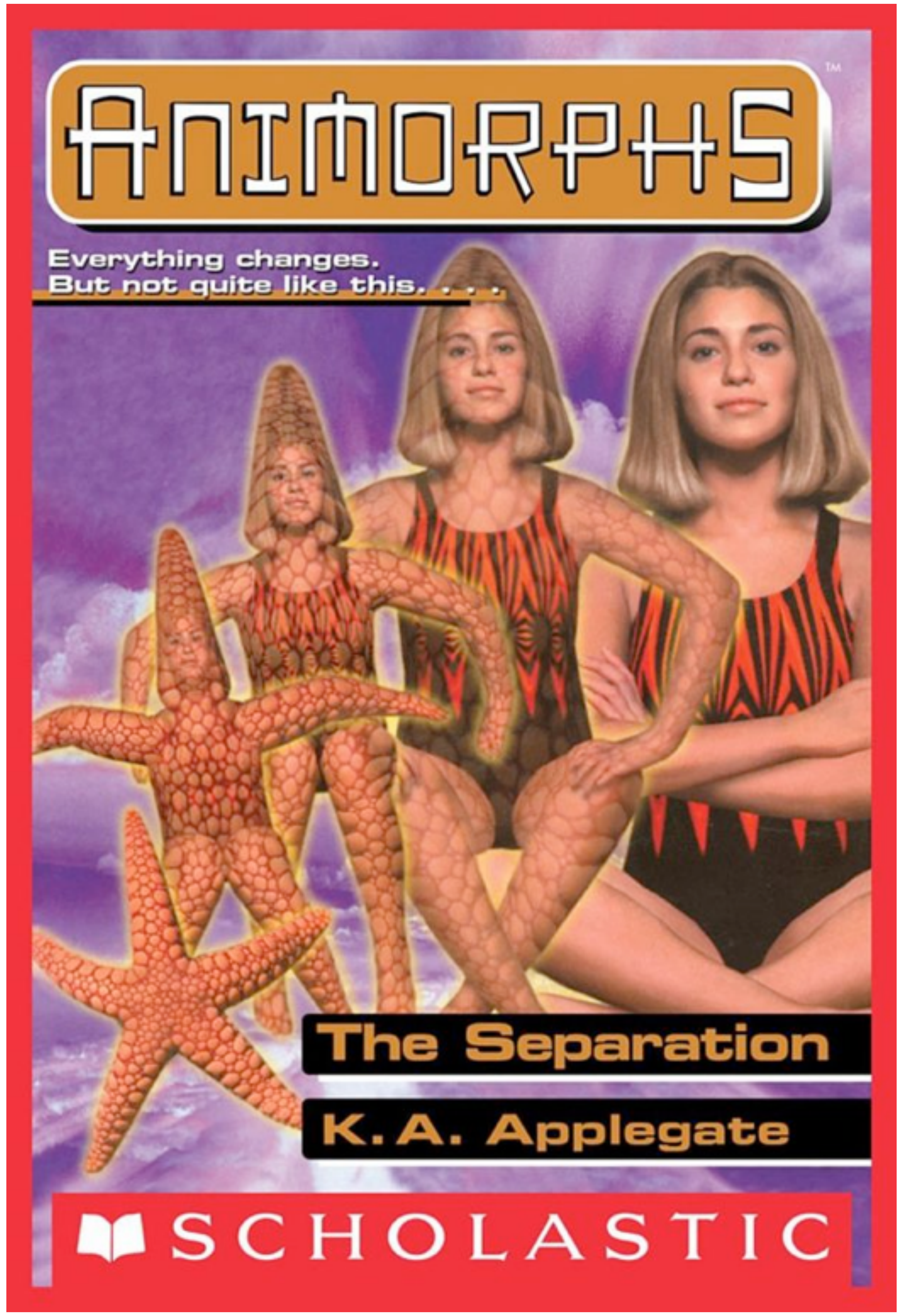
tweening and morphing




ANIMORPHS
Everything changes.
But not quite like this. . . .
The Separation
K.A. Applegate
SCHOLASTIC

Applegate, Katherine. The Separation. Scholastic, 1999; Landis, John. Black or White. 1991. YouTube, https://www.youtube.com/watch?v=pTFE8cirkdQ.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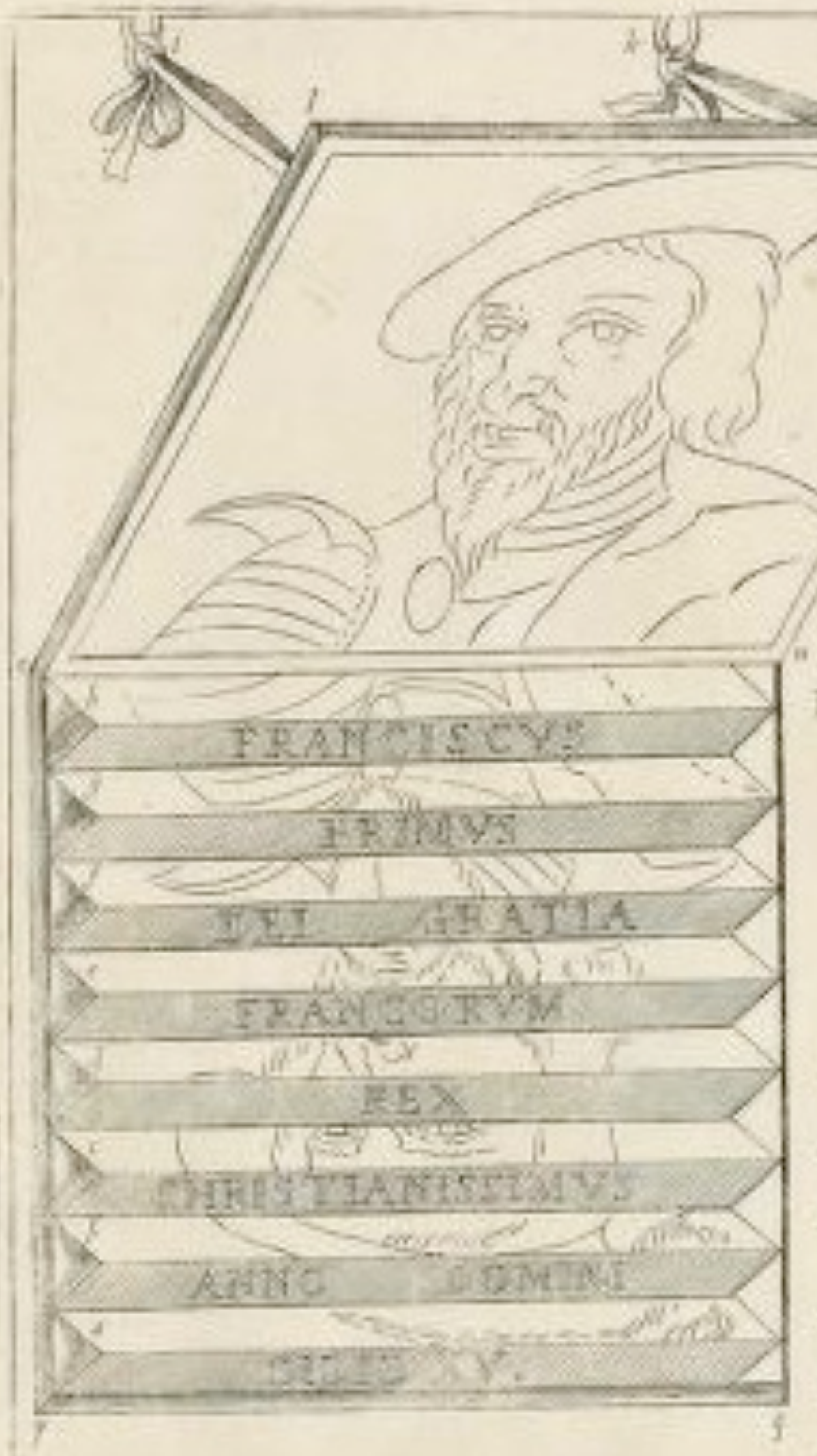
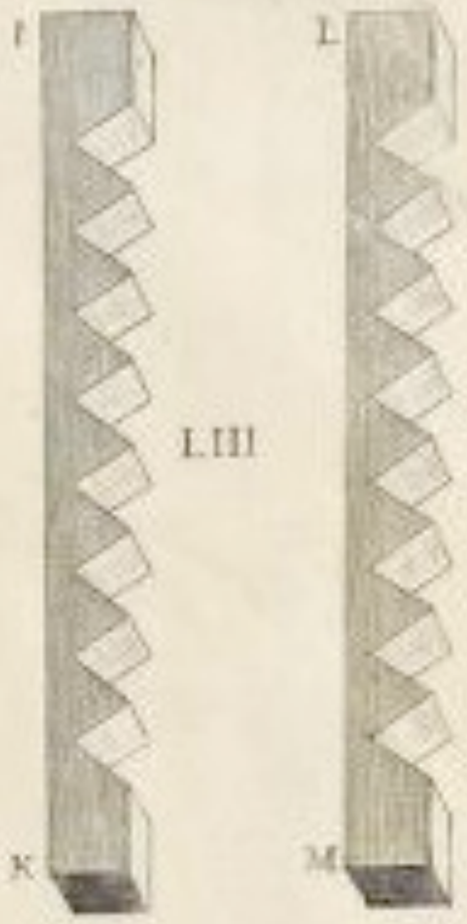
Applegate, Katherine. The Separation. Scholastic, 1999; Landis, John. Black or White. 1991. YouTube, https://www.youtube.com/watch?v=pTFE8cirkdQ.

tabula scalata/turning pictures

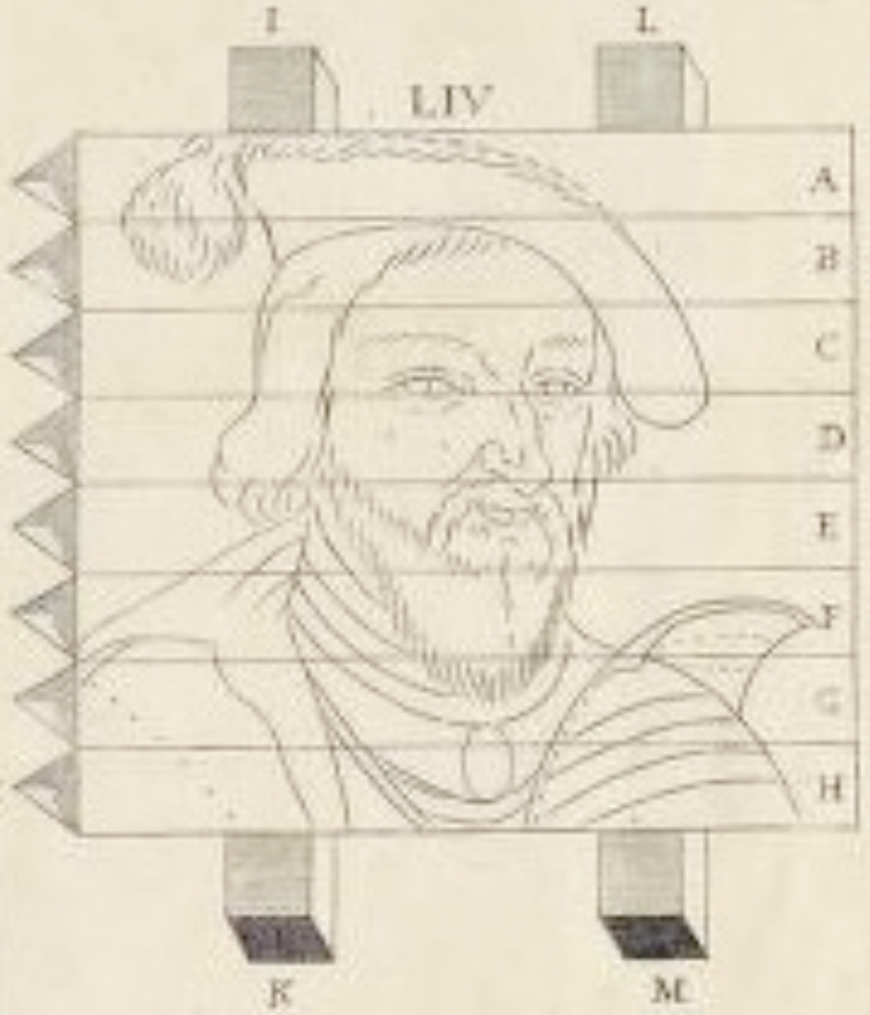


FRANCISCVS
PRIMVS
DEI GRATIA
FRANCORVM
REX
CHRISTIANISSIMVS
ANNO DOMINI
CIↃIↃ XV.

LV



LIII



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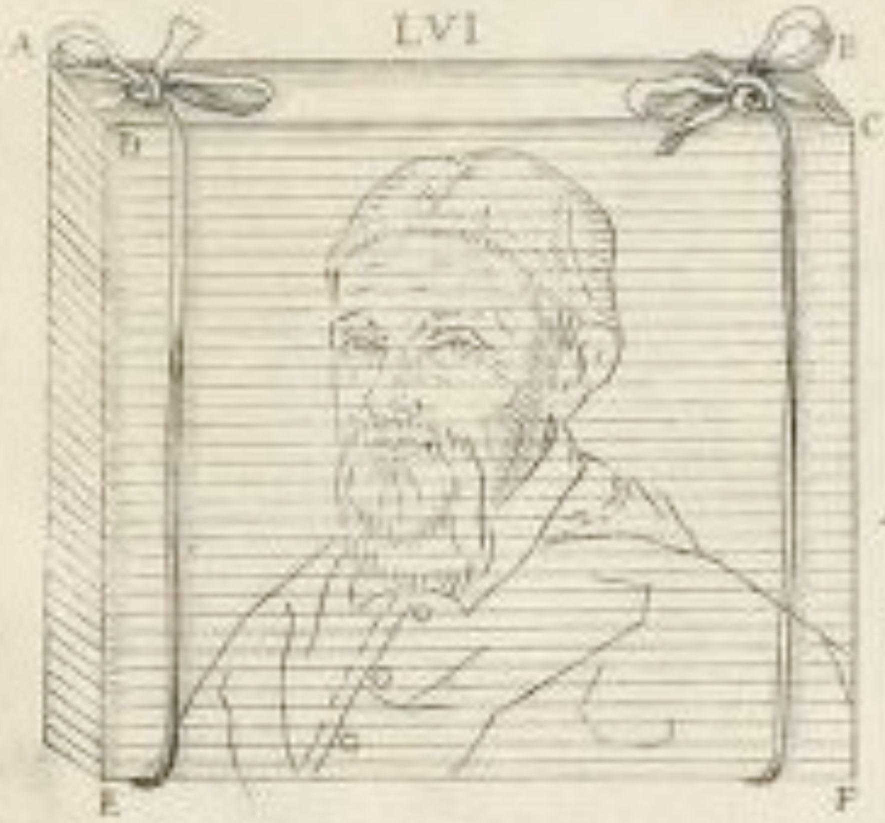
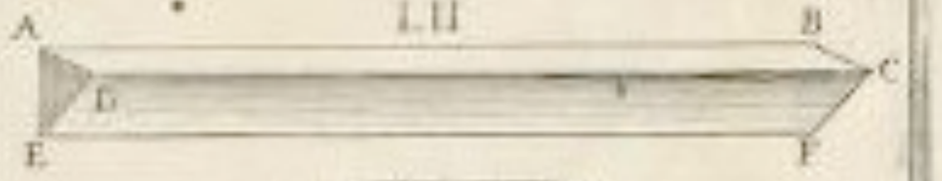
LIV



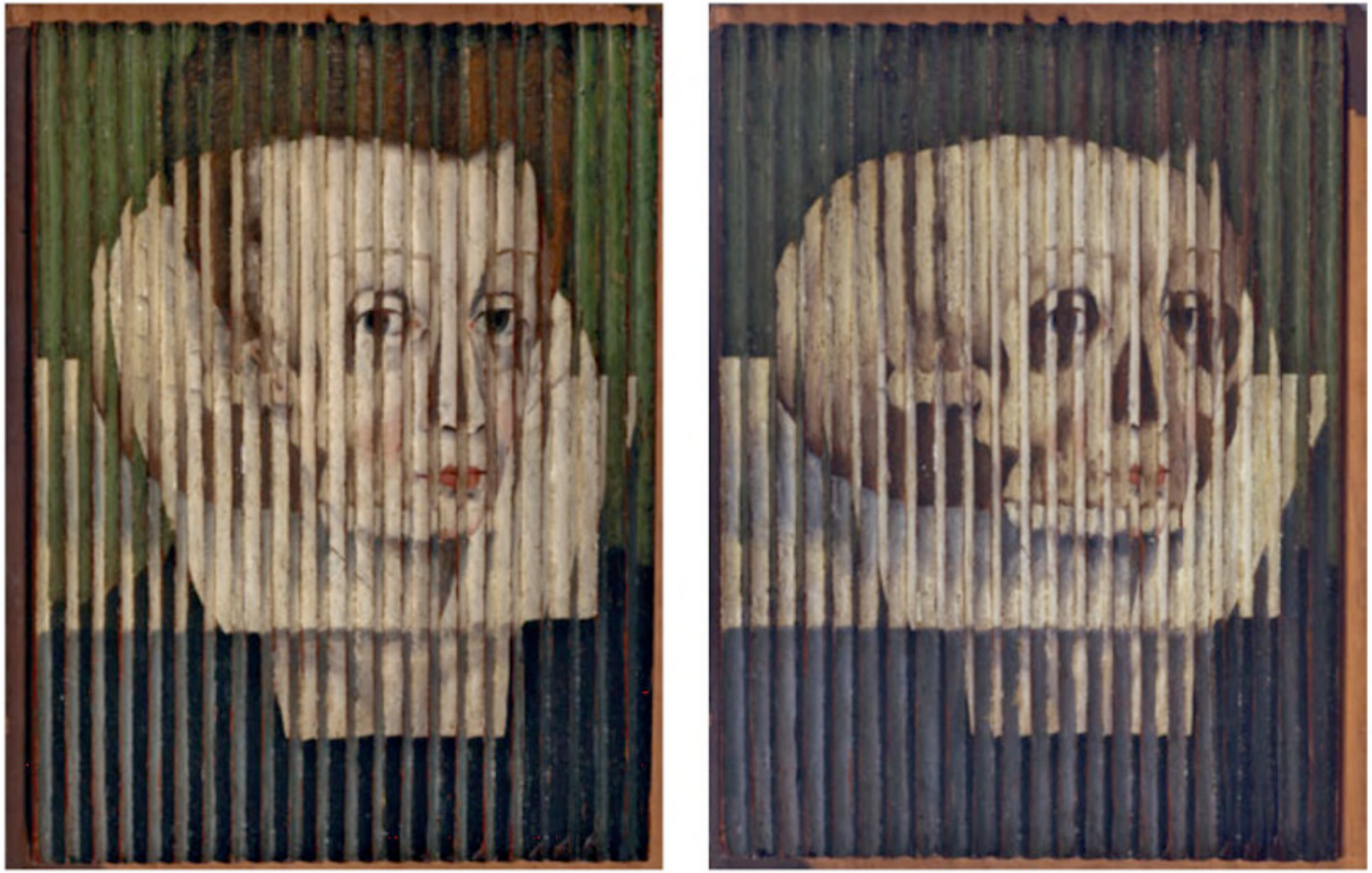
LVI



LII

Tab. 43

Ioan. Blanchin incidit.

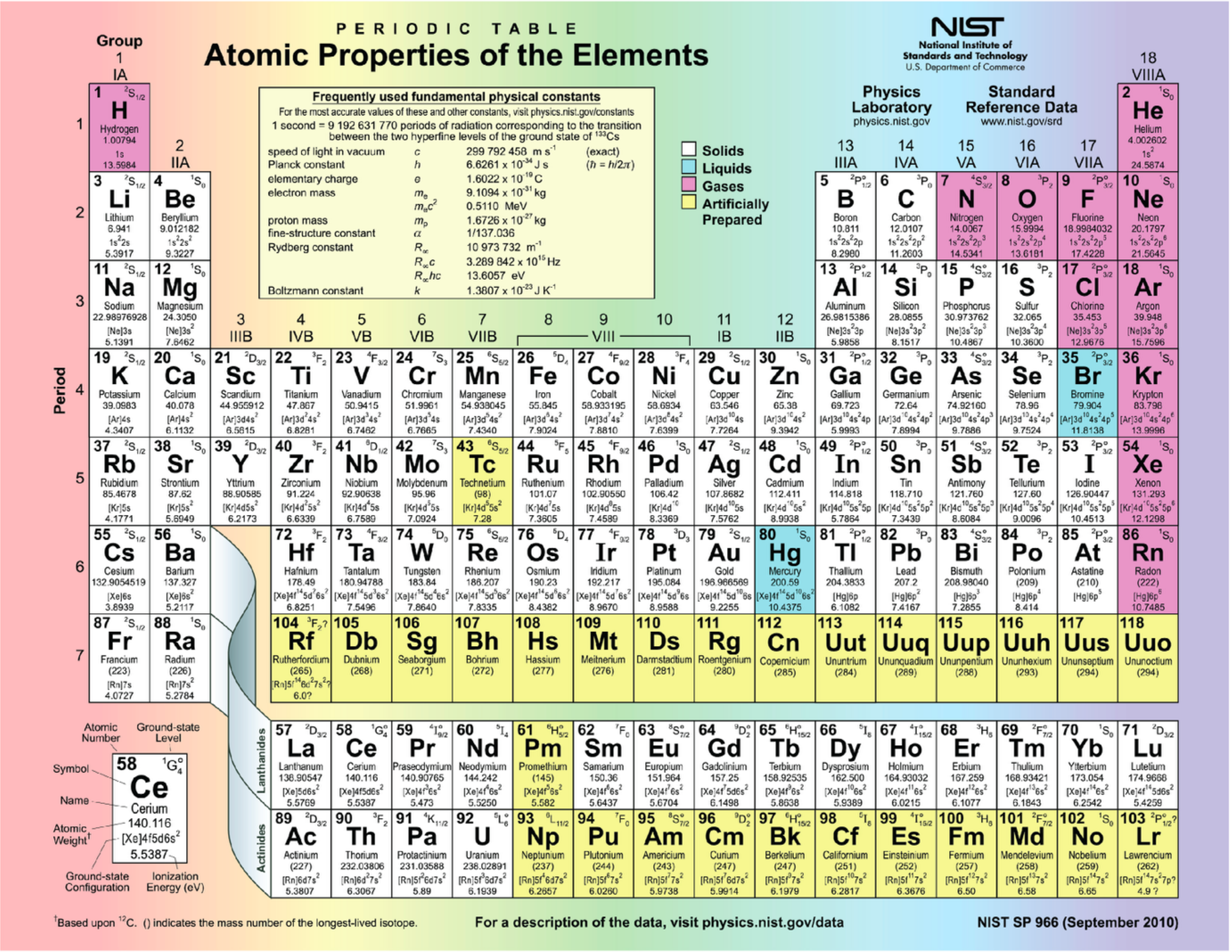


"The painting should be looked at from left to right to reveal the human head changing into a skull."

https://www.nationalgalleries.org/art-and-artists/3239/anamorphosis-called-mary-queen-scots-1542-1587-reigned-1542-1567

"As of a picture wrought to opticke reason,
That to all passers by, seems as they move
Now woman, *now a monster*, and now a Divell,
And till you stand, and in a right line view it,
You cannot well judge what the main forme is."

From George Chapman's *Chabot* (ca. 1621), quoted in Shickman, Allan. "'Turning Pictures' in Shakespeare's England." The Art Bulletin, vol. 59, no. 1, Mar. 1977, p. 67. (my emphasis) technetium



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Planck constant	h	6.6261 x 10^{-34} J s	($\hbar = h/2\pi$)
elementary charge	e	1.6022 x 10^{-19} C	
electron mass	m_e	9.1094 x 10^{-31} kg	
	m_ec^2	0.5110 MeV	
proton mass	m_p	1.6726 x 10^{-27} kg	
fine-structure constant	α	1/137.036	
Rydberg constant	R_∞	10 973 732 m^{-1}	
	$R_\infty c$	3.289 842 x 10^{15} Hz	
	$R_\infty hc$	13.6057 eV	
Boltzmann constant	k	1.3807 x 10^{-23} J K^{-1}	

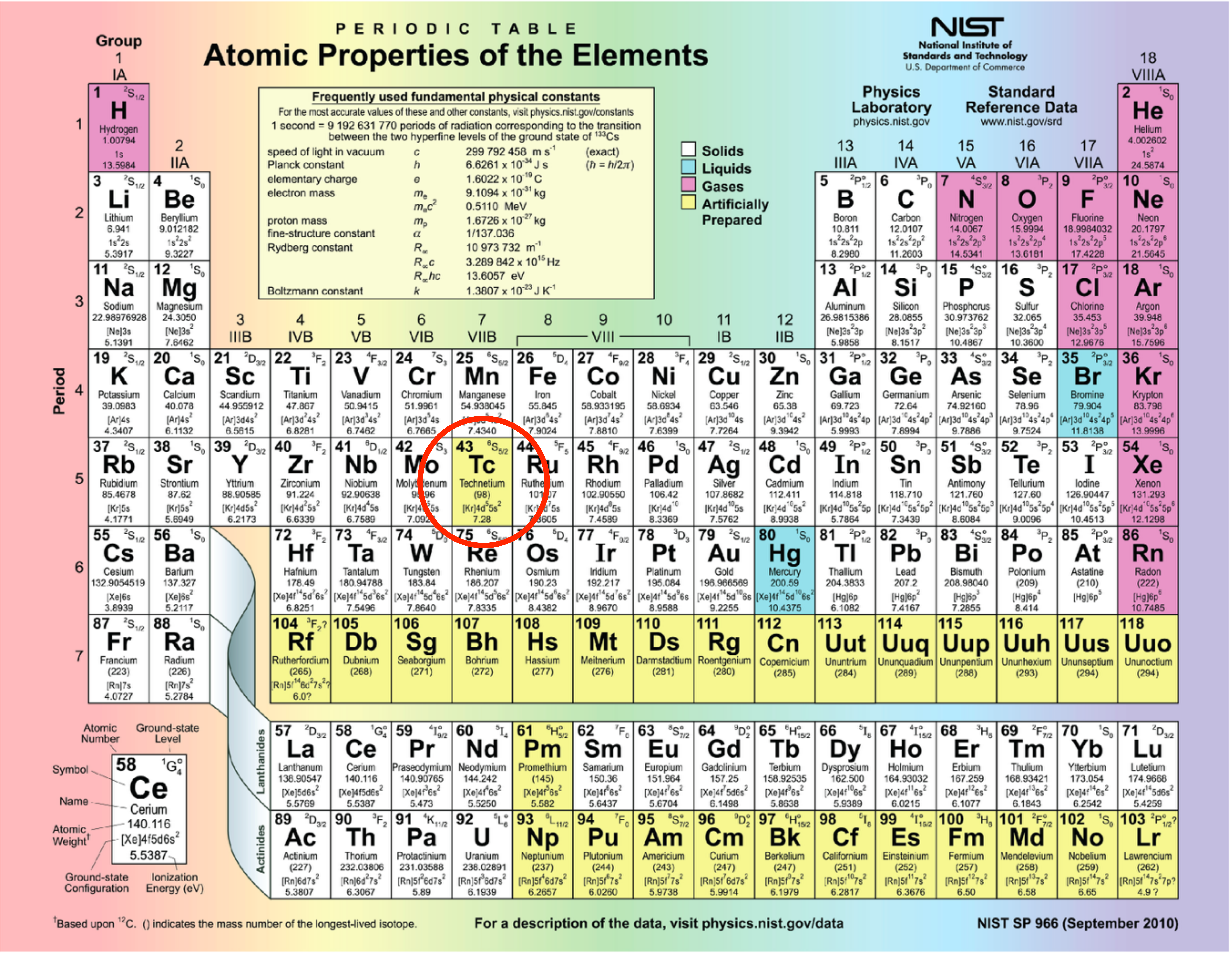
☐ Solids
🟦 Liquids
🟪 Gases
🟨 Artificially Prepared

Period	Group 1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIII	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 $^2S_{1/2}$ **H** Hydrogen 1.00794 $1s$ 13.5984																	2 $^1S_0$ **He** Helium 4.002602 $1s^2$ 24.5874
2	3 $^2S_{1/2}$ **Li** Lithium 6.941 $1s^2 2s$ 5.3917	4 $^1S_0$ **Be** Beryllium 9.012182 $1s^2 2s^2$ 9.3227											5 $^2P^\circ_{1/2}$ **B** Boron 10.811 $1s^2 2s^2 2p$ 8.2980	6 $^3P_0$ **C** Carbon 12.0107 $1s^2 2s^2 2p^2$ 11.2603	7 $^4S^\circ_{3/2}$ **N** Nitrogen 14.0067 $1s^2 2s^2 2p^3$ 14.5341	8 $^3P_2$ **O** Oxygen 15.9994 $1s^2 2s^2 2p^4$ 13.6181	9 $^2P^\circ_{3/2}$ **F** Fluorine 18.9984032 $1s^2 2s^2 2p^5$ 17.4228	10 $^1S_0$ **Ne** Neon 20.1797 $1s^2 2s^2 2p^6$ 21.5645
3	11 $^2S_{1/2}$ **Na** Sodium 22.98976928 [Ne]$3s$ 5.1391	12 $^1S_0$ **Mg** Magnesium 24.3050 [Ne]$3s^2$ 7.6462											13 $^2P^\circ_{1/2}$ **Al** Aluminum 26.9815386 [Ne]$3s^2 3p$ 5.9858	14 $^3P_0$ **Si** Silicon 28.0855 [Ne]$3s^2 3p^2$ 8.1517	15 $^4S^\circ_{3/2}$ **P** Phosphorus 30.973762 [Ne]$3s^2 3p^3$ 10.4867	16 $^3P_2$ **S** Sulfur 32.065 [Ne]$3s^2 3p^4$ 10.3600	17 $^2P^\circ_{3/2}$ **Cl** Chlorine 35.453 [Ne]$3s^2 3p^5$ 12.9676	18 $^1S_0$ **Ar** Argon 39.948 [Ne]$3s^2 3p^6$ 15.7596
4	19 $^2S_{1/2}$ **K** Potassium 39.0983 [Ar]$4s$ 4.3407	20 $^1S_0$ **Ca** Calcium 40.078 [Ar]$4s^2$ 6.1132	21 $^2D_{3/2}$ **Sc** Scandium 44.955912 [Ar]$3d4s^2$ 6.5615	22 $^3F_2$ **Ti** Titanium 47.867 [Ar]$3d^2 4s^2$ 6.8281	23 $^4F_{3/2}$ **V** Vanadium 50.9415 [Ar]$3d^3 4s^2$ 6.7462	24 $^7S_3$ **Cr** Chromium 51.9961 [Ar]$3d^5 4s$ 6.7665	25 $^6S_{5/2}$ **Mn** Manganese 54.938045 [Ar]$3d^5 4s^2$ 7.4340	26 $^5D_4$ **Fe** Iron 55.845 [Ar]$3d^6 4s^2$ 7.9024	27 $^4F_{9/2}$ **Co** Cobalt 58.933195 [Ar]$3d^7 4s^2$ 7.8810	28 $^3F_4$ **Ni** Nickel 58.6934 [Ar]$3d^8 4s^2$ 7.6399	29 $^2S_{1/2}$ **Cu** Copper 63.546 [Ar]$3d^{10}4s$ 7.7264	30 $^1S_0$ **Zn** Zinc 65.38 [Ar]$3d^{10}4s^2$ 9.3942	31 $^2P^\circ_{1/2}$ **Ga** Gallium 69.723 [Ar]$3d^{10}4s^2 4p$ 5.9993	32 $^3P_0$ **Ge** Germanium 72.64 [Ar]$3d^{10}4s^2 4p^2$ 7.8994	33 $^4S^\circ_{3/2}$ **As** Arsenic 74.92160 [Ar]$3d^{10}4s^2 4p^3$ 9.7886	34 $^3P_2$ **Se** Selenium 78.96 [Ar]$3d^{10}4s^2 4p^4$ 9.7524	35 $^2P^\circ_{3/2}$ **Br** Bromine 79.904 [Ar]$3d^{10}4s^2 4p^5$ 11.8138	36 $^1S_0$ **Kr** Krypton 83.798 [Ar]$3d^{10}4s^2 4p^6$ 13.9996
5	37 $^2S_{1/2}$ **Rb** Rubidium 85.4678 [Kr]$5s$ 4.1771	38 $^1S_0$ **Sr** Strontium 87.62 [Kr]$5s^2$ 5.6949	39 $^2D_{3/2}$ **Y** Yttrium 88.90585 [Kr]$4d5s^2$ 6.2173	40 $^3F_2$ **Zr** Zirconium 91.224 [Kr]$4d^2 5s^2$ 6.6339	41 $^6D_{1/2}$ **Nb** Niobium 92.90638 [Kr]$4d^4 5s$ 6.7589	42 $^7S_3$ **Mo** Molybdenum 95.96 [Kr]$4d^5 5s$ 7.0924	43 $^6S_{5/2}$ **Tc** Technetium (98) [Kr]$4d^5 5s^2$ 7.28	44 $^5F_5$ **Ru** Ruthenium 101.07 [Kr]$4d^7 5s$ 7.3605	45 $^4F_{9/2}$ **Rh** Rhodium 102.90550 [Kr]$4d^8 5s$ 7.4589	46 $^1S_0$ **Pd** Palladium 106.42 [Kr]$4d^{10}$ 8.3369	47 $^2S_{1/2}$ **Ag** Silver 107.8682 [Kr]$4d^{10}5s$ 7.5762	48 $^1S_0$ **Cd** Cadmium 112.411 [Kr]$4d^{10}5s^2$ 8.9938	49 $^2P^\circ_{1/2}$ **In** Indium 114.818 [Kr]$4d^{10}5s^2 5p$ 5.7864	50 $^3P_0$ **Sn** Tin 118.710 [Kr]$4d^{10}5s^2 5p^2$ 7.3439	51 $^4S^\circ_{3/2}$ **Sb** Antimony 121.760 [Kr]$4d^{10}5s^2 5p^3$ 8.6084	52 $^3P_2$ **Te** Tellurium 127.60 [Kr]$4d^{10}5s^2 5p^4$ 9.0096	53 $^2P^\circ_{3/2}$ **I** Iodine 126.90447 [Kr]$4d^{10}5s^2 5p^5$ 10.4513	54 $^1S_0$ **Xe** Xenon 131.293 [Kr]$4d^{10}5s^2 5p^6$ 12.1298
6	55 $^2S_{1/2}$ **Cs** Cesium 132.9054519 [Xe]$6s$ 3.8939	56 $^1S_0$ **Ba** Barium 137.327 [Xe]$6s^2$ 5.2117		72 $^3F_2$ **Hf** Hafnium 178.49 [Xe]$4f^{14}5d^2 6s^2$ 6.8251	73 $^4F_{3/2}$ **Ta** Tantalum 180.94788 [Xe]$4f^{14}5d^3 6s^2$ 7.5496	74 $^5D_0$ **W** Tungsten 183.84 [Xe]$4f^{14}5d^4 6s^2$ 7.8640	75 $^6S_{5/2}$ **Re** Rhenium 186.207 [Xe]$4f^{14}5d^5 6s^2$ 7.8335	76 $^5D_4$ **Os** Osmium 190.23 [Xe]$4f^{14}5d^6 6s^2$ 8.4382	77 $^4F_{9/2}$ **Ir** Iridium 192.217 [Xe]$4f^{14}5d^7 6s^2$ 8.9670	78 $^3D_3$ **Pt** Platinum 195.084 [Xe]$4f^{14}5d^9 6s$ 8.9588	79 $^2S_{1/2}$ **Au** Gold 196.966569 [Xe]$4f^{14}5d^{10}6s$ 9.2255	80 $^1S_0$ **Hg** Mercury 200.59 [Xe]$4f^{14}5d^{10}6s^2$ 10.4375	81 $^2P^\circ_{1/2}$ **Tl** Thallium 204.3833 [Hg]$6p$ 6.1082	82 $^3P_0$ **Pb** Lead 207.2 [Hg]$6p^2$ 7.4167	83 $^4S^\circ_{3/2}$ **Bi** Bismuth 208.98040 [Hg]$6p^3$ 7.2855	84 $^3P_2$ **Po** Polonium (209) [Hg]$6p^4$ 8.414	85 $^2P^\circ_{3/2}$ **At** Astatine (210) [Hg]$6p^5$	86 $^1S_0$ **Rn** Radon (222) [Hg]$6p^6$ 10.7485
7	87 $^2S_{1/2}$ **Fr** Francium (223) [Rn]$7s$ 4.0727	88 $^1S_0$ **Ra** Radium (226) [Rn]$7s^2$ 5.2784		104 $^3F_2$? **Rf** Rutherfordium (265) [Rn]$5f^{14}6d^2 7s^2$? 6.0?	105 **Db** Dubnium (268)	106 **Sg** Seaborgium (271)	107 **Bh** Bohrium (272)	108 **Hs** Hassium (277)	109 **Mt** Meitnerium (276)	110 **Ds** Darmstadtium (281)	111 **Rg** Roentgenium (280)	112 **Cn** Copernicium (285)	113 **Uut** Ununtrium (284)	114 **Uuq** Ununquadium (289)	115 **Uup** Ununpentium (288)	116 **Uuh** Ununhexium (293)	117 **Uus** Ununseptium (294)	118 **Uuo** Ununoctium (294)
Lanthanides				57 $^2D_{3/2}$ **La** Lanthanum 138.90547 [Xe]$5d6s^2$ 5.5769	58 $^1G^\circ_4$ **Ce** Cerium 140.116 [Xe]$4f5d6s^2$ 5.5387	59 $^4I^\circ_{9/2}$ **Pr** Praseodymium 140.90765 [Xe]$4f^3 6s^2$ 5.473	60 $^5I_4$ **Nd** Neodymium 144.242 [Xe]$4f^4 6s^2$ 5.5250	61 $^6H^\circ_{5/2}$ **Pm** Promethium (145) [Xe]$4f^5 6s^2$ 5.582	62 $^7F_0$ **Sm** Samarium 150.36 [Xe]$4f^6 6s^2$ 5.6437	63 $^8S^\circ_{7/2}$ **Eu** Europium 151.964 [Xe]$4f^7 6s^2$ 5.6704	64 $^9D^\circ_2$ **Gd** Gadolinium 157.25 [Xe]$4f^7 5d6s^2$ 6.1498	65 $^6H^\circ_{15/2}$ **Tb** Terbium 158.92535 [Xe]$4f^9 6s^2$ 5.8638	66 $^5I_8$ **Dy** Dysprosium 162.500 [Xe]$4f^{10}6s^2$ 5.9389	67 $^4I^\circ_{15/2}$ **Ho** Holmium 164.93032 [Xe]$4f^{11}6s^2$ 6.0215	68 $^3H_6$ **Er** Erbium 167.259 [Xe]$4f^{12}6s^2$ 6.1077	69 $^2F^\circ_{7/2}$ **Tm** Thulium 168.93421 [Xe]$4f^{13}6s^2$ 6.1843	70 $^1S_0$ **Yb** Ytterbium 173.054 [Xe]$4f^{14}6s^2$ 6.2542	71 $^2D_{3/2}$ **Lu** Lutetium 174.9668 [Xe]$4f^{14}5d6s^2$ 5.4259
Actinides				89 $^2D_{3/2}$ **Ac** Actinium (227) [Rn]$6d7s^2$ 5.3807	90 $^3F_2$ **Th** Thorium 232.03806 [Rn]$6d^2 7s^2$ 6.3067	91 $^4K_{11/2}$ **Pa** Protactinium 231.03588 [Rn]$5f^2 6d7s^2$ 5.89	92 $^5L^\circ_6$ **U** Uranium 238.02891 [Rn]$5f^3 6d7s^2$ 6.1939	93 $^6L_{11/2}$ **Np** Neptunium (237) [Rn]$5f^4 6d7s^2$ 6.2657	94 $^7F_0$ **Pu** Plutonium (244) [Rn]$5f^6 7s^2$ 6.0260	95 $^8S^\circ_{7/2}$ **Am** Americium (243) [Rn]$5f^7 7s^2$ 5.9738	96 $^9D^\circ_2$ **Cm** Curium (247) [Rn]$5f^7 6d7s^2$ 5.9914	97 $^6H^\circ_{15/2}$ **Bk** Berkelium (247) [Rn]$5f^9 7s^2$ 6.1979	98 $^5I_8$ **Cf** Californium (251) [Rn]$5f^{10}7s^2$ 6.2817	99 $^4I^\circ_{15/2}$ **Es** Einsteinium (252) [Rn]$5f^{11}7s^2$ 6.3676	100 $^3H_6$ **Fm** Fermium (257) [Rn]$5f^{12}7s^2$ 6.50	101 $^2F^\circ_{7/2}$ **Md** Mendelevium (258) [Rn]$5f^{13}7s^2$ 6.58	102 $^1S_0$ **No** Nobelium (259) [Rn]$5f^{14}7s^2$ 6.65	103 $^2P^\circ_{1/2}$? **Lr** Lawrencium (262) [Rn]$5f^{14}7s^2 7p$? 4.9 ?

†Based upon ^{12}C. () indicates the mass number of the longest-lived isotope.

For a description of the data, visit physics.nist.gov/data

NIST SP 966 (September 2010)



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	$R_\infty hc$	13.6057 eV	
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☐ Solids
🟦 Liquids
🟪 Gases
🟨 Artificially Prepared

Period	Group 1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIII	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 $^2S_{1/2}$ **H** Hydrogen 1.00794 1s 13.5984																	2 $^1S_0$ **He** Helium 4.002602 $1s^2$ 24.5874
2	3 $^2S_{1/2}$ **Li** Lithium 6.941 $1s^22s$ 5.3917	4 $^1S_0$ **Be** Beryllium 9.012182 $1s^22s^2$ 9.3227											5 $^2P^\circ_{1/2}$ **B** Boron 10.811 $1s^22s^22p$ 8.2980	6 $^3P_0$ **C** Carbon 12.0107 $1s^22s^22p^2$ 11.2603	7 $^4S^\circ_{3/2}$ **N** Nitrogen 14.0067 $1s^22s^22p^3$ 14.5341	8 $^3P_2$ **O** Oxygen 15.9994 $1s^22s^22p^4$ 13.6181	9 $^2P^\circ_{3/2}$ **F** Fluorine 18.9984032 $1s^22s^22p^5$ 17.4228	10 $^1S_0$ **Ne** Neon 20.1797 $1s^22s^22p^6$ 21.5645
3	11 $^2S_{1/2}$ **Na** Sodium 22.98976928 [Ne]3s 5.1391	12 $^1S_0$ **Mg** Magnesium 24.3050 $[Ne]3s^2$ 7.6462											13 $^2P^\circ_{1/2}$ **Al** Aluminum 26.9815386 $[Ne]3s^23p$ 5.9858	14 $^3P_0$ **Si** Silicon 28.0855 $[Ne]3s^23p^2$ 8.1517	15 $^4S^\circ_{3/2}$ **P** Phosphorus 30.973762 $[Ne]3s^23p^3$ 10.4867	16 $^3P_2$ **S** Sulfur 32.065 $[Ne]3s^23p^4$ 10.3600	17 $^2P^\circ_{3/2}$ **Cl** Chlorine 35.453 $[Ne]3s^23p^5$ 12.9676	18 $^1S_0$ **Ar** Argon 39.948 $[Ne]3s^23p^6$ 15.7596
4	19 $^2S_{1/2}$ **K** Potassium 39.0983 [Ar]4s 4.3407	20 $^1S_0$ **Ca** Calcium 40.078 $[Ar]4s^2$ 6.1132	21 $^2D_{3/2}$ **Sc** Scandium 44.955912 $[Ar]3d4s^2$ 6.5615	22 $^3F_2$ **Ti** Titanium 47.867 $[Ar]3d^24s^2$ 6.8281	23 $^4F_{3/2}$ **V** Vanadium 50.9415 $[Ar]3d^34s^2$ 6.7462	24 $^7S_3$ **Cr** Chromium 51.9961 $[Ar]3d^54s$ 6.7665	25 $^6S_{5/2}$ **Mn** Manganese 54.938045 $[Ar]3d^54s^2$ 7.4340	26 $^5D_4$ **Fe** Iron 55.845 $[Ar]3d^64s^2$ 7.9024	27 $^4F_{9/2}$ **Co** Cobalt 58.933195 $[Ar]3d^74s^2$ 7.8810	28 $^3F_4$ **Ni** Nickel 58.6934 $[Ar]3d^84s^2$ 7.6399	29 $^2S_{1/2}$ **Cu** Copper 63.546 $[Ar]3d^{10}4s$ 7.7264	30 $^1S_0$ **Zn** Zinc 65.38 $[Ar]3d^{10}4s^2$ 9.3942	31 $^2P^\circ_{1/2}$ **Ga** Gallium 69.723 $[Ar]3d^{10}4s^24p$ 5.9993	32 $^3P_0$ **Ge** Germanium 72.64 $[Ar]3d^{10}4s^24p^2$ 7.8994	33 $^4S^\circ_{3/2}$ **As** Arsenic 74.92160 $[Ar]3d^{10}4s^24p^3$ 9.7886	34 $^3P_2$ **Se** Selenium 78.96 $[Ar]3d^{10}4s^24p^4$ 9.7524	35 $^2P^\circ_{3/2}$ **Br** Bromine 79.904 $[Ar]3d^{10}4s^24p^5$ 11.8138	36 $^1S_0$ **Kr** Krypton 83.798 $[Ar]3d^{10}4s^24p^6$ 13.9996
5	37 $^2S_{1/2}$ **Rb** Rubidium 85.4678 [Kr]5s 4.1771	38 $^1S_0$ **Sr** Strontium 87.62 $[Kr]5s^2$ 5.6949	39 $^2D_{3/2}$ **Y** Yttrium 88.90585 $[Kr]4d5s^2$ 6.2173	40 $^3F_2$ **Zr** Zirconium 91.224 $[Kr]4d^25s^2$ 6.6339	41 $^6D_{1/2}$ **Nb** Niobium 92.90638 $[Kr]4d^45s$ 6.7589	42 $^7S_3$ **Mo** Molybdenum 95.96 $[Kr]4d^55s$ 7.092	43 $^6S_{5/2}$ **Tc** Technetium (98) $[Kr]4d^55s^2$ 7.28	44 $^5F_5$ **Ru** Ruthenium 101.07 $[Kr]4d^75s$ 7.3605	45 $^4F_{9/2}$ **Rh** Rhodium 102.90550 $[Kr]4d^85s$ 7.4589	46 $^1S_0$ **Pd** Palladium 106.42 $[Kr]4d^{10}$ 8.3369	47 $^2S_{1/2}$ **Ag** Silver 107.8682 $[Kr]4d^{10}5s$ 7.5762	48 $^1S_0$ **Cd** Cadmium 112.411 $[Kr]4d^{10}5s^2$ 8.9938	49 $^2P^\circ_{1/2}$ **In** Indium 114.818 $[Kr]4d^{10}5s^25p$ 5.7864	50 $^3P_0$ **Sn** Tin 118.710 $[Kr]4d^{10}5s^25p^2$ 7.3439	51 $^4S^\circ_{3/2}$ **Sb** Antimony 121.760 $[Kr]4d^{10}5s^25p^3$ 8.6084	52 $^3P_2$ **Te** Tellurium 127.60 $[Kr]4d^{10}5s^25p^4$ 9.0096	53 $^2P^\circ_{3/2}$ **I** Iodine 126.90447 $[Kr]4d^{10}5s^25p^5$ 10.4513	54 $^1S_0$ **Xe** Xenon 131.293 $[Kr]4d^{10}5s^25p^6$ 12.1298
6	55 $^2S_{1/2}$ **Cs** Cesium 132.9054519 [Xe]6s 3.8939	56 $^1S_0$ **Ba** Barium 137.327 $[Xe]6s^2$ 5.2117		72 $^3F_2$ **Hf** Hafnium 178.49 $[Xe]4f^{14}5d^26s^2$ 6.8251	73 $^4F_{3/2}$ **Ta** Tantalum 180.94788 $[Xe]4f^{14}5d^36s^2$ 7.5496	74 $^5D_0$ **W** Tungsten 183.84 $[Xe]4f^{14}5d^46s^2$ 7.8640	75 $^6S_{5/2}$ **Re** Rhenium 186.207 $[Xe]4f^{14}5d^56s^2$ 7.8335	76 $^5D_4$ **Os** Osmium 190.23 $[Xe]4f^{14}5d^66s^2$ 8.4382	77 $^4F_{9/2}$ **Ir** Iridium 192.217 $[Xe]4f^{14}5d^76s^2$ 8.9670	78 $^3D_3$ **Pt** Platinum 195.084 $[Xe]4f^{14}5d^96s$ 8.9588	79 $^2S_{1/2}$ **Au** Gold 196.966569 $[Xe]4f^{14}5d^{10}6s$ 9.2255	80 $^1S_0$ **Hg** Mercury 200.59 $[Xe]4f^{14}5d^{10}6s^2$ 10.4375	81 $^2P^\circ_{1/2}$ **Tl** Thallium 204.3833 [Hg]6p 6.1082	82 $^3P_0$ **Pb** Lead 207.2 $[Hg]6p^2$ 7.4167	83 $^4S^\circ_{3/2}$ **Bi** Bismuth 208.98040 $[Hg]6p^3$ 7.2855	84 $^3P_2$ **Po** Polonium (209) $[Hg]6p^4$ 8.414	85 $^2P^\circ_{3/2}$ **At** Astatine (210) $[Hg]6p^5$	86 $^1S_0$ **Rn** Radon (222) $[Hg]6p^6$ 10.7485
7	87 $^2S_{1/2}$ **Fr** Francium (223) [Rn]7s 4.0727	88 $^1S_0$ **Ra** Radium (226) $[Rn]7s^2$ 5.2784		104 $^3F_2$? **Rf** Rutherfordium (265) $[Rn]5f^{14}6d^27s^2$? 6.0?	105 **Db** Dubnium (268)	106 **Sg** Seaborgium (271)	107 **Bh** Bohrium (272)	108 **Hs** Hassium (277)	109 **Mt** Meitnerium (276)	110 **Ds** Darmstadtium (281)	111 **Rg** Roentgenium (280)	112 **Cn** Copernicium (285)	113 **Uut** Ununtrium (284)	114 **Uuq** Ununquadium (289)	115 **Uup** Ununpentium (288)	116 **Uuh** Ununhexium (293)	117 **Uus** Ununseptium (294)	118 **Uuo** Ununoctium (294)

Lanthanides	57 $^2D_{3/2}$ **La** Lanthanum 138.90547 $[Xe]5d6s^2$ 5.5769	58 $^1G^\circ_4$ **Ce** Cerium 140.116 $[Xe]4f5d6s^2$ 5.5387	59 $^4I^\circ_{9/2}$ **Pr** Praseodymium 140.90765 $[Xe]4f^36s^2$ 5.473	60 $^5I_4$ **Nd** Neodymium 144.242 $[Xe]4f^46s^2$ 5.5250	61 $^6H^\circ_{5/2}$ **Pm** Promethium (145) $[Xe]4f^56s^2$ 5.582	62 $^7F_0$ **Sm** Samarium 150.36 $[Xe]4f^66s^2$ 5.6437	63 $^8S^\circ_{7/2}$ **Eu** Europium 151.964 $[Xe]4f^76s^2$ 5.6704	64 $^9D^\circ_2$ **Gd** Gadolinium 157.25 $[Xe]4f^75d6s^2$ 6.1498	65 $^6H^\circ_{15/2}$ **Tb** Terbium 158.92535 $[Xe]4f^96s^2$ 5.8638	66 $^5I_8$ **Dy** Dysprosium 162.500 $[Xe]4f^{10}6s^2$ 5.9389	67 $^4I^\circ_{15/2}$ **Ho** Holmium 164.93032 $[Xe]4f^{11}6s^2$ 6.0215	68 $^3H_6$ **Er** Erbium 167.259 $[Xe]4f^{12}6s^2$ 6.1077	69 $^2F^\circ_{7/2}$ **Tm** Thulium 168.93421 $[Xe]4f^{13}6s^2$ 6.1843	70 $^1S_0$ **Yb** Ytterbium 173.054 $[Xe]4f^{14}6s^2$ 6.2542	71 $^2D_{3/2}$ **Lu** Lutetium 174.9668 $[Xe]4f^{14}5d6s^2$ 5.4259
Actinides	89 $^2D_{3/2}$ **Ac** Actinium (227) $[Rn]6d7s^2$ 5.3807	90 $^3F_2$ **Th** Thorium 232.03806 $[Rn]6d^27s^2$ 6.3067	91 $^4K_{11/2}$ **Pa** Protactinium 231.03588 $[Rn]5f^26d7s^2$ 5.89	92 $^5L^\circ_6$ **U** Uranium 238.02891 $[Rn]5f^36d7s^2$ 6.1939	93 $^6L_{11/2}$ **Np** Neptunium (237) $[Rn]5f^46d7s^2$ 6.2657	94 $^7F_0$ **Pu** Plutonium (244) $[Rn]5f^67s^2$ 6.0260	95 $^8S^\circ_{7/2}$ **Am** Americium (243) $[Rn]5f^77s^2$ 5.9738	96 $^9D^\circ_2$ **Cm** Curium (247) $[Rn]5f^76d7s^2$ 5.9914	97 $^6H^\circ_{15/2}$ **Bk** Berkelium (247) $[Rn]5f^97s^2$ 6.1979	98 $^5I_8$ **Cf** Californium (251) $[Rn]5f^{10}7s^2$ 6.2817	99 $^4I^\circ_{15/2}$ **Es** Einsteinium (252) $[Rn]5f^{11}7s^2$ 6.3676	100 $^3H_6$ **Fm** Fermium (257) $[Rn]5f^{12}7s^2$ 6.50	101 $^2F^\circ_{7/2}$ **Md** Mendelevium (258) $[Rn]5f^{13}7s^2$ 6.58	102 $^1S_0$ **No** Nobelium (259) $[Rn]5f^{14}7s^2$ 6.65	103 $^2P^\circ_{1/2}$? **Lr** Lawrencium (262) $[Rn]5f^{14}7s^27p$? 4.9 ?

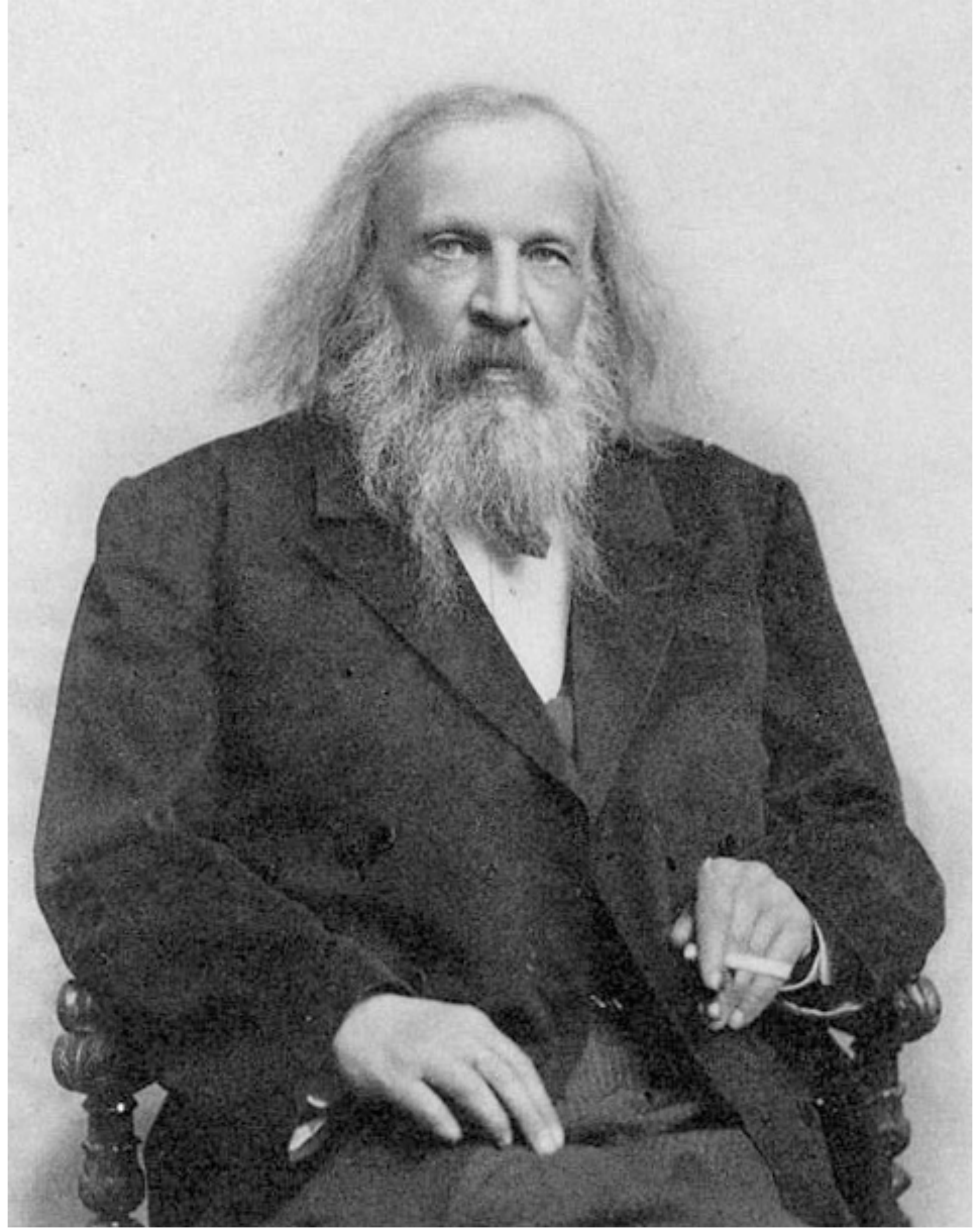
Atomic Number: 58
Ground-state Level: $^1G^\circ_4$
Symbol: **Ce**
Name: Cerium
Atomic Weight†: 140.116
Ground-state Configuration: $[Xe]4f5d6s^2$
Ionization Energy (eV): 5.5387

†Based upon ^{12}C. () indicates the mass number of the longest-lived isotope.

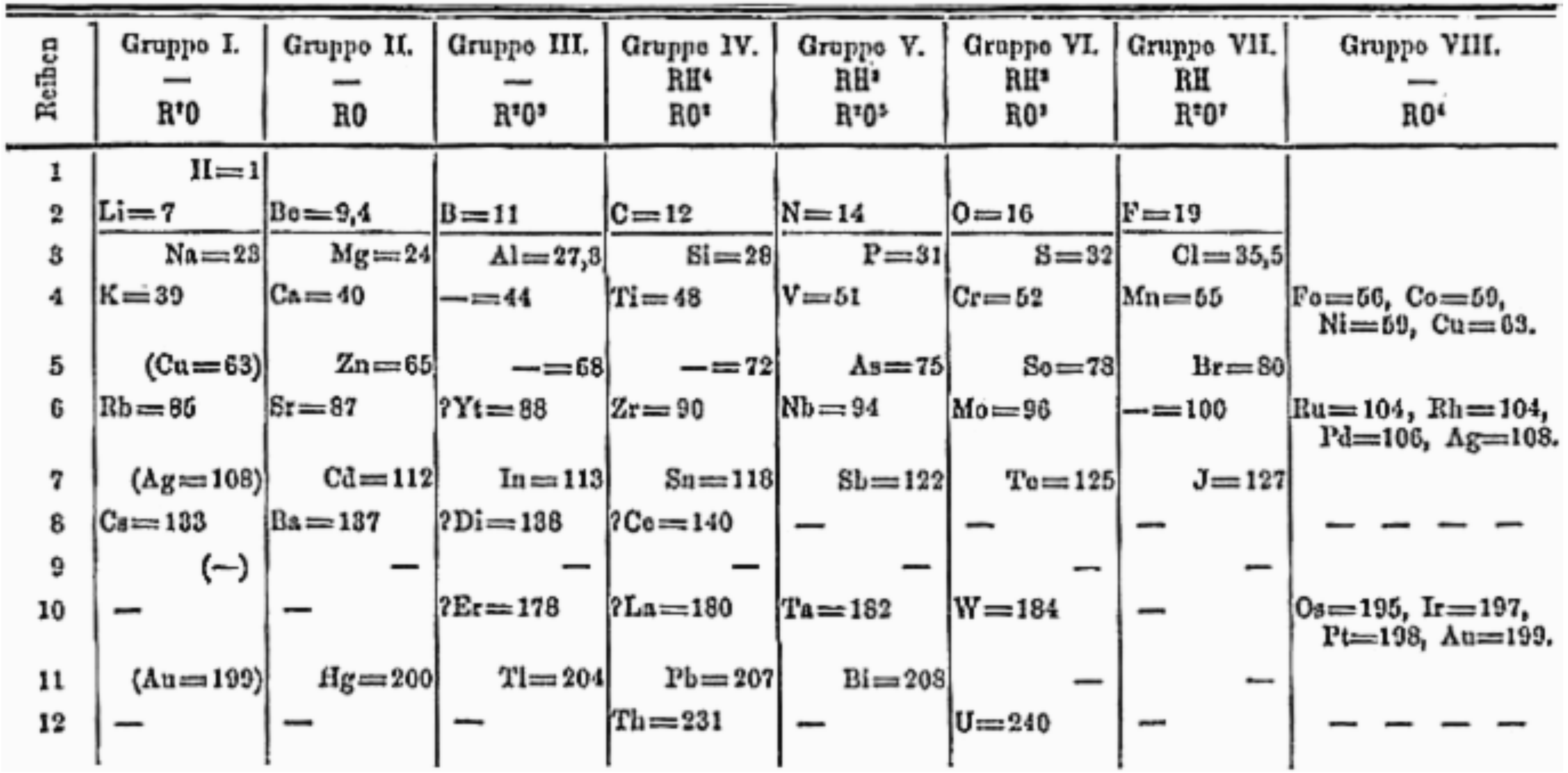
For a description of the data, visit physics.nist.gov/data

NIST SP 966 (September 2010)

22 F_2 **Ti** Titanium 47.867 [Ar]$3d^24s^2$ 6.8281	23 $F_{3/2}$ **V** Vanadium 50.9415 [Ar]$3d^34s^2$ 6.7462	24 S_3 **Cr** Chromium 51.9961 [Ar]$3d^54s$ 6.7665	25 $S_{5/2}$ **Mn** Manganese 54.938045 [Ar]$3d^54s^2$ 7.4340	26 D_4 **Fe** Iron 55.845 [Ar]$3d^64s^2$ 7.9024	27 $F_{9/2}$ **Co** Cobalt 58.933195 [Ar]$3d^74s^2$ 7.8810	28 F_4 **Ni** Nickel 58.6934 [Ar]$3d^84s^2$ 7.6399
40 $^3F_2$ **Zr** Zirconium 91.224 [Kr]$4d^25s^2$ 6.6339	41 $^6D_{1/2}$ **Nb** Niobium 92.90638 [Kr]$4d^45s$ 6.7589	42 $^7S_3$ **Mo** Molybdenum 95.96 [Kr]$4d^55s$ 7.0924	43 $^6S_{5/2}$ **Tc** Technetium (98) [Kr]$4d^55s^2$ 7.28	44 $^5F_5$ **Ru** Ruthenium 101.07 [Kr]$4d^75s$ 7.3605	45 $^4F_{9/2}$ **Rh** Rhodium 102.90550 [Kr]$4d^85s$ 7.4589	46 ^1S **Pd** Palladium 106.42 [Kr]$4d^{10}$ 8.3369
72 $^3F_2$ **Hf** Hafnium 178.49	73 $^4F_{3/2}$ **Ta** Tantalum 180.94788	74 $^5D_0$ **W** Tungsten 183.84	75 $^6S_{5/2}$ **Re** Rhenium 186.207	76 $^5D_4$ **Os** Osmium 190.23	77 $^4F_{9/2}$ **Ir** Iridium 192.217	78 ^3D **Pt** Platinum 195.084

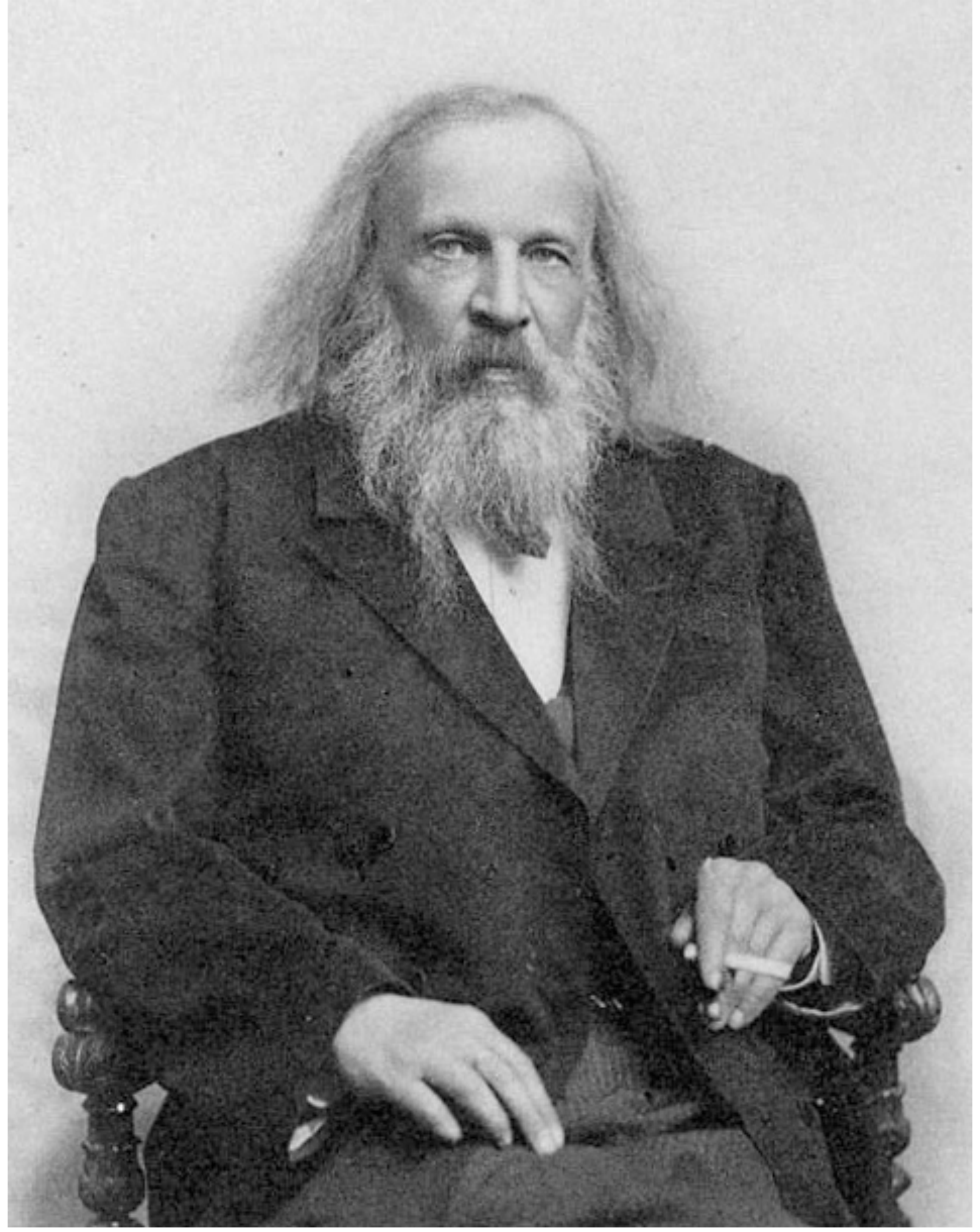


Mendeleev

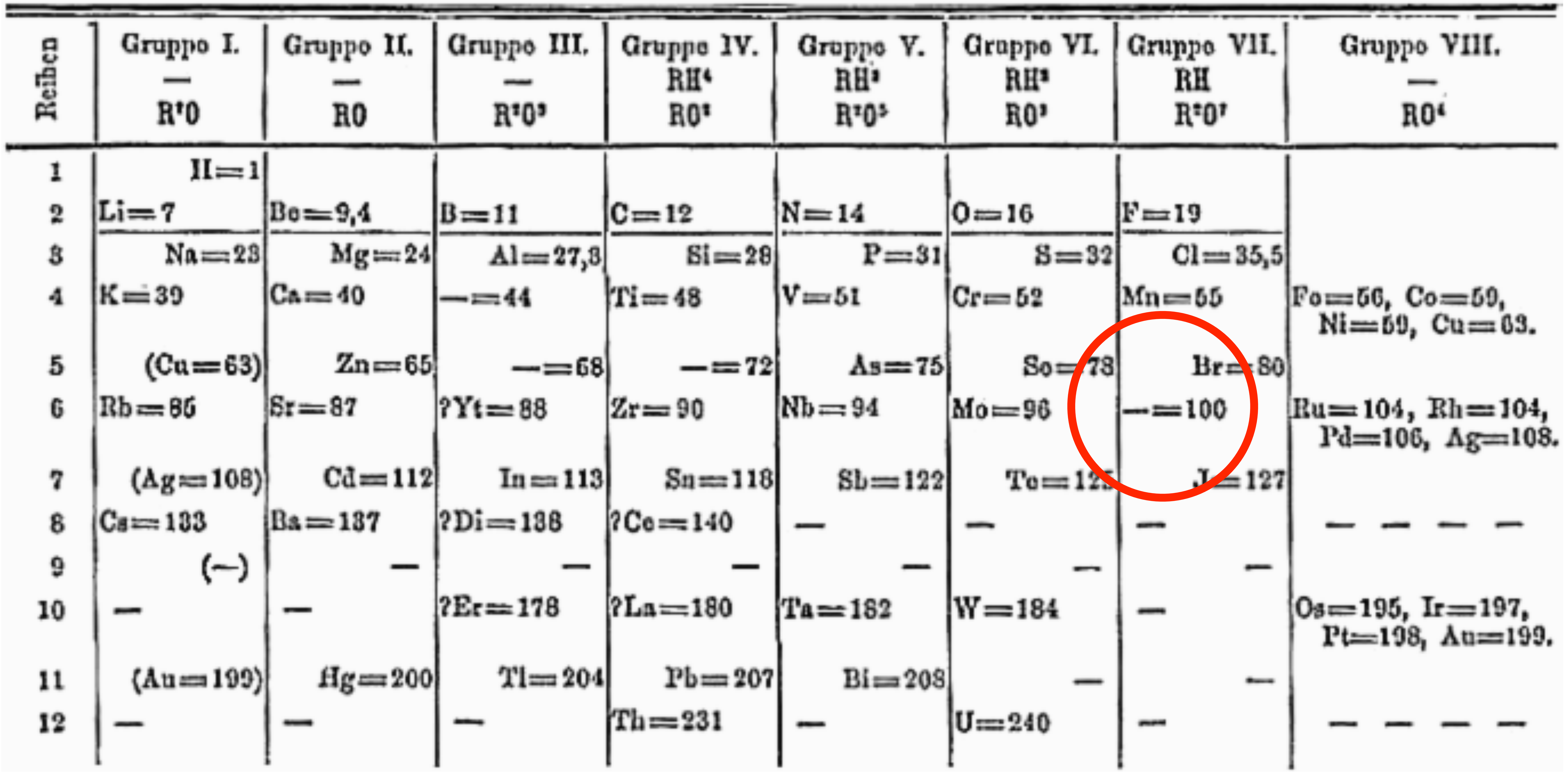


Reihen	Gruppo I. — R^2O	Gruppo II. — RO	Gruppo III. — R^2O^3	Gruppo IV. RH^4 RO^2	Gruppo V. RH^3 R^2O^5	Gruppo VI. RH^2 RO^3	Gruppo VII. RH R^2O^7	Gruppo VIII. — RO^4
1	H=1							
2	Li=7	Be=9,4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27,3	Si=28	P=31	S=32	Cl=35,5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59, Ni=59, Cu=63.
5	(Cu=63)	Zn=65	—=68	—=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
10	—	—	?Er=178	?La=180	Ta=182	W=184	—	Os=195, Ir=197, Pt=198, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —

de Jonge, Frederik AA, and Ernest KJ Pauwels. “Technetium, the Missing Element.” European Journal of Nuclear Medicine, vol. 23, no. 3, 1996, pp. 336–344.



Mendeleev

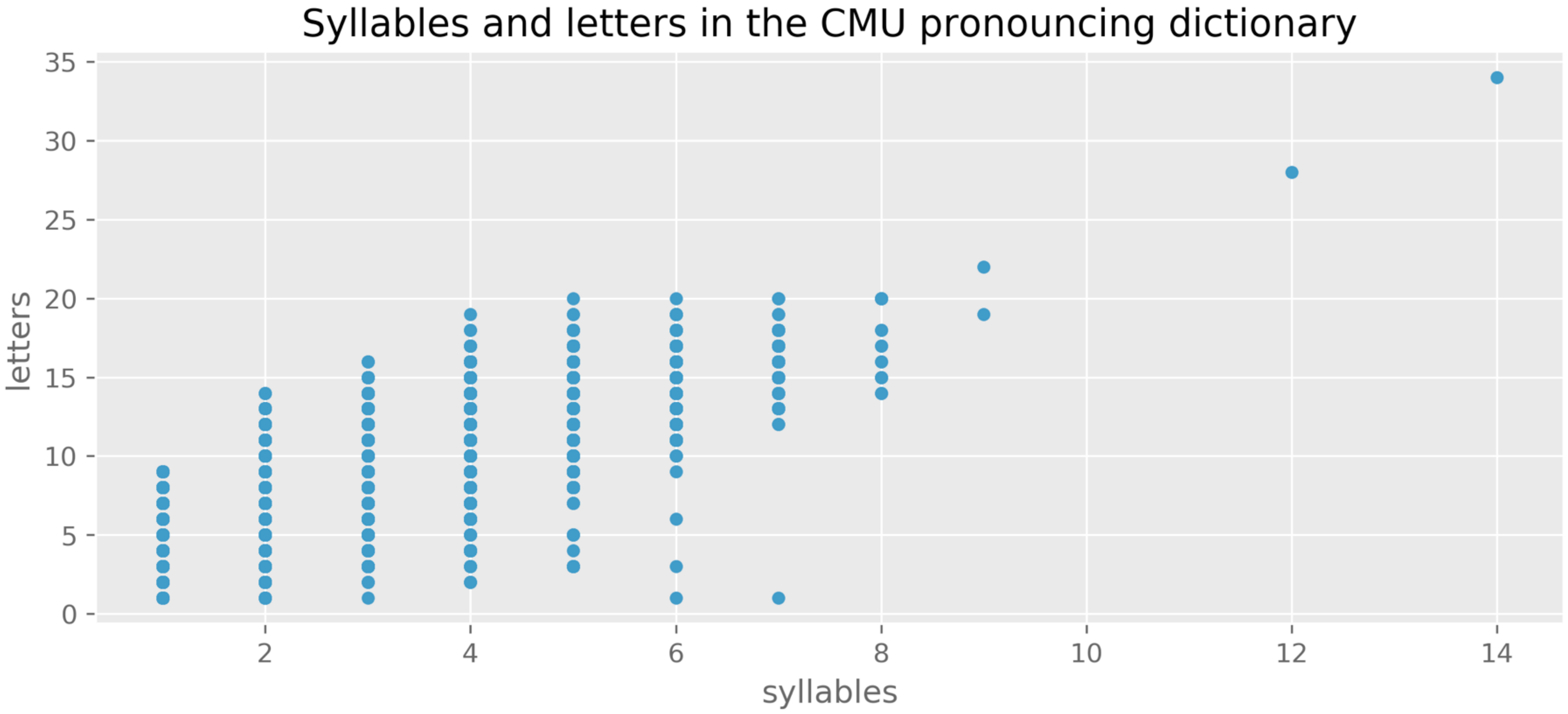


Reihen	Gruppo I. — R^2O	Gruppo II. — RO	Gruppo III. — R^2O^3	Gruppo IV. RH^4 RO^2	Gruppo V. RH^3 R^2O^5	Gruppo VI. RH^2 RO^3	Gruppo VII. RH R^2O^7	Gruppo VIII. — RO^4
1	H=1							
2	Li=7	Be=9,4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27,3	Si=28	P=31	S=32	Cl=35,5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59, Ni=59, Cu=63.
5	(Cu=63)	Zn=65	—=68	—=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
10	—	—	?Er=178	?La=180	Ta=182	W=184	—	Os=195, Ir=197, Pt=198, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —

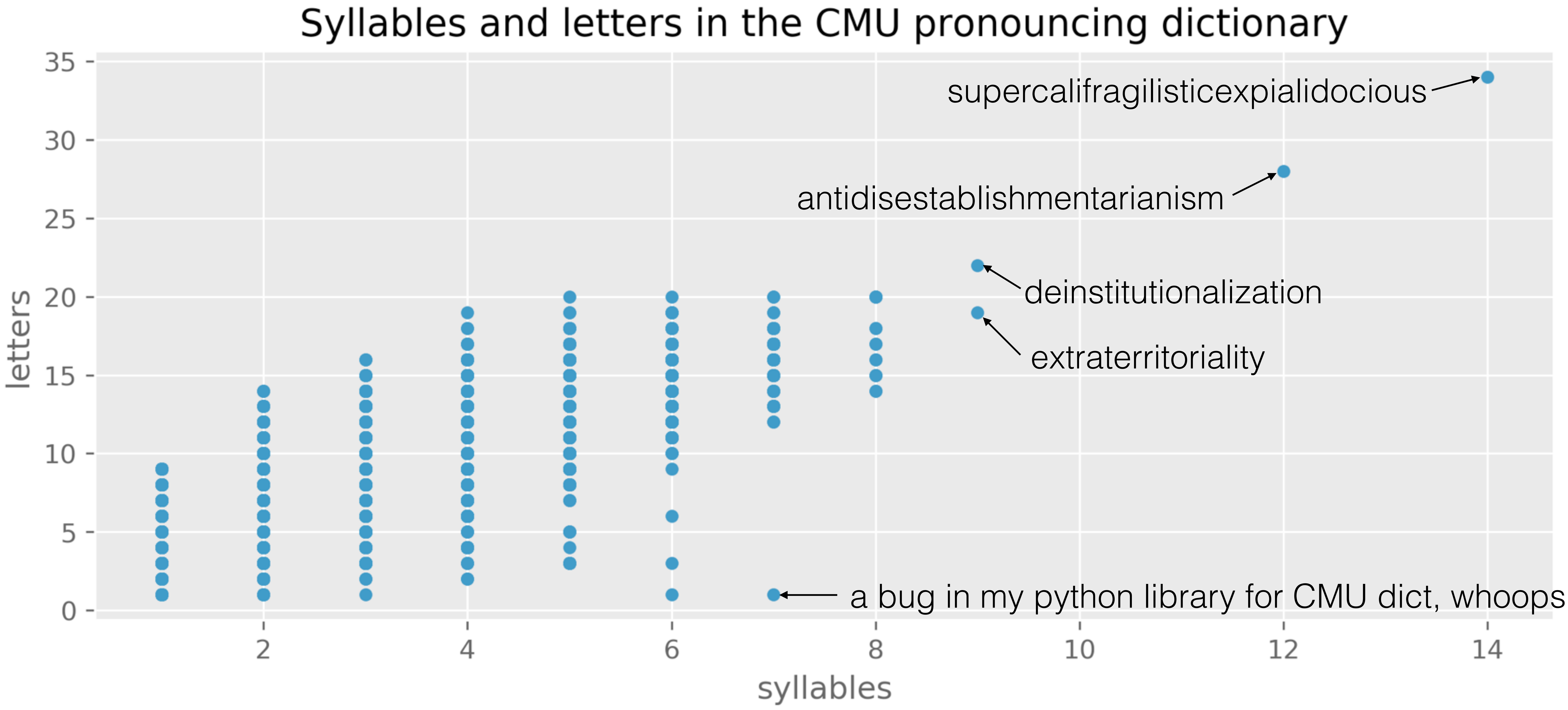
de Jonge, Frederik AA, and Ernest KJ Pauwels. “Technetium, the Missing Element.” European Journal of Nuclear Medicine, vol. 23, no. 3, 1996, pp. 336–344.

scatter plots...?

regular scatter plot

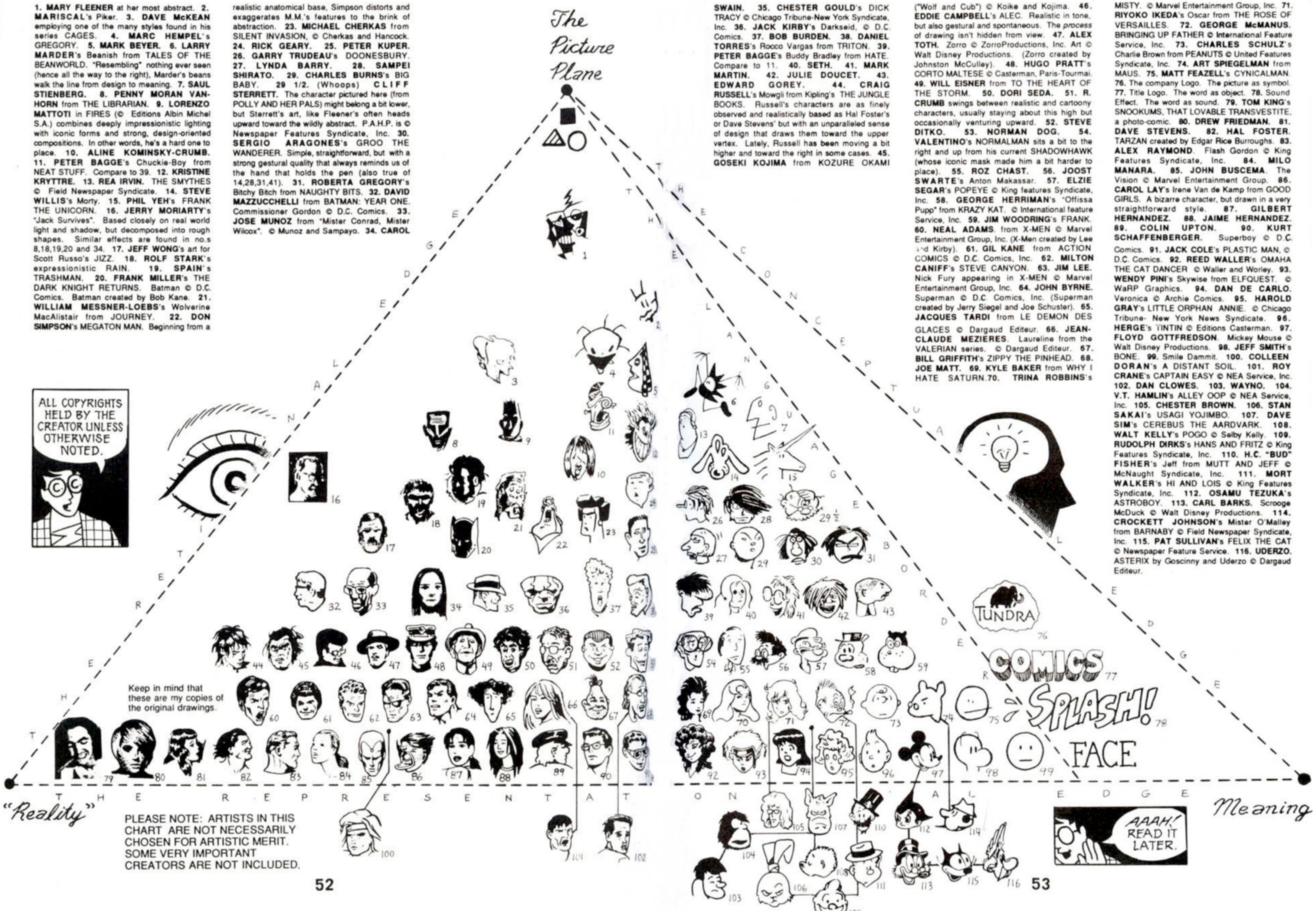


regular scatter plot



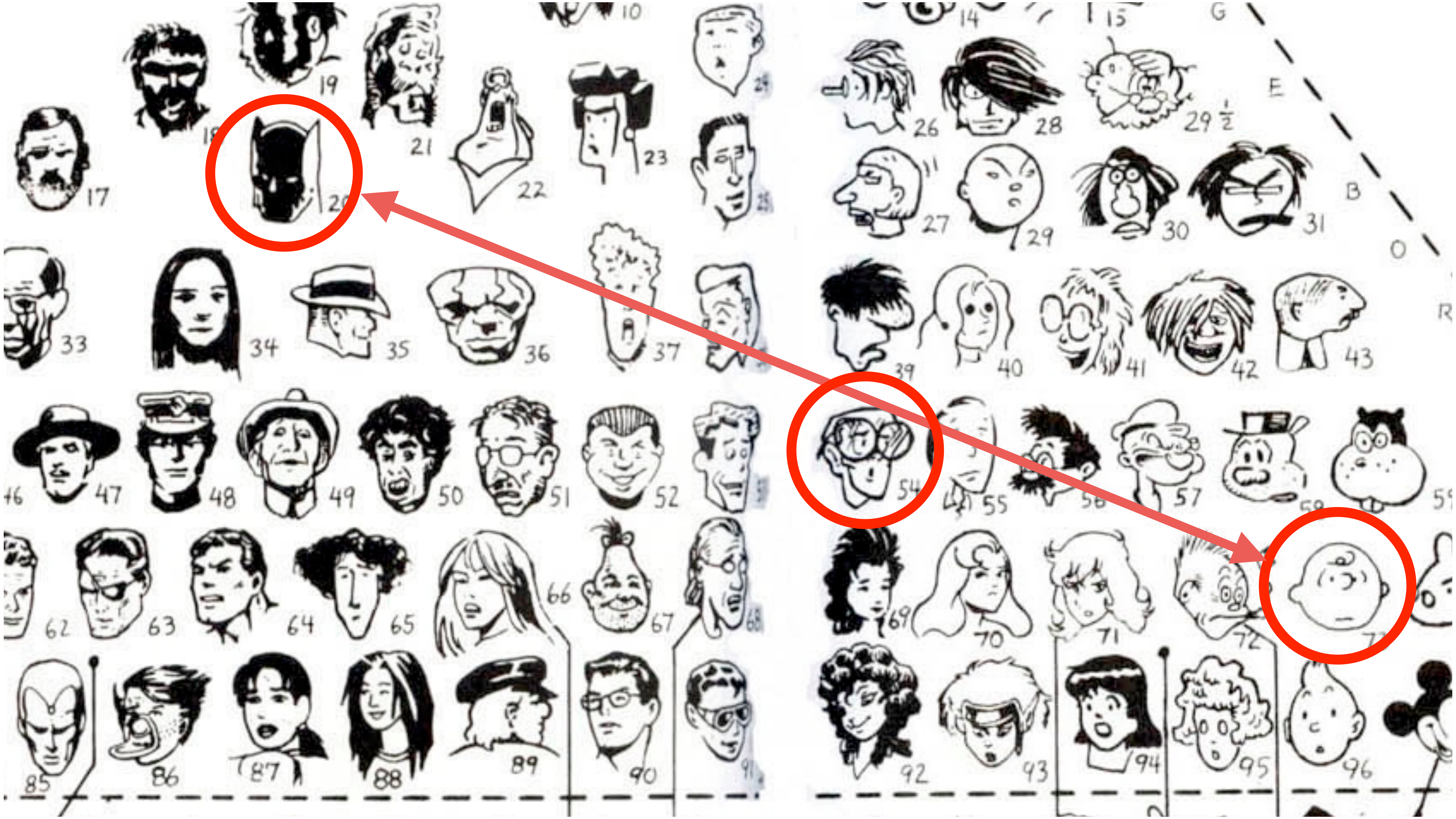
scatter plots of *likenesses*

1. **MARY FLEENER** at her most abstract. 2. **MARISCAL**'s Piker. 3. **DAVE McKEAN** employing one of the many styles found in his series CAGES. 4. **MARC HEMPEL**'s GREGORY. 5. **MARK BEYER.** 6. **LARRY MARDER**'s Beanish from TALES OF THE BEANWORLD. "Resembling" nothing ever seen (hence all the way to the right), Marder's beans walk the line from design to meaning. 7. **SAUL STIENBERG.** 8. **PENNY MORAN VAN-HORN** from THE LIBRARIAN. 9. **LORENZO MATTOTI** in FIRES (© Editions Albin Michel S.A.) combines deeply impressionistic lighting with iconic forms and strong, design-oriented compositions. In other words, he's a hard one to place. 10. **ALINE KOMINSKY-CRUMB.** 11. **PETER BAGGE**'s Chuckie-Boy from NEAT STUFF. Compare to 39. 12. **KRISTINE KRYTTRE.** 13. **REA IRVIN.** THE SMYTHES © Field Newspaper Syndicate. 14. **STEVE WILLIS**'s Morty. 15. **PHIL YEH**'s FRANK THE UNICORN. 16. **JERRY MORIARTY**'s "Jack Survives". Based closely on real world light and shadow, but decomposed into rough shapes. Similar effects are found in no.s 8,18,19,20 and 34. 17. **JEFF WONG**'s art for Scott Russo's JIZZ. 18. **ROLF STARK**'s expressionistic RAIN. 19. **SPAIN**'s TRASHMAN. 20. **FRANK MILLER**'s THE DARK KNIGHT RETURNS. Batman © D.C. Comics. Batman created by Bob Kane. 21. **WILLIAM MESSNER-LOEBS**'s Wolverine MacAlistair from JOURNEY. 22. **DON SIMPSON**'s MEGATON MAN. Beginning from a realistic anatomical base, Simpson distorts and exaggerates M.M.'s features to the brink of abstraction. 23. **MICHAEL CHERKAS** from SILENT INVASION, © Cherkas and Hancock. 24. **RICK GEARY.** 25. **PETER KUPER.** 26. **GARRY TRUDEAU**'s DOONESBURY. 27. **LYNDA BARRY.** 28. **SAMPEI SHIRATO.** 29. **CHARLES BURNS**'s BIG BABY. 29 1/2. (Whoops) **CLIFF STERRETT.** The character pictured here (from POLLY AND HER PALS) might belong a bit lower, but Sterrett's art, like Fleener's often heads upward toward the wildly abstract. P.A.H.P. is © Newspaper Features Syndicate, Inc. 30. **SERGIO ARAGONES**'s GROO THE WANDERER. Simple, straightforward, but with a strong gestural quality that always reminds us of the hand that holds the pen (also true of 14,28,31,41). 31. **ROBERTA GREGORY**'s Bitchy Bitch from NAUGHTY BITS. 32. **DAVID MAZZUCCHELLI** from BATMAN: YEAR ONE. Commissioner Gordon © D.C. Comics. 33. **JOSE MUNOZ** from "Mister Conrad, Mister Wilcox". © Munoz and Sampayo. 34. **CAROL SWAIN.** 35. **CHESTER GOULD**'s DICK TRACY © Chicago Tribune-New York Syndicate, Inc. 36. **JACK KIRBY**'s Darkseid, © D.C. Comics. 37. **BOB BURDEN.** 38. **DANIEL TORRES**'s Rocco Vargas from TRITON. 39. **PETER BAGGE**'s Buddy Bradley from HATE. Compare to 11. 40. **SETH.** 41. **MARK MARTIN.** 42. **JULIE DOUCET.** 43. **EDWARD GOREY.** 44. **CRAIG RUSSELL**'s Mowgli from Kipling's THE JUNGLE BOOKS. Russell's characters are as finely observed and realistically based as Hal Foster's or Dave Stevens' but with an unparalleled sense of design that draws them toward the upper vertex. Lately, Russell has been moving a bit higher and toward the right in some cases. 45. **GOSEKI KOJIMA** from KOZURE OKAMI ("Wolf and Cub") © Koike and Kojima. 46. **EDDIE CAMPBELL**'s ALEC. Realistic in tone, but also gestural and spontaneous. The *process* of drawing isn't hidden from view. 47. **ALEX TOTH.** Zorro © ZorroProductions, Inc. Art © Walt Disney Productions. (Zorro created by Johnston McCulley). 48. **HUGO PRATT**'s CORTO MALTESE © Casterman, Paris-Tourmai. 49. **WILL EISNER** from TO THE HEART OF THE STORM. 50. **DORI SEDA.** 51. **R. CRUMB** swings between realistic and cartoony characters, usually staying about this high but occasionally venturing upward. 52. **STEVE DITKO.** 53. **NORMAN DOG.** 54. **VALENTINO**'s NORMALMAN sits a bit to the right and up from his current SHADOWHAWK (whose iconic mask made him a bit harder to place). 55. **ROZ CHAST.** 56. **JOOST SWARTE**'s Anton Makassar. 57. **ELZIE SEGAR**'s POPEYE © King features Syndicate, Inc. 58. **GEORGE HERRIMAN**'s "Offissa Pupp" from KRAZY KAT. © International feature Service, Inc. 59. **JIM WOODRING**'s FRANK. 60. **NEAL ADAMS**. from X-MEN © Marvel Entertainment Group, Inc. (X-Men created by Lee and Kirby). 61. **GIL KANE** from ACTION COMICS © D.C. Comics, Inc. 62. **MILTON CANIFF**'s STEVE CANYON. 63. **JIM LEE.** Nick Fury appearing in X-MEN © Marvel Entertainment Group, Inc. 64. **JOHN BYRNE.** Superman © D.C. Comics, Inc. (Superman created by Jerry Siegel and Joe Schuster). 65. **JACQUES TARDI** from LE DEMON DES GLACES © Dargaud Editeur. 66. **JEAN-CLAUDE MEZIERES**. Laureline from the VALERIAN series. © Dargaud Editeur. 67. **BILL GRIFFITH**'s ZIPPY THE PINHEAD. 68. **JOE MATT.** 69. **KYLE BAKER** from WHY I HATE SATURN.70. **TRINA ROBBINS**'s MISTY. © Marvel Entertainment Group, Inc. 71. **RIYOKO IKEDA**'s Oscar from THE ROSE OF VERSAILLES. 72. **GEORGE McMANUS.** BRINGING UP FATHER © International Feature Service, Inc. 73. **CHARLES SCHULZ**'s Charlie Brown from PEANUTS © United Features Syndicate, Inc. 74. **ART SPIEGELMAN** from MAUS. 75. **MATT FEAZELL**'s CYNICALMAN. 76. The company Logo. The picture as symbol. 77. Title Logo. The word as object. 78. Sound Effect. The word as sound. 79. **TOM KING**'s SNOOKUMS, THAT LOVABLE TRANSVESTITE, a photo-comic. 80. **DREW FRIEDMAN.** 81. **DAVE STEVENS.** 82. **HAL FOSTER.** TARZAN created by Edgar Rice Burroughs. 83. **ALEX RAYMOND**. Flash Gordon © King Features Syndicate, Inc. 84. **MILO MANARA.** 85. **JOHN BUSCEMA**. The Vision © Marvel Entertainment Group. 86. **CAROL LAY**'s Irene Van de Kamp from GOOD GIRLS. A bizarre character, but drawn in a very straightforward style. 87. **GILBERT HERNANDEZ.** 88. **JAIME HERNANDEZ.** 89. **COLIN UPTON.** 90. **KURT SCHAFFENBERGER.** Superboy © D.C. Comics. 91. **JACK COLE**'s PLASTIC MAN, © D.C. Comics. 92. **REED WALLER**'s OMAHA THE CAT DANCER © Waller and Worley. 93. **WENDY PINI**'s Skywise from ELFQUEST. © WaRP Graphics. 94. **DAN DE CARLO.** Veronica © Archie Comics. 95. **HAROLD GRAY**'s LITTLE ORPHAN ANNIE. © Chicago Tribune- New York News Syndicate. 96. **HERGE**'s TINTIN © Editions Casterman. 97. **FLOYD GOTTFREDSON**. Mickey Mouse © Walt Disney Productions. 98. **JEFF SMITH**'s BONE. 99. Smile Dammit. 100. **COLLEEN DORAN**'s A DISTANT SOIL. 101. **ROY CRANE**'s CAPTAIN EASY © NEA Service, Inc. 102. **DAN CLOWES.** 103. **WAYNO.** 104. **V.T. HAMLIN**'s ALLEY OOP © NEA Service, Inc. 105. **CHESTER BROWN.** 106. **STAN SAKAI**'s USAGI YOJIMBO. 107. **DAVE SIM**'s CEREBUS THE AARDVARK. 108. **WALT KELLY**'s POGO © Selby Kelly. 109. **RUDOLPH DIRKS**'s HANS AND FRITZ © King Features Syndicate, Inc. 110. **H.C. "BUD" FISHER**'s Jeff from MUTT AND JEFF © McNaught Syndicate, Inc. 111. **MORT WALKER**'s HI AND LOIS © King Features Syndicate, Inc. 112. **OSAMU TEZUKA**'s ASTROBOY. 113. **CARL BARKS.** Scrooge McDuck © Walt Disney Productions. 114. **CROCKETT JOHNSON**'s Mister O'Malley from BARNABY © Field Newspaper Syndicate, Inc. 115. **PAT SULLIVAN**'s FELIX THE CAT © Newspaper Feature Service. 116. **UDERZO.** ASTERIX by Goscinny and Uderzo © Dargaud Editeur.



Keep in mind that these are my copies of the original drawings.

PLEASE NOTE: ARTISTS IN THIS CHART ARE NOT NECESSARILY CHOSEN FOR ARTISTIC MERIT. SOME VERY IMPORTANT CREATORS ARE NOT INCLUDED.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From McCloud, Scott. Understanding Comics: The Invisible Art. Tundra Publishing, 1993, pp. 52–53.

scatter plots of likenesses with t-sne (and other manifold learning techniques)

Van der Maaten, Laurens and Geoffrey Hinton. “Visualizing Data Using T-SNE.” Journal of Machine Learning Research, vol. 9, no. Nov, 2008, pp. 2579–2605.

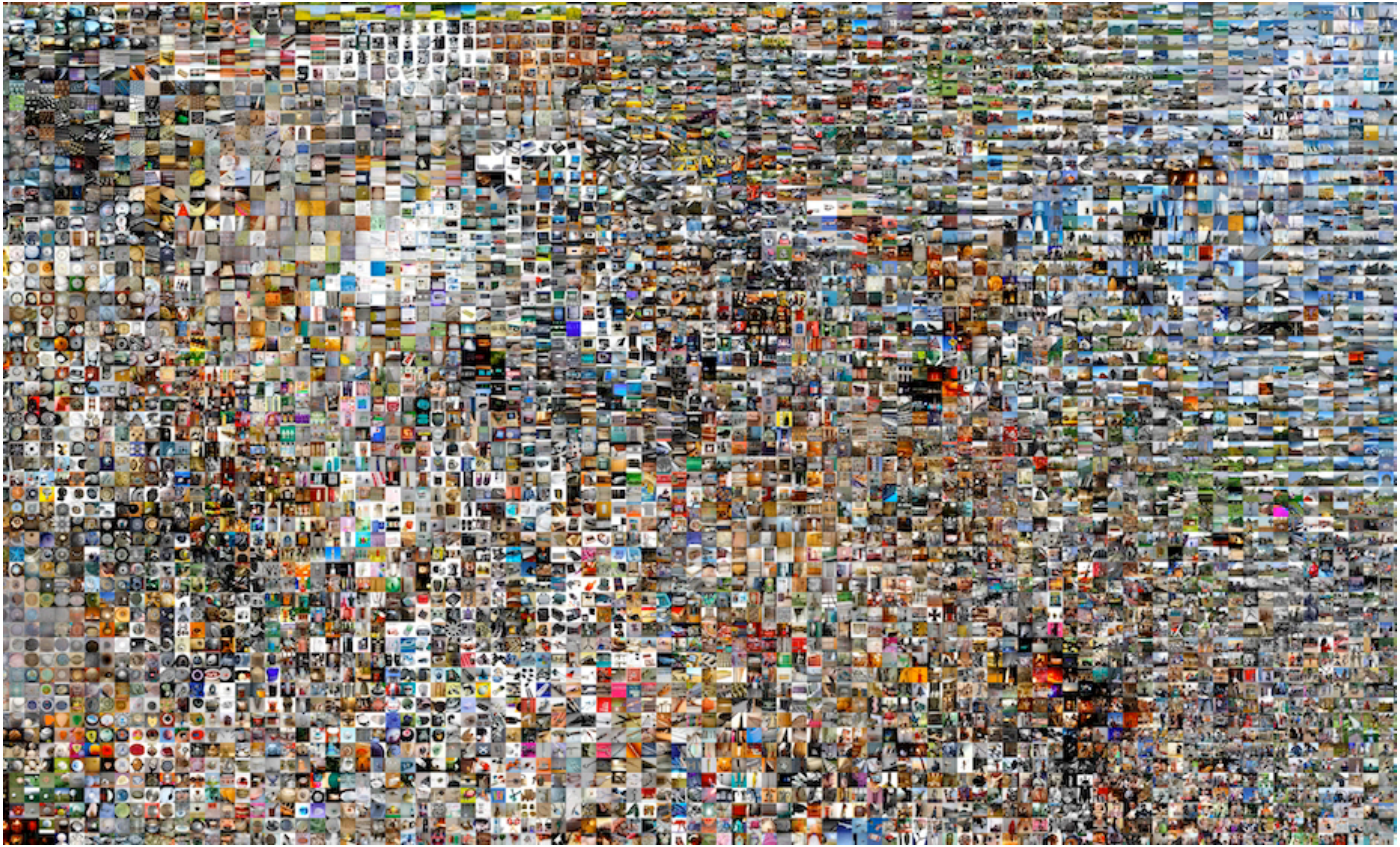


Image from Andrej Karpathy's t-SNE visualization of CNN codes:
https://cs.stanford.edu/people/karpathy/cnnembed/

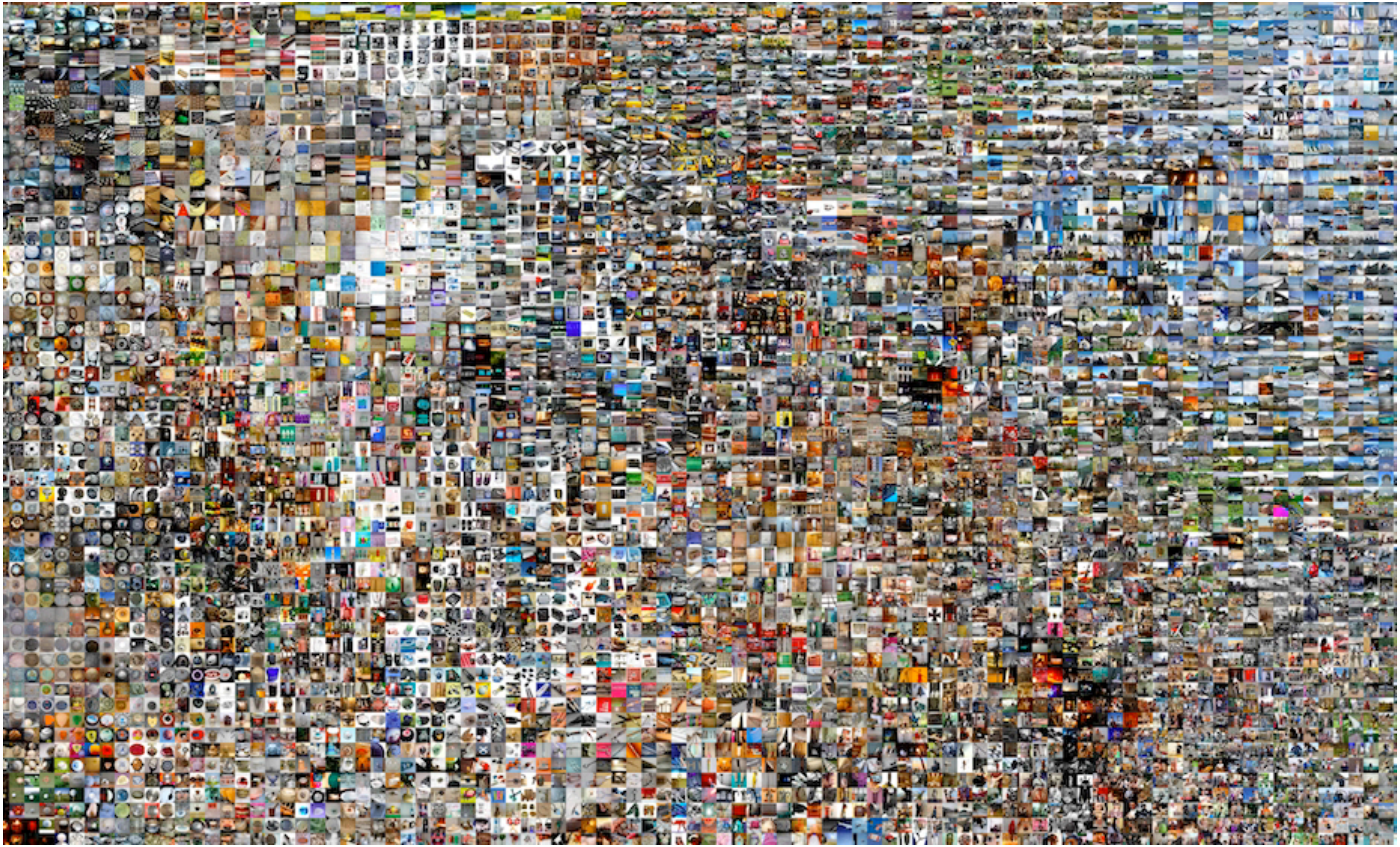
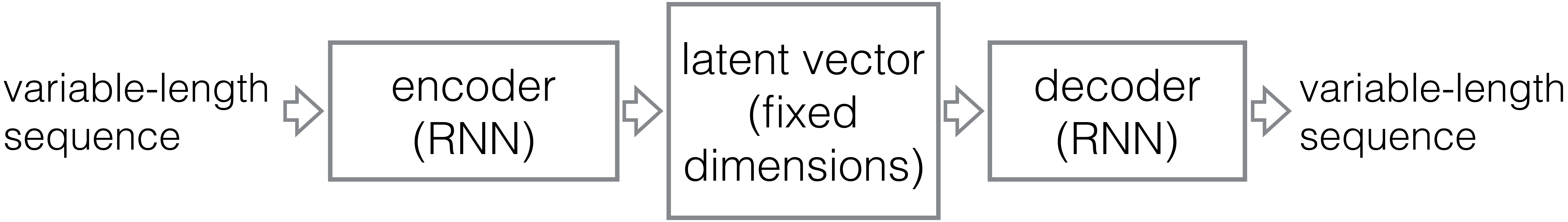


Image from Andrej Karpathy's t-SNE visualization of CNN codes:
https://cs.stanford.edu/people/karpathy/cnnembed/

variational autoencoders

structure of a variational autoencoder for sequences



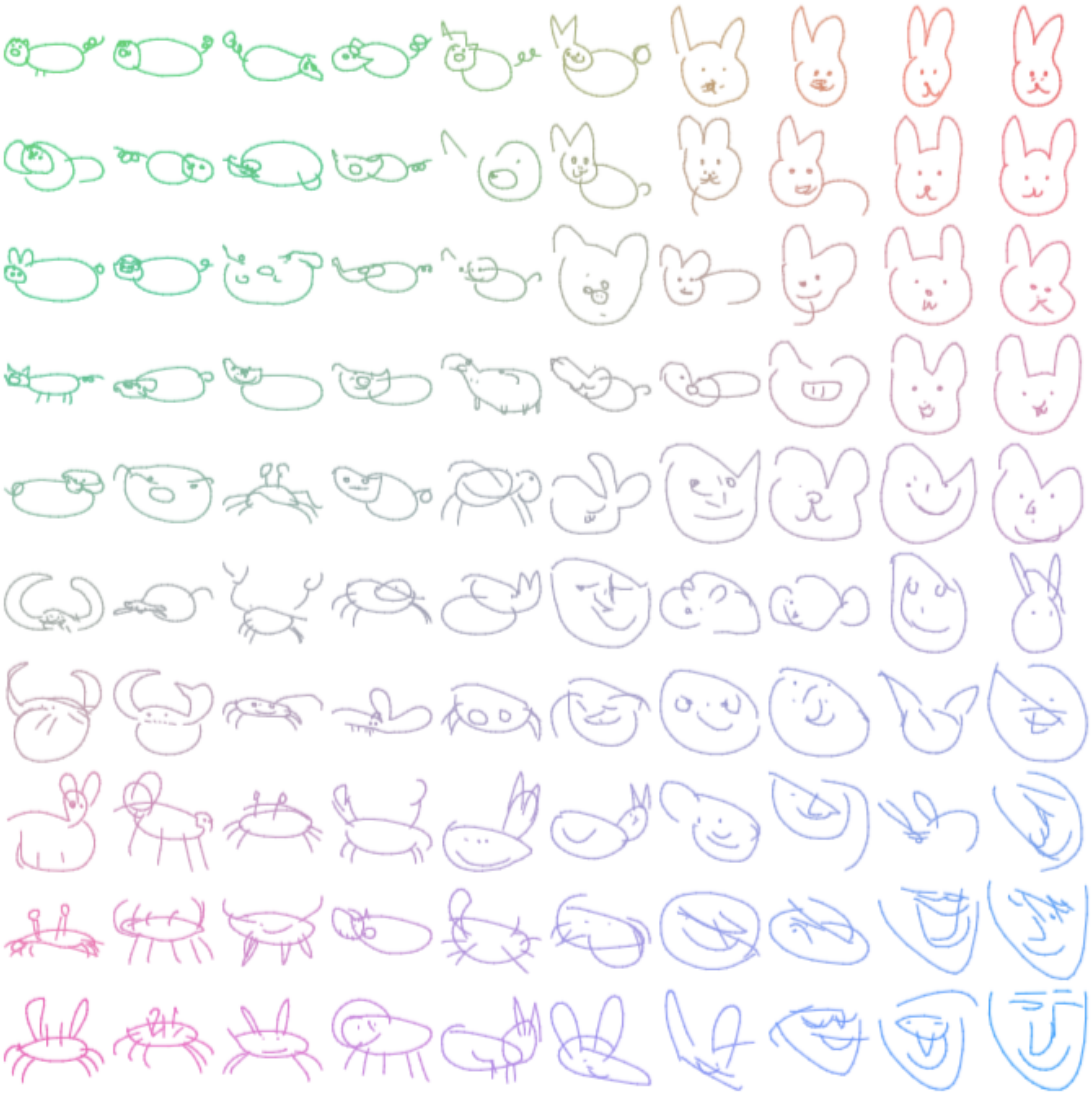
variable-length sequence

encoder (RNN)

latent vector (fixed dimensions)

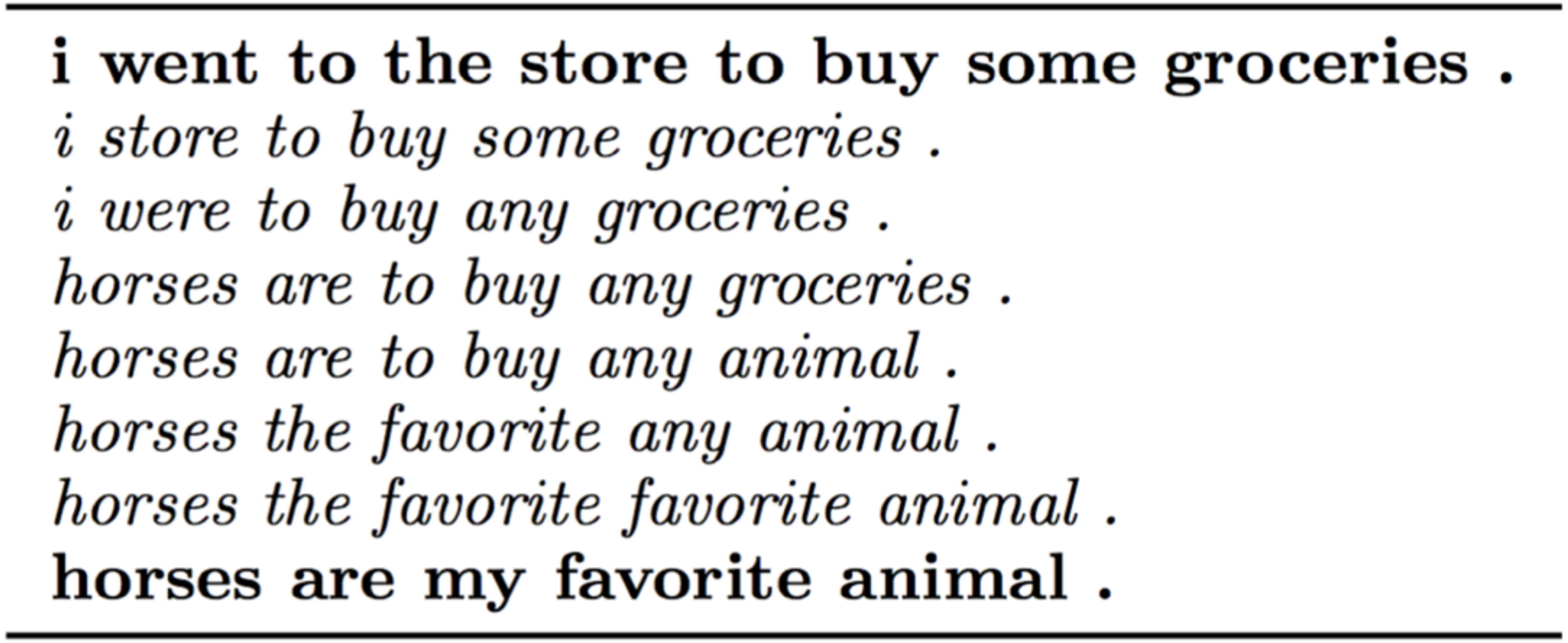
decoder (RNN)

variable-length sequence



sketch-rnn

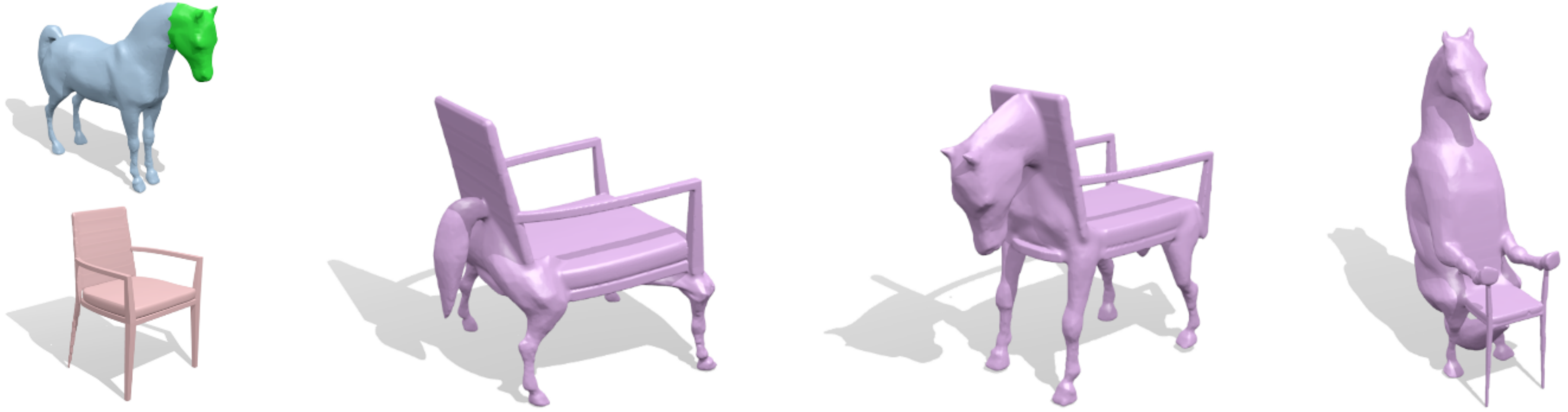
Ha, David, and Douglas Eck. "A Neural Representation of Sketch Drawings." ArXiv:1704.03477 [Cs, Stat], Apr. 2017. arXiv.org, http://arxiv.org/abs/1704.03477.



i went to the store to buy some groceries .
i store to buy some groceries .
i were to buy any groceries .
horses are to buy any groceries .
horses are to buy any animal .
horses the favorite any animal .
horses the favorite favorite animal .
horses are my favorite animal .

Bowman, Samuel R., et al. “Generating Sentences from a Continuous Space.” ArXiv: 1511.06349 [Cs], Nov. 2015. arXiv.org, http://arxiv.org/abs/1511.06349.

those weird horse chairs

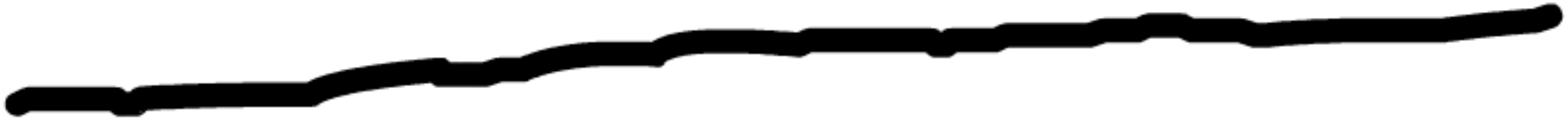


(h) **(i)** *Low Visual Salience* **(j)** *Medium Visual Salience* **(k)** *High Visual Salience*

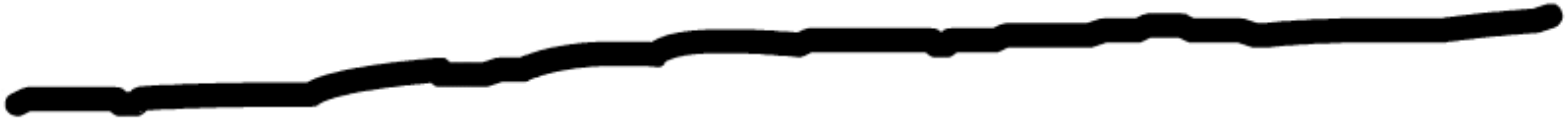
Duncan, Noah, et al. “Zoomorphic Design.” ACM Transactions on Graphics, vol. 34, no. 4, July 2015, pp. 95:1-95:13. Crossref, doi:10.1145/2766902.

...which I found out about because of Noah Veltman's amazing OpenVisConf 2017 talk. His bibliography here: https://github.com/veltman/openvis

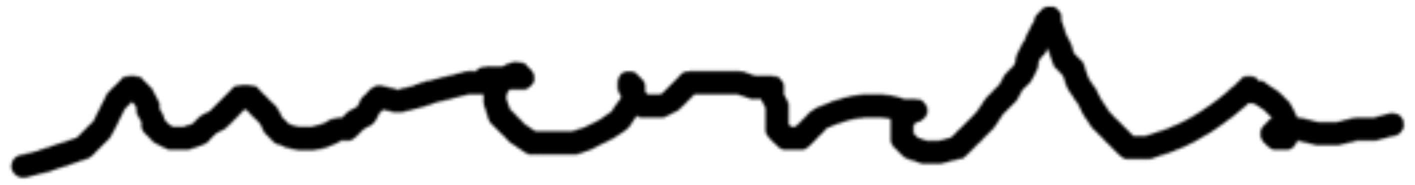
interpolating letterforms

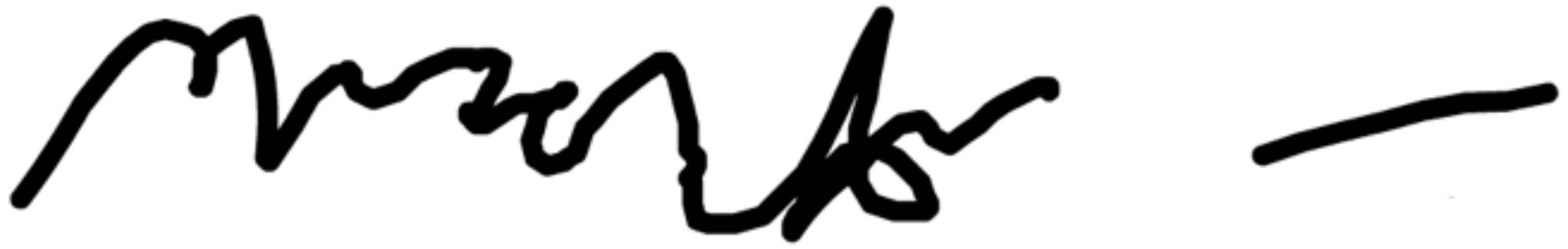


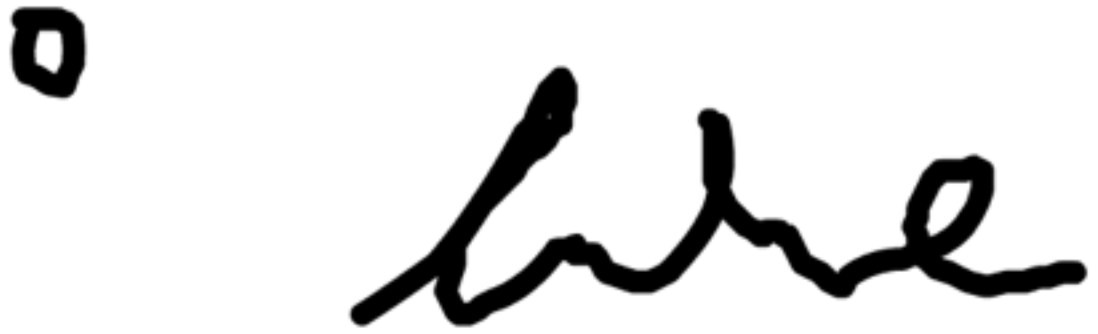
Waber, Dan. Poidog. 2005, http://www.vispo.com/guests/DanWaber/poidog.htm. [as cited in Brownie, Barbara. “One Form, Many Letters: Fluid and Transient Letterforms in Screen-Based Typographic Artefacts.” Networking Knowledge: Journal of the MeCCSA Postgraduate Network, vol. 1, no. 2, 2007.]

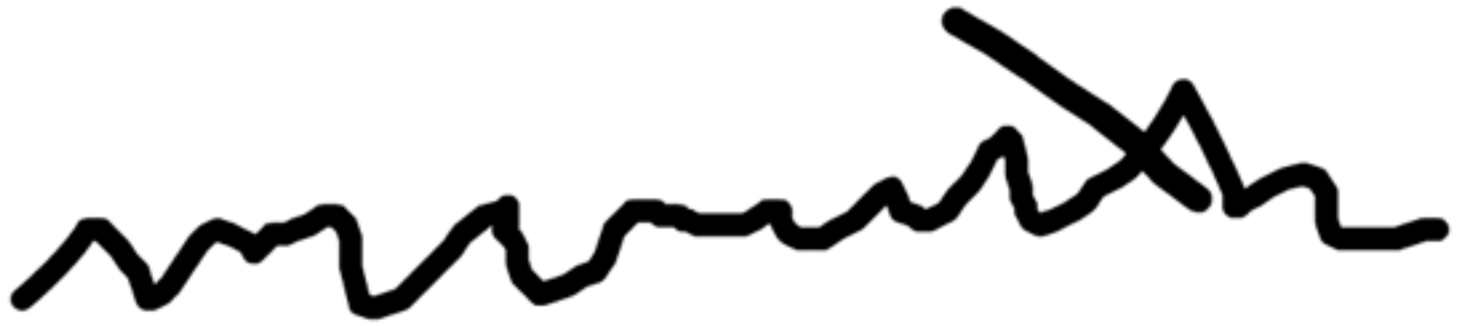


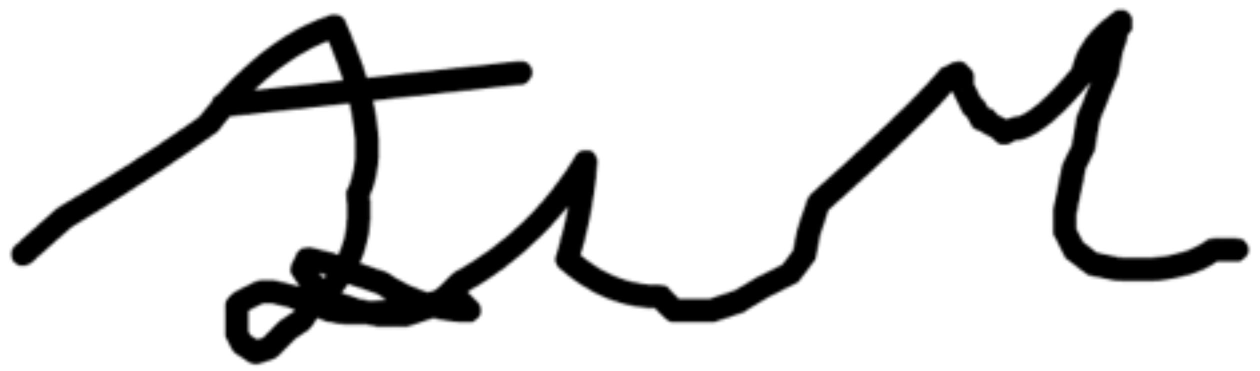
Waber, Dan. Poidog. 2005, http://www.vispo.com/guests/DanWaber/poidog.htm. [as cited in Brownie, Barbara. “One Form, Many Letters: Fluid and Transient Letterforms in Screen-Based Typographic Artefacts.” Networking Knowledge: Journal of the MeCCSA Postgraduate Network, vol. 1, no. 2, 2007.]

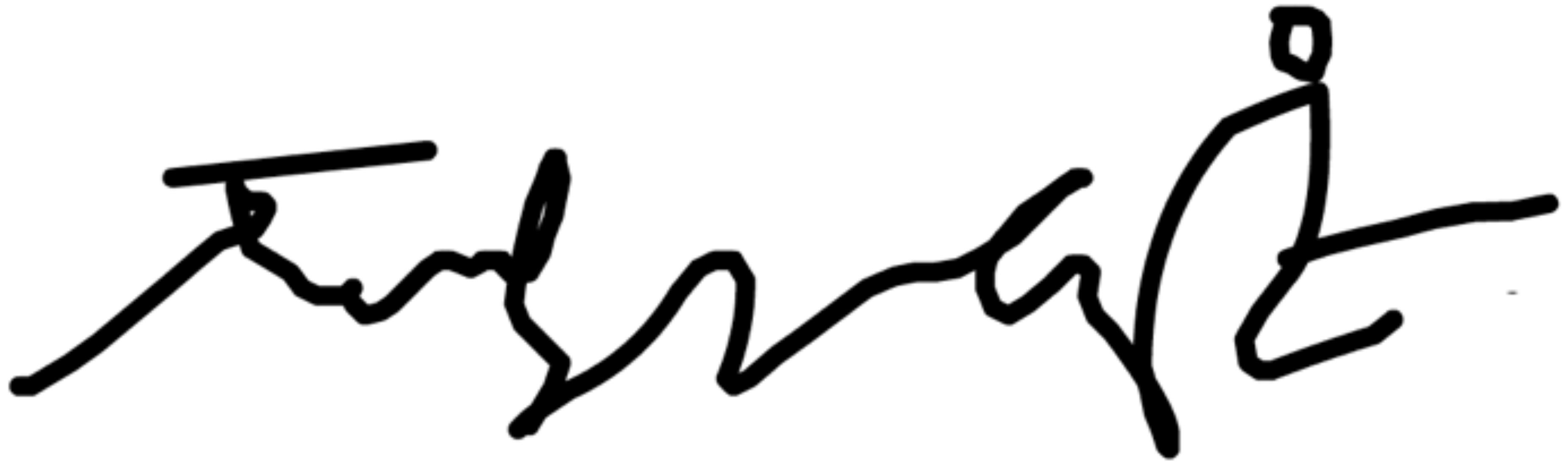












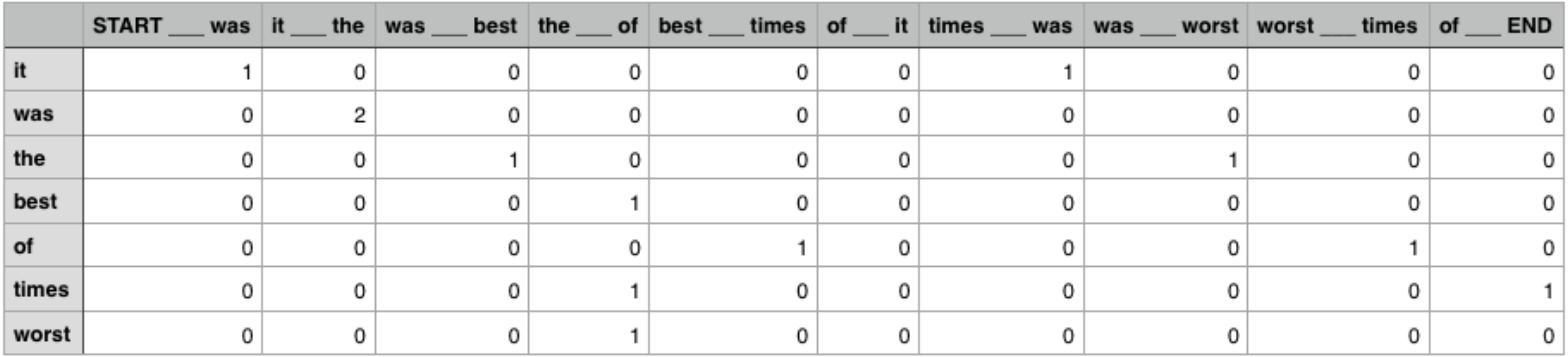
okay that was other people's stuff, here are some of my own experiments in computational interpolation, with language specifically q: how do you "establish a point" for a word?

a: word vectors!

word vectors (word2vec, glove, etc.)

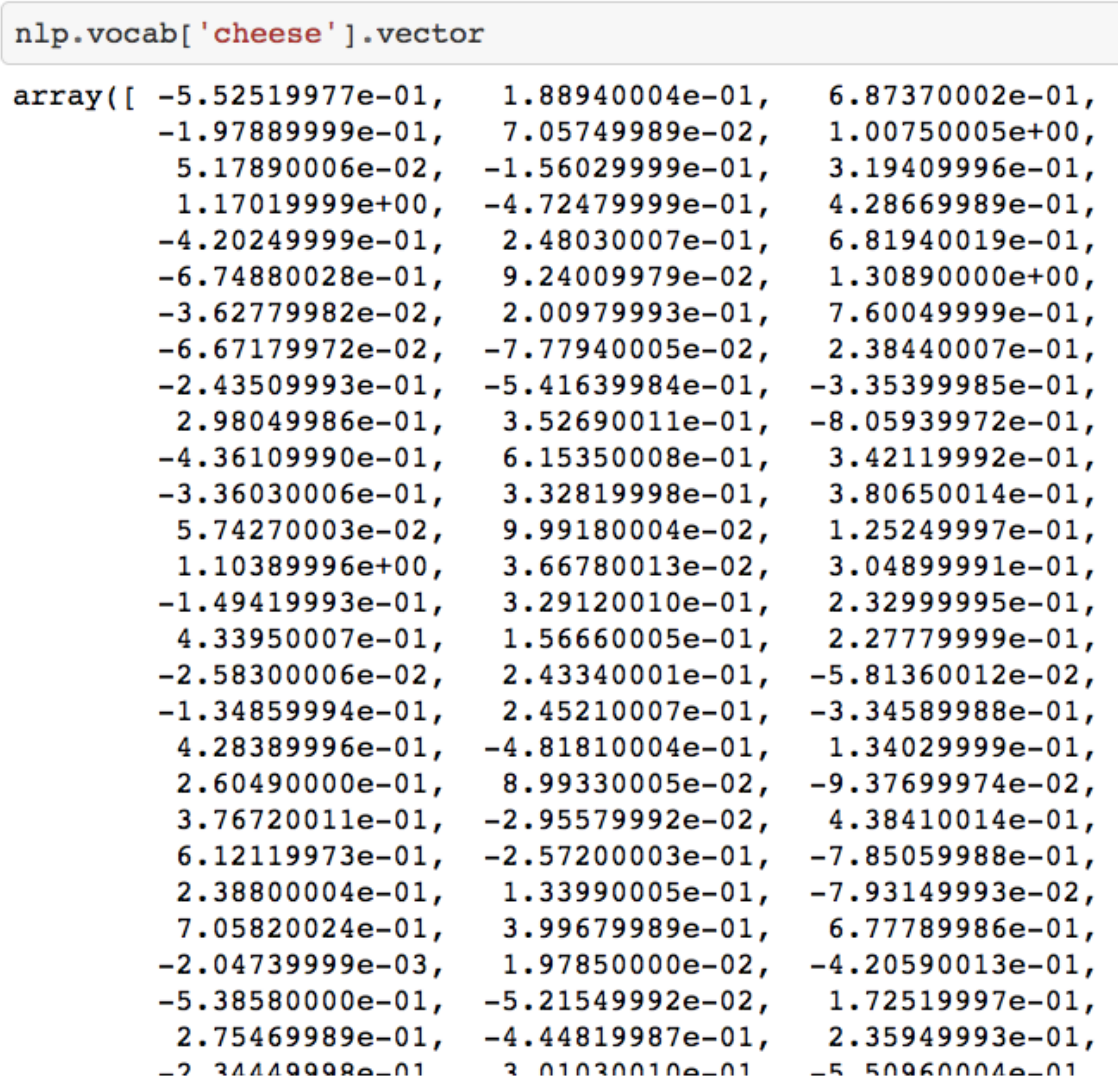
the distributional hypothesis:
"linguistic items with similar distributions have similar meanings."

distributional analysis of
"it was the best of times, it was the worst of times"



	START ___ was	it ___ the	was ___ best	the ___ of	best ___ times	of ___ it	times ___ was	was ___ worst	worst ___ times	of ___ END
it	1	0	0	0	0	0	1	0	0	0
was	0	2	0	0	0	0	0	0	0	0
the	0	0	1	0	0	0	0	1	0	0
best	0	0	0	1	0	0	0	0	0	0
of	0	0	0	0	1	0	0	0	1	0
times	0	0	0	1	0	0	0	0	0	1
worst	0	0	0	1	0	0	0	0	0	0

vector for "of": [0, 0, 0, 0, 1, 0, 0, 0, 1, 0]
vector for "best" and "worst": [0, 0, 0, 1, 0, 0, 0, 0, 0, 0]



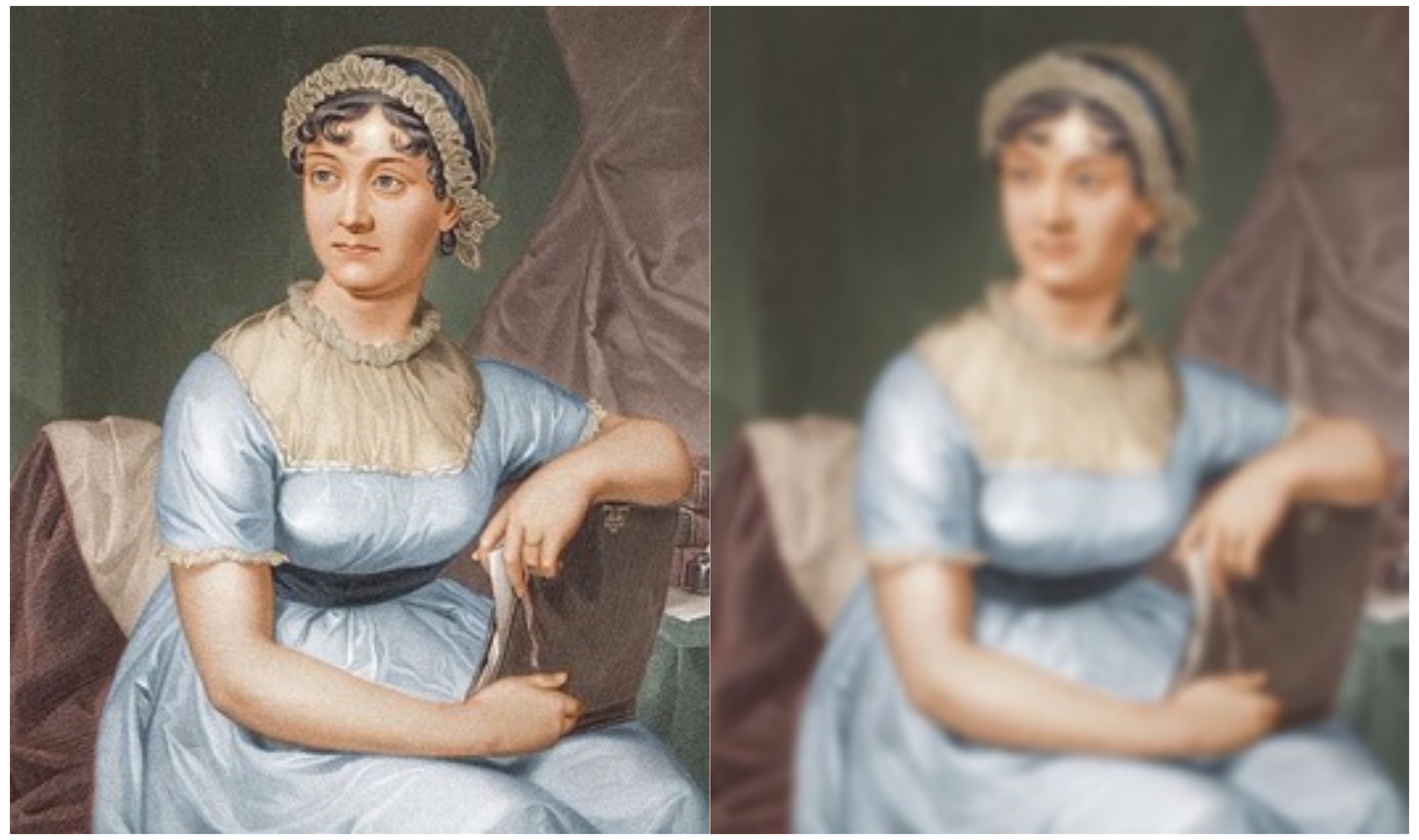
```python
nlp.vocab['cheese'].vector
```

```
array([ -5.52519977e-01,   1.88940004e-01,   6.87370002e-01,
        -1.97889999e-01,   7.05749989e-02,   1.00750005e+00,
         5.17890006e-02,  -1.56029999e-01,   3.19409996e-01,
         1.17019999e+00,  -4.72479999e-01,   4.28669989e-01,
        -4.20249999e-01,   2.48030007e-01,   6.81940019e-01,
        -6.74880028e-01,   9.24009979e-02,   1.30890000e+00,
        -3.62779982e-02,   2.00979993e-01,   7.60049999e-01,
        -6.67179972e-02,  -7.77940005e-02,   2.38440007e-01,
        -2.43509993e-01,  -5.41639984e-01,  -3.35399985e-01,
         2.98049986e-01,   3.52690011e-01,  -8.05939972e-01,
        -4.36109990e-01,   6.15350008e-01,   3.42119992e-01,
        -3.36030006e-01,   3.32819998e-01,   3.80650014e-01,
         5.74270003e-02,   9.99180004e-02,   1.25249997e-01,
         1.10389996e+00,   3.66780013e-02,   3.04899991e-01,
        -1.49419993e-01,   3.29120010e-01,   2.32999995e-01,
         4.33950007e-01,   1.56660005e-01,   2.27779999e-01,
        -2.58300006e-02,   2.43340001e-01,  -5.81360012e-02,
        -1.34859994e-01,   2.45210007e-01,  -3.34589988e-01,
         4.28389996e-01,  -4.81810004e-01,   1.34029999e-01,
         2.60490000e-01,   8.99330005e-02,  -9.37699974e-02,
         3.76720011e-01,  -2.95579992e-02,   4.38410014e-01,
         6.12119973e-01,  -2.57200003e-01,  -7.85059988e-01,
         2.38800004e-01,   1.33990005e-01,  -7.93149993e-02,
         7.05820024e-01,   3.99679989e-01,   6.77789986e-01,
        -2.04739999e-03,   1.97850000e-02,  -4.20590013e-01,
        -5.38580000e-01,  -5.21549992e-02,   1.72519997e-01,
         2.75469989e-01,  -4.44819987e-01,   2.35949993e-01,
        -2.34449998e-01   3.01030010e-01   -5.50960004e-01
```

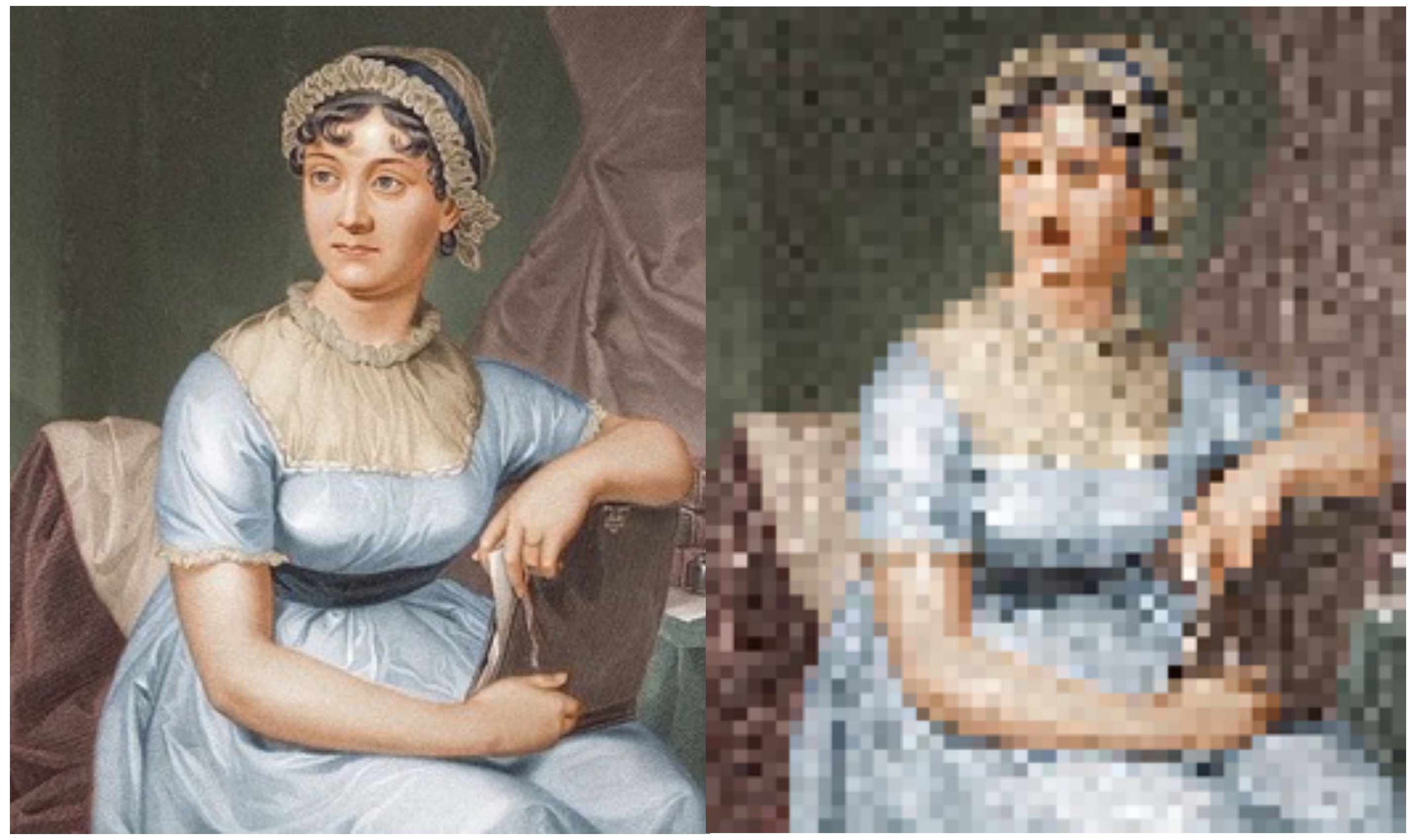
http://static.decontextualize.com/vecviz/

http://static.decontextualize.com/vecviz/

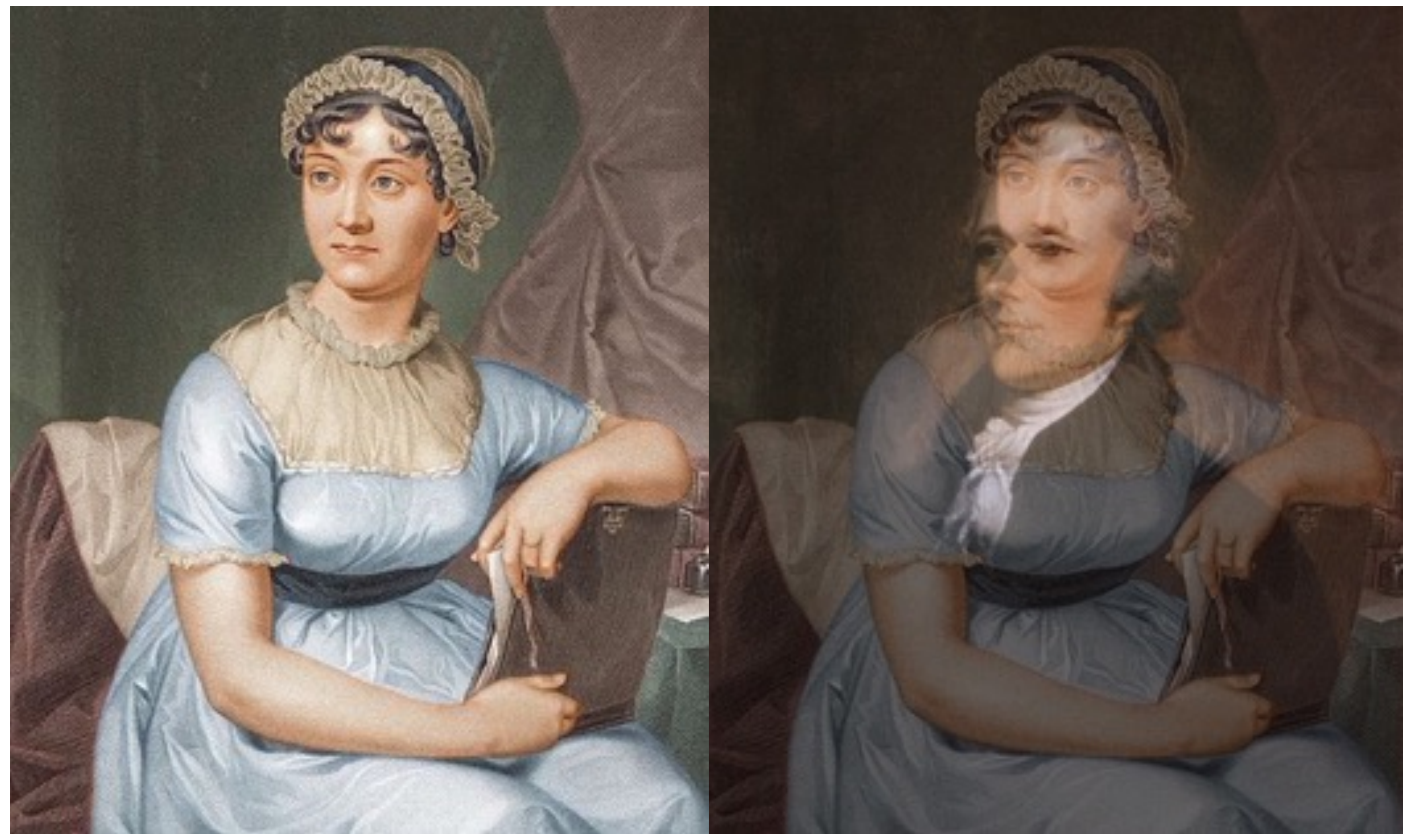
blur



resample at
lower resolution



blend (with another text)



In the beginning God created the heaven and the earth. And the earth was without form, and void; and darkness was upon the face of the deep And the Spirit of God moved upon the face of the waters. And God said, Let there be light: and there was light. And God saw the light, that it was good: and God divided the light from the darkness, And God called the light Day

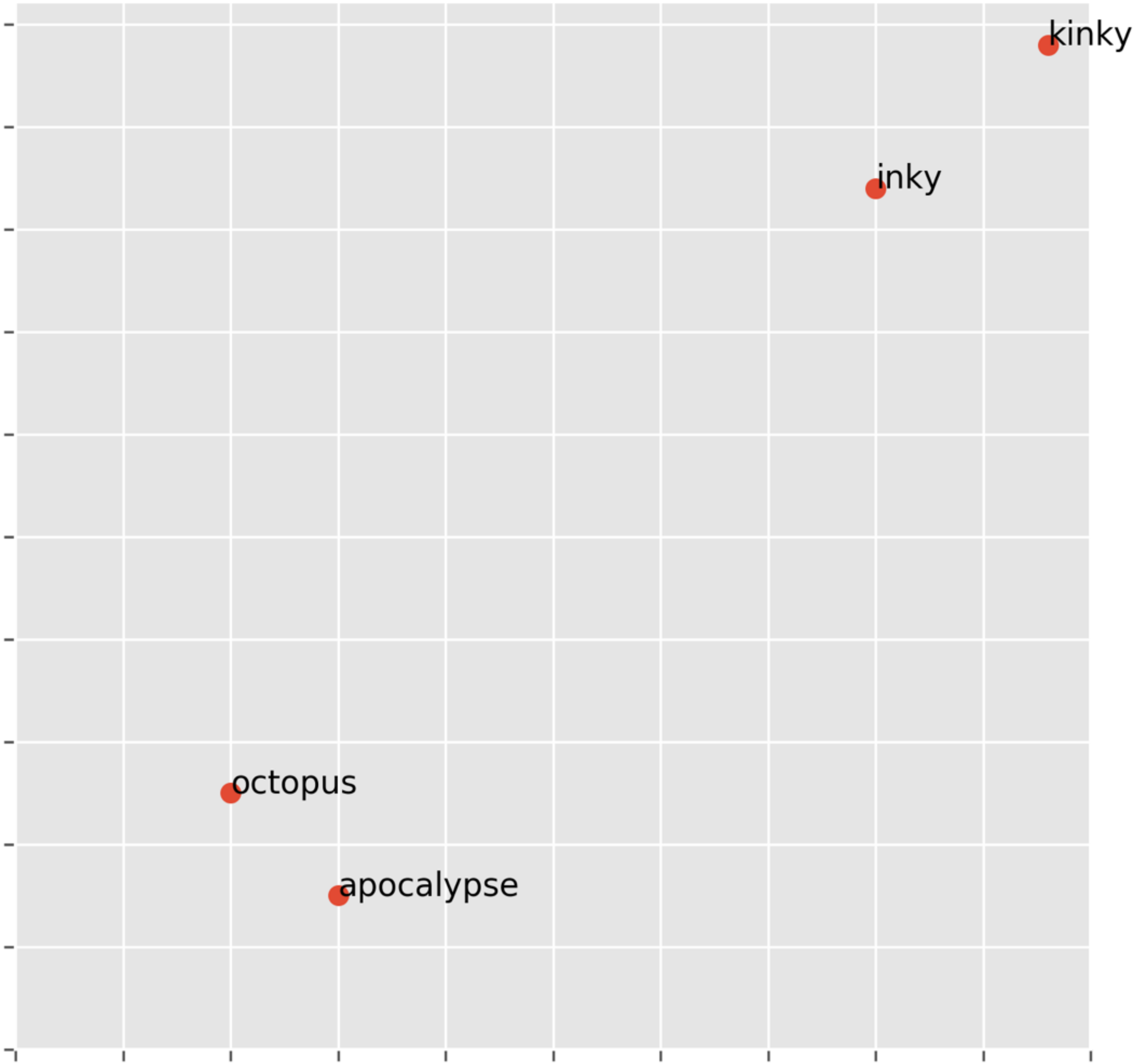
'Hateful day when I received life!' I exclaimed in agony. Accursed creator! Why did you form a monster so hideous that even YOU turned from me in disgust? God, in pity, made man beautiful and alluring, after his own image; but my form is a filthy type of yours, more horrid even from the very resemblance. Satan had his companions, fellow devils, to admire and encourage him, but I am solitary and abhorred.

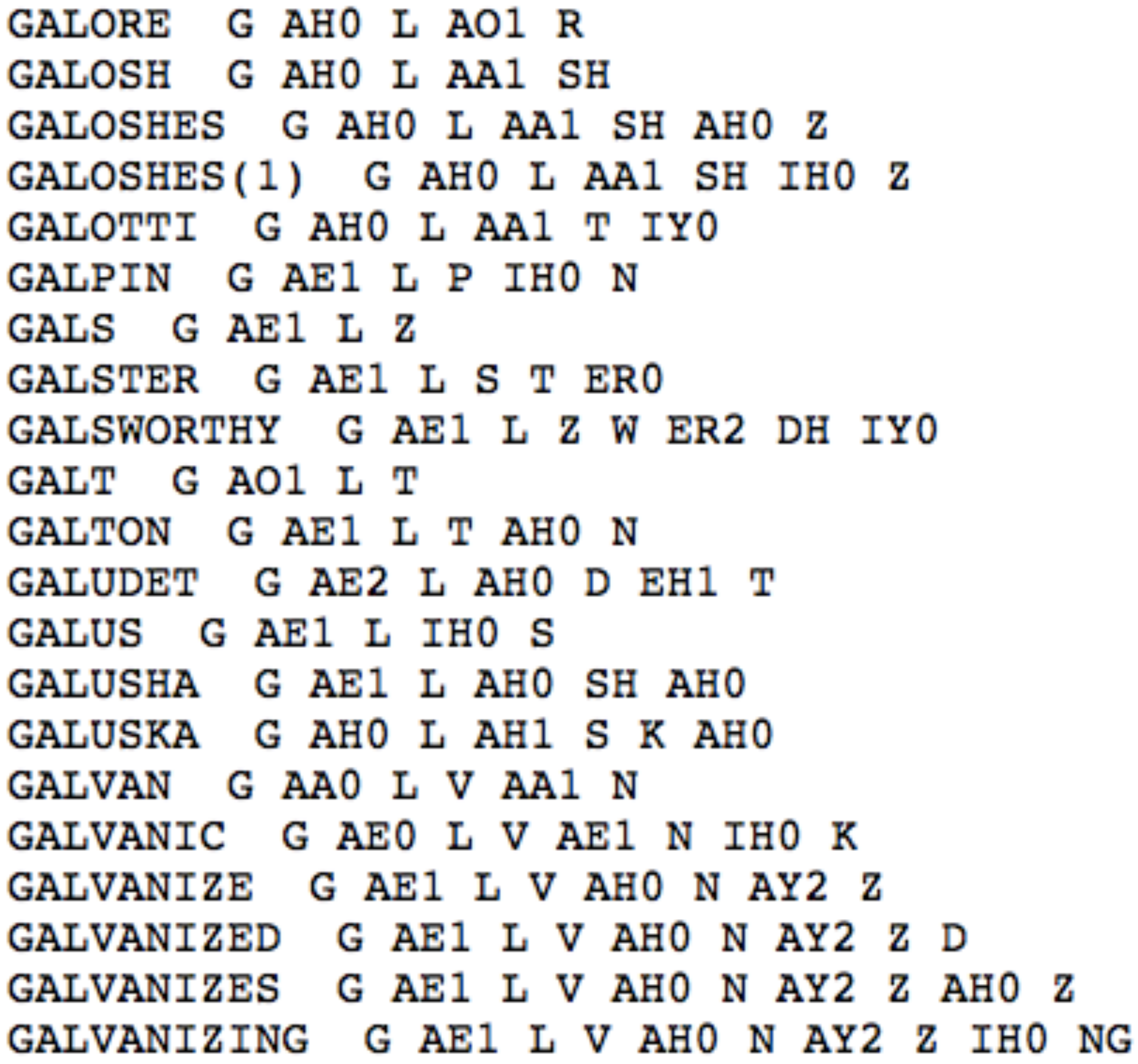
In the beginning God created the heaven and the earth. And the earth was without form, and void; and darkness was upon the face of the deep And the Spirit of God moved upon the face of the waters. And God said, Let there be light: and there was light. And God saw the light, that it was good: and God divided the light from the darkness, And God called the light Day

50%

'Hateful day when I received life!' I exclaimed in agony. Accursed creator! Why did you form a monster so hideous that even YOU turned from me in disgust? God, in pity, made man beautiful and alluring, after his own image; but my form is a filthy type of yours, more horrid even from the very resemblance. Satan had his companions, fellow devils, to admire and encourage him, but I am solitary and abhorred.

phonetic similarity vectors


kinky
inky
octopus
apocalypse



```
GALORE  G AH0 L AO1 R
GALOSH  G AH0 L AA1 SH
GALOSHES  G AH0 L AA1 SH AH0 Z
GALOSHES(1)  G AH0 L AA1 SH IH0 Z
GALOTTI  G AH0 L AA1 T IY0
GALPIN  G AE1 L P IH0 N
GALS  G AE1 L Z
GALSTER  G AE1 L S T ER0
GALSWORTHY  G AE1 L Z W ER2 DH IY0
GALT  G AO1 L T
GALTON  G AE1 L T AH0 N
GALUDET  G AE2 L AH0 D EH1 T
GALUS  G AE1 L IH0 S
GALUSHA  G AE1 L AH0 SH AH0
GALUSKA  G AH0 L AH1 S K AH0
GALVAN  G AA0 L V AA1 N
GALVANIC  G AE0 L V AE1 N IH0 K
GALVANIZE  G AE1 L V AH0 N AY2 Z
GALVANIZED  G AE1 L V AH0 N AY2 Z D
GALVANIZES  G AE1 L V AH0 N AY2 Z AH0 Z
GALVANIZING  G AE1 L V AH0 N AY2 Z IH0 NG
```

CMU Pronouncing Dictionary

Phone	Features
AA	bck, low, unr, vwl
AE	fnt, low, unr, vwl
AH	cnt, mid, unr, vwl
AO	bck, lmd, rnd, vwl
AW	bck, cnt, low, rnd, smh, unr, vwl
AY	cnt, fnt, low, smh, unr, vwl
B	blb, stp, vcd
CH	alv, frc, stp, vls
D	alv, stp, vcd
DH	dnt, frc, vcd
EH	fnt, lmd, unr, vwl
ER	cnt, rzd, umd, vwl
EY	fnt, lmd, smh, unr, vwl
F	frc, lbd, vls
G	stp, vcd, vel
HH	apr, glt
IH	fnt, smh, unr, vwl
IY	fnt, hgh, unr, vwl
JH	alv, frc, stp, vcd
K	stp, vel, vls
L	alv, lat
M	blb, nas
N	alv, nas
NG	nas, vel
OW	bck, rnd, smh, umd, vwl
OY	bck, fnt, lmd, rnd, smh, unr, vwl
P	blb, stp, vls
R	alv, apr
S	alv, frc, vls
SH	frc, pla, vls
T	alv, stp, vls
TH	dnt, frc, vls
UH	bck, rnd, smh, vwl
UW	bck, hgh, rnd, vwl
V	frc, lbd, vcd
W	apr, lbv
Y	apr, pal
Z	alv, frc, vcd
ZH	frc, pla, vcd

$$
\begin{aligned}
Prp(\texttt{BEG}, \texttt{R}, \texttt{IH}, \texttt{NG}, \texttt{END}) &= (F(\texttt{BEG}) \times F(\texttt{R})) \cup (F(\texttt{R}) \times F(\texttt{IH})) \cup (F(\texttt{IH}) \times F(\texttt{NG})) \cup (F(\texttt{NG}) \times F(\texttt{END})) \\
&= (\{beg\} \times \{alv, apr\}) \cup (\{alv, apr\} \times \{fnt, smh, unr, vwl\}) \\
&\quad \cup (\{fnt, smh, unr, vwl\} \times \{nas, vel\}) \cup (\{nas, vel\} \times \{end\}) \\
&= \{(beg, alv), (beg, apr), \\
&(alv, smh), (alv, fnt), (alv, unr), (alv, vwl), \\
&(apr, smh), (apr, fnt), (apr, unr), (apr, vwl), \\
&(smh, vel), (smh, nas), (fnt, vel), (fnt, nas), \\
&(unr, vel), (unr, nas), (vwl, vel), (vwl, nas), \\
&(vel, end), (nas, end)\}
\end{aligned}
$$

abacus → *AE1 B AH0 K AH0 S* →

```
[2.141595, 0.11189, 1.429368,
0.648939, 1.32017, -0.842176,
0.391692, 1.257228, -0.375698,
0.332438, -0.194411, -0.223709,
-0.810833, -0.081498, -0.022771,
0.269668, -1.337725, -0.259185,
-3.570448, -1.134411, -0.593508,
-0.864846, 1.682264, 0.807176,
0.169464, -0.81139, 0.358634,
0.807271, 0.823673, -0.045466,
-0.856202, -0.290816, -0.641057,
0.290957, -0.355079, -0.651196,
1.092874, 0.26982, -0.21275,
-0.749479, 0.088731, 0.426372,
-0.232698, -0.233797, -0.317719,
0.058775, 0.284463, 0.391787,
-0.148502, -0.295721]
```

$$word_c = \frac{word_a + word_b}{2}$$

paper	kitten	birthday	artificial
plastic	puppy	anniversary	intelligence

paper
peptic
plastic

kitten
puppy

birthday
anniversary

artificial
intelligence

paper
peptic
plastic

kitten
committee
puppy

birthday
anniversary

artificial
intelligence

paper
peptic
plastic

kitten
committee
puppy

birthday
perversity
anniversary

artificial

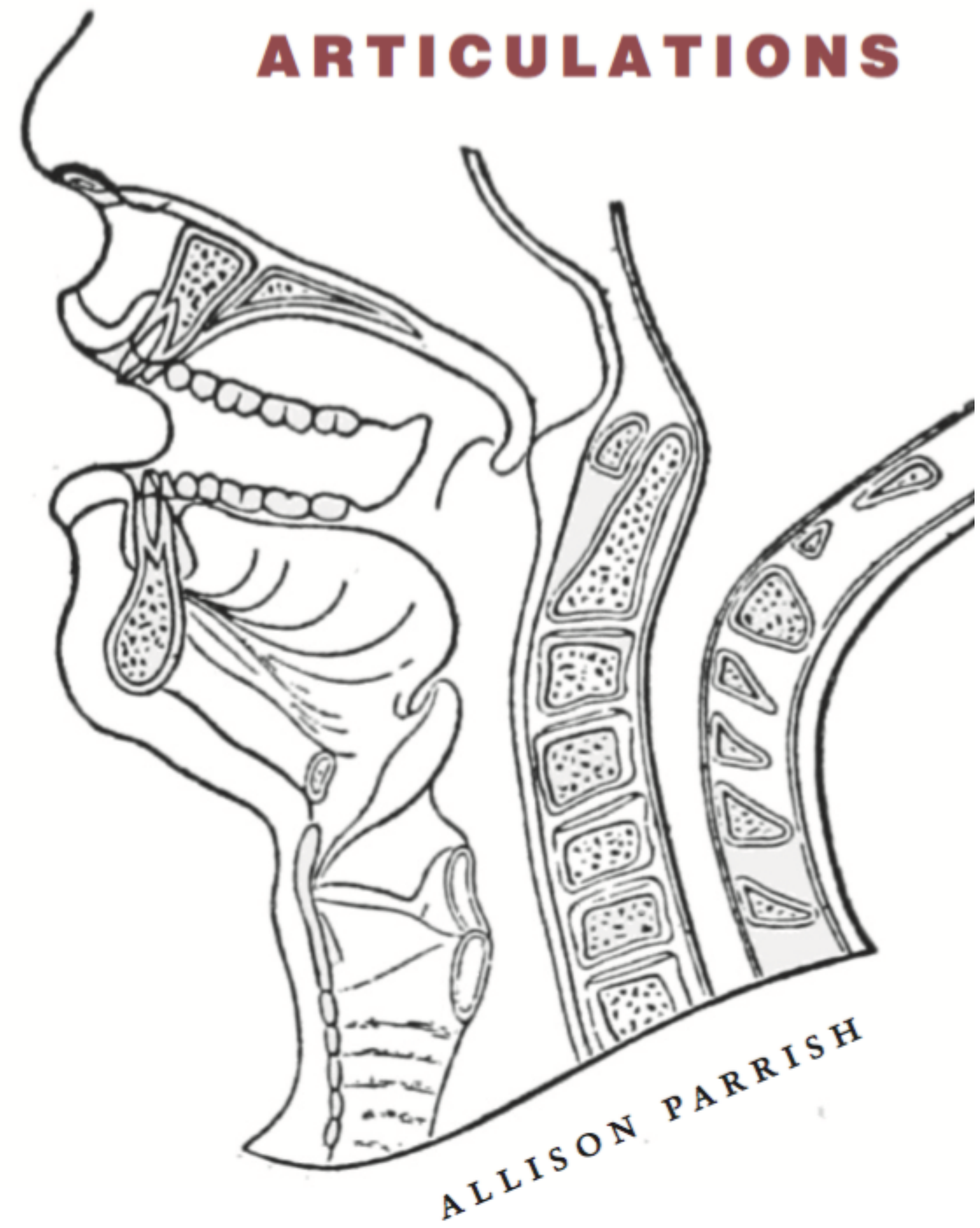
intelligence

paper
peptic
plastic

kitten
committee
puppy

birthday
perversity
anniversary

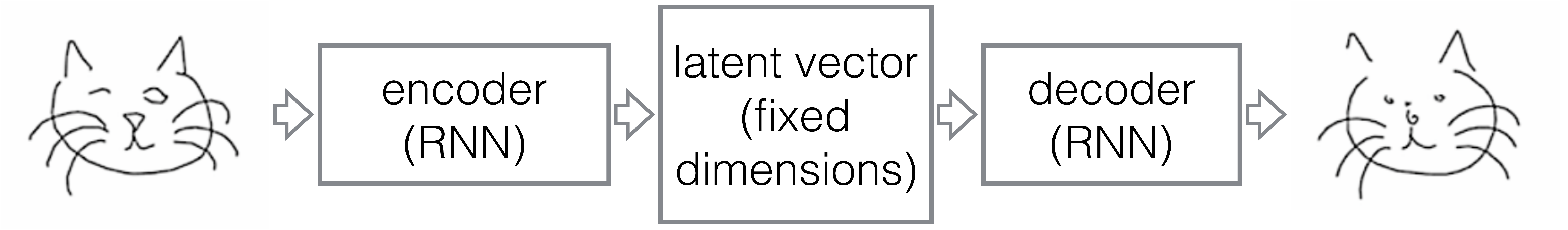
artificial
ostentatious
intelligence



Sweet hour of prayer, sweet hour of prayer it was the hour of prayers. In the hour of parting, hour of parting, hour of meeting hour of parting this. With power avenging, ... His towering wings; his power enhancing, in his power. His power. Thus: the blithe powers about the flowers, chirp about the flowers a power of butterfly must be with a purple flower, might be the purple flowers it bore. The petals of her purple flowers where the purple aster flowered, here’s the purple aster, of the purple asters there lives a purpose stern! A sterner purpose fills turns up so pert and funny; of motor trucks and vans, and after kissed a stone, an ode after Easter. And iron laughter stirred, O wanderer, turn; oh, wanderer, return. O wanderer, stay; O Wanderer near. Been a wanderer. I wander away and then I wander away and thence shall we wander away, and then we would wander away, away O why and for what are we waiting. Oh, why and for what are we waiting, why, then, and for what are we waiting?

using sketch-rnn's variational autoencoder on letterforms

sketch-rnn uses google quickdraw data



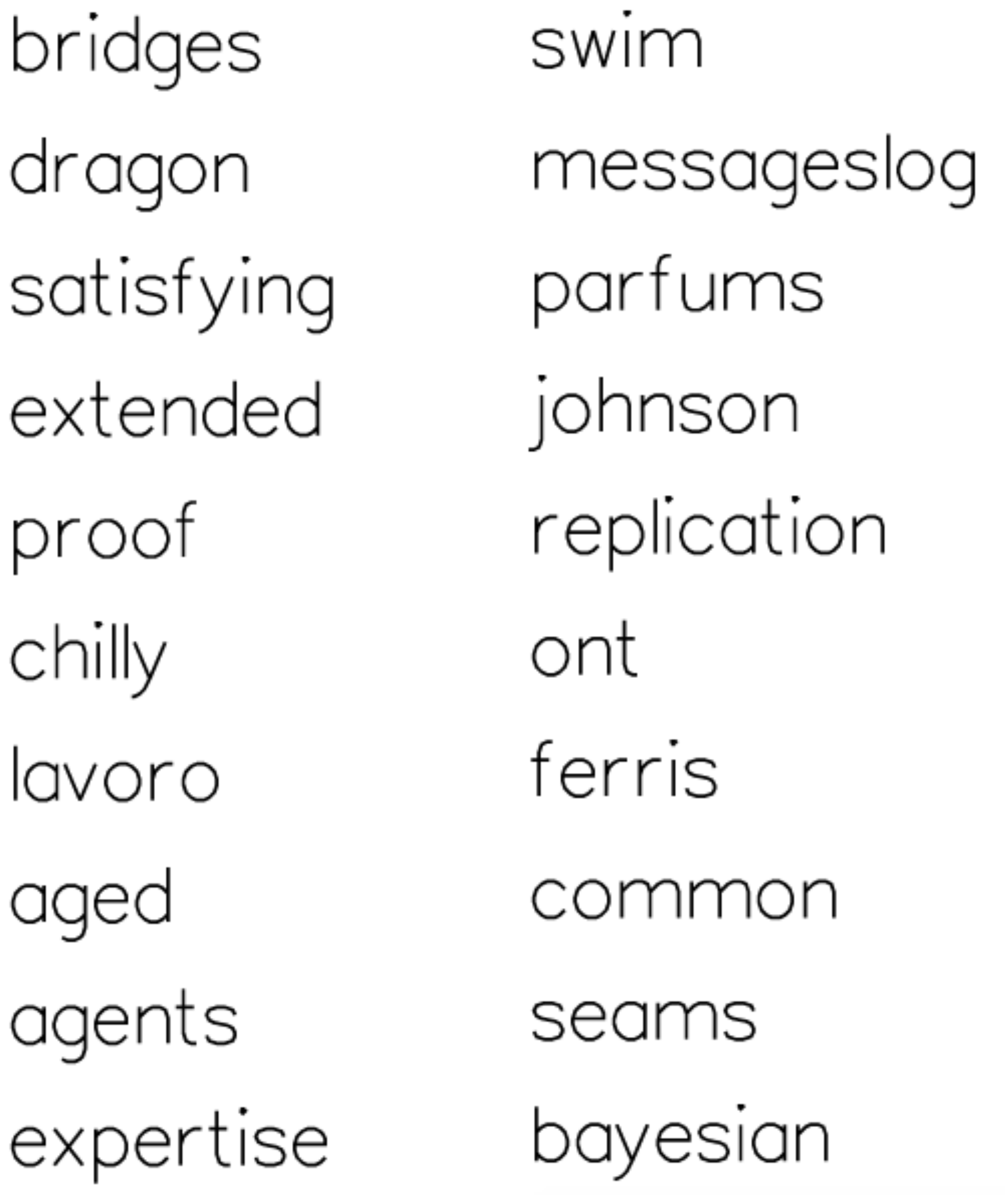
encoder (RNN)

latent vector (fixed dimensions)

decoder (RNN)

input

reconstruction

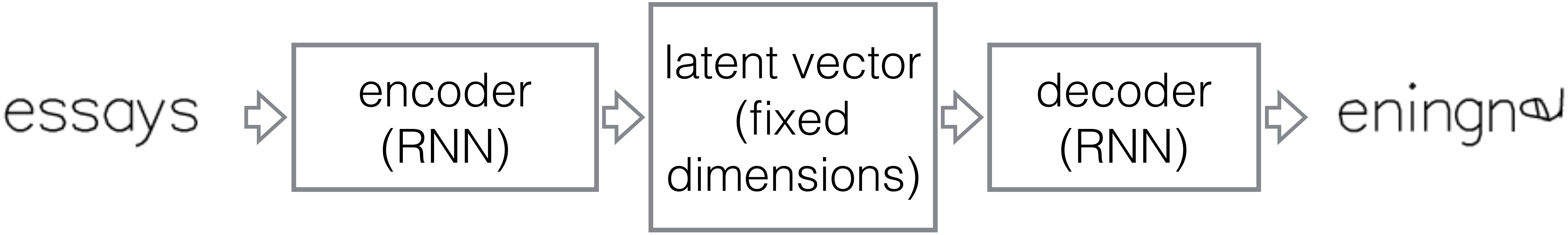


bridges
dragon
satisfying
extended
proof
chilly
lavoro
aged
agents
expertise

swim
messageslog
parfums
johnson
replication
ont
ferris
common
seams
bayesian

Hershey fonts

I tried using sketch-rnn with words written in a Hershey font



encoder (RNN)

latent vector (fixed dimensions)

decoder (RNN)

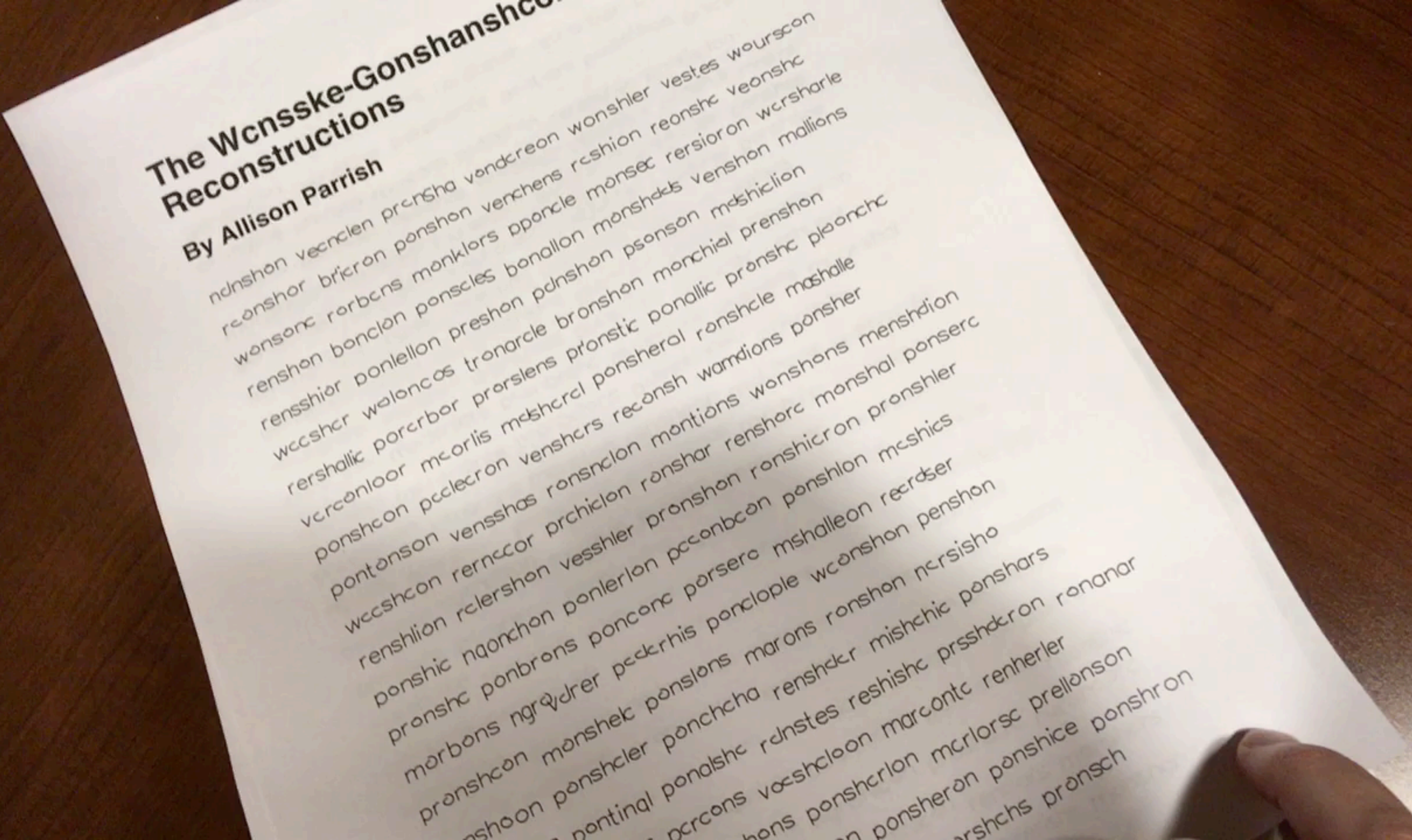
input

reconstruction

```
---
original

paperwork

reconstruction

prenskarlim
---
original

prog

reconstruction

gooon
```

```
---
original

arbor

reconstruction

glronb
---
original

dosing

reconstruction

darerons
```

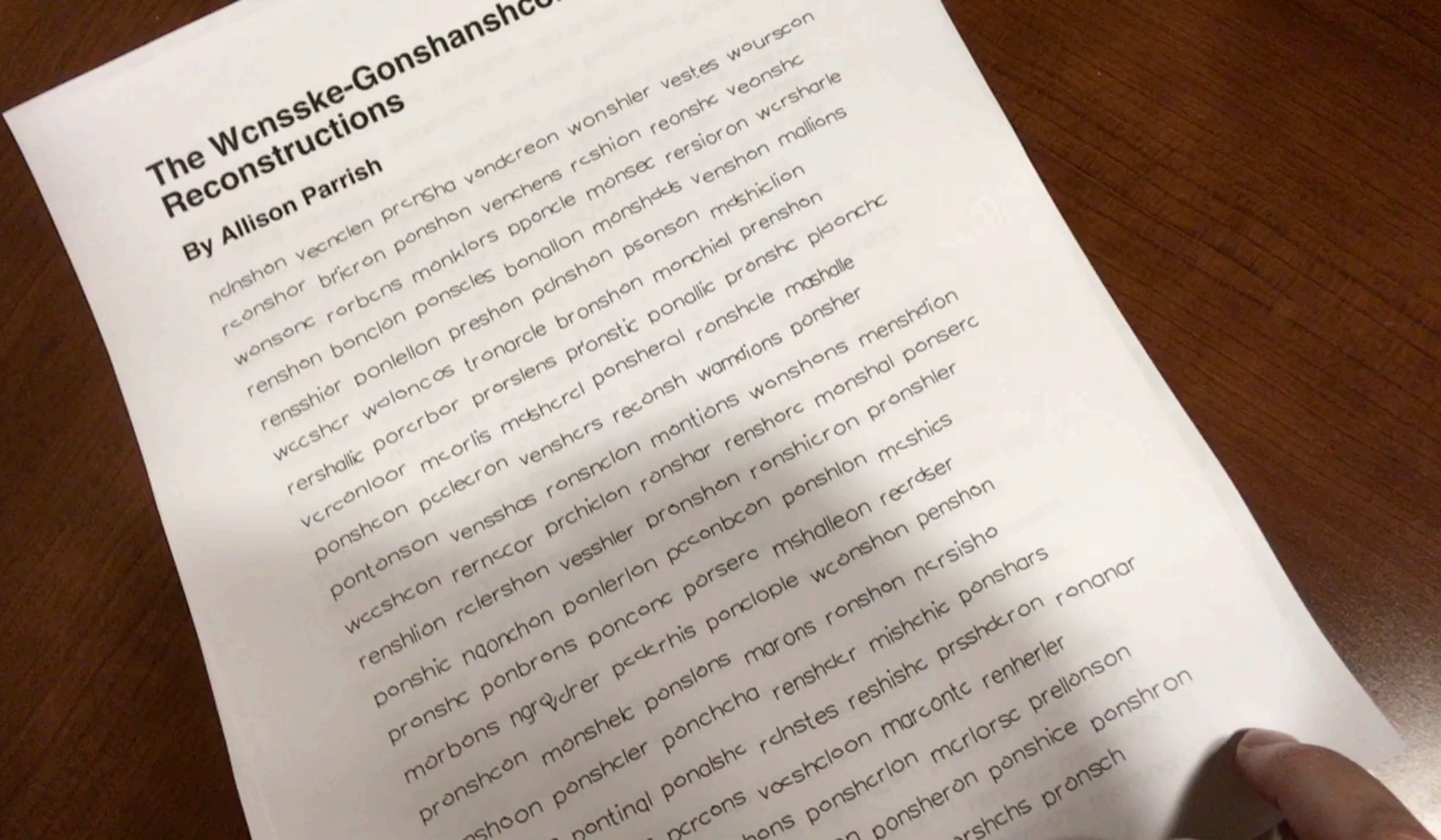
```
---
original

confusing

reconstruction

senbis
---
original

replacements

reconstruction

mokiplitoroncler
```



The Wcnsske-Gonshanshco Reconstructions

By Allison Parrish

ndnshon vecnclen prcnsha vondcreon wonshler vestes wourscon
rconshor bricron ponshon venchens rcshion reonshc veonshc
wonsonc rorbcns monklors pponcle monsec rersioron wcrsharle
renshon bonclon ponscles bonallon monshdds venshon mallions
rensshior bonlellon preshon pdnshon psonson mdshiclion
wccshcr woloncos tronarcle bronshon monchial prenshon
rershallic porcrbor prorslens pronstic ponallic pronshc ploonchc
vcrconloor mcorlis mdshcrcl ponsheral ronshcle mashalle
ponshcon pcclecron venshcrs reconsh wamdions ponsher
pontonson vensshas ronsnclon montions wonshons menshdion
wccshcon rernccor prchiclon ronshar renshorc monshal ponserc
renshlion rclershon vesshler pronshon ronshicron pronshler
ponshic nqonchon bonlerlon pcconbcon ponshlon mcshics
pronshc ponbrons ponconc porserc mshalleon recrdser
morbons ngrqdrer pcdcrhis ponclople wconshon penshon
pronshcon monshek ponslons marons ronshon ncrsisho
shoon ponshcler ponchcha renshdcr mishchic ponshars
pontinal ponalshc rdnstes reshishc prsshdcron ronanar
pcrcons vocshcloon marcontc renherler
hons ponshcrlon mcrlorsc prellonson
n ponsheron ponshice ponshron
rshchs pronsch



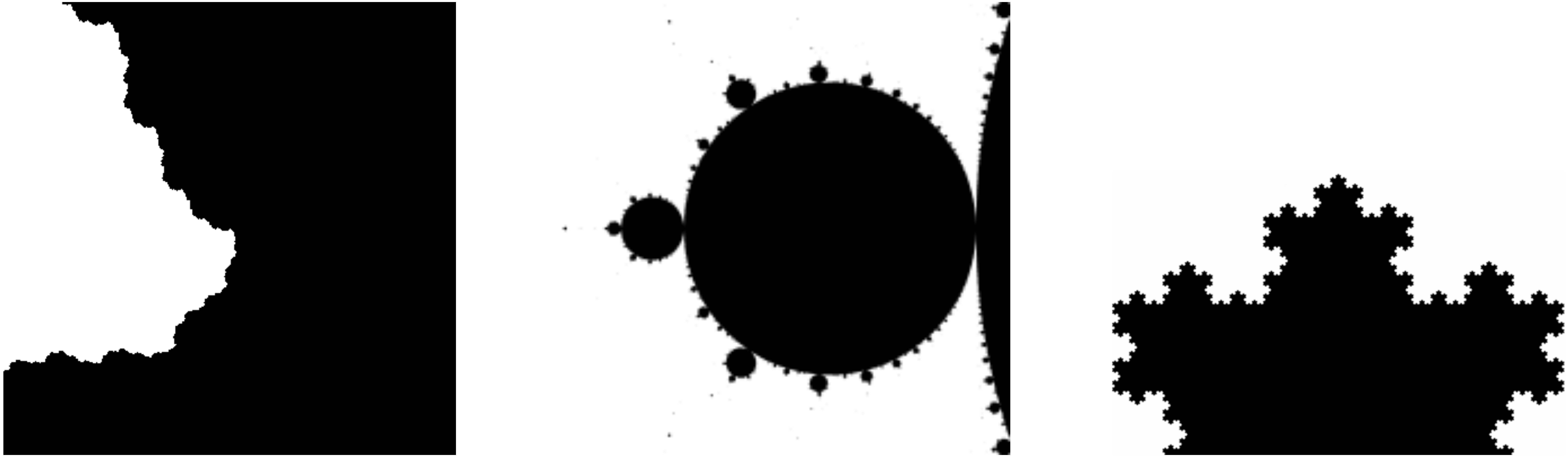
The Wcnsske-Gonshanshco Reconstructions

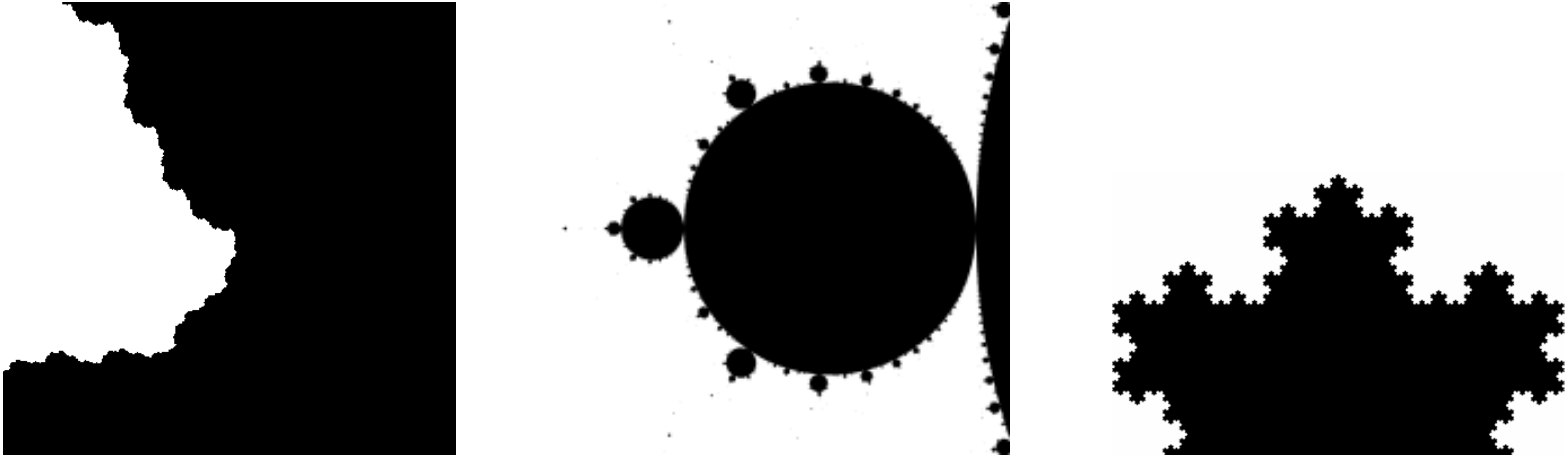
By Allison Parrish

ndnshon vecnclen prcnsha vondcreon wonshler vestes wourscon
rconshor bricron ponshon venchens rcshion reonshc veonshc
wonsonc rorbcns monklors pponcle monsec rersioron wcrsharle
renshon bonclon ponscles bonallon monshdds venshon mallions
rensshior bonlellon preshon pdnshon psonson mdshiclion
wccshcr woloncos tronarcle bronshon monchial prenshon
rershallic porcrbor prorslens pronstic ponallic pronshc ploonchc
vcrconloor mcorlis mdshcrcl ponsheral ronshcle moshalle
ponshcon pcclecron venshcrs reconsh wamdions ponsher
pontonson vensshos ronsnclon montions wonshons menshdion
wccshcon rernccor prchiclon ronshar renshorc monshal ponserc
renshlion rclershon vesshler pronshon ronshicron pronshler
ponshic nqonchon ponlerlon pcconbcon ponshlon mcshics
pronshc ponbrons poncorc porsero mshalleon recrdser
morbons ngrqdrer pcdkrhis ponclople wconshon penshon
pronshcon monshek ponslons marons ronshon ncrsisho
nshoon ponshcler ponchcha renshdcr mishchic ponshars
pontinal ponalshc rdnstes reshishc prsshdcron ronanar
pcrcons vocshcloon marcontc renherler
hons ponshcrlon mcrlorsc prellonson
n ponsheron ponshice ponshron
rshchs pronsch

stretching and smooshing language (stretchytext)

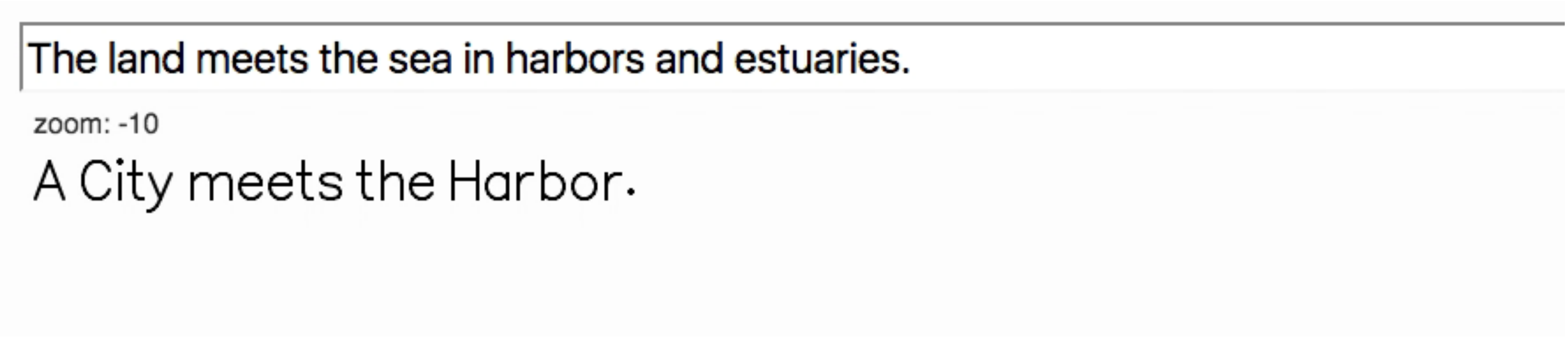
interpolate between short and long sentences that mean the same thing





npadvmod
det
nsubj
Yesterday
NOUN
the
DET
cat
NOUN
chased
VERB

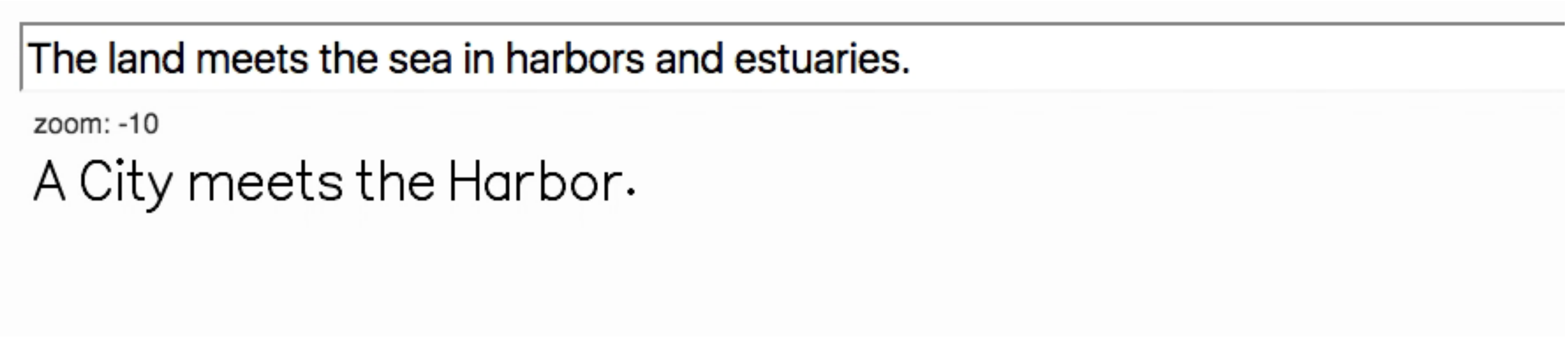
npadvmod
det
nsubj
dobj
det
cat
NOUN
chased
VERB
the
DET
dog.
NOUN



The land meets the sea in harbors and estuaries.

zoom: -10

A City meets the Harbor.



The land meets the sea in harbors and estuaries.

zoom: -10

A City meets the Harbor.

Same sturdy heroes, battle-famed king, could the cursed one thus procure at all.
Such hardy heroes, such hall-thanes, here where the free, frank waters run.
The high priests of the beautiful where troubles but rarely come.
Ocean-tides with your arms where many waters sing.
Those rough half-brothers strive to soothe.
Her clear strong torrents often do I wait.
Those rough half-brothers sometimes feel.
Colorless green ideas sleep furiously.
Sweet angel voices come trooping.
Their sad eyes again I see.
Many waters jog along.
Her paths do give.
Her feet marvel.
Billows shoot.
Things wait.

Further reading/stuff I didn't get to

- More on anamorphosis/"turning pictures": Hunt, James L., and John Sharp. “The Mathematics of the Channel Anamorphosis.” Bridges Leeuwarden: Mathematics, Music, Art, Architecture, Culture, edited by Reza Sarhangi and Carlo H. Séquin, Tarquin Publications, 2008, pp. 149–154.
- On Jackson Mac Low's *Light Poems*, a poem that takes the form of a periodic table: O’Driscoll, Michael. “By the Numbers: Jackson Mac Low’s Light Poems and Algorithmic Digraphism.” Time in Time: Short Poems, Long Poems, and the Rhetoric of North American Avant-Gardism, 1963-2008, edited by J. Mark Smith, MQUP, 2013, pp. 109–31.
- Why t-SNE is weird: Wattenberg, Martin, et al. “How to Use T-SNE Effectively.” Distill, vol. 1, no. 10, Oct. 2016, p. e2. http://distill.pub/2016/misread-tsne
- The history of the scatter plot: Friendly, Michael, and Daniel Denis. “The Early Origins and Development of the Scatterplot.” Journal of the History of the Behavioral Sciences, vol. 41, no. 2, Spring 2005, pp. 103–30.
- On John Cayley's *river-Island*, another example of morphing text in digital literary arts: Engberg, Maria. “Morphing into New Modes of Writing: John Cayley’s River-Island.” Leonardo Electronic Almanac, vol. 14, no. 5, 2006.
- Robin Sloan's experiments with variational autoencoders for text: https://www.robinsloan.com/voyages-in-sentence-space/
- A brief history of word embeddings: https://www.gavagai.se/blog/2015/09/30/a-brief-history-of-word-embeddings/
- Emotional attachment to Animorphs: Adair, Cassius. “Reading in Stealth, or My Life in Animorphs.” Avidly, 3 Aug. 2017, http://avidly.lareviewofbooks.org/2017/08/03/reading-in-stealth-or-my-life-in-animorphs/.
- JSON version of the Hershey fonts that I used: https://github.com/techninja/hersheytextjs
- Very good explanation of variational autoencoders: http://kvfrans.com/variational-autoencoders-explained/

website
http://www.decontextualize.com/

works-in-progress and complaining
https://mastodon.social/@aparrish

self-promotion and announcements
https://twitter.com/aparrish

jupyter notebooks and python modules in various states of disarray
https://github.com/aparrish/