

TEXT in VISUALIZATION

Richard Brath^{*†} & Ebad Banissi[†]

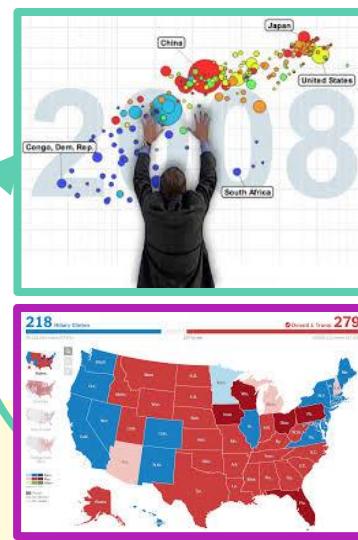
^{*†}London South Bank University / ^{*}Uncharted Software

richard.brath@alumni.utoronto.ca

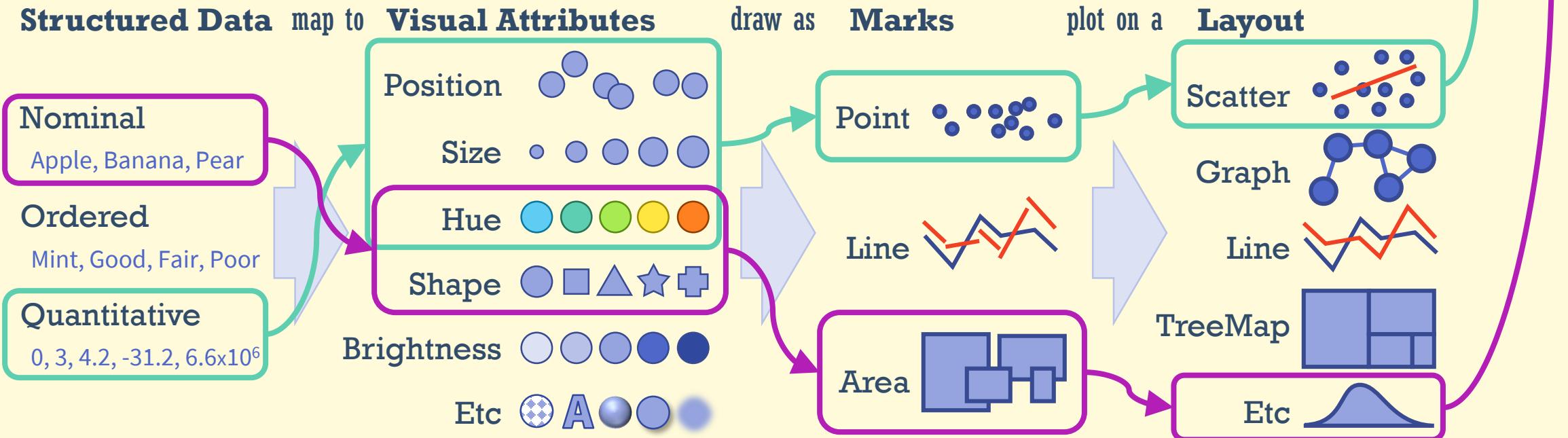
OUTLINE

1. *Identify* the gaps and opportunities for text in visualization
2. *Expand* the breadth of design space of text in visualization
3. *Generate* and *Invent* new kinds of typographic visualizations
4. *Propose* a breadth of new research questions

1. Current conceptualization of the design space of text in visualization is very limited.

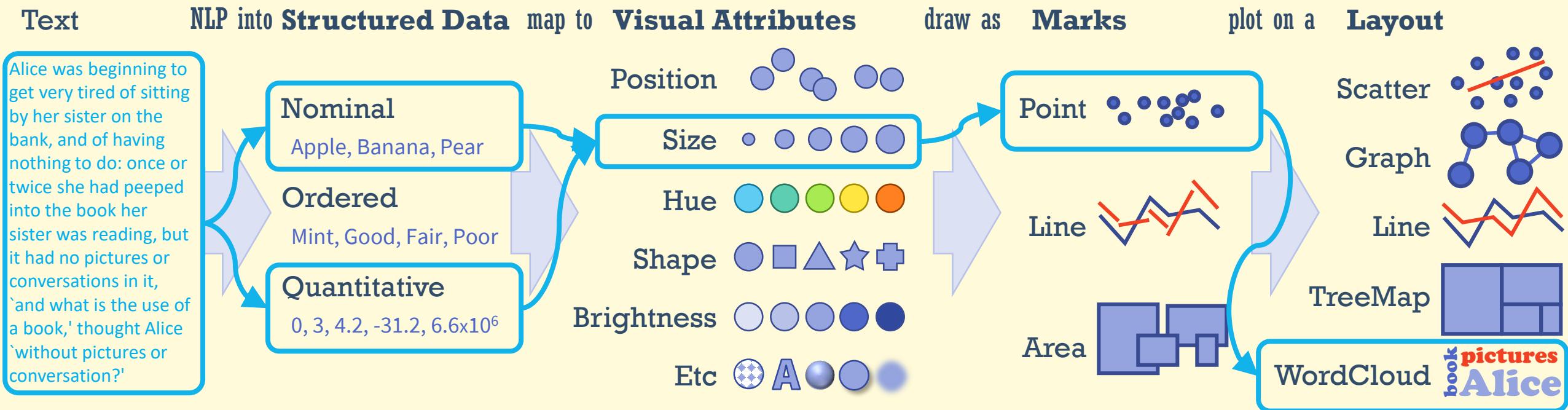


Visualization Production Pipeline



1. Extending the current visualization design space to text typically is a pre-processing step

Visualization Production Pipeline naively extended for Text



Contribution 1: Identification of **gaps** in the current design space

2. The design space is very big

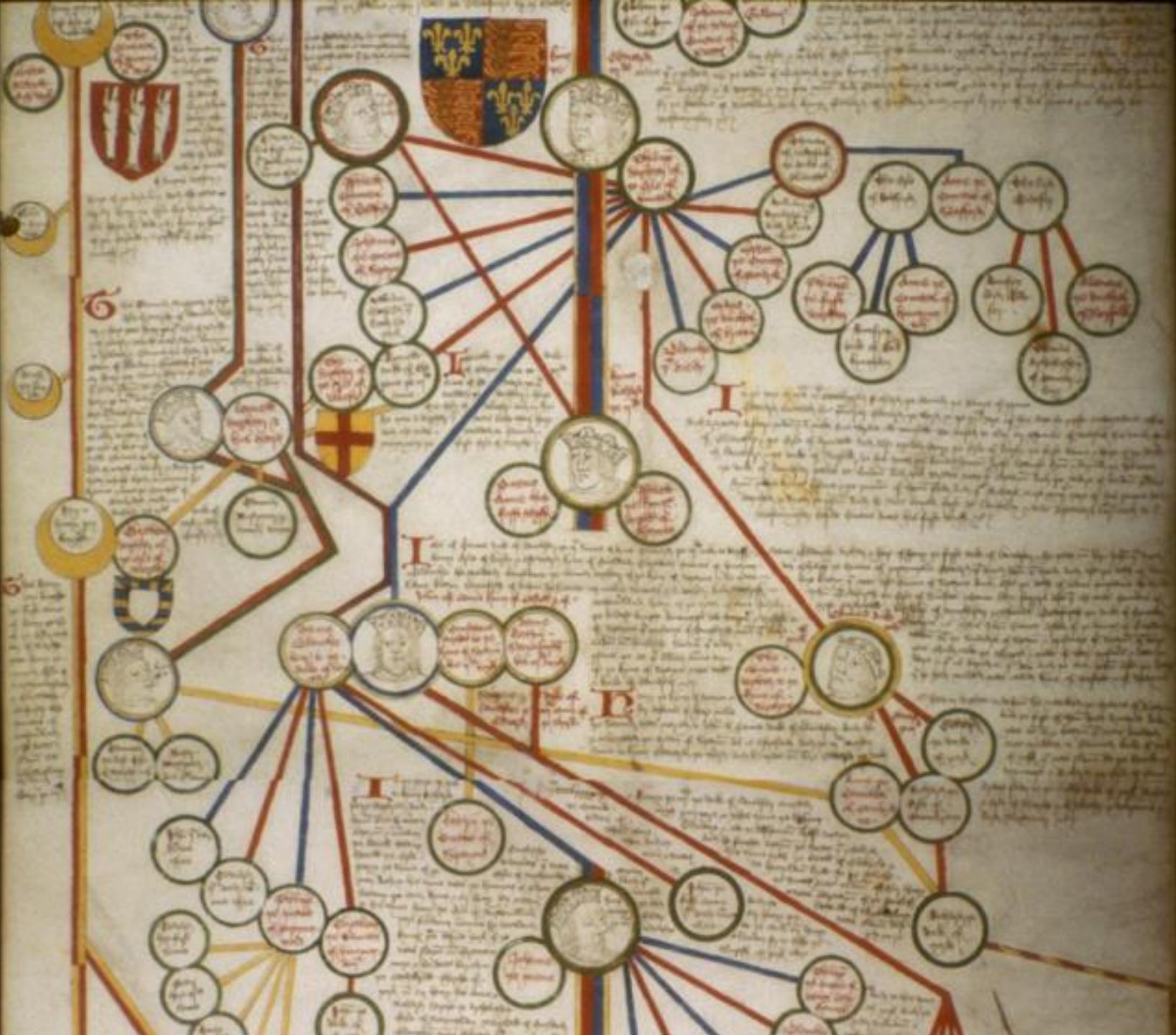


Note many ways text indicates data, e.g. rivers in backwards italics; spacing of text labels to indicated quantitative extends, e.g. SEE; underlines ordered dash, solid,double; town names use size, caps, underline and italics to indicate properties, etc.

1925 - A. Stieler and H. Haack. *Stieler's Atlas of Modern Geography*. 254 Maps & Insets on 108 Sheets Engraved on Copper. Tenth (Centenary) Edition. Completely Revised & Largely Redrawn under the Direction of Professor H. Haack in Justus Perthes' Geogr. Institute. (in two parts). Justus Perthes' Geogr. Institute, 1925. davidrumsey.com 06/06/2015

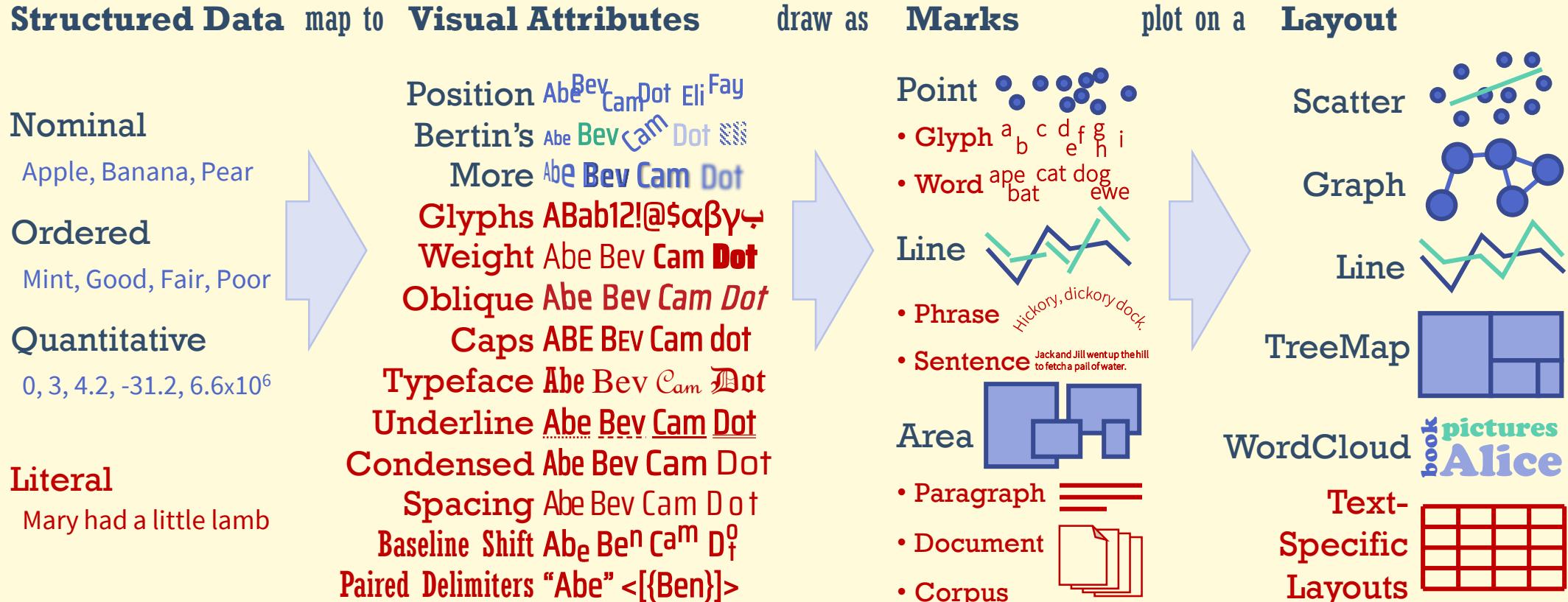
2. The design space is extremely big

Genealogical tree from late 1400's. Note graph nodes use of iconic images (people, shield) or text, where text may be black or red (or blue or gold in other medieval documents). The nodes can vary in size, color, or shape (circle, crescent, shield). Textual commentary is intertwined throughout, in proximity to relevant nodes. Genealogy of the kings of England to Richard III. Chronicle of the Percy family. MS Bodl. Rolls 5, c. 1485. Via [Bodleian library](#).



2. Design space for visualization with **text**

Visualization Encoding Pipeline extended for Text



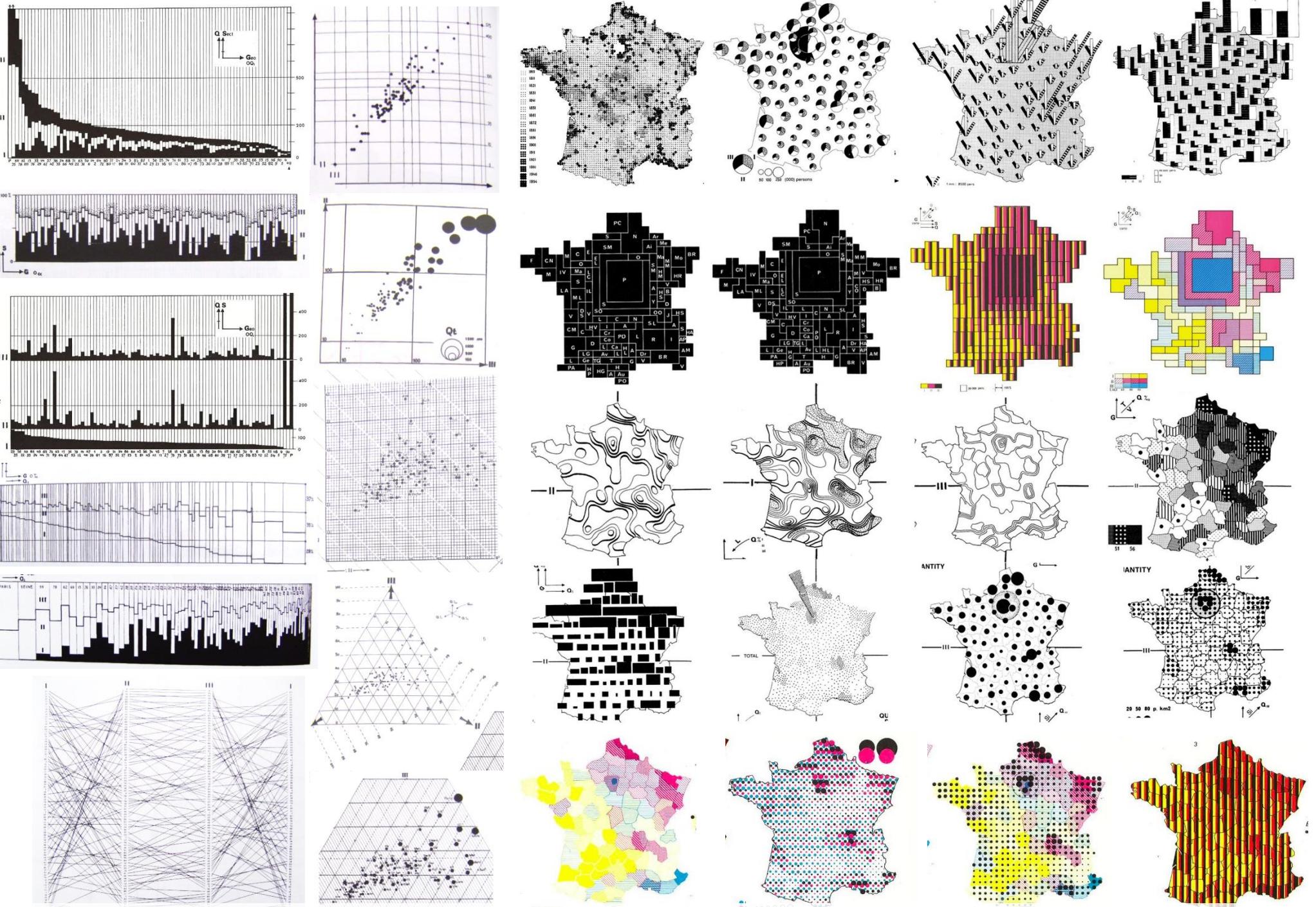
These encodings can be used in any combination: for example, these literal words are sequenced into a sentence, with the underline stopping at two thirds, word size is proportional to word length, and consonants are bold.

Contribution 2: Extended design space for **text in visualization**

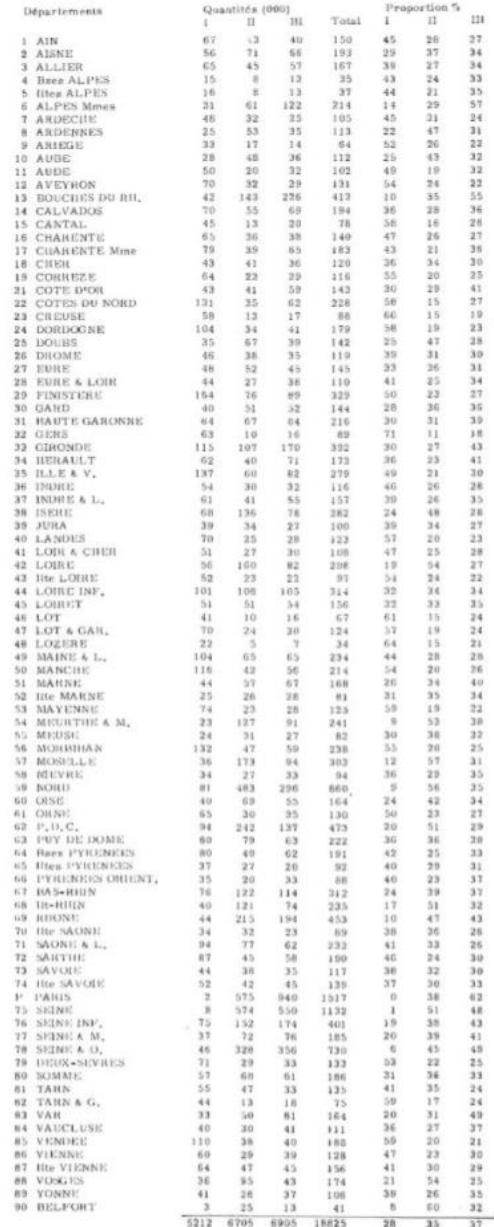
3. Generate Visualizations

e.g. Bertin 1967:

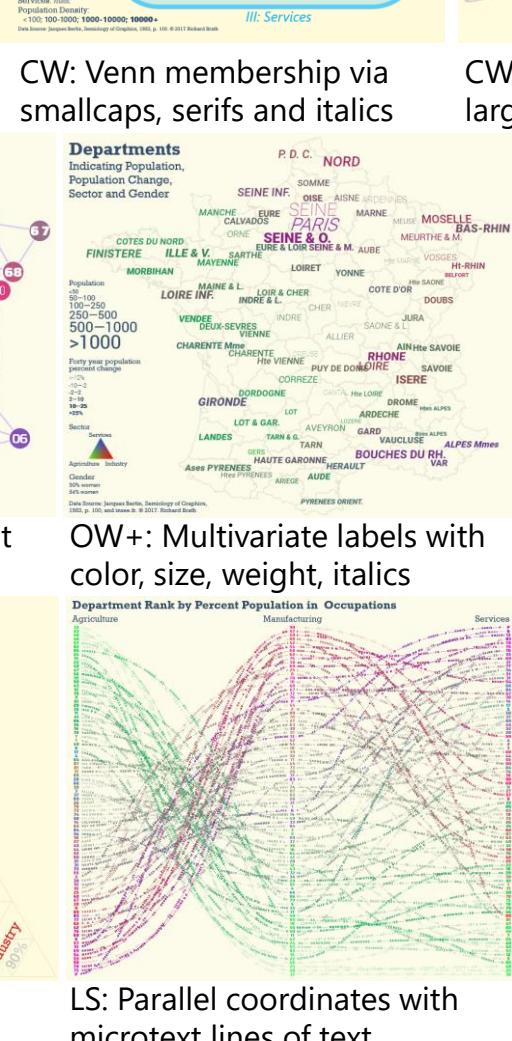
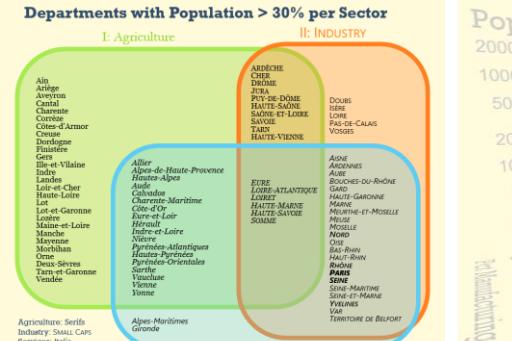
Département	Quantités (000)	Total	Proportion %	
	I	II	III	
1 AIN	67	73	40	150
2 AISNE	56	71	66	193
3 ALLIER	65	45	57	167
4 Ardèche ALPES	15	19	13	53
5 Hautes ALPES	16	8	13	35
6 ALPES Mmes	31	61	122	214
7 ARDECHE	48	32	35	105
8 ARDENNES	25	53	35	113
9 ARIEGE	33	17	14	64
10 AUBE	28	48	36	112
11 AUDE	50	20	32	102
12 AVEYRON	70	32	29	131
13 BOUCHES DU RH.	42	143	236	417
14 CALVADOS	70	55	68	194
15 CANTAL	45	13	20	78
16 CHARENTE	65	36	38	149
17 CHAUHET Mine	78	39	65	143
18 CHIERS	43	21	20	84
19 CORSEZE	64	23	29	118
21 COTE D'OR	43	41	59	143
22 COTES DU NORD	131	35	62	226
23 CREUSE	58	13	17	86
24 DORDOGNE	104	34	41	179
25 DOUBS	35	67	39	142
26 DROME	46	38	35	119
27 EURE	48	52	45	145
28 EURE & LOIR	44	27	36	110
29 FINISTERE	154	76	89	329
30 GARD	40	51	52	144
31 HAUTE GARONNE	64	67	64	216
32 GERS	63	10	14	71
33 GIRONDE	115	107	110	332
34 HERAULT	62	40	71	173
35 ILLE & V.	137	60	82	270
36 ISERE	54	30	32	116
37 INDORE & Lo.	61	41	55	157
38 ISERE	68	136	76	282
39 JURA	39	34	27	100
40 LANDES	70	25	28	123
41 LOIRE & CHER	51	27	30	108
42 LOIRE	56	160	82	298
43 Lite LOIRE	52	23	22	97
44 LOIRE INF.	101	108	105	314
45 LOUJET	51	51	54	156
46 LOT	41	10	16	67
47 LOT & GAR.	70	24	20	124
48 LOZERE	23	5	7	34
49 MAINE & Lo.	104	65	65	234
50 MANCHE	116	42	56	214
51 MARNE	44	57	67	168
52 Lite MARNE	25	26	28	81
53 MAYENNE	74	23	28	125
54 MEURTHE & Mo.	23	127	91	241
55 MEUSE	24	31	27	82
56 MORBIAN	132	47	59	238
57 MOSELLE	36	173	94	393
58 NUVELLE	34	27	33	94
59 NIORT	81	483	296	660
60 OISE	40	68	55	164
61 ORLÉANS	65	30	35	130
62 P. DE C.	34	123	135	479
63 PYR DE DOM	80	78	63	222
64 Hautes PYRINÉES	80	49	62	181
65 Bass PYRINÉES	37	27	20	92
66 PYRINÉES ORIENT.	35	20	33	86
67 BAS-RHIN	76	122	114	312
68 Ht-RHIN	40	121	74	225
69 RHONE	44	215	194	453
70 Lite SAONE	34	32	23	89
71 SAONE & Lo.	94	77	62	233
72 SARTHE	87	45	58	199
73 VAR	44	38	35	117
74 Hte SAVOIE	52	45	45	139
75 PARIS	2	575	840	1177
76 SEINE	8	574	550	1129
76 SEINE INF.	75	152	174	401
77 SEINE & M.	37	72	76	185
78 SEINE & O.	46	328	356	710
79 DEUX-SÈVRES	71	29	33	133
80 SOMME	57	68	61	186
81 TARN	55	47	33	135
82 TARN & G.	44	13	18	35
83 VAR	33	50	61	164
84 VAUCLUSE	40	30	41	111
85 VENDEE	110	38	40	188
86 VIGNEAUX	60	29	39	128
87 VILLEFRANCHE	64	45	43	156
88 VOSGES	36	95	43	174
89 YONNE	41	28	37	106
90 BELFORT	3	25	13	11



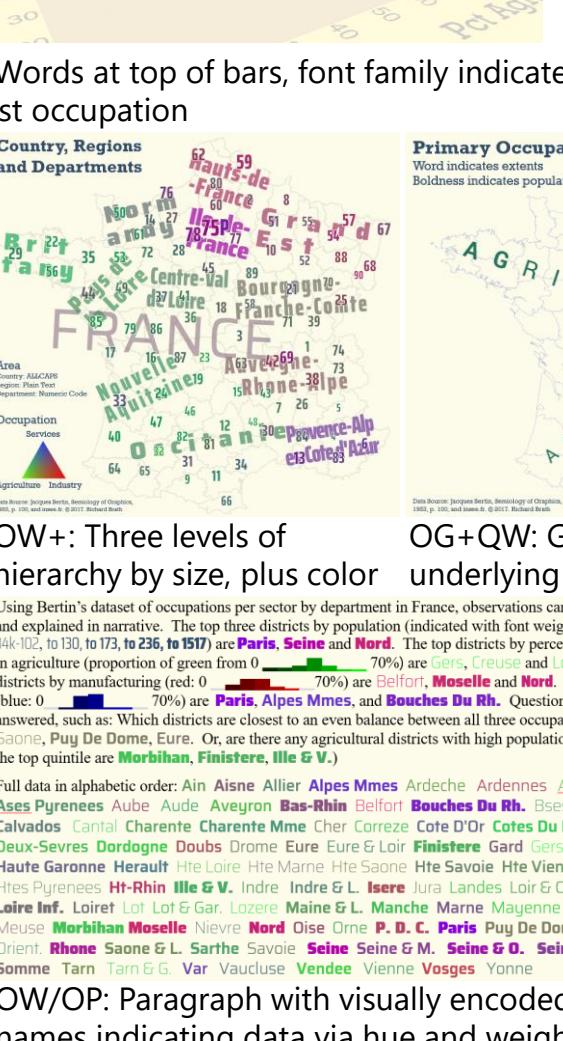
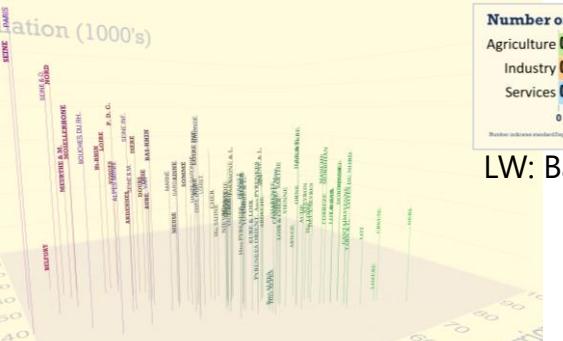
3a. Generate New Typographic Visualizations



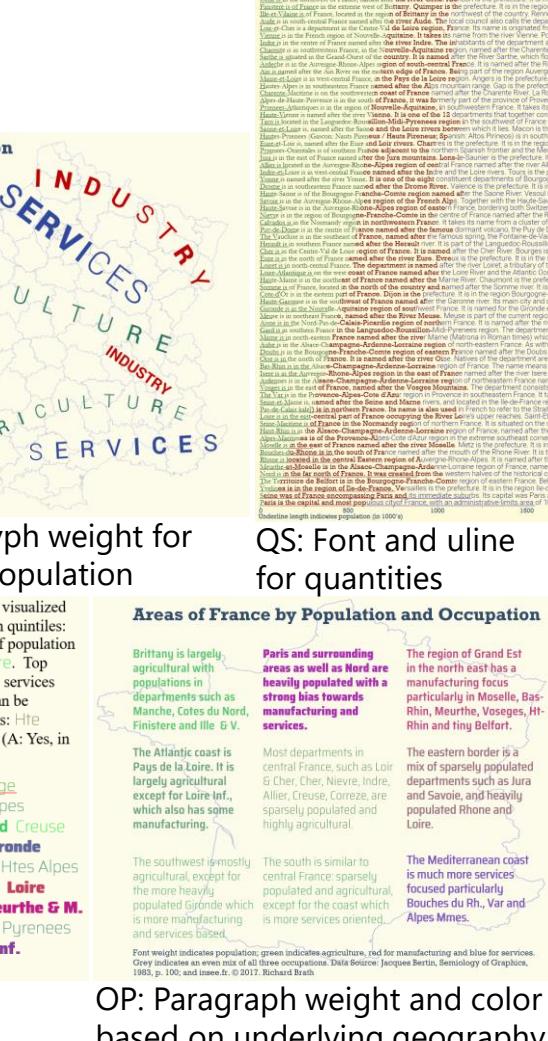
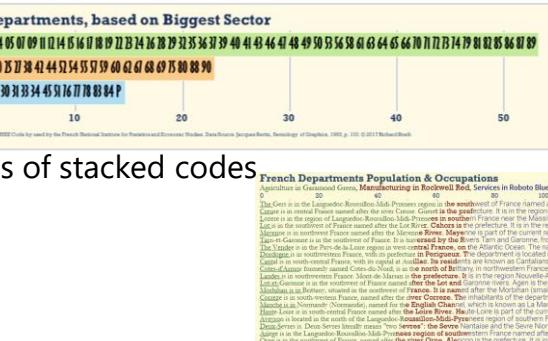
OW: Ternary plot of codes with color and size



LS: Parallel coordinates with microtext lines of text



OW/OP: Paragraph with visually encoded names indicating data via hue and weight



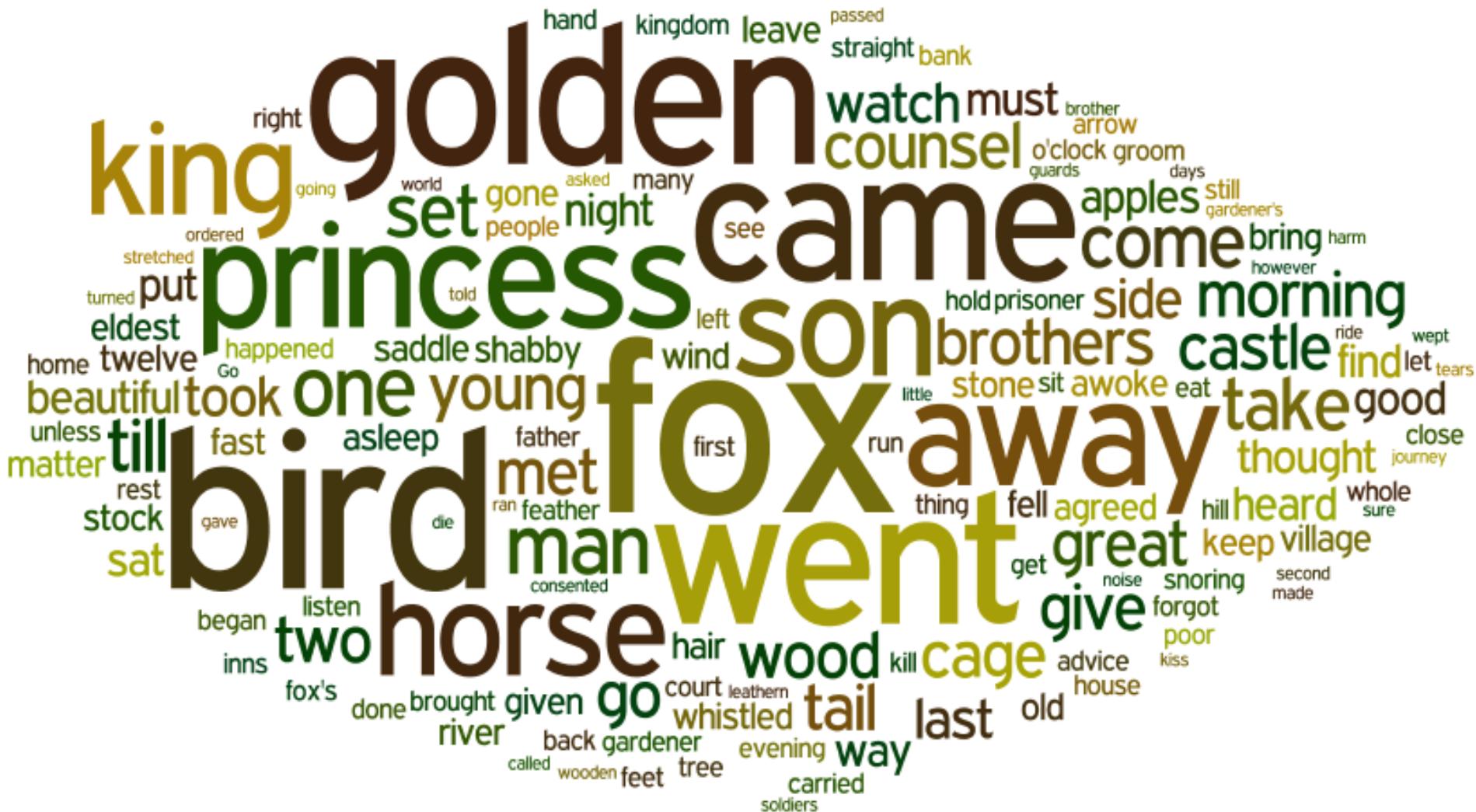
OP: Paragraph weight and color based on underlying geography

An extended typographic design space can also be used to generate many different types of new typographic visualizations; using the same dataset as Bertin as an example.

Topics

Who are the characters?

What are their traits?

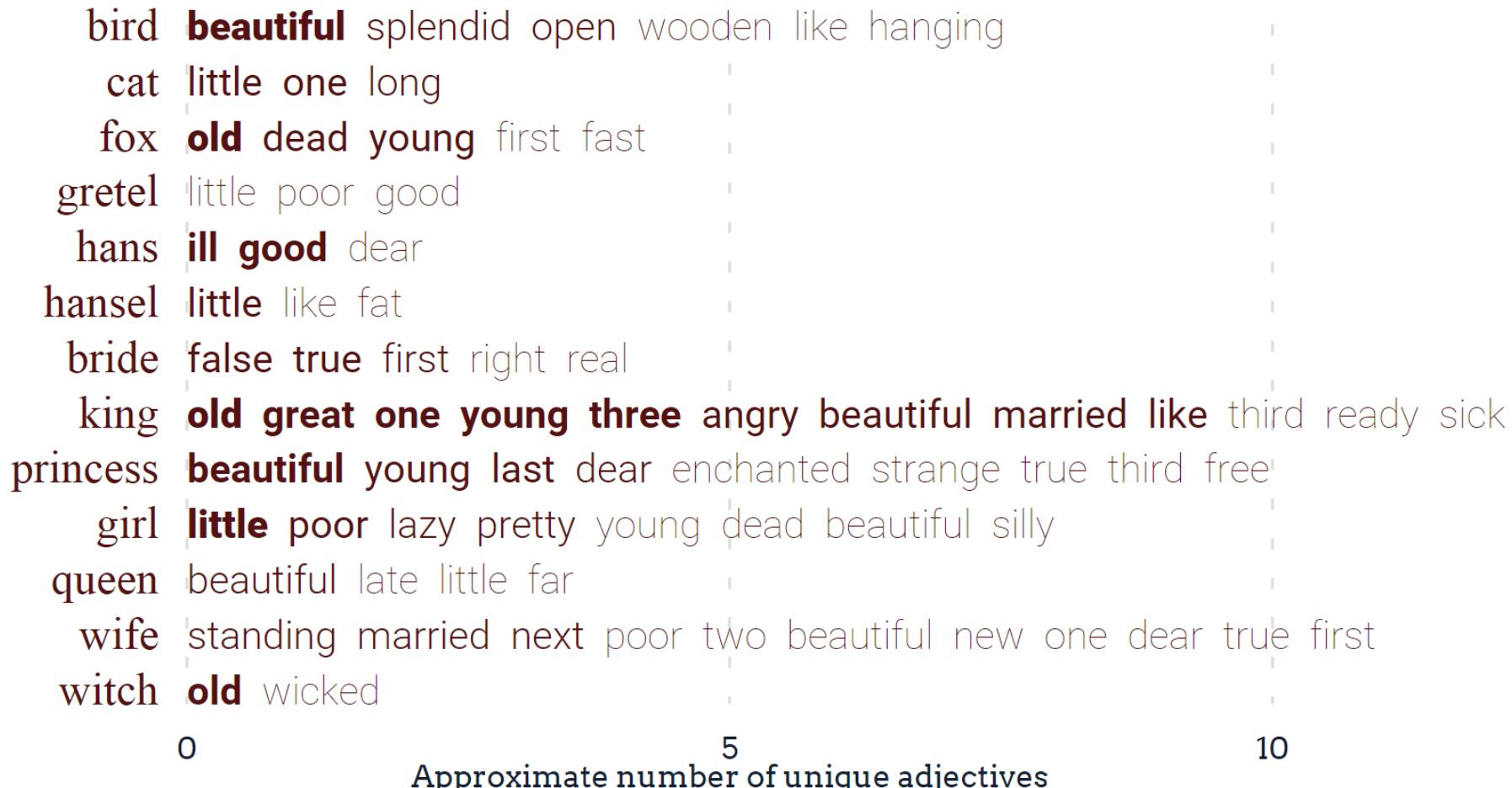


Topics

- Apply to whole text
 - Find characters
 - Find adjectives within 3 words of a character
 - Plot results
- Stack of adjectives per character
- Any expected characteristics pop-out?

Characters from *Grimms' Fairy Tales* with Associated Adjectives Weighted by Frequency

Character List of adjectives, weighted by frequency: 2 3 4-5 6-9 10+

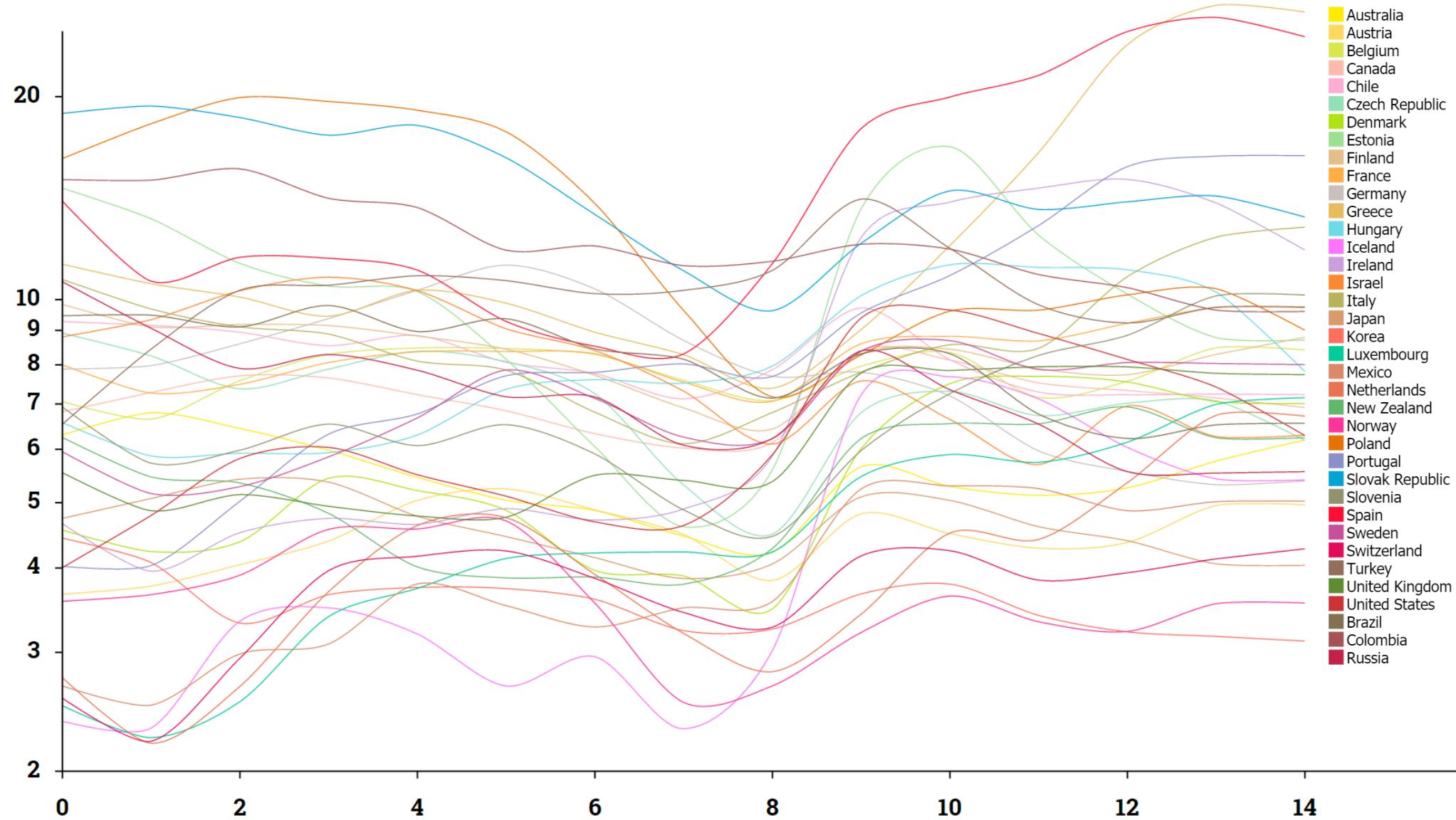


Line Chart

- Which line is which?
- Can't perceive > 10 unique colors

Unemployment Rate as Percent Civilian Labour Force

2000-2014 by Country.

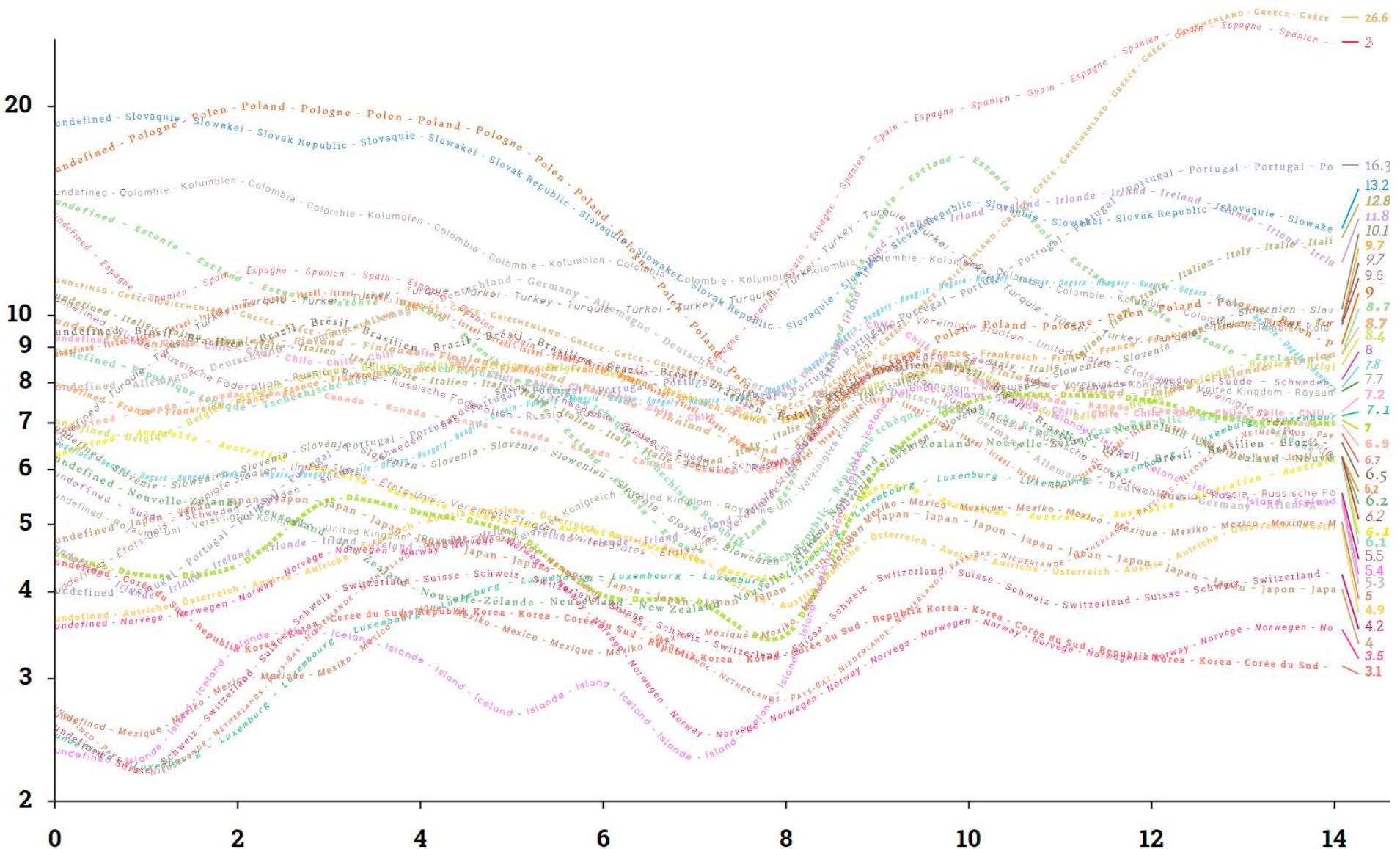


Line Chart

- Turn the line into text

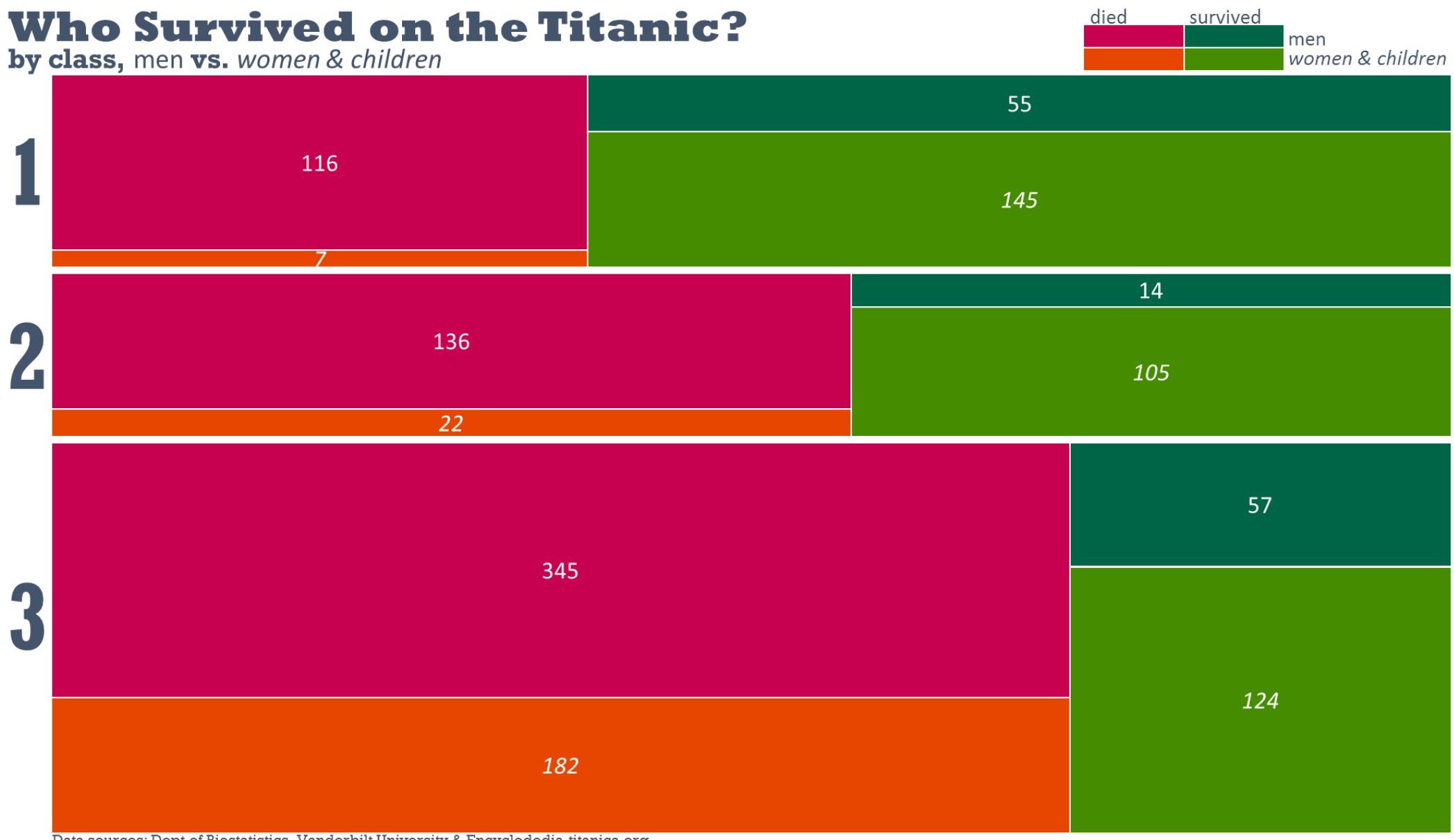
Unemployment Rate as Percent Civilian Labour Force

2000-2014 by Country. Each line is labeled with microtext in multiple languages.



Mosaic Plot

- Low data density
- Who were they?



Who Survived on the Titanic?

by class, men vs. women & children

men	women & children
died	survived

1	Hudson Allison Thomas Andrews Ramon Artagaveytia John Astor John Baumann Quigg Baxter Thomson Beattie Jakob Birnbaum Stephen Blackwell John Borebank John Brady Emil Brandeis Arthur Brewe Archibald Butt Alexander Cairns Frans Carlson Francisco Carrau Howard Case Tyrell Cavendish Herbert Chaffee Roderick Chisholm Walter Clark George Clifford Edward Colley Alexander Compton John Crafton Edward Crosby John Cumings Thornton Davidson Walter Douglas William Dullel John Farthing Benjamin Foreman Charles Fortune Mark Fortune Thomas Franklin Richard Fry Jacques Futrelle Arthur Gee Victor Giglio George Goldschmidt George Graham Benjamin Guggenheim Charles Harrington Henry Harris William Harrison Charles Hays Christopher Head Herbert Hilliard William Hopkins Alexander Holovsky William Hoyt Charles Jones Henry Julian Edwin Keeping Edward Kent Frederick Kenyon Herman Klaber Ervin Lewy Mr Lindeberg-Lind Milton Long Joseph Loring John Maguire Daniel Marvin Thomas McCaffry Timothy McCarthy Edgar Meyer Francis Millet William Minahan Harry Molson Clarence Moore Charles Natsch Arthur Newell Arthur Nicholson Engelhart Ostby Servanda Ovié y Rodríguez William Parr Austen Partner Vivian Payne Thomas Pears Walter Porter John Reuchlin Sante Ringhini Victor Robbins Washington Roebling Hugh Rodd Mr Rosenshine John Ross Martin Rothschild Alfred Rowe Arthur Ryerson William Silvey John Smart James Smith Lucien Smith Richard Smith William Spencer William Stead Albert Stewart Isidor Straus Frederick Sutton Emil Tausig John Thayer Manuel Uruchurutu Wyckoff Van der Hoeve William Walker Frank Warren John Weir Percival White Richard White George Wick George Widener Harry Widener Charles Williams Fletcher Williams-Lambert George Wright	Harry Anderson Algernon Barkworth Richard Beckwith Karl Behr Dickinson Bishop Mauritz Bjornstrom-Steffansson Henry Blank George Bradley Edward Calderhead Thomas Cardea William Carter Norman Chambers Paul Chevre Peter Daly Robert Daniel Albert Dick Washington Dodge Mr Duff Gordon Irving Flynn Henry Frauenthal Isaac Frauenthal Maximilian Frölicher-Stehli Samuel Goldenberg Archibald Gracie William Greenfield George Harder Henry Harper Hammad Hassab Walter Hawksford Mr Homer Frederick Hoyt Joseph Ismay Edwin Kimball Gustave Lesure Pierre Marechal James McGough Philipp Mock Alfred Omont Arthur Peuchen George Rhems Mr Romaine Adolphe Saalfeld Abraham Salomon Frederic Seward Spencer Silverthorne Oberst Simonius-Blumer William Sloper John Snyder Frederic Spedden Max Stahelin-Maeglin Charles Stengel Elmer Taylor Gilbert Tucker Richard Williams Hugh Woolner Elisabeth Allen Hudson Allison Kornelia Andrews Charlotte Appleton Madeleine Astor Leontine Aubert Nellie Barber Helene Baxter Albia Bazzani Sallie Beckwith Rosalie Bidois Ellen Bird Helen Bishop Amelia Bissette Caroline Bonnell Elizabeth Bonnell Grace Bowen Elsie Bowerman Margaret Brown Caroline Brown Emma Bucknell Elizabeth Burns Helen Candeo Charlotte Cardea William Carter Lucile Carter Eleanor Cassebeer Julia Cavendish Carrie Chaffee Bertha Chambers Victoire Chaudanson Gladys Cherry Edith Chibnal Virginia Clark Alice Cleaver Sara Compton Mary Compton Malvina Cornell Harriet Crosby Catherine Crosbie Florence Cumings Sarah Daniels Orian Davidson Vera Dick Washington Dodge Ruth Dodge Mary Douglas Mahala Duff Gordon Olive Earnshaw Caroline Endres Elizabeth Eustis Antoinette Fleggenhauer Margaret Fleming Alice Fortune Ethel Fortune Mabel Fortune Mary Fortune Laura Francatelli Clara Frauenthal Hedwig Frölicher Margaretha Frölicher-Stehli Lily Futrelle Amalie Geiger Dorothy Gibson Pauline Gibson Edwiga Goldenberg Margaret Graham Edith Graham Blanche Greenfield Dorothy Harder Myra Harper Irene Harris Margaret Hays Clara Hays Jean Hippach Ida Hippach Anna Hogeboom Mary Holzhausen Jane Hoyt Amelie Icard Marion Kenyon Gertrude Kimball Emilie Kreuchen Farnham Leader Bertha LeRoy Sigrid Lindstrom Mary Lines Elizabeth Lines Gretchen Longley Elise Lurette Géorgette Madill Roberta Maioni Mary Marvin Mrs Mayne Leila Meyer Daisy Minahan Lillian Minahan Madeleine Newell Helen Newsom Fermina Oliva y Ocaña Helene Ostby Edith Pears Maria Penasco y Castellana Anne Perreault Lily Potter Elisabeth Robert Edith Rosenbaum Lucy Rothes Elizabeth Rothschild John Ryerson Emily Ryerson Suzette Ryerson Emma Sagesser Emma Schabert Augusta Serepeca Elizabeth Shutes Alice Silvey Mary Smith Nellie Snyder Robert Spedden Margaretta Spedden Marie Spencer Annie Stengel Martha Stephenson Martha Stone Margaret Swift Ruth Taussig Tillie Taussig Juliet Taylor John Thayer Marian Thayer Gertrude Thorne Anna Ward Anna Warren Ella White Mary Wick Mary Wick Eleanor Widener Constance Willard Helen Wilson Marie Young
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Helen Allison Bessie Allison Jose Carras Edith Evans Ann Isham Victor Penasco y Castellana Rosalie Straus

2	Samuel Abelson Charles Aldworth Frank Andrew William Angle John Ashby Charles Baimbridge Frederick Banfield Robert Bateman Henry Beauchamp William Berriman William Botsford Solomon Bowenur James Bracken Thomas Brown Kurt Bryhl Reginald Butler Thomas Byles William Campbell William Carbines Ernest Carter Charles Chapman John Chapman Charles Clarke Reginald Coleridge Erik Collander Harvey Collyer Harry Cotterill Alfred Cunningham Jose de Brito Sebastian del Carlo Herbert Denbury William Downton James Drew George Eitemiller Ingvor Enander Harry Faunthorpe Stanley Fox Archie Frost Joseph Fynney Harry Gale Shadrach Gale Lawrence Gavey William Gilbert Edgar Giles Frederick Giles Ralph Giles John Gill William Gillespie Hans Givard Samuel Greenberg Reginald Hale William Harbeck John Harper Walter Harris Benjamin Hart Samuel Herman Leonard Hickman Lewis Hickman Stanley Hickman Richard Hocking Samuel Hoeking Henry Hodges Stephen Hold Ambrose Hood Benjamin Howard George Hunt Sidney Jacobsohn John Jarvis Clifford Jefferys Ernest Jefferys Stephen Jenkin Sinai Kantor Daniel Keane Charles Kirkland Robert Knight John Kvillner William Lahtinen John Lamb Joseph Lauroh Reine Levy Robert Leyson John Lingane Charles Louch Noel Malachard Albert Mallet Serafino Mangiavacchi William Matthews Frank Mayberry Arthur McCrae James McCrie Peter McKane August Meyer Jacob Milling Henry Mitchell Juozas Montvila Ernest Morawecik Mr Morley Thomas Myles Nicholas Nasser Louis Navratil Israel Nesson Joseph Nicholls Robert Norman Richard Otter Alfred Pain Clifford Parker Frank Parkes Frederick Pengelly René Pernot Joseph Peruschitz Escort Phillips Martin Ponessel Franz Pulbaum David Reeves Peter Renouf Emilia Richard Reginald Rogers August Schmidt Charles Sedgwick Percival Sharp Ernst Stjestedt Richard Slemen Samuel Sobey Samuel Stanton Philip Stokes George Swane Moses Troupiansky William Turpin James Veal John Ware William Ware Ennis Watson Leopold Weisz Edwy West Edward Wheadon Frederick Wheeler Edgardo Andrew Percy Bailey Lillian Carter Sara Chapman Irene Corbett Mary Corey Charles Davies Percy Deacon William Dibden Arne Fahlstrom Joseph Fillbrook Annie Funk Alfred Gaskell Marta Hiltunen Ellen Howard Claire Karnes Anna Lahtinen Mary Mack Thomas Mudd George Sweet Dorothy Turpin Mrs Yrois	Edward Beane Lawrence Beesley Albert Caldwell Sidney Collett George Harris Masabumi Hosono William Mellors Baron Nourney Percy Oxenham Julian Padro y Manent Emilio Pallas y Castello Emilio Portaluppi Charles Wilhelms Charles Williams Hannah Abelson Mary" Angle Ada Ball Ethel Beane Richard Becker Marion Becker Ruth Becker Nellie Becker Lilian Bentham Mildred Brown Edith Brown Elizabeth Brown Dagmar Bryhl Kate Buss Karolina Bystrom Alden Caldwell Sylvia Caldwell Clear Cameron Julie Christy Alice Christy Ada Clarke Lotte Collyer Charlotte Collyer Selena Cook John Davies Elizabeth Davies Mary Davis Argentia del Carlo Elsie Doling Ada Doling Marshall Drew Lulu Drew Asuncion Duran y More Florentina Duran y More Elizabeth Faunthorpe Ethel Garside Viljo Hamalainen Anna Hamalainen Nina Harper Eva Hart Esther Hart Alice Herman Kate Herman Jane Herman Mary Hewlett Nellie Hocking Eliza Hocking Annie Hold Bertha Ilett Amy Jacobsohn Marie Jervan Miriam Kantor Nora Keane Fannie Kelly Louise Laroche Simonne Laroche Juliette Laroche Bertha Lehmann Jessie Leitch Amelia Lemore Alice Louch Andre Mallet Antoinette Mallet Madeleine Mellinger Elizabeth Mellinger Adele Nasar Edmond Navratil Michel Navratil Elizabeth Nye Lutie Parrish Alice Phillips Mrs Phillips Rosa Pinsky Phyllis Quick Winifred Quick Jane Quick Lillian Renouf Encarnacion Reynaldo George Richards William Richards Emily Richards Lucy Ridsdale Emily Rugg Imanta Shelley Lyli Silver Maude Sincock Anna Sinkkonen Hilda Slayter Marion Smith Ellen Toomey Jessie Trout Winnie Trout Nellie Walcroft Florence Ware Bertha Watt Bessie" Watt Susan Webber Mathilde Weisz Ralph Wells Joan Wells Addie" Wells Barbara West Constance West Ada West Marion Wright
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3	Anthony Abbing Mauritz Adahl John Adams William Alexander Ilmari Alhomaki Ahmed Ali William Ali William Allen Albert Andersen Anders Andersson Johan Andersson Paul Andreasson Minko Angheloff Josef Arnold-Franchi Ernst Aronsson Adola Asim Carl Asplund Geros Assaf Ali Assam Sleiman Attalah Albert Augustsson Rafffull Baccos Karl Backstrom Mohamed Badt Cerin Balkic David Barton William Beavan John Bengtsson Karl Berglund Seman Betros Tannous Betros Hans Birkeland Guentcho Bostandjeff Hanna Boulos John Bourke Dai Bowen Lewis Braund Karl Brobeck William Brocklebank Jeremiah Burke Luka Cacic Patrick Canavan Ernest Cann Joseph Caram August Carlsson Carl Carlson Alfred Carver Francesco Celotti David Charters Emil Christmann Apostolos Chronopoulos Domingos Coelho Patrick Colbert Peju Coleff Satio Coleff Thomas Conlon Michael Connaghton Patrick Connors Jacob Cook Bartol Cor Ivan Cor Liuditev Cor Harry Corn Daniel Coxon Ernest Cease John Cribb Shedid Daher Branko Dakic Ernst Danbon Yoto Danoff Ristiu Dantcheff John Davies Alfred Davies Evan Davies Thomas Davison Bertram Dean Redjo Delalic Marinko Demetri Mitto Denkoff Samuel Dennis William Dennis Jovan Dimic Valtcho Dintcheff Tannous Doharr Patrick Dooley Jozef Drzenovic Frank Duane Adolf Dyker Johan Ekstrom Dibo Elias Joseph Elias William Elsbury Farred Emir Thomas Everett James Farrell James Flynn John Flynn Joseph Foley William Ford Arthur Fox Charles Franklin Martin Gallagher John Garforth Stanio Gheorghescu Eliezer Gilinsky Nathan Goldsmith Frank Goldsmith Manuel Goncalves Charles Goodwin George Green Daniel Gronnestad Robert Guest Alfred Gustafsson Anders Gustafsson Karl Gustafsson Ingvald Hagland Konrad Hagland Pekka Hakkarainen Leon Hampe Mansour Hanna Claus Hansen Henrik Hansen Henry Hansen David Harmer Henry Hart Ignac Hendekovic John Holm Johan Holthen John Hogan Adolf Humblet Youssef Ibrahim Shawah Ylio Ilieff Kanio Ivanoff Jose Jardin Hans Jensen Niels Jensen Jakob Johansson Erik Johansson Gustaf Johansson Karl Johansson Nils Johansson Alfred Johnson William Johnson Malkom Johnson Andrew Johnston Lailo Jonkoff Nils Jonsson Johannes Kalvik Julius Karlsson Nils Karlsson Catavelas Katavelas Andyu Keane Arthur Keefe James Kelly James Kelly Betros Khalil John Kieman Philip Kieman Thomas Kilgannon Vincenz Kink Theodor Kraeff Saksis Laihoni Kristo Laleff Len Lam August Larsson Bengt Larsson Edward Larsson-Rondberg Antti Leimonen Peter Lemberopoulos Denis Lemmon Lionel Leonard James Lester Rene Lievens Edvard Lindell Michael Linehan Lee Ling Simon Lithman William Lobb Edward Lockyer Henry Lovell Johan Lundahl Stanko Lyntakoff George MacKay Matti Maenpaa John Mahon Simon Maisner Kalle Makinen Sarkis Mardirosian Marin Markoff Johann Markun Nicola Matinoff Michael McEvoy Martin McMahon Neal McNamee Alfonzo Meo Robert Mernagh Frank Miles Ivan Mineff Lazar Minkoff Stoytcho Mionoff Mito Mitkoff Sigurd Moen Leonard Moore Daniel Moran James Moran William Morley Thomas Morrow Rahamin Moutal Joseph Murdin Penko Naidenoff William Nancarrow Minko Nankoff Mustafa Nasr Christo Niklasson August Nilsson Isakki Nirva Richard Nosworthy Mansouer Novel Johan Nyseven Thomas O'Brien Timothy O'Brien Patrick O'Connor Nils Odahl Henry Olsen Karl Olsen Ole Olsen Nils Olsson Thor Olsvigen Luka Oreskovic Jakob Pasic George Patchett Uscher Paulner Stefo Pavlovic Ernest Pearce Olaf Pedersen Joseph Peduzzi Edward Pekoniemi Nikolai Peltomaki John Perkin Marius Petersen Nedelio Petroff Pentcho Petroff John Peterson Vassil Plotcharsky Tome Poknic Alexander Radeff Raihed Razi James Reed Tido Rekic Harold Reynolds Matti Rintamaki Samuel Reeder Bridget Bradley Ellen Carr Gus Cohen Kate Connolly Neville Coutts William Coutts Minnie" Coutts Laura Cribb Maggie Daly Mary Davison Emma de Messemaeker Bertram Dean Millvina Dean Eva Dean Margaret Devaney Elizabeth Dowdell Jennie Drapkin Anna Dyker Virginia Emanuel Katie Gilnagh Mary Lynn Frankie Goldsmith Emily Goldsmith Elin Hakkarainen Jennie Hansen Nora Heikkinen Hilda Hellstrom Hildur Hirvonen Helga Hirvonen Ellina Honkanen May Howard Annie Jernym Harold Johnson Elisabeth Johnson Eleanor Johnson Manca Karun Annie Kelly Mary Kelly Luise Kink-Heilmann Luise Kink-Heilmann Aurora Landgren Olga Lundin Maggie Madigan Margaret Mannion Fatima Masselman Katie McCarthy Agnes McCoy Alicia McCoy Bridget McDermott Mary McGovern Annie McGowan Ellie Mockler Meier Moor Beila Moor Bertha Moran Geros Moubarek William Moubarek Amernia" Moubarek Mantoura Moussa Katie Mullens Bertha Mulvihill Kate Murphy Margaret Murphy Nora Murphy Jane Najib Mary Nakid Mary" Nakid Elias Nicola-Yared Jamila Nicola-Yared Berta Nilsson Helmina Nilsson Anna Nysten Hannah" O'Brien Bridget O'Driscoll Nellie O'Dwyer Velin Ohman Norah O'Leary Artur Olsen Mara Osman Michael Peter Anna Peter Catherine Peter Hannah Riordan Sarah Roth Anna Salkjelsvill Beatrice Sandstrom Agnes Sandstrom Marguerite Sandstrom Ellen Shine Anna Sjoblom Julia Smyth Amy Stanley Victor Sunderland Johan Svensson Assad Thomas Thelma Thomas Florence Thorneycroft Georges Touma Maria Touma Hanne Touma Anna Tuja Hedwig Turkula Shawneene Whabee Elin Wilkes Selini Yasbeck	Olaus Abelseth Abraham Abramsson Nassef Albimona Wennerstrom Andersson Johan Asplund Hanna Barah Lee Bing Daniel Buckley Chang Chip Karl Dahl Eugene Daly Guillaume de Messemaeker Theodore de Mulder Edward Dorking Joseph Duquenne Luigi Finoli Choong Foo Oskar Hedman Ling Hee Abraham Hyman Ivan Jalsevac Carl Jansson Bernt Johannessen-Bratthamer Oskar Johansson Palmquist Carl Jonsson Eirik Juslusa Einar Karlsson Franz Karun John Kennedy Anton Kink-Heilmann Nesan Krekorian Ali Lam Fang Lang Philip Leeni Eino Lindqvist Nikola Lulic Thure Lundstrom Fridtjof Madsen Hanna Mamee Thomas McCormack Bernard McCoy Karl Midtsjø Albert Moss Sahid Nakid Juha Niskanen Patrick O'Keefe Oscar Olsson Ernst Person Berk Pickard Edward Ryan Julius Sap Jan Sheerlink Juho Strandén Johan Sundman Gunnar Tenglin William Tornquist David Vartanian
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4	Eugene Abbott Rossmore Abbott Johanna Ahlin Owen Allum Ida Andersson Sigrid Andersson Ellis Andersson Alfrida Andersson Josefine Arnold-Franchi Carl Asplund Clarence Asplund Filip Malake Attalah Saide Barbara Julia Barry Ernst Bjorklund Akar Boulos Nourelain Boulos Mary Bourke Catherine Bourke Elin Braf Katherine Buckley Mary Burns Manda Cacic Marija Cacic Jego Cacic Jovo Calic Petar Calic Mary Canavan Maria Caran Jeannie Carr Demetrios Chronopoulos Kate Connolly Jesu Culomovic Gerda Dahlberg Gilbert Danbon Anna Danbon Joseph Davies Alfons de Pelsmaeker Mirko Dika Elizabeth Doyle Gustaf Edwardsson Hans Ekhund Joseph Elias Tannous Elias Eberhard Fischer Honora Fleming Daisy Ford Ruby Ford Edward Ford William Ford Margaret Ford Harold Goodwin Sidney Goodwin William Goodwin Jessie Goodwin Lillian Goodwin Charles Goodwin Augusta Goodwin Aloisia Haas Kate Hagardon Alice Harknett Houssein Hassan Nora Hegarty Wenda Heininen Jenny Henriksson Delia Henry Ida Ilmakangas Pieta Ilmakangas Kristina Latimer Patrick Lane Henry Lelefbre Ida Lelefbre Jeanne Lelefbre Mathilde Lelefbre Frances Lelefbre Mary Lemon Katrin Jussila Mari Jussila Nikolai Kallio Fared Kassem Maria" Khalil Maria Kink Gertrud Klases Klas Klases Hulda Klases Kristina Latimer Patrick Lane Henry Lelefbre Ida Lelefbre Jeanne Lelefbre Mathilde Lelefbre Frances Lelefbre Mary Lemon Agda Lindahl Augusta Lindholm Elin Lindell Cordelia Lobb Bridget Mahon Mary Mangan Katherine McGowan Eileen McNamee Bridget McNeil Marion Meanwell Annie Meek Pehr Myhrman Hammah Naughton Manta Nieminen Patrick O'Connell Maurice O'Conor Bridget O'Donoghue Elina Olsson Jelka Oreskovic Marija Oreskovic Olaf Olsen Bridget O'Sullivan Stina Palsson Torborg Palsson Alma Palsson Eino Paloma Juha Paloma Ernesti Paloma Jaako Paluma Maria Paluma Alfred Peacock Treastall Peacock Edith Peacock Katie Peters Matilda Petracen Ellen Petterson Mate Pokrnica Lena Rasmussen Albert Rice Arthur Rice Erie Rice Eugene Rice George Rice Margaret Rice Sami Riihivouri Emma Risien Grace Robins Salli Rosblom Viktor Rosblom Helena Rosblom Alfred Rush Harry Sadowitz Thomas Sage William Sage Ada Sage Constance Sage Dolly Sage Stella Sage Douglas Sage Frederick Sage Annie Sage Elias Samaan Yousef Samaan Harald Skoog Karl Skoog Margit Skoog Anna Skoog Ida Strandberg Telma Strom Elsa Strom Tannous Thomas James van Billard Walter van Billard Catharina Van Impe Rosalie Van Impe Augusta Vander Planke Leo Vander Planke Emilia Vander Planke Hulda Vestrom Jakob Wiklund Edward Willey Silent Zabour Thamine Zabour	Katie McCarthy Agnes McCoy Alicia McCoy Bridget McDermott Mary McGovern Annie McGowan Ellie Mockler Meier Moor Beila Moor Bertha Moran Geros Moubarek William Moubarek Amernia" Moubarek Mantoura Moussa Katie Mullens Bertha Mulvihill Kate Murphy Margaret Murphy Nora Murphy Jane Najib Mary Nakid Mary" Nakid Elias Nicola-Yared Jamila Nicola-Yared Berta Nilsson Helmina Nilsson Anna Nysten Hannah" O'Brien Bridget O'Driscoll Nellie O'Dwyer Velin Ohman Norah O'Leary Artur Olsen Mara Osman Michael Peter Anna Peter Catherine Peter Hannah Riordan Sarah Roth Anna Salkjelsvill Beatrice Sandstrom Agnes Sandstrom Marguerite Sandstrom Ellen Shine Anna Sjoblom Julia Smyth Amy Stanley Victor Sunderland Johan Svensson Assad Thomas Thelma Thomas Florence Thorneycroft Georges Touma Maria Touma Hanne Touma Anna Tuja Hedwig Turkula Shawneene Whabee Elin Wilkes Selini Yasbeck
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Skim

What are some keywords here?
→

Dorothy lived in the midst of the great Kansas prairies, with Uncle Henry, who was a farmer, and Aunt Em, who was the farmer's wife. Their house was small, for the lumber to build it had to be carried by wagon many miles. There were four walls, a floor and a roof, which made one room; and this room contained a rusty looking cookstove, a cupboard for the dishes, a table, three or four chairs, and the beds. Uncle Henry and Aunt Em had a big bed in one corner, and Dorothy a little bed in another corner. There was no garret at all, and no cellar except a small hole dug in the ground, called a cyclone cellar, where the family could go in case one of those great whirlwinds arose, mighty enough to crush any building in its path. It was reached by a trap door in the middle of the floor, from which a ladder led down into the small, dark hole.

When Dorothy stood in the doorway and looked around, she could see nothing but the great gray prairie on every side. Not a tree nor a house broke the broad sweep of flat country that reached to the edge of the sky in all directions. The sun had baked the plowed land into a gray mass, with little cracks running through it. Even the grass was not green, for the

Skim

What are some
keywords here?
→

Dorothy lived in the **midst** of the great **Kansas prairies**, with **Uncle Henry**, who was a **farmer**, and **Aunt Em**, who was the **farmer's wife**. Their house was **small**, for the **lumber** to **build** it had to be **carried** by **wagon** many miles. There were **four walls**, **a floor** and **a roof**, which made one **room**; and this **room contained** a **rusty looking cookstove**, a **cupboard** for the **dishes**, a **table**, three or **four chairs**, and the **beds**. **Uncle Henry** and **Aunt Em** had a **big bed** in one **corner**, and **Dorothy** a **little bed** in another **corner**. There was no **garret** at all, and no **cellar** except a **small hole dug** in the ground, called a **cyclone cellar**, where the family could go in case one of those great **whirlwinds** arose, mighty enough to **crush** any **building** in its **path**. It was reached by a **trap door** in the **middle** of the **floor**, from which a **ladder led** down into the **small, dark hole**.

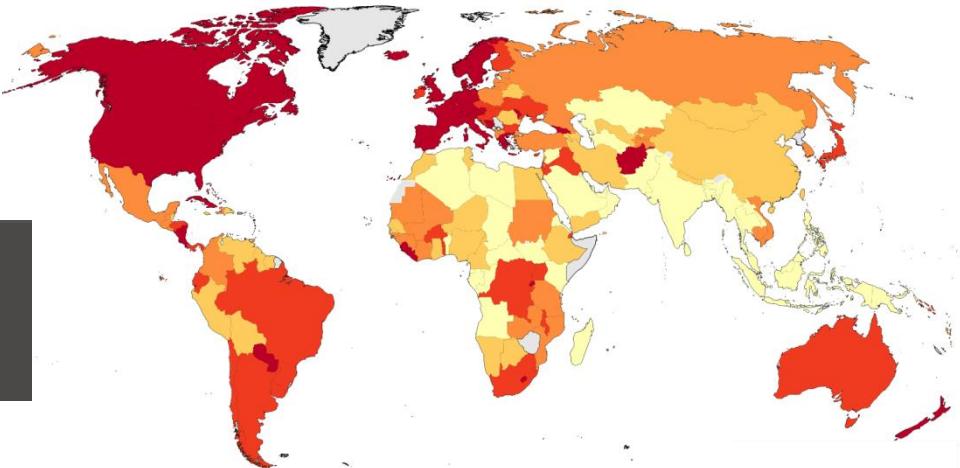
When **Dorothy** stood in the **doorway** and looked around, she could see nothing but the great **gray prairie** on every side. Not a tree nor a house broke the **broad sweep** of **flat country** that reached to the **edge** of the **sky** in all **directions**. The sun had **baked** the **plowed land** into a **gray mass**, with little **cracks** running through it. Even the **grass** was not **green**, for the

Country Comparison

- What's the value for Singapore?
- Are big countries over-represented?
- How to compare across multiple variables?
e.g. Are there countries with high health expenditures, short lives, and high HIV?

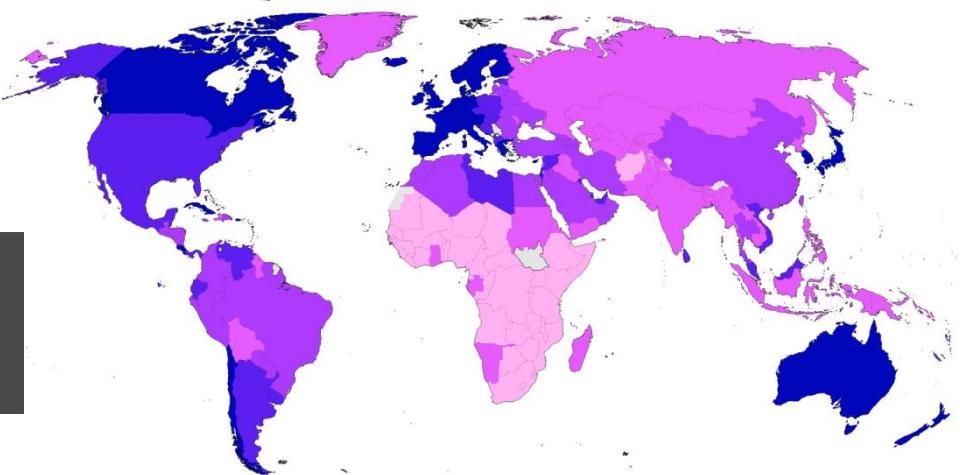
2010-Health expenditure, total (% of GDP)

less than 4.4  9.2 or more



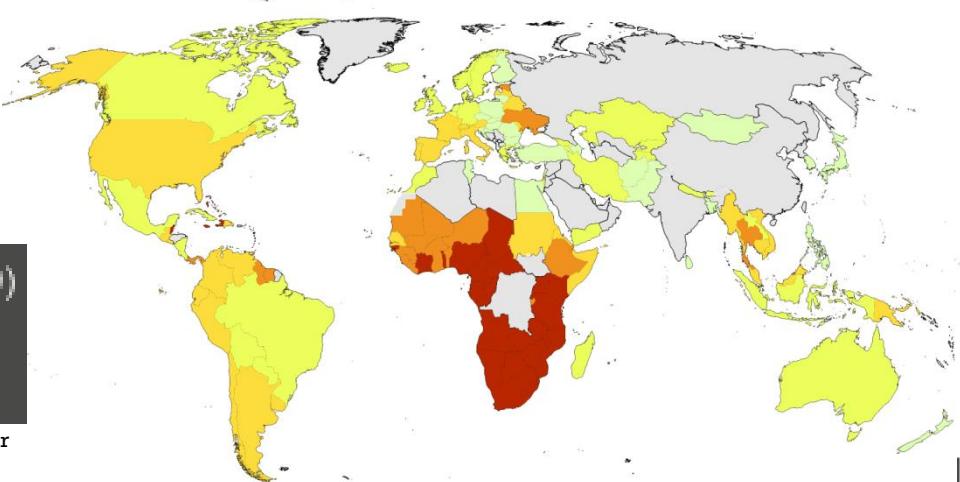
2010-Life expectancy at birth, total (years)

less than 60.6  78.5 or more



2010-Prevalence of HIV, total (% of population ages 15-49)

less than 0.1  1.6 or more



Images sourced directly from data.worldbank.org. Note: hue has been shifted in images in order to differentiate the three different maps to facilitate discussion purposes. Extracted May 2013.

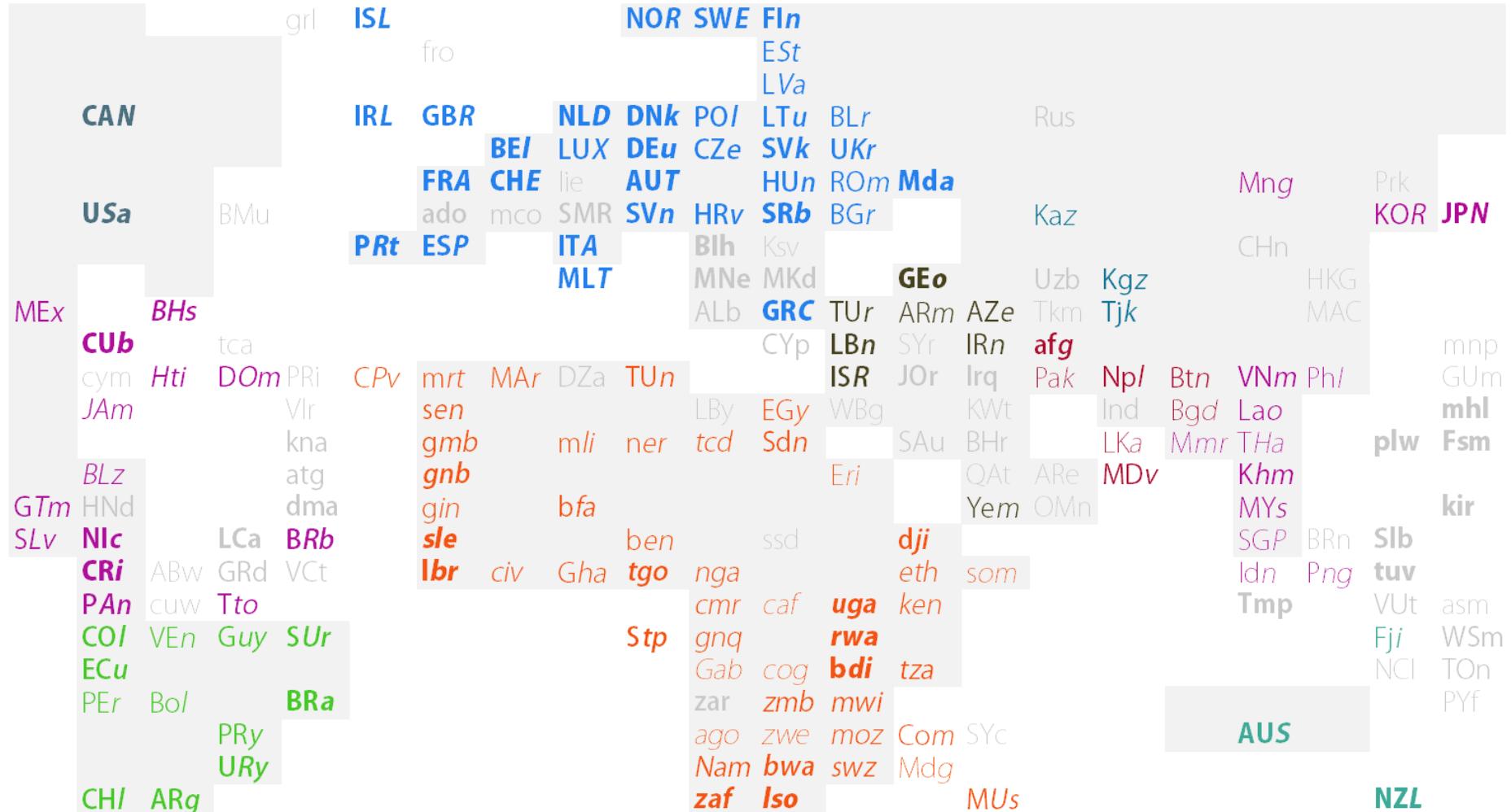
Country Comparison

- Can identify small countries
- Can compare multiple variables across countries.

e.g. Are there countries with high health expenditures and short lives?

Health Expenditure, Life Expectancy and HIV by country 2010

The font attributes indicates data via font weight, caps and italics. Font size is consistent, so that countries small in size or population are not visibly smaller. © 2013 Richard Brath



Health Expenditure
(% of GDP) font weight:

AAA	< 4.0 %	AAA	7.0 - 8.5
AAA	4.0 - 5.5	AAA	8.5 - 10
AAA	5.5 - 7.0	AAA	> 10 %

Data source: data.worldbank.org. Region color based on World Factbook, grey if no HIV data

Life Expectancy
(at birth, in years) caps:

abc	< 60
Abc	60 - 70
ABC	70 - 80
ABC	> 80

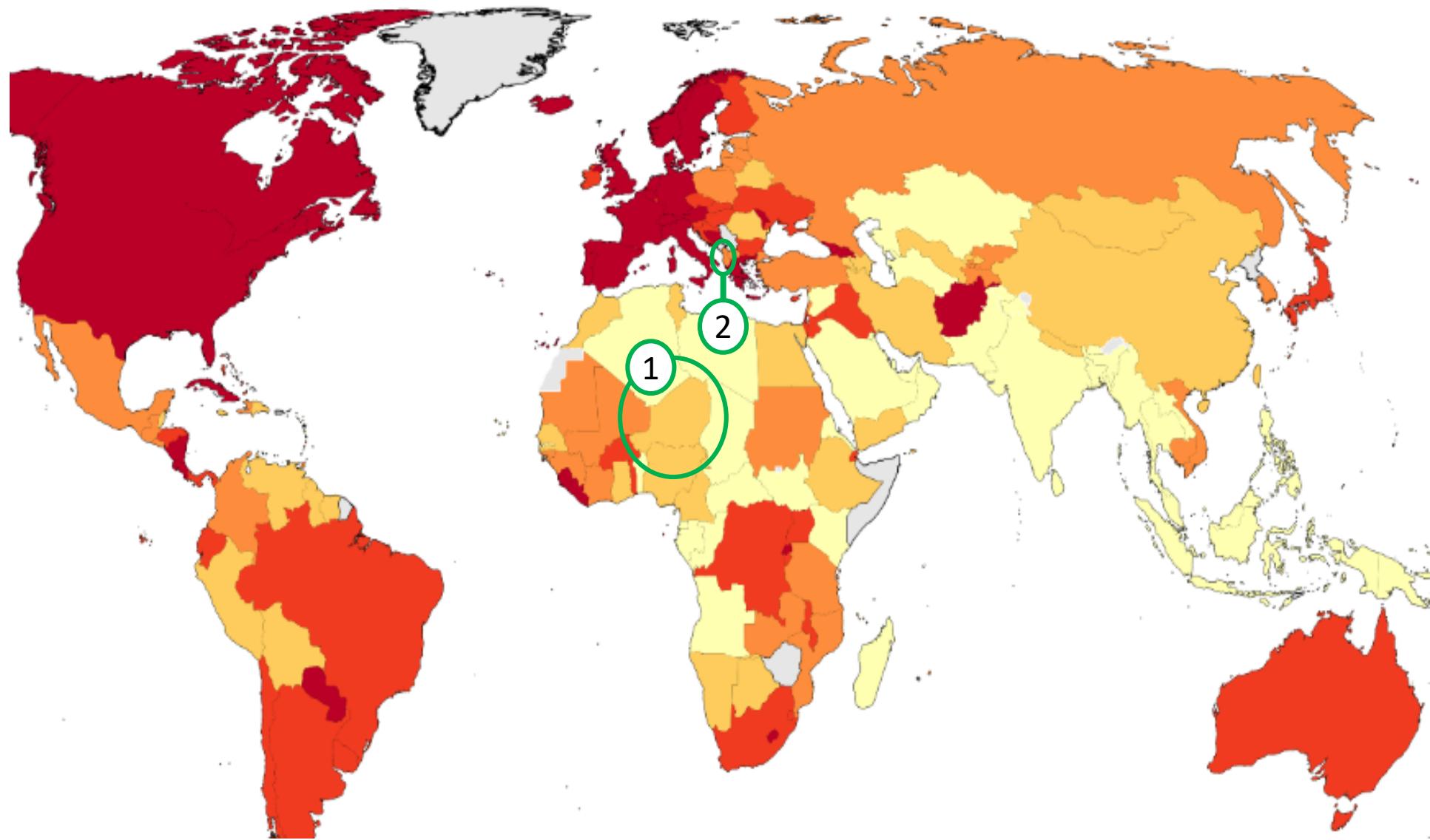
Prevalence of HIV
(% of population age 15-49) italics:

ABC	abc	< 0.1 %
ABC	abc	0.1 - 0.6
ABC	abc	0.6 - 1.6
ABC	abc	> 1.6 %

4. Evaluate New Visualizations

- Example questions for map identification and location.

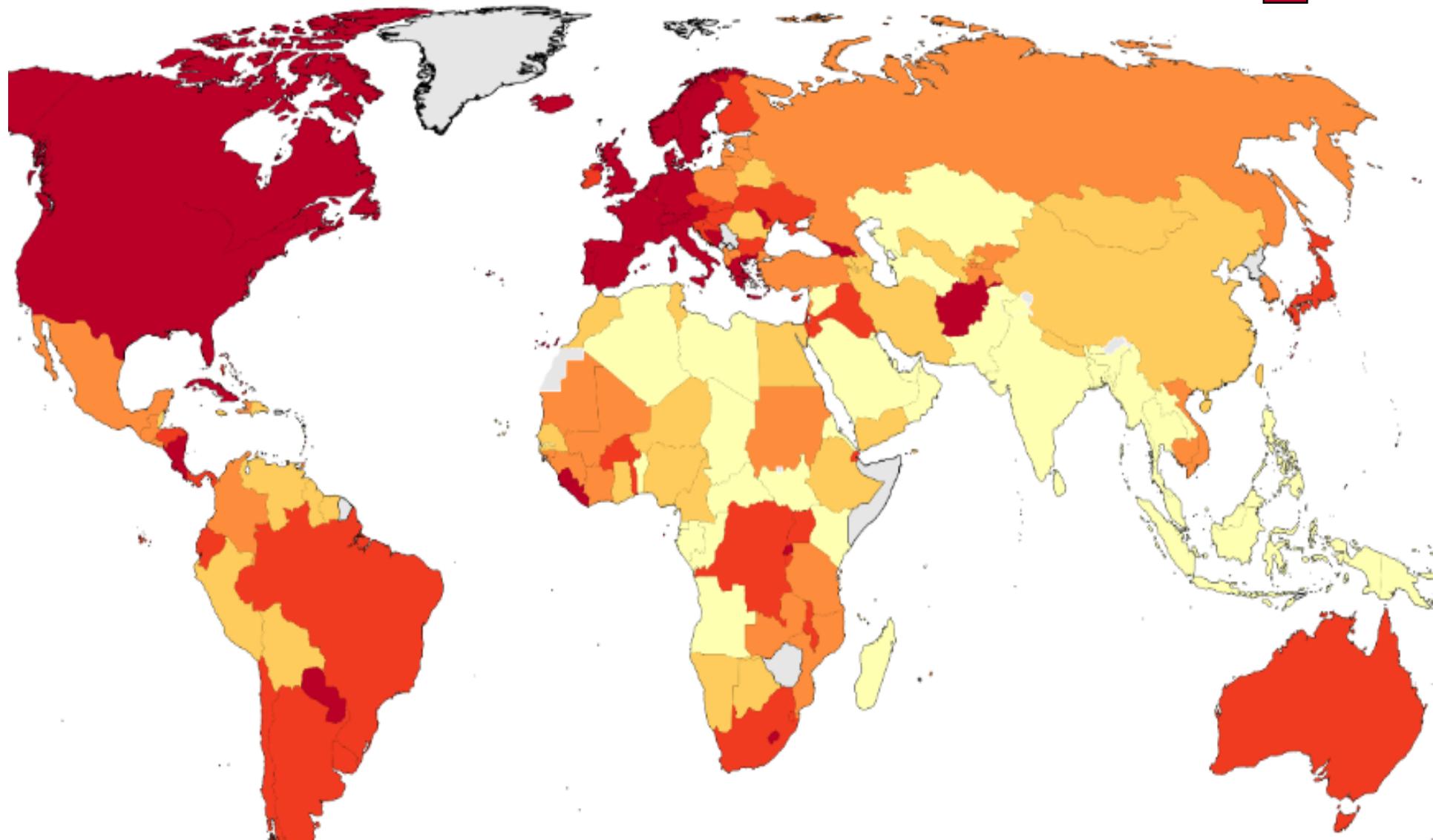
A. Identify Countries



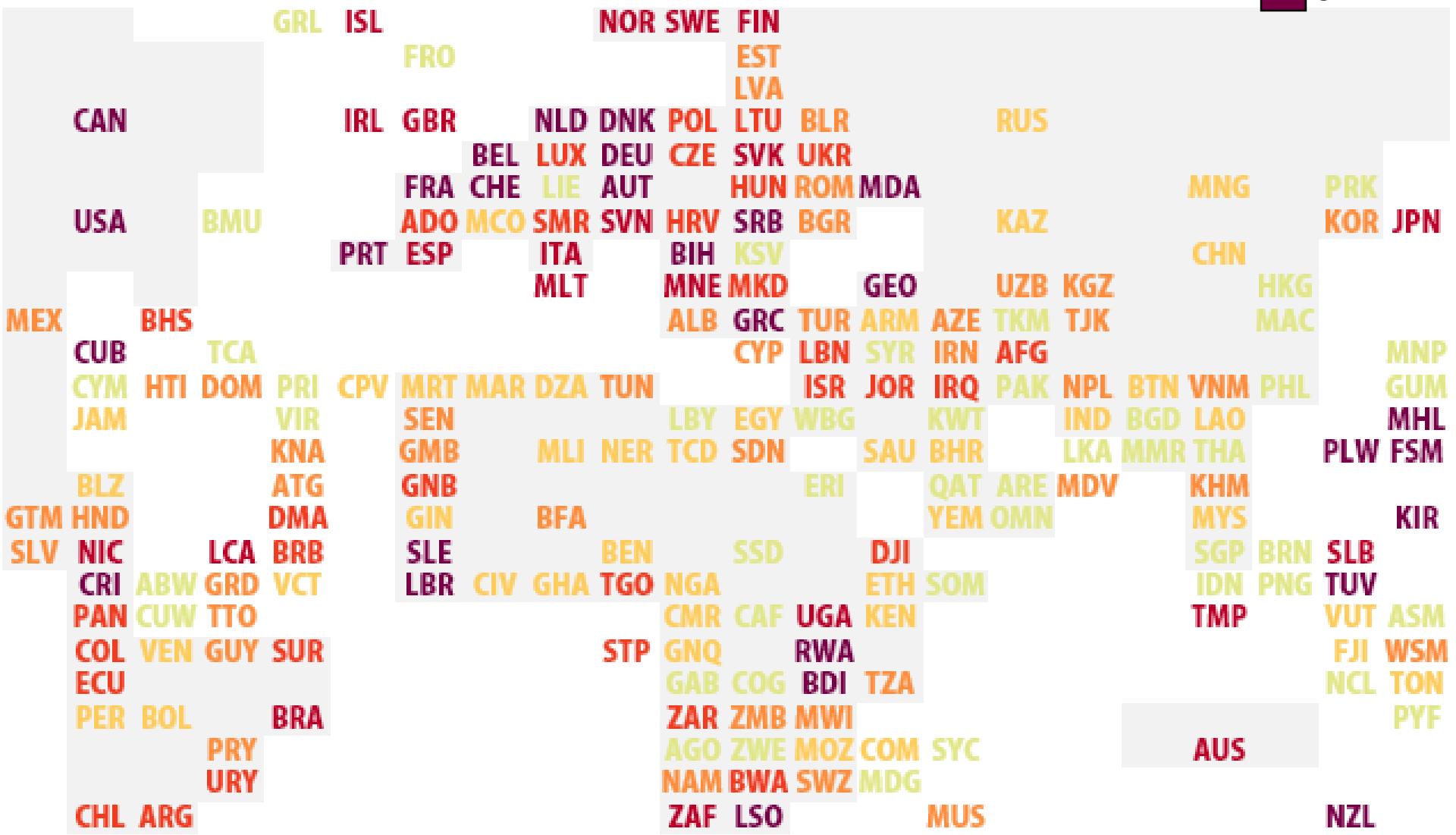
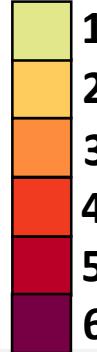
B. Identify Countries

C. Color of Angola and Bulgaria

1
2
3
4
5



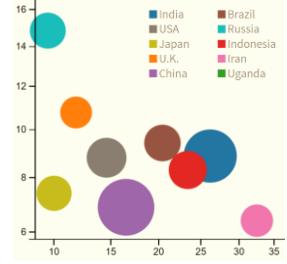
D. Color of Zambia and Moldova



4. Evaluate New Visualizations

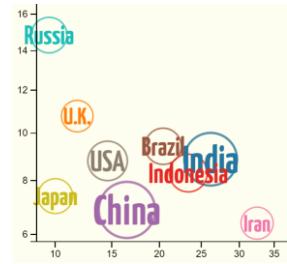
Before

Scatter



Legend or interaction required to identify

After: TextViz

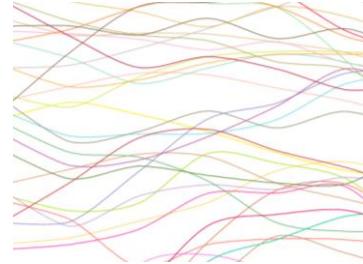


Explicit labels for direct identification

Evaluation

Task Model
Cognitive models predict scatterplot is 28-75% slower than label plot for identification and location tasks

Timeseries

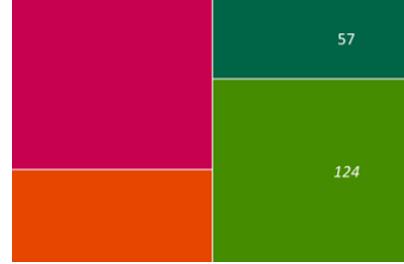


Viewers do not perceive >10 unique colors

Task Observations

- 2/6 experts attempted the non-microtext chart, 4/6 dismissed
- 5/6 complete microtext variants (too small for one)

Set Visualization

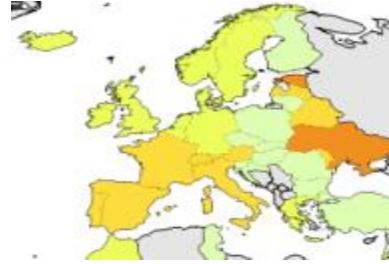


Set members not identifiable
Venn diagram areas errors

Encoding Accuracy

- String area within 5% of target geometric area
- Fewer labels, higher error
- Tall boxes higher error than wide boxes

Thematic Maps



Performs poorly on locate & identify tasks

Task Performance
ISO-code map outperforms choropleth map:
• 4.4x for identification task
• 1.6x for location task

Text Skimming

Dorothy lived in the midst of the great Kansas prairies, with Uncle who was a farmer, and Aunt Em, who was the farmer's wife. Their was small, for the lumber to build it had to be carried by wagon m miles. There were four walls, a floor and a roof, which made one r and this room contained a rusty looking cookstove, a cupboard fo dishes, a table, three or four chairs, and the beds. Uncle Henry an Em had a big bed in one corner, and Dorothy a little bed in another corner. There was no garret at all, and no cellar except a small hole the ground, called a cyclone cellar, where the family could go in c of those great whirlwinds arose, mighty enough to crush any built its path. It was reached by a trap door in the middle of the floor, fr which a ladder led down into the small, dark hole.

Slow linear search to find uncommon words to skim

Dorothy lived in the midst of the great Kansas prairies, with Uncle who was a farmer, and Aunt Em, who was the farmer's wife. Their was small, for the lumber to build it had to be carried by wagon m miles. There were four walls, a floor and a roof, which made one r and this room contained a rusty looking cookstove, a cupboard fo dishes, a table, three or four chairs, and the beds. Uncle Henry an Em had a big bed in one corner, and Dorothy a little bed in another corner. There was no garret at all, and no cellar except a small hole the ground, called a cyclone cellar, where the family could go in c of those great whirlwinds arose, mighty enough to crush any built its path. It was reached by a trap door in the middle of the floor, fr which a ladder led down into the small, dark hole.

Weighted words by inverse frequency aids skimming

Treemap



Small text illegible
Area estimation poor

Hugo Crosby -- "Silent Night" - Silent night, Holy night, All is bright
The Ink Spots -- "I Didn't Care" - If I didn't care more than words can say
Elton John -- "I'm Still Standing" - I'm still standing, I'm still standing
The Roy Acuff -- "McMabah Comeback" - From the great salt lake ocean to the wide Pacific
Billie Holiday -- "God Bless the Child" - You know brother and friend and pray
Gene Autry -- "Rodeo the Red-Roan Beatin'" - Don't you see, the rodeo
Billie Holiday -- "Rock Around the Clock" - Day, there's the day
The Penguins -- "Earth Angel" - Earth angel, earth angel, will you be my friend, my dear
John Denver -- "Country Roads" - When I was a boy, I used to sit and dream
Paul Anka -- "Diana" - I'm so young and you're so old, This, my darling, I've been
Elvis Presley -- "It's Now or Never" - It's now or never, Come hold me tight, Kiss i
The Beatles -- "I Want to Hold Your Hand" - I want to hold your hand, I want to hold
The Monkees -- "I'm a Believer" - I thought love was only true in fairy tales, Heard
Peter, Paul and Mary -- "Blowin' in the Wind" - Blowin' in the wind, makes me wonder
Hugo Jerry -- "In the Summertime" - In the summertime when the weather is hot, you
Helen Reddy -- "I Am Woman" - I am woman, hear my cry, I am woman, I
Carl Douglas -- "Kung Fu Fighting" - Now here it is, time to make you move, Something
Elton John -- "Tiny Dancer" - I'm just a小小人儿, I'm just a tiny dancer
Roger Whittaker -- "The Last Farewell" - There's a ship, it's tied and ready, in the
John Travolta & Olivia Newton-John -- "Stayin' Alive" - Stayin' alive, stayin' alive, stayin' alive
Gloria Gaynor -- "I Will Survive" - At first I was afraid, I was petrified, kept th
Vitas Gerulaitis -- "I'm a Believer" - I'm a believer, I'm a believer, I'm a believ
The Bee Gees -- "How Deep Is Your Love" - Ah, ah, ah, ah, was ist los mit dir mein Schatz? At
Peter Gabriel -- "In Your Eyes" - In your eyes, I can see the world, I can see the world
Bryan Adams -- "Everything I Do" - Look into my eyes, you will se
Scorpions -- "Wind of Change" - I follow the horizon, Down to Gorky Park, Listening

Consistently sized text,
Bold length → quantity

Metrics

- 1.8- 2.7x more items readable
- More content via longer strings
- Length lower margin of error in size estimation

4. Critical Refinement

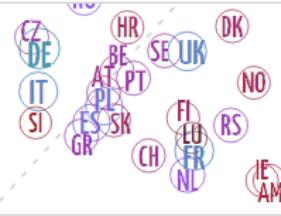
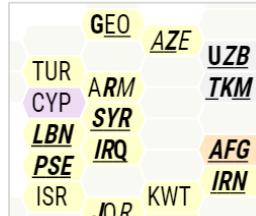
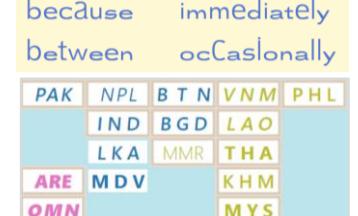
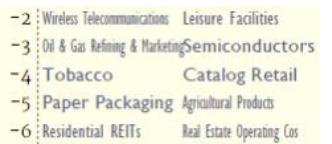
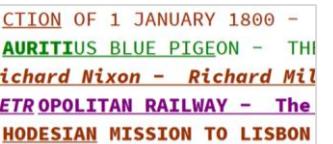


- Literal faster, automaticity, serendipity...
- Legibility and readability
- Multi-level readings macro/micro/stroop
- Interactions search/alphasort/toggle/modes
- Semantic encodings
- Live in the wild today
- Variable fonts Open Type 1.8
- Evaluation speed of detection or understanding? baseline?
- Long labels greater area biases perception?
- Characterization cardinality, normal, sequential/diverging
- How much weight, what slope?

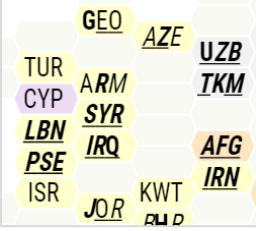
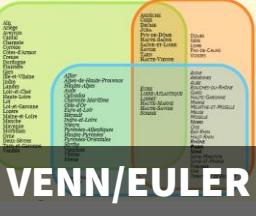
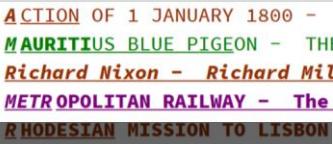
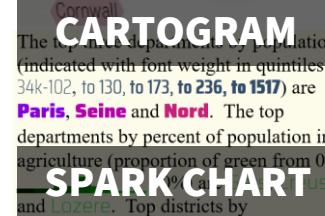
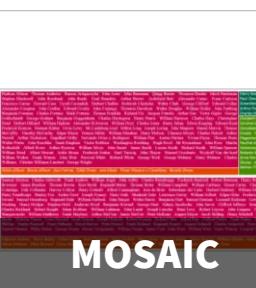
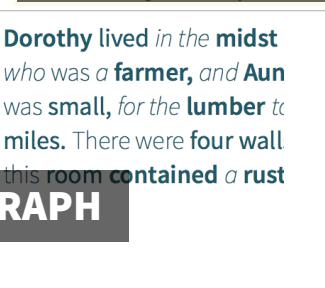
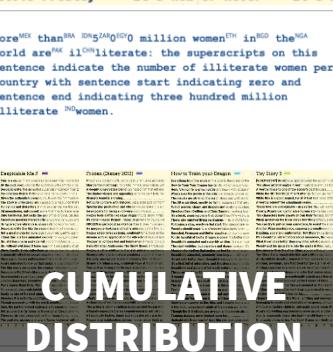
Contribution 4: Breadth of new research questions

The multi-faceted potential of text prompts massive new research questions. Visualization moves beyond immediate preattentive representations to issues around multi-level access and interpretation, even adding a new cognitive mode to visualization. Broader collaboration with cartographers, typographers, linguists, designers, psychologists and philosophers are feasible.

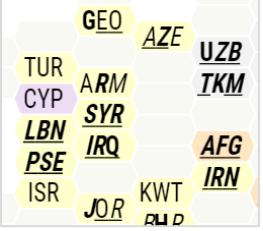
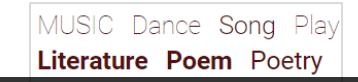
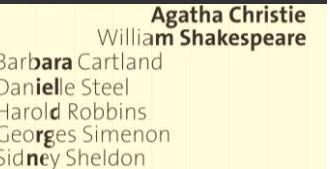
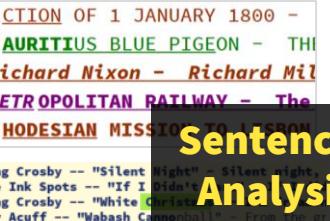
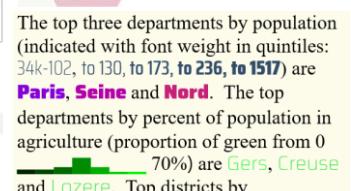
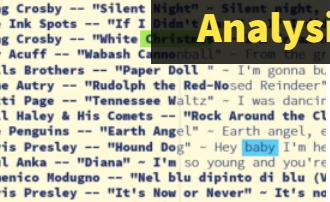
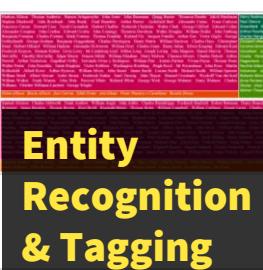
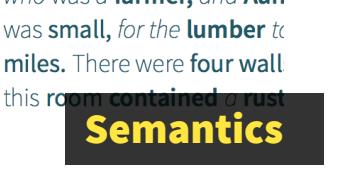
Summary: Breadth of New Visualizations

Mark Scope	Literal	Categorical	Ordered	Quantitative
Point	Glyph (Syllable)			
Word				
Line	Phrase			
Sentence (Title)				
Area	Paragraph			
Document				
Corpus				

New Visualizations → extensible to many viz types

Mark	Scope	Literal	Categorical	Ordered	Quantitative
Point	Glyph (Syllable)	 SCATTER	 GEO AZE UZB TUR CYP SYR IRQ LBN PSE ISR JOR KWT STEM & LEAF	 because immediately between occasionally PAK NPL GRID NM PHL IND BGD LAO LKA MMR THA ARE MDV OMN KHM MYS SGP BRN MUSIC Dance Song Play Literature Poem Poetry PLAY BALL GAME PLAYING king old great one young princess beautiful young last girl little poor lazy pretty queen beautiful late little far	 Sonnez les matines! Ding dingo dong. NOTATION INDUSTRY SERVICES AGRICULTURE Agatha Christie William Shakespeare Barbara Cartland Danielle Steel Harold Robbins George Boxplot Sidney Sheldon
Word		 Grand Canyon Yosemite Olympic Yellowstone Glacier	 UNEXPECTED! SNEAKING masterly GRAPH GAMBLER!		
Line	Phrase	 -2 Wireless Telecommunications Leisure Facilities -3 Oil & Gas Refining & Marketing Semiconductors -4 Tobacco Catalog Retail DISTRIBUTION	 VENN/EULER	 Health Care EXPRESS SCRIPTS Household Goods Products Life Sciences Tools Walgreens Boots Construction Costco Wholesale Air Freight & Logistics Defense Trading Companies Manufacturing King Products Distributors Multiline Retail General Electric Diversified Services Bed Bath & Beyond Gas Utilities Industrial Condomerates Utility CARTOGRAM	 The top departments by population (indicated with font weight in quintiles: 34k-102, to 130, to 173, to 236, to 1517) are Paris, Seine and Nord. The top departments by percent of population in agriculture (proportion of green from 0 to 100%) are SPARK CHART and Lozère. Top districts by
	Sentence (Title)	 bed Trump won't let Jose Ir bed Trumps - Goddard keep bed Trumps - Goddard keep LINE CHART		 they rewarded me evil for good to the spoiling of my soul and I was the song of the drunkards even to such as are of a clean heart But as for me I will come into thy house in the multitude of thy mercy I will walk in mine integrity when they were sick	 ACTION OF 1 JANUARY 1800 - MAURITIUS BLUE PIGEON - Richard Nixon - Richard Mil METROPOLITAN RAILWAY - The RHODESIAN MISSION TO LISBON BAR CHART Bing Crosby -- "I'm Dreamin' of a White Christmas" -- I'm dreamin' of a white Christmas just like today Bing Crosby -- "White Christmas" -- I'm dreamin' of a white Christmas just like today Roy Acuff -- "Wabash Cannonball" -- From the hills of Wabash Cannonball Mills Brothers -- "Paper Doll" -- I'm gonna be a paper doll Gene Autry -- "Rudolph the Red-Nosed Reindeer" Patti Page -- "Tennessee Waltz" -- I was dancing with the Tennessee Waltz Bill Haley & His Comets -- "Rock Around the Clock" -- Rock around the clock The Penguins -- "Earth Angel" -- Earth angel, earth angel Elvis Presley -- "Hound Dog" -- Hey baby, I'm the hound dog Paul Anka -- "Diana" -- I'm so young and you're Diana Domenico Modugno -- "Nel blu dipinto di blu" (V Elvis Presley -- "It's Now or Never" -- It's now or never More than 800 million women in the world are illiterate: the superscripts on this sentence indicate the number of illiterate women per country with sentence start indicating zero and sentence end indicating three hundred million illiterate women.
Area	Paragraph		 MOSAIC	 Brittany is largely agricultural with small populations in some departments such as Manche, Côte du Nord, Finistère and Ille & Vilaine. Paris and surrounding areas as well as Nord are heavily populated with a strong bias towards manufacturing and services. The region of Grand Est in the north east has heavy manufacturing facilities, particularly in Moselle, Bas-Rhin, Meurthe, Vosges, Hte-Rhin and tiny Belfort. The Atlantic coast is Pays de la Loire. It is largely agricultural except for Loire Inf., which has some manufacturing. The eastern border is a mix of sparsely populated departments such as Jura and Savoie, and densely populated and high agricultural. PARAGRAPH	 How to Train your Dragon 2 Dawn of the Planet of the Apes How to Train your Dragon The Hobbit: Desolation of Smaug The Hobbit: The Desolation of Smaug The Hobbit: The Desolation of Smaug CUMULATIVE DISTRIBUTION
	Document				
	Corpus				

New Visualizations → high relevance to NLP research

Mark	Scope	Literal	Categorical	Ordered	Quantitative
Point	Glyph (Syllable)	 Segmentation	 Topic characterization	 Relationship Analysis	 Summarization
Word		 Sentiment & Emotion	 Topic characterization	 Relationship Analysis	 Summarization
Line	Phrase	 Categories	 Classifiers & Sets	 Sentence Analysis	 Sentence Analysis
Area	Paragraph			 Dorothy lived in the midst who was a farmer, and Aun was small, for the lumber to miles. There were four wall this room contained a rust Semantics	 Opinion Analysis
Document		 Entity Recognition & Tagging	 Text Generation		
Corpus					

Peer-reviewed Published Research (2014-2018)

1. **"The Design Space of Typeface,"** at *VisWeek*, 2014 (Paris 2014). (12)
This poster contributes an itemization of typographic attributes to preattentively encode data. 2 pages.
[Link](#).
2. **"Using Font Attributes in Knowledge Maps and Information Retrieval,"** at *First Workshop on Knowledge Maps and Information Retrieval*, 2014 (London 2014). (11)
This paper contributes three new visualization techniques based on typographic attributes relevant to knowledge maps. 8 pages. [Link](#).
3. **"Evaluating Lossiness and Fidelity in Information Visualization"** at *SPIE 2015* (San Francisco 2015). (9)
Contribution is a quantitative scoring model for comparing information loss across visualization alternatives. 14 pages. [Link](#).
4. **"Using Text in Visualizations for Micro/Macro Readings"** at *TextVis Workshop 2015* (Atlanta 2015). (6)
Contribution is notion of literal encoding as separate from other preattentive encodings enabling micro and macro readings of text visualizations and novel word-based stem-and-leaf plot. 8 pages. [Link](#).
5. **"Using Type to Add Data to Data Visualizations"** at *TypeCon 2015*, (Denver 2015).
Contribution is a historic review of the font attribute design space with several applications including one novel glyph-based technique. 4 pages. [Link](#).
6. **"Font Attributes enrich Knowledge Maps and Information Retrieval"** in *International Journal on Digital Libraries*, 2016. (1)
This journal article reviews font attributes and applies them to tasks relevant to knowledge maps (document overviews) and information retrieval (search), including text analytic tasks (i.e. natural language processing) such as skimming, opinion analysis, character analysis, topic modeling and sentiment analysis. 20 pages. [Link](#).
7. **"Using Typography to Expand the Design Space of Data Visualization."** in *She Ji: The Journal of Design, Economics, and Innovation* vol. 2, no. 1 (Spring 2016): 59–87. (7)
This journal article summarizes the authors' cross-disciplinary research approach engaging visualization researchers, cartographers and typographers to 1) identify the gaps in visualization theory, 2) review adjacent fields to comprehensively assess techniques, 3) extend an common existing visualization framework with separation between type attributes, typographic scope and data type, 4) illustrate many potential applications from this framework, and 5) broad evaluation including critiques across domain. 29 pages. [Link](#). (Note this paper is a template for the entire thesis)
8. **"Typographic Sets: Labelled Set Elements with Font Attributes,"** at *International Workshop on Set Visualization and Reasoning 2016* (Philadelphia 2016). (5)
This paper shows how many visualization techniques indicating members in sets can be extended using typographic attributes, with unique contributes including identification of membership in up to ten sets and scalability to thousands of elements. 15 pages. [Link](#).
9. **"Evaluation of Visualization by Critiques"** at *Beyond Time and Errors: Novel Evaluation Methods for Visualization (BELIV)* (Baltimore 2016).
This position paper extends design critiques as a form of evaluation, different than pre-existing "evaluation by inspection" techniques, uniquely providing broader scope and context. 8 pages. [Link](#).
10. **"Multivariate Label-based Thematic Maps"** in *International Journal of Cartography*, 23 Mar 2017. (2)
This journal article focuses on thematic maps where traditionally colored shapes are used to indicate data instead use labels, which can indicate more than one or two variables; and provides solutions to issues of representation of strings of differing lengths and label occlusion. 16 pages. [Link](#).
11. **"Stem & Leaf Plots Extended for Text Visualizations"** at *14th International Conference Computer Graphics, Imaging and Visualization (CGIV) 2017*. (Marrakech, 2017). (1)
This short paper extends the visualization technique of "stem and leaf plots" using font attributes and tokens of different scope (single character, word, phrase). 6 pages. [Link](#).
12. **"Microtext Line Charts"** at *Information Visualization 2017* (IV2017). (London). (1)
This paper brings together microtext and path dependent cartographic text to embed text directly into lines on line charts, making it easier to identify lines and enabling additional data to be displayed. 8 pages. [Link](#).
13. **"Bertin's forgotten typographic variables and new typographic visualization"**. in Computer and Geographic Information Systems (CaGIS) Journal special issue on 50th anniversary of Jacques Bertin Nov 2018. Shows how the text framework can be used to create a dozen new visualizations using Bertin's same data, including two new visualization techniques. 21 pages. [Link](#).