Artificial Intelligence

Eliza

(1)	(2)	(3)	(4)
It seems that	you	hate	me

Eliza

- Decomposition
  - "It seems that" – discard
  - "you" – change to I
  - "hate" – store
  - "me" – change to you
  - (0 you <> me) = decomposition template
- Template fires reassembly strategy
- Reassemble using reassembly rules

Our Bias:

Artificial intelligence techniques may be a necessary ingredient for the development of a successful clinical advisory tool that focuses on individual patients rather than retrieval of generic information

AIM

- Reassembly rule
  - What makes you think/ I /<>/ you
  - What makes you think I hate you

```
(sorry ((0)
        (please don't apologize)
        (apologies are not necessary)
        (what feelings do you have when you apologize)
        (I've told you that apologies are not required)))
(remember 5 ((0 you remember 0)
        (do you often think of 4)
        (does thinking of 4 bring anything else to mind))
        ((0 do i remember 0)
        (did you think i would forget 5)
        (why do you think i should recall 5 now)
        (what about 5)
        (you mentioned 5))
((0)
(newkey)))
```

Men are all alike.
IN WHAT WAY?
They're always bugging us about something or other.
CAN YOU THINK OF A SPECIFIC EXAMPLE?
Well, my boyfriend made me come here.
YOUR BOYFRIEND MADE YOU COME HERE
He says I'm depressed much of the time.
I AM SORRY TO HEAR YOU ARE DEPRESSED
It's true. I am unhappy
DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE UNHAPPY
I need some help, that much seems certain.
WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP
Perhaps I could learn to get along with my mother.
TELL ME MORE ABOUT YOUR FAMILY

Demands (Judged Most Important)

- Should be able to explain their diagnostic or treatment decisions to physician users
- Should be portable and flexible so that they may be accessed at any time and place
- Should display an understanding of their own medical knowledge
- Should improve the cost-effectiveness of tests and therapies
- Should automatically learn new information when interacting with medical experts
- Should display common sense

Table 2. Evolution of data analytic techniques

Technique	Typical Question Format	Necessary Technologies	Products/Vendors	Characteristics
Data collection (1960–1970s)	How many patients were admitted to the ICU last year?	Data stored on tape/disks	IBM	Retrospective, static data interrogation, programmed queries
Data access (1980s)	What was the mortality in our coronary artery bypass (CABG) last patients year?	Relational database and structured query language	Oracle, Sybase	Retrospective, dynamic data interrogation at record level, programmed queries
Data warehousing (1990s)	What was the CABG mortality last year? → Drill down to those patients with atrial fibrillation	Multidimensional databases and online analytical processing systems	Pilot, Microstrategy	Retrospective dynamic data interrogation at multiple levels, natural language queries
Data mining (emerging)	What's causing the high rate of atrial fibrillation in the ICU?	Massive data bases, multiprocessor computers	Lockheed, IBM	Prospective, proactive information delivery

ICU, intensive care unit.

Table 1. Decision support systems

Model Driven Decision Support	Data Driven Decision Support
Monolithic	Modular
Incorporation of a body of knowledge	Self-learning
Designed to reproduce the expert	Typically act as intelligent assistants to an expert
All solutions are preprogrammed	Capable of arriving at novel, unexpected solutions or observations
Likely to require substantial maintenance as medical knowledge evolves	Inherently autodidactic and therefore largely self-maintained

AIM

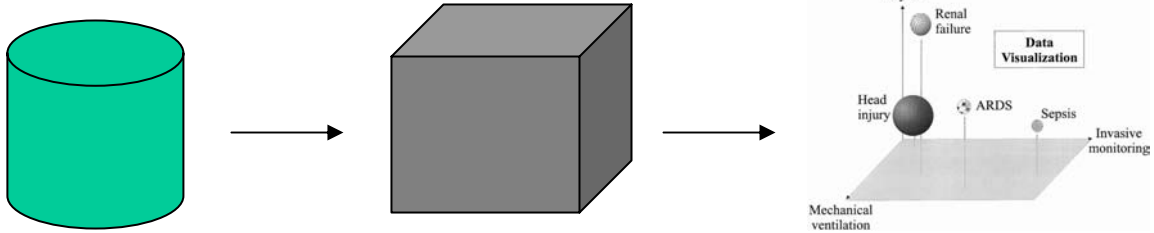
- Strong vs. weak AI
- Rule-based vs data-driven

Data mining

- The process of (automatically) extracting previously unknown, valid and actionable information from large databases and using the information to make crucial business decisions

Data mining today

Data mining

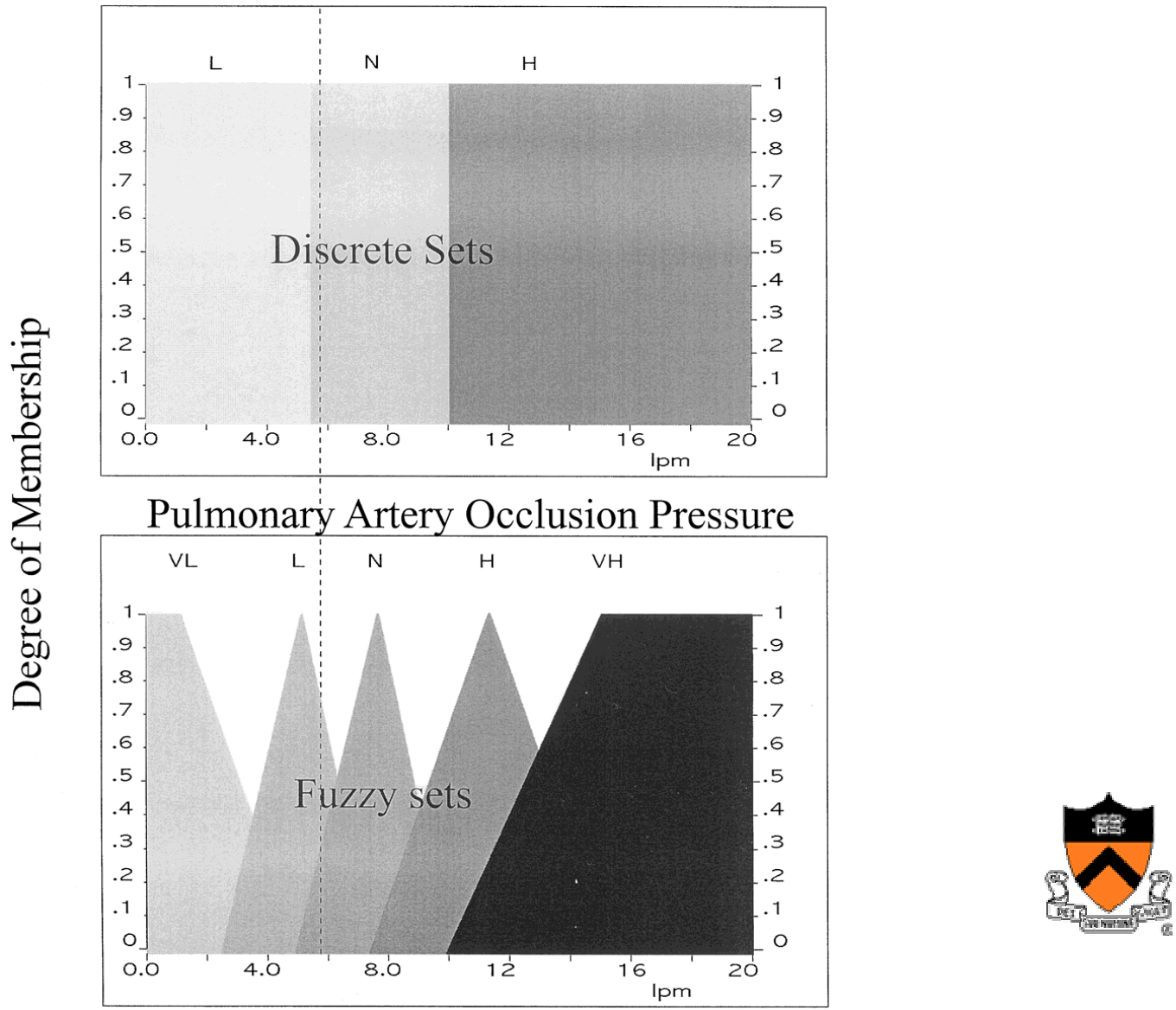


Large database

Data visualization

Fuzzy logic

- Hx fuzzy logic/systems
- Method of dealing with ambiguity
- Fuzzy control systems

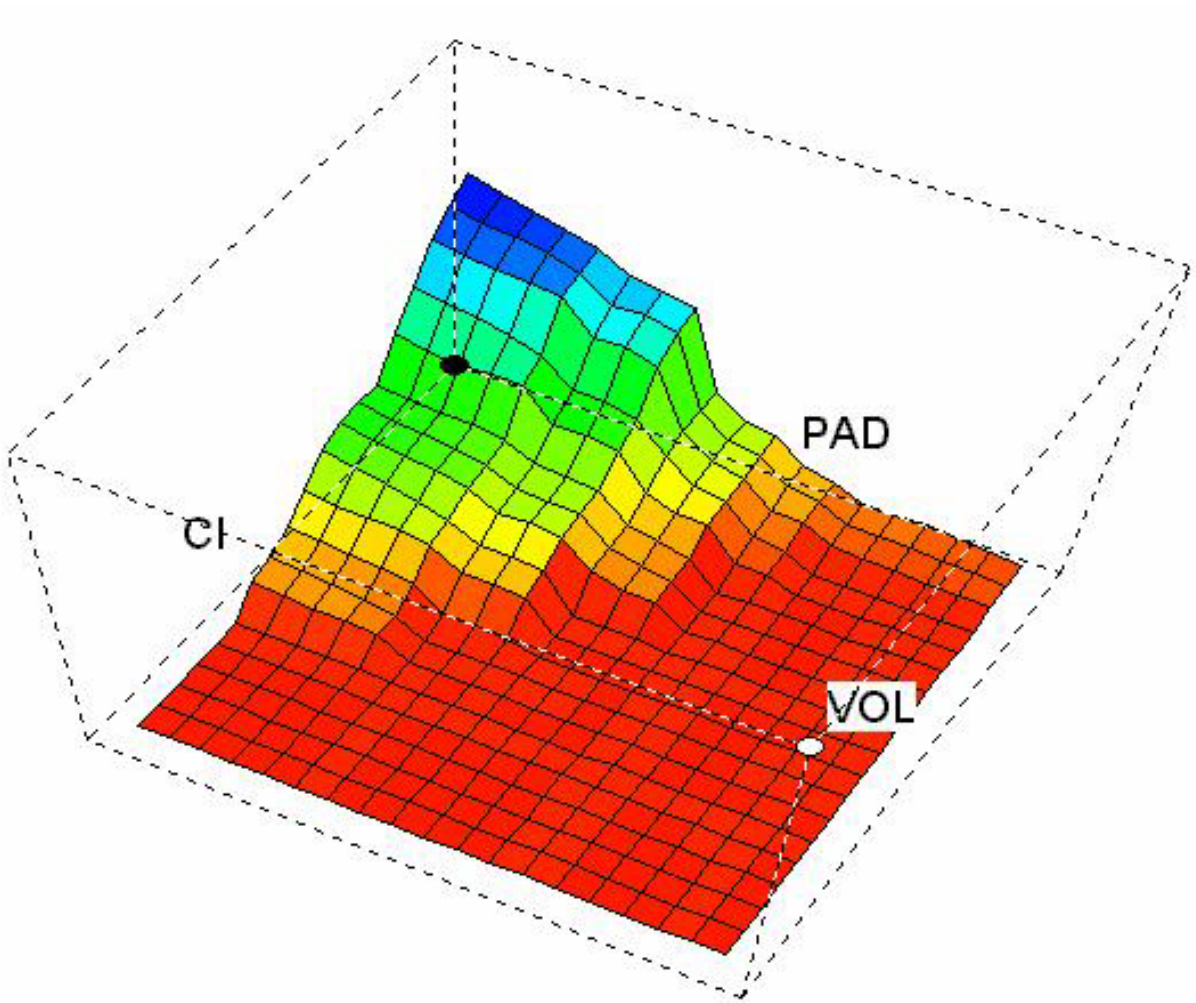

Degree of Membership
L
N
H
1
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0.0
4.0
8.0
12
16
20
lpm
Discrete Sets
Pulmonary Artery Occlusion Pressure
VL
L
N
H
VH
Fuzzy sets

Fuzzy rules

Spreadsheet Rule Editor - RB1

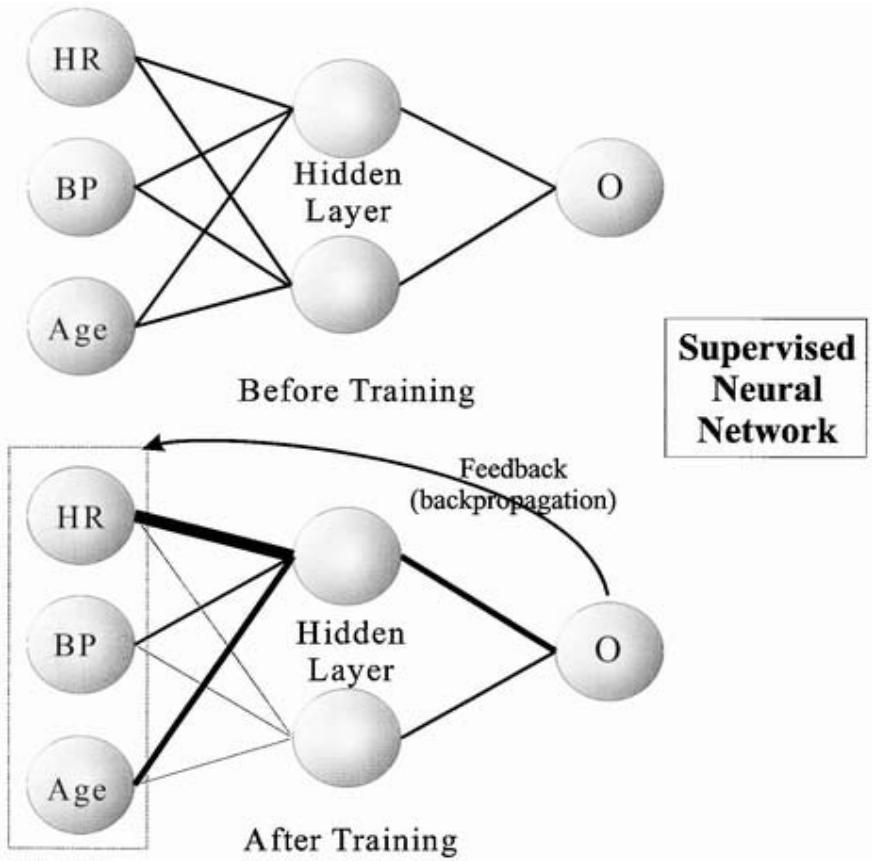
	IF		THEN	
	CI	PAD	DoS	RTBI
1	low	low	0.00	low
2	low	low	0.50	medium
3	low	low	1.00	high
4	low	medium	0.10	low
5	low	medium	0.50	medium
6	low	medium	0.90	high
7	low	high	0.90	low
8	low	high	0.50	medium
9	low	high	0.10	high
10	medium	low	0.20	low
11	medium	low	0.90	medium
12	medium	low	0.20	high
13	medium	medium	0.90	low
14	medium	medium	0.80	medium
15	medium	medium	0.20	high
16	medium	high	1.00	low
17	medium	high	0.20	medium
18	medium	high	0.00	high
19	high	low	0.80	low
20	high	low	0.70	medium
21	high	low	0.20	high
22	high	medium	1.00	low
23	high	medium	0.10	medium
24	high	medium	0.00	high
25	high	high	1.00	low
26	high	high	0.00	medium
27	high	high	0.00	high
28				
29				
30				
31				

Fuzzy



Neural nets

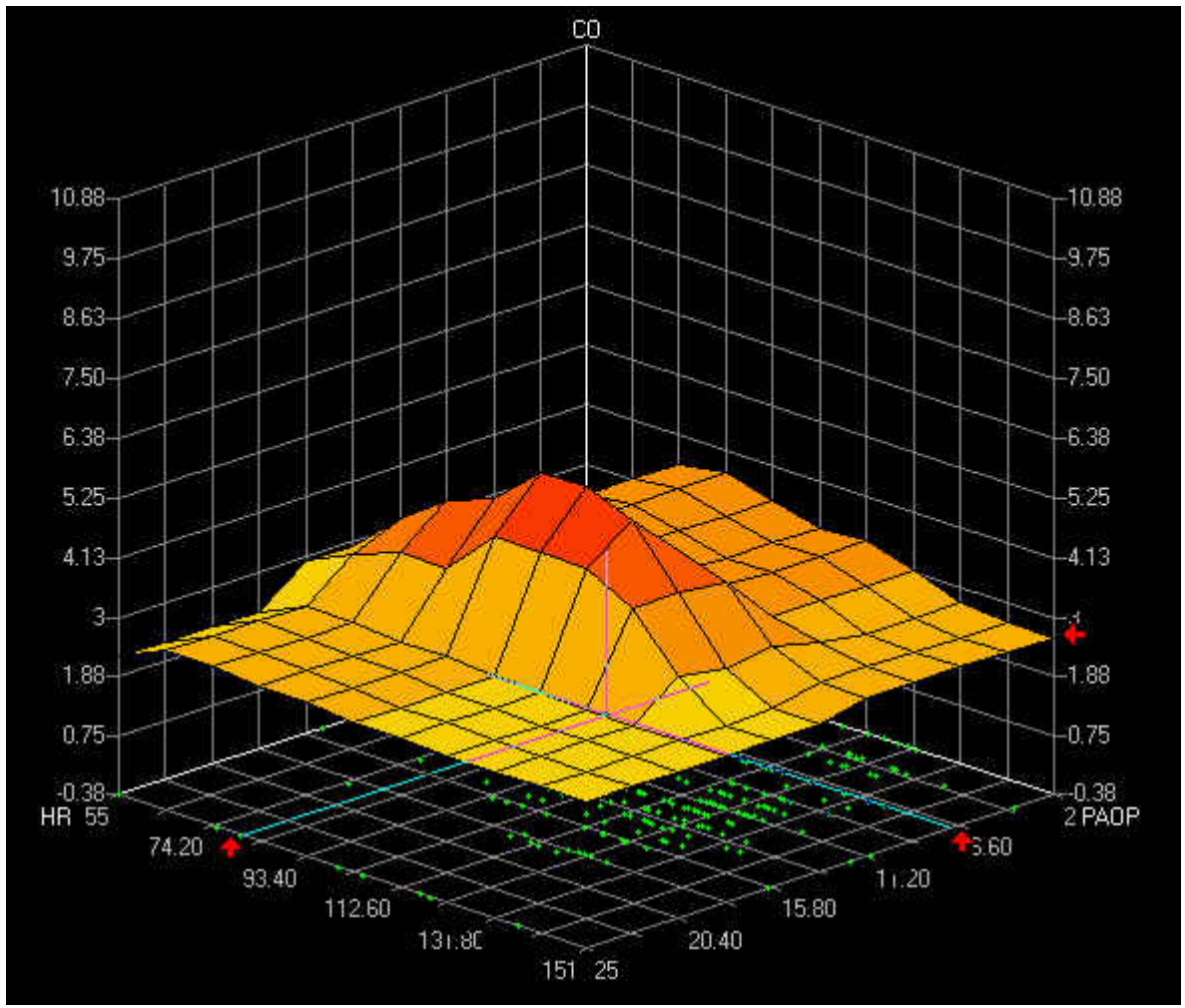
- Simulate the brain
- Neurons and synapses
- Unsupervised
  - Clusters: identify suspected or unsuspected patterns
- Supervised
  - Feedback reinforcement/inhibition


HR
BP
Age
Hidden Layer
O
Before Training
Supervised Neural Network
Feedback (backpropagation)
HR
BP
Age
Hidden Layer
O
After Training

Neurofuzzy

- Combines fuzzy (supervision) and neural net (learning)

Neurofuzzy


CO
10.88
9.75
8.63
7.50
6.38
5.25
4.13
3
1.88
0.75
-0.38
HR 55
74.20
93.40
112.60
151 25
20.40
15.80
11.20
3.60
2 PAOP

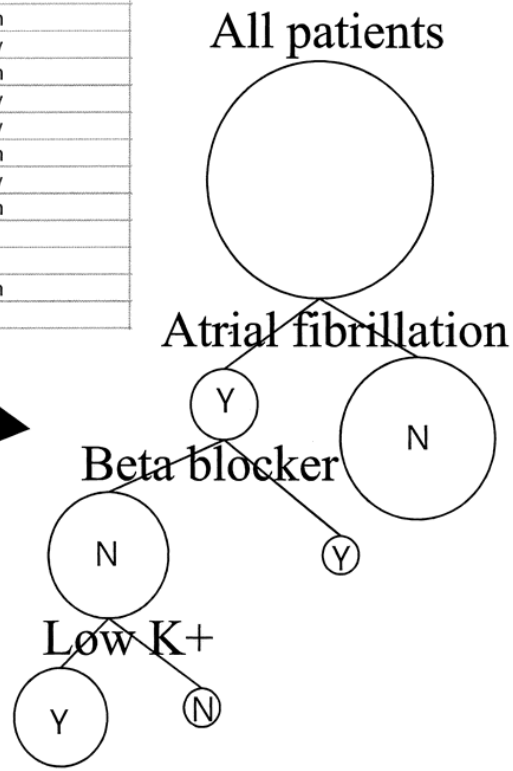
Machine learning

- Start with lots of data
- The algorithm develops explicit (non black-box) descriptions of relationships among the data elements
- Business analogy
  - Develop a model to predict likelihood of delinquency or loan default

Data set

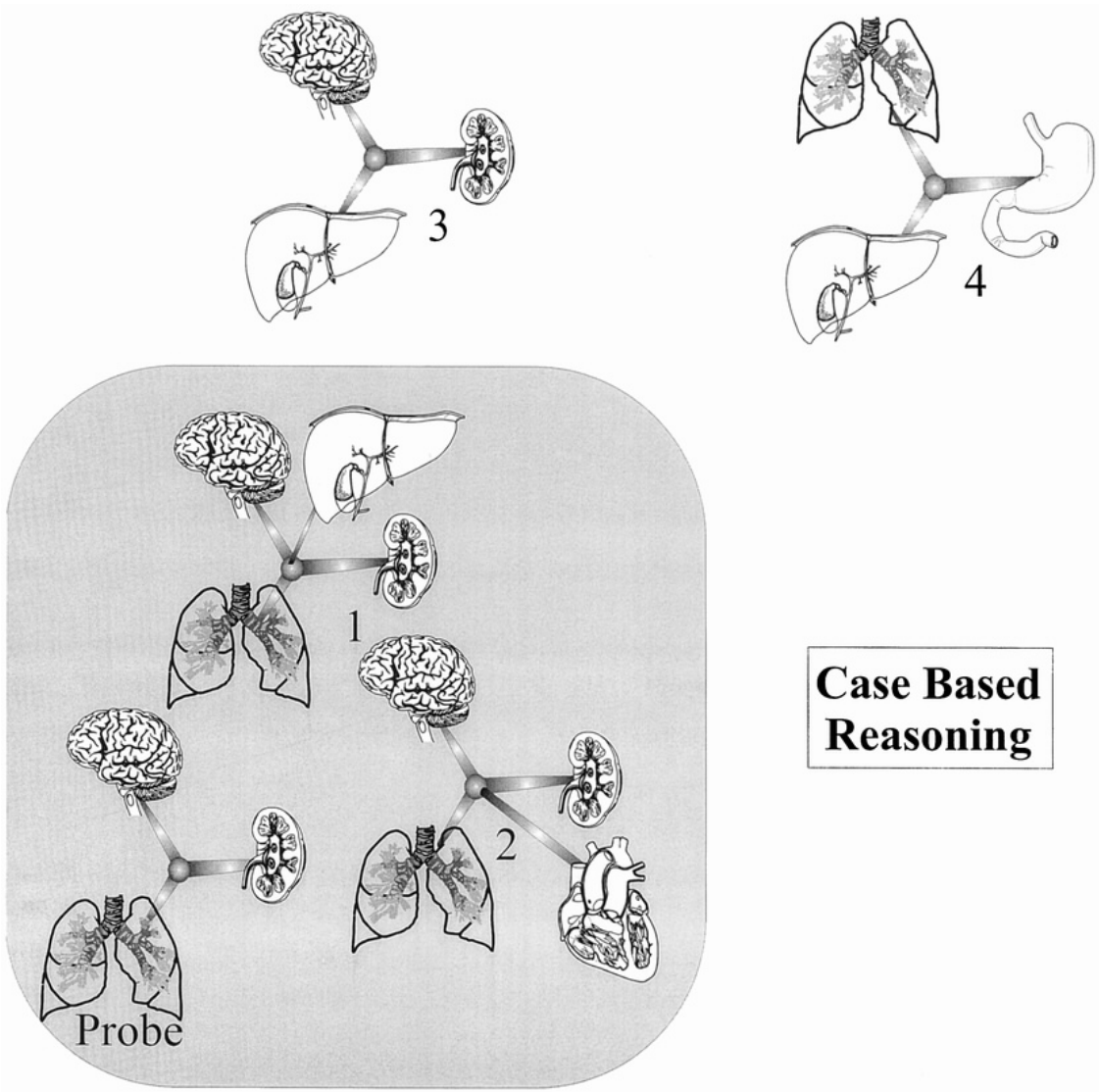
	Independent variables					Dependent variable
Case #	Beta blocker	Mg++	K+	CVP	Chest tube output	Atrial fibrillation
1	y	2	3.3	10	1250	y
2	y	2.3	4.1	12	500	y
3	n	1.9	3.6	7	400	n
4	y	2.1	3.7	5	750	y
5	n	2.5	5	3	400	n
6	n	1.8	4.1	16	2000	y
7	n	1.7	3	12	1500	y
8	y	2.5	4.3	3	300	n
9	n	2.4	4.7	4	450	y
10	y	2.2	6	11	750	n
200	n	1.8	4.2	8	600	n

Machine Learning



Case-based reasoning

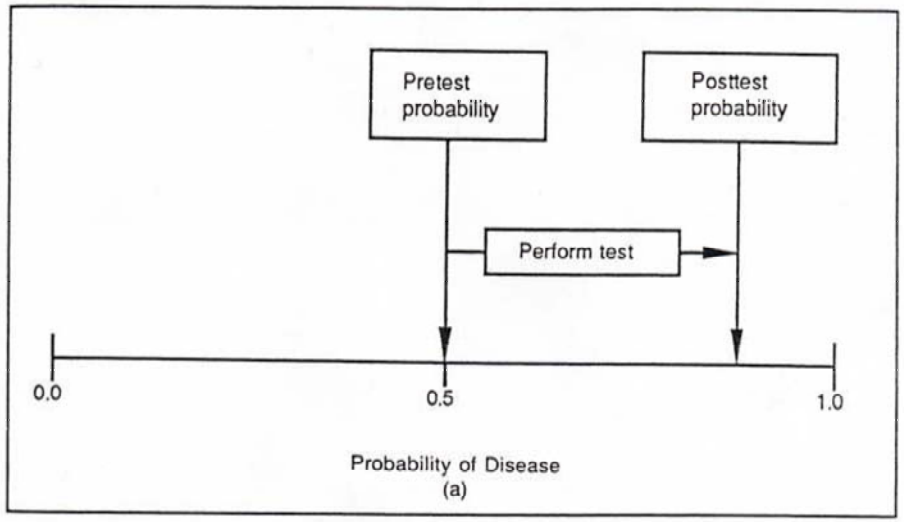
- Body of knowledge
- Use it to extrapolate to unknowns
  - Supermarket layout
  - What do I pack for this trip
  - Help desk
- Used in instruction
- Expert vs. novice in a domain



Case Based Reasoning

Belief networks

- Network of interdependent variables using Bayesian logic
- Used in military applications (which is the bogie) and help desks
- Methodology
  - Create tree of nodes
  - Assign “pretest probabilities”
  - Expose tree to real data



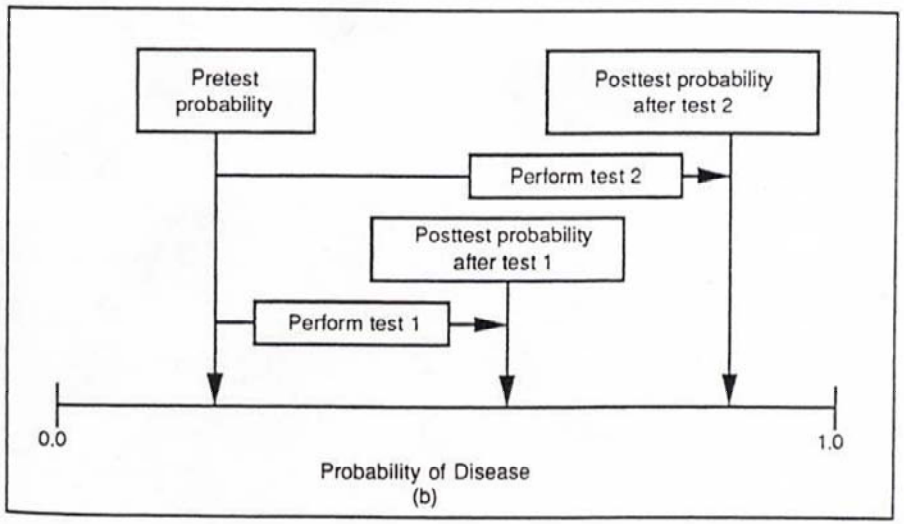


FIGURE 3.2. The effect of test results on the probability of disease. *(a)* A positive test result often increases the probability of disease. *(b)* Test 2 reduces uncertainty about presence of disease (increases the probability of disease) more than test 1 does.

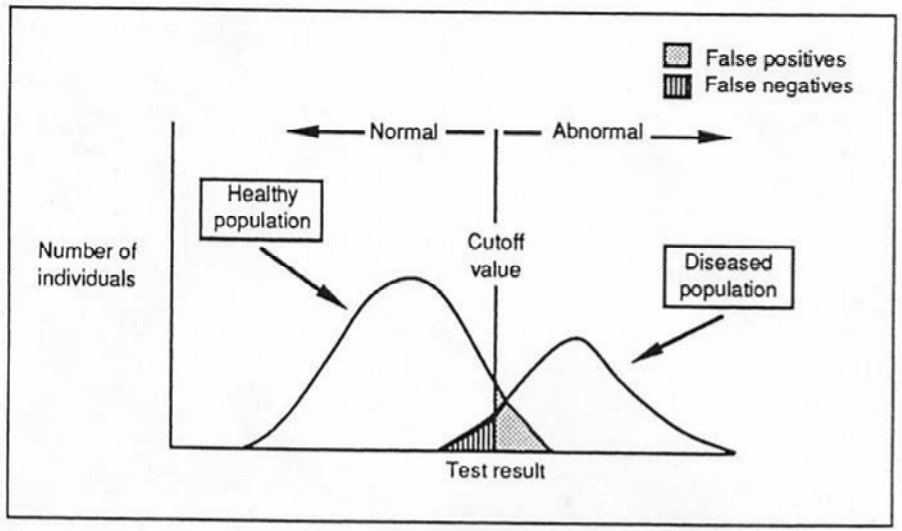
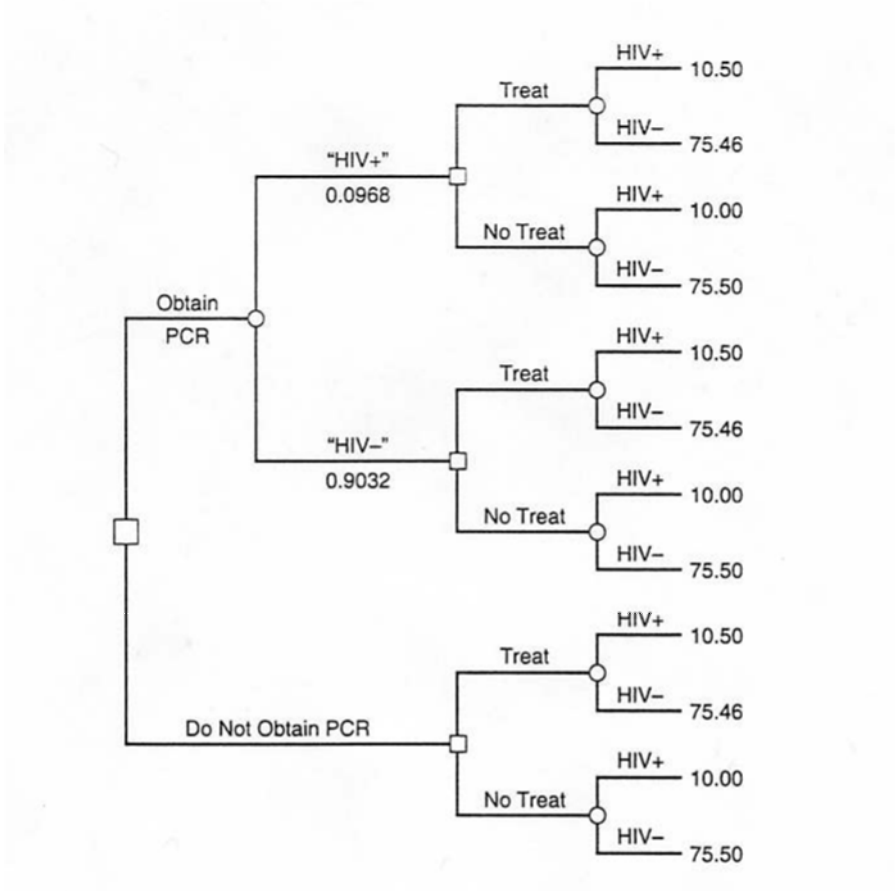
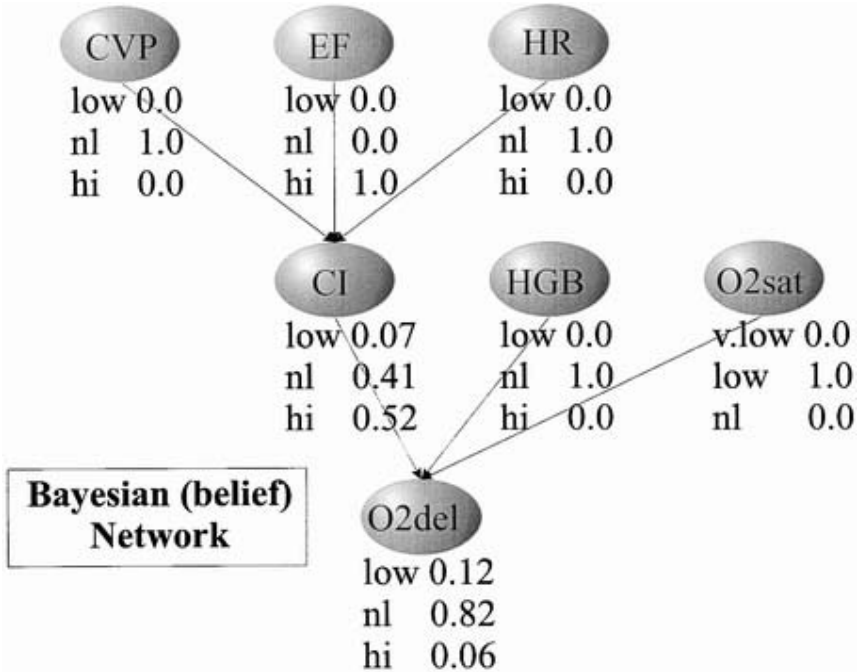


FIGURE 3.3. Distribution of test results in healthy and diseased individuals. Varying the cutoff between "normal" and "abnormal" across the continuous range of possible values changes the relative proportions of false positives and false negatives for the two populations.


Obtain
PCR
"HIV+"
0.0968
"HIV–"
0.9032
Do Not Obtain PCR
Treat
No Treat
Treat
No Treat
Treat
No Treat
HIV+
HIV–
10.50
75.46
10.00
75.50
10.50
75.46
10.00
75.50
10.50
75.46
10.00
75.50


CVP
low 0.0
nl 1.0
hi 0.0
EF
low 0.0
nl 0.0
hi 1.0
HR
low 0.0
nl 1.0
hi 0.0
CI
low 0.07
nl 0.41
hi 0.52
HGB
low 0.0
nl 1.0
hi 0.0
O2sat
v.low 0.0
low 1.0
nl 0.0
O2del
low 0.12
nl 0.82
hi 0.06
Bayesian (belief) Network

Genetic algorithm

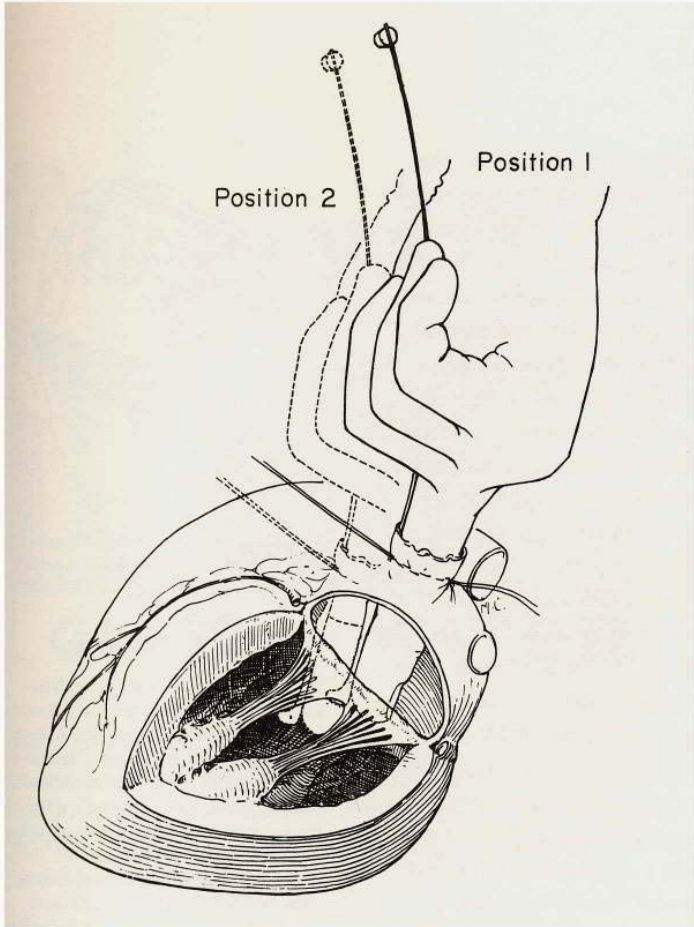
- Uses the efficiency of Darwinian selection to find near optimal solutions to difficult problems
  - Traveling salesman problem
  - SICU resident scheduling PROBLEM
- Methodology
  - Create a bunch of solutions
  - Let them compete
  - Cull out bad ones
  - Allow them to mutate and cross-breed
  - Recursive

Data visualization

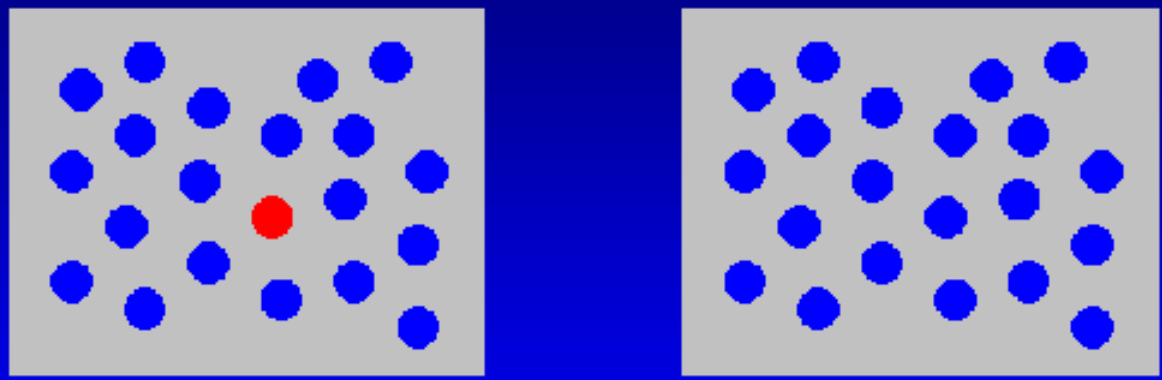
- Ways of seeing patterns in large data sets
- Uses the efficiency of human pattern recognition

Parent disciplines/people

- Tufte
  - Data density, chart clutter, small multiples
- Human computer-interface (Schneiderman)
- Cognitive science
- Graphic design
- Physiology of perception (Ware)
  - Color palettes, pre-cognition
- Military (NASA, military and commercial aviation), financial, scientific…

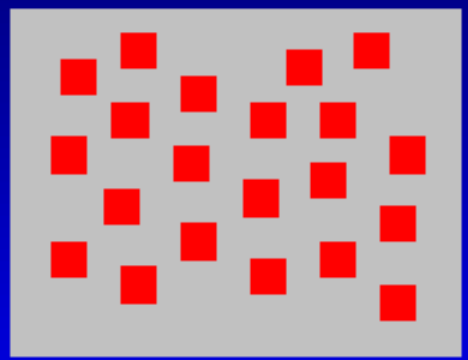

Position 2
Position 1

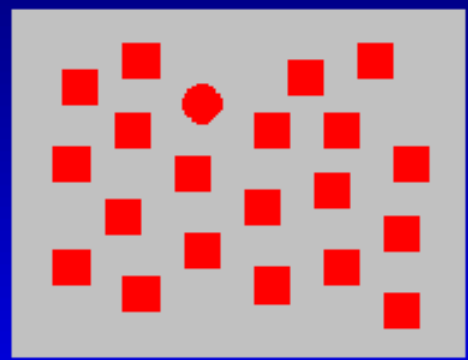
Example: Color Selection



Viewer can rapidly and accurately determine whether the target (red circle) is present or absent. Difference detected in color.

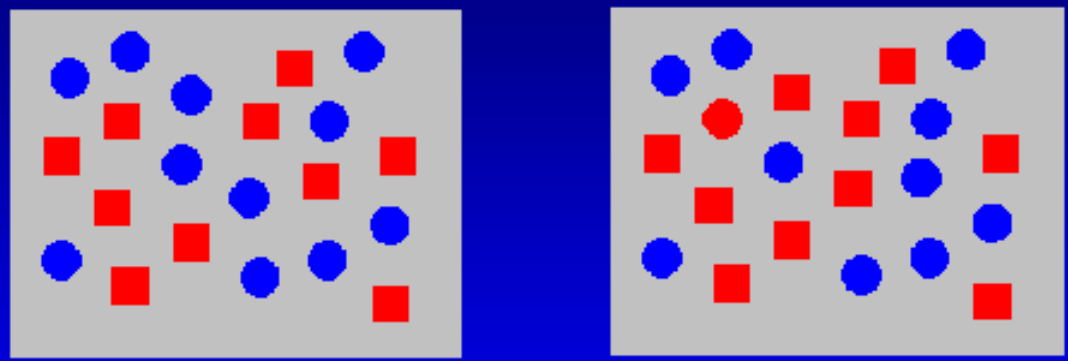
Example: Shape Selection





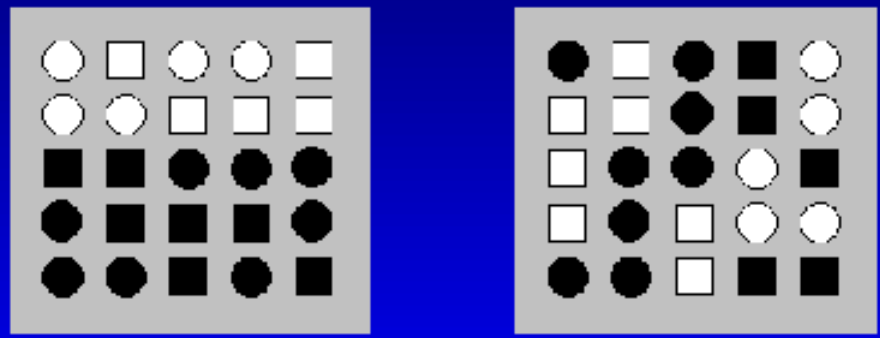
Viewer can rapidly and accurately determine whether the target (red circle) is present or absent. Difference detected in form (curvature)

Example: Conjunction of Features



Viewer cannot rapidly and accurately determine whether the target (red circle) is present or absent when target has two or more features, each of which are present in the distractors. Viewer must search sequentially.

Example: Conjunction of Features



Viewer cannot rapidly and accurately determine the boundary if it is determined by features that are shared across groups. On the right the boundary is determined by a conjunction of shape and value and cannot be detected preattentively; the lefthand boundary can

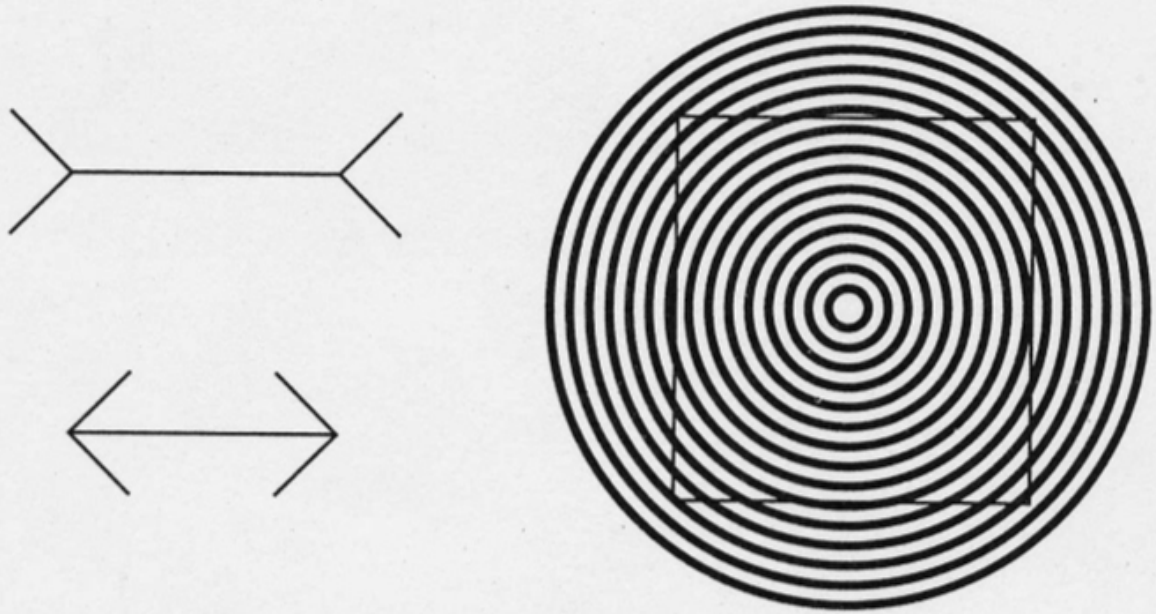


Figure 1.7 In the Muller-Lyer illusion, on the left, the horizontal line in the upper figure appears longer than the same line in the lower figure. On the right, the rectangle is distorted into a "pincushion" shape.

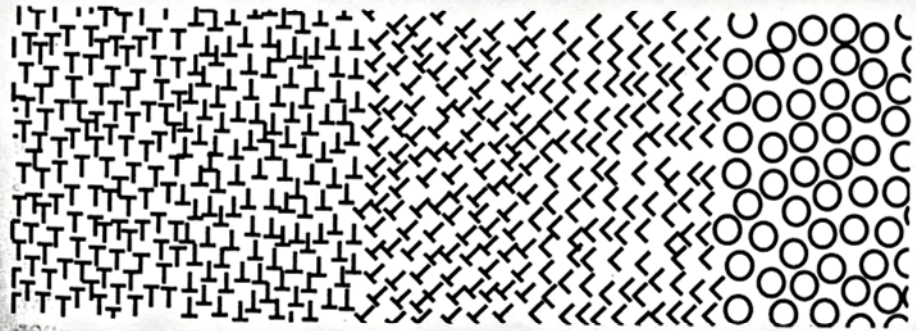


Figure 1.8 Five regions of texture. Some are easier to visually distinguish than others. Adapted from Beck (1966).

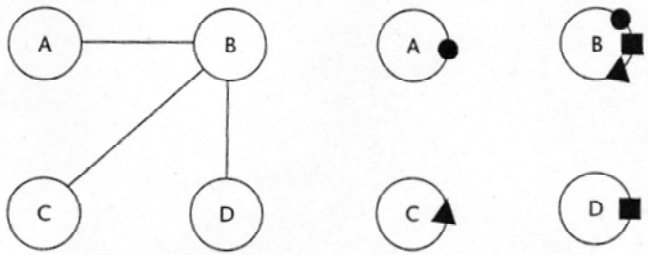


Figure 1.4 Two different graphical methods for showing relationships between entities.

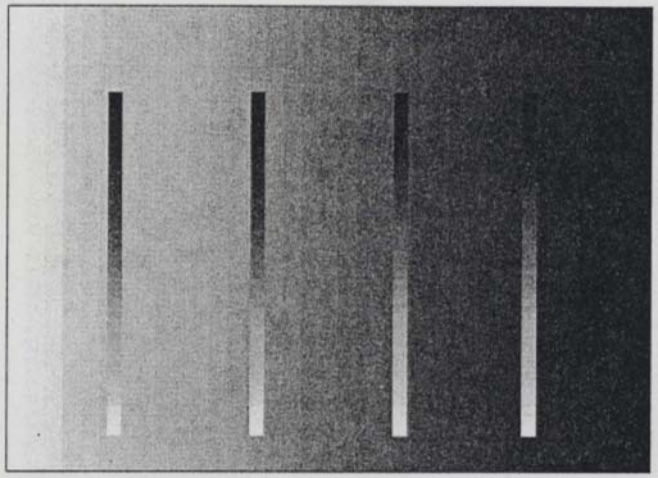


Figure 3.17 Perceived differences between gray-scale values are enhanced where the values are close to the light part of the background. The effect is known as crispening.

8568972698468976268976435892265986598655489768926989 8
0246299687402655762798678904567923276928546098677209 8
9083457980279075904709827908579084772908759082790875 4
9870985674906897578625984569024379047219079070981145 0
8568972698468976268976445892265986598655489768926989 8

To count the **3**s in the next table, it is necessary only to scan the black digits. This is because lightness is pre-attentively processed.

8568972698468976268976**3**5892265986598655489768926989 8
0246299687402655762798678904567923276928546098677209 8
908**3**457980279075904709827908579084772908759082790875 4
9870985674906897578625984569024**3**79047219079070981145 0
8568972698468976268976445892265986598655489768926989 8

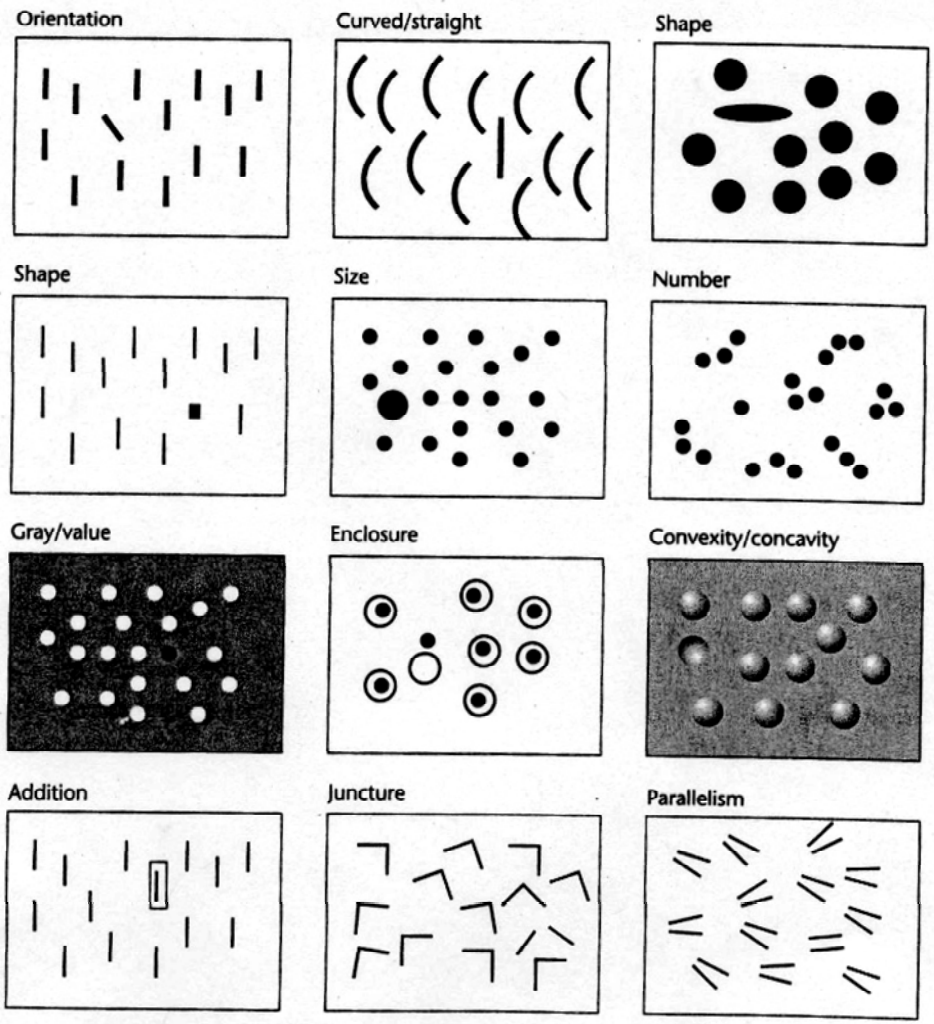


Figure 5.5 Most of the differences shown above are pre-attentively distinguished. Only juncture and parallelism are not.

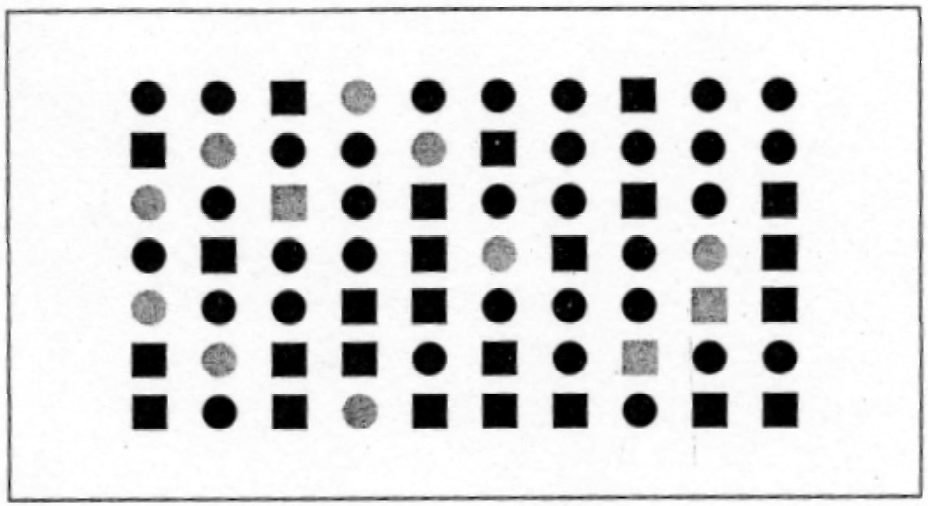


Figure 5.7 Searching for the gray squares is slow because they are identified by conjunction coding.

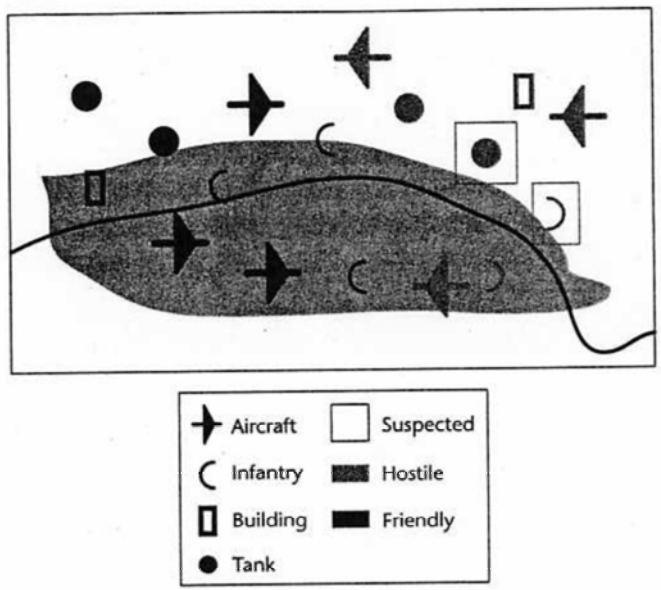


Figure 5.9 A set of symbols for a military command and control display.

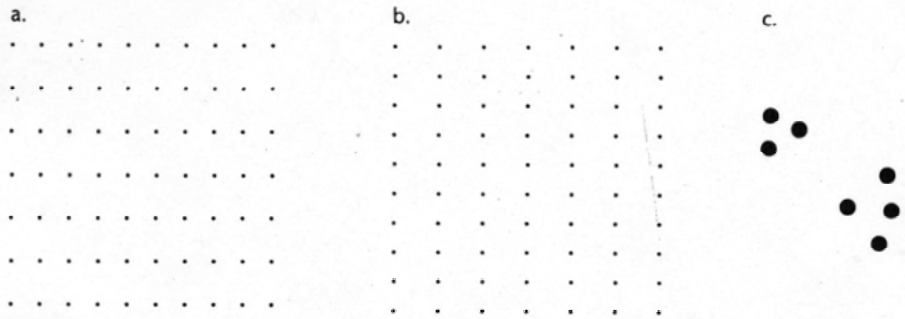


Figure 6.2 Spatial proximity is a powerful cue for perceptual organization. A matrix of dots is perceived as rows on the left (a) and columns on the right (b). In (c), because of proximity relationships, we perceive two groupings of three dots.

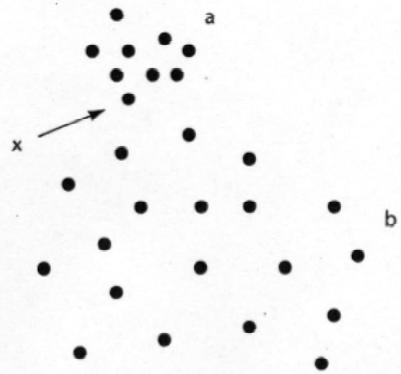


Figure 6.3 The principle of spatial concentration. The dot labeled x is perceived as part of group a rather than group b.

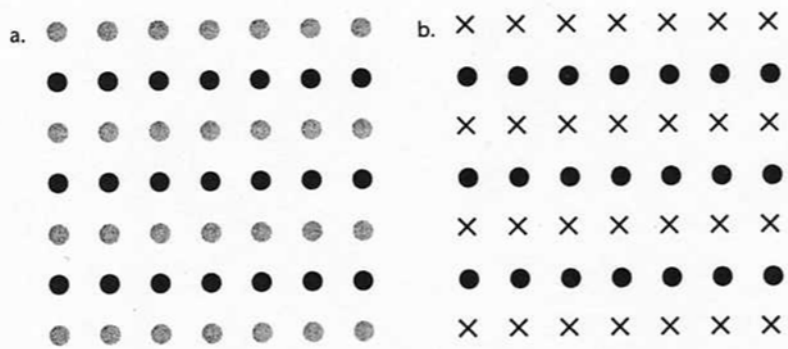


Figure 6.4 According to the Gestalt psychologists, similarity between the elements in alternate rows causes the row percept to dominate.

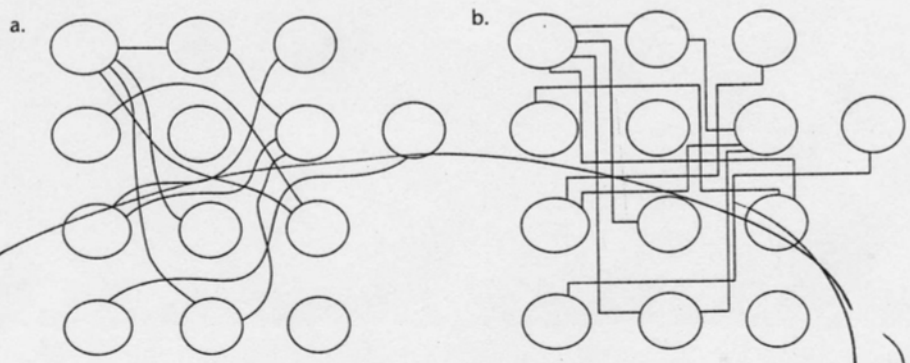


Figure 6.7 In (a), smooth continuous contours are used to connect the elements, while in (b), lines with abrupt changes in direction are used. It is much easier to perceive connections when contours connect smoothly.

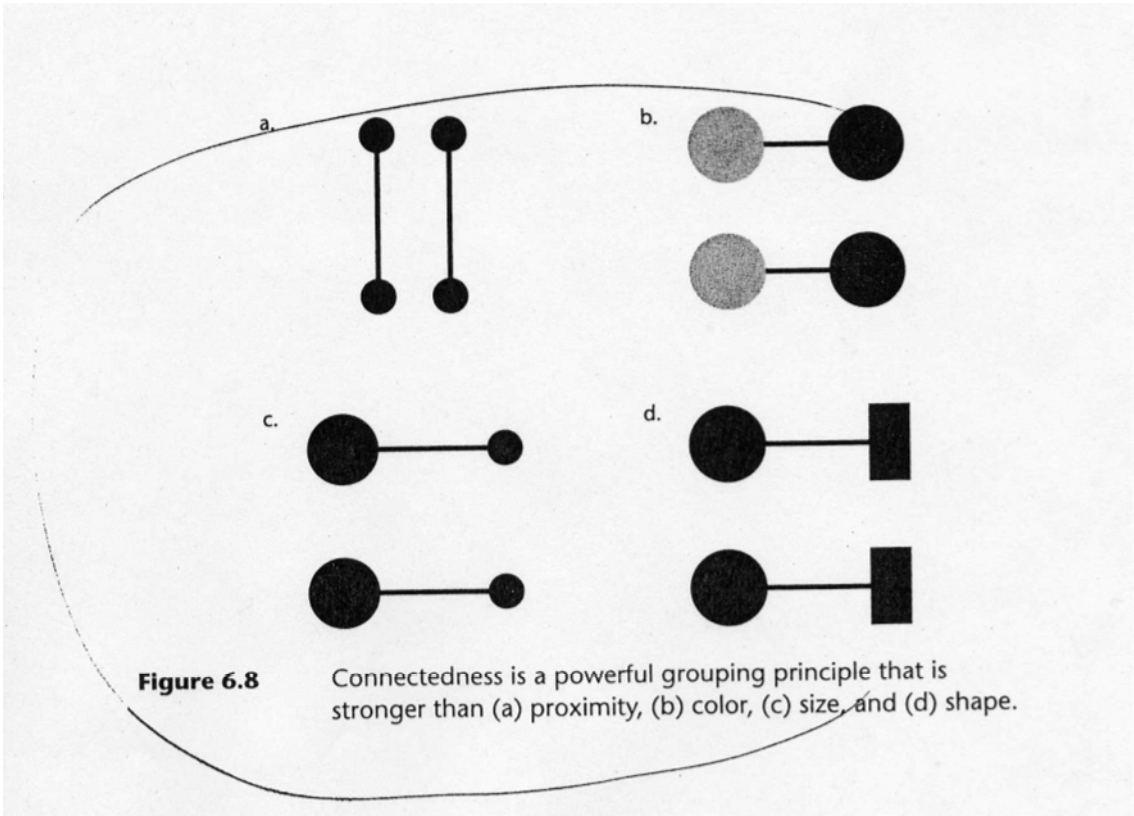


Figure 6.8 Connectedness is a powerful grouping principle that is stronger than (a) proximity, (b) color, (c) size, and (d) shape.

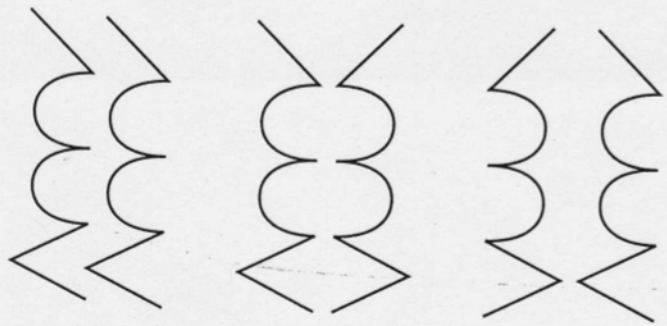


Figure 6.9 The pattern on the left consists of two identical parallel contours. In each of the other two patterns, one of the contours has been reflected about a vertical axis, producing bilateral symmetry. The result is a much stronger sense of a holistic figure.

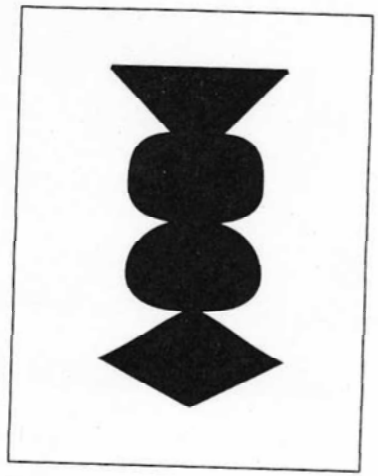


Figure 6.16 Symmetry, surrounding white space, and a closed contour all contribute to the strong sense that this shape is figure, rather than ground.

Figure 6.17 Rubin's Vase. The cues for figure and ground are roughly equally balanced, resulting in a bistable percept of either two faces or a vase.

Figure 6.22 Drawing in a style based on the pen strokes used by Edmund Halley (1696), discussed in Tufte (1983), to represent the trade winds of the North Atlantic. Halley described the wind direction as being given by "the sharp end of each little stroak pointing out that part of the Horizon, from whence the wind continually comes."

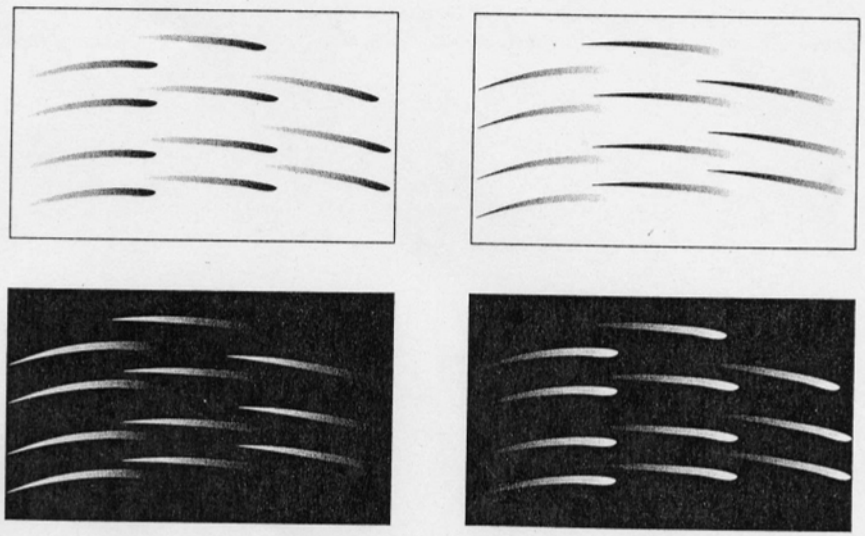


Figure 6.23 Vector direction can be unambiguously given by means of color change relative to the background.

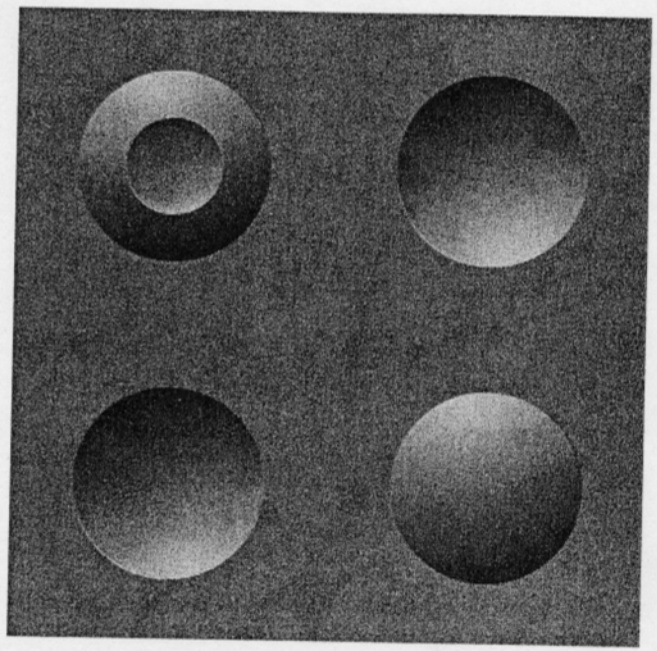


Figure 7.14 The brain generally assumes that lighting comes from above. The bumps in this image become hollows when the picture is turned upside down.

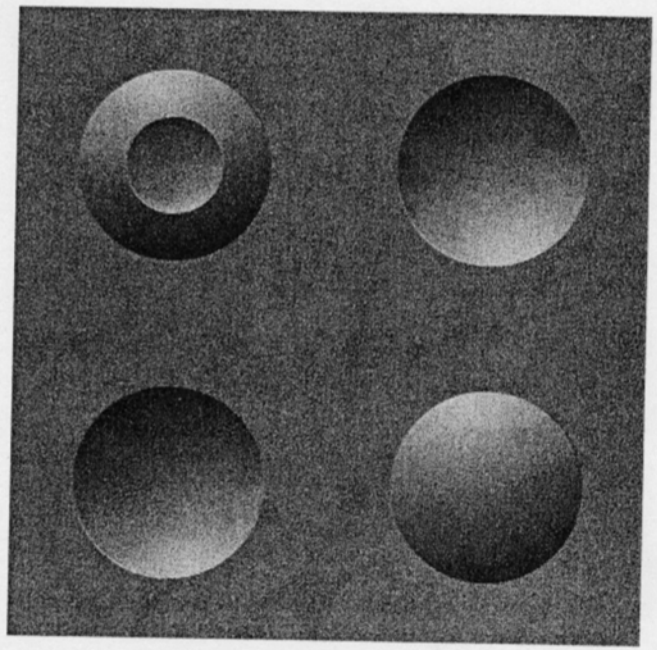
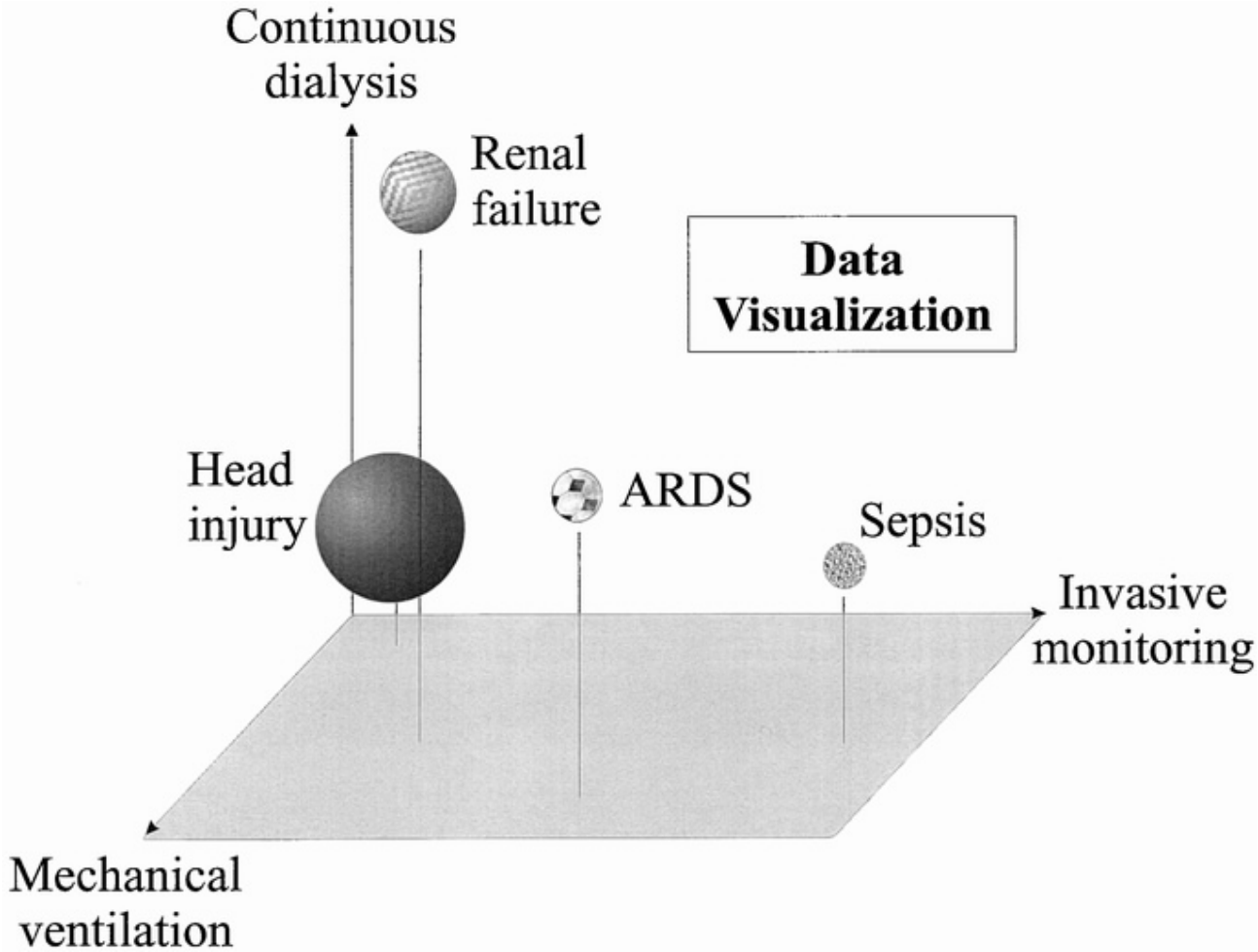
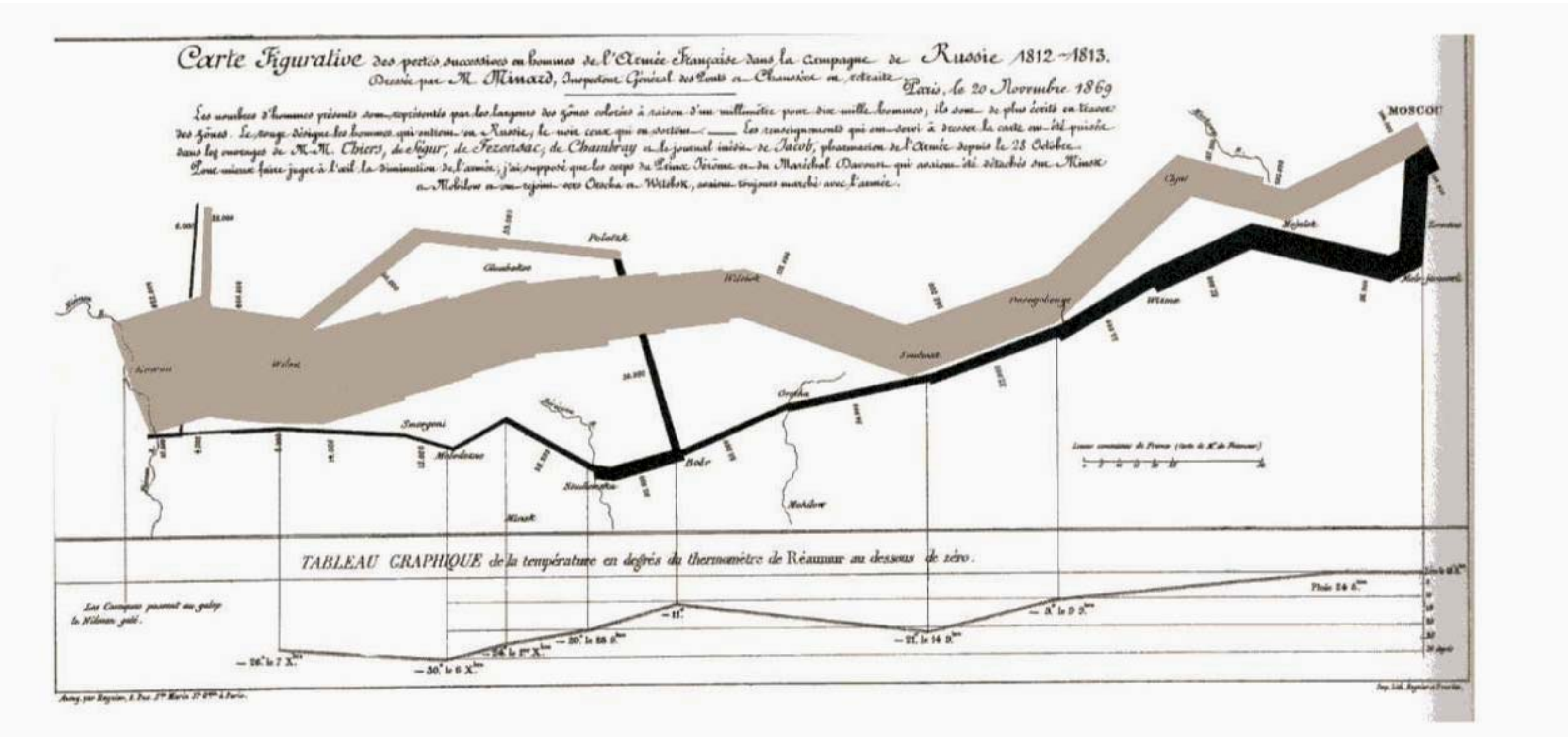
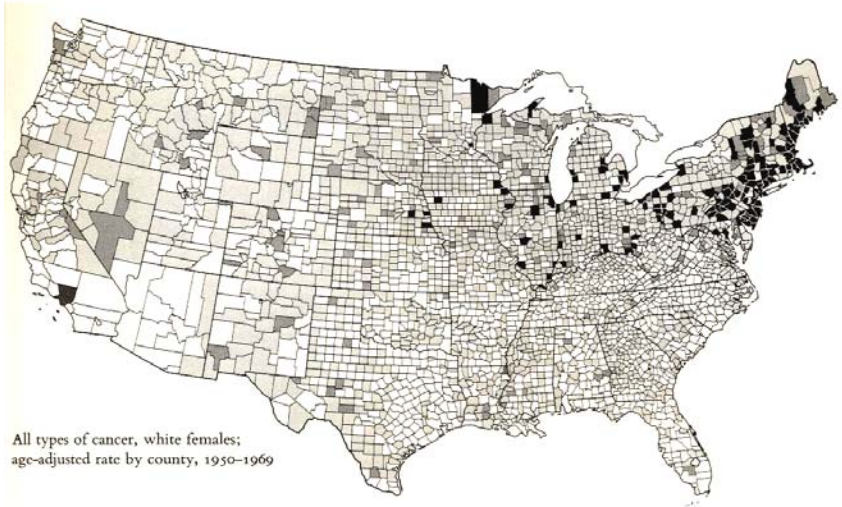


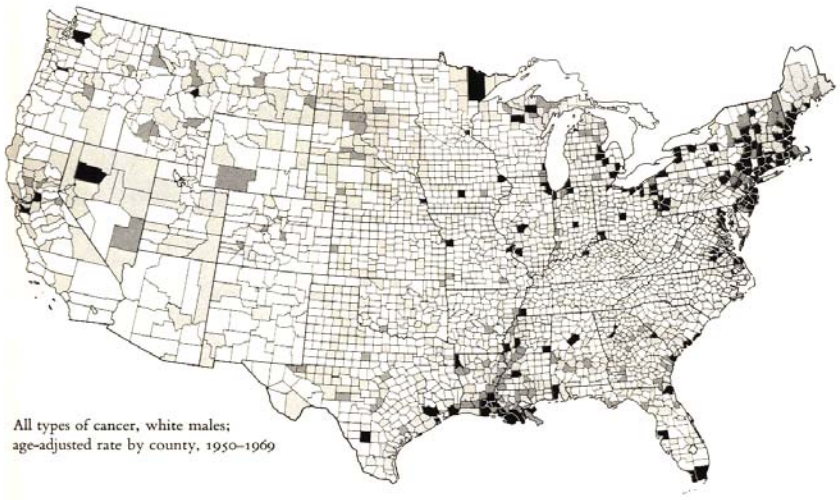
Figure 7.14 The brain generally assumes that lighting comes from above. The bumps in this image become hollows when the picture is turned upside down.


Continuous dialysis
Renal failure
Data Visualization
Head injury
ARDS
Sepsis
Invasive monitoring
Mechanical ventilation


Carte Figurative des pertes successives en hommes de l'Armée Française dans la Campagne de Russie 1812–1813.
Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite.
Paris, le 20 Novembre 1869
MOSCOU
TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.



All types of cancer, white females;
age-adjusted rate by county, 1950–1969



All types of cancer, white males;
age-adjusted rate by county, 1950–1969

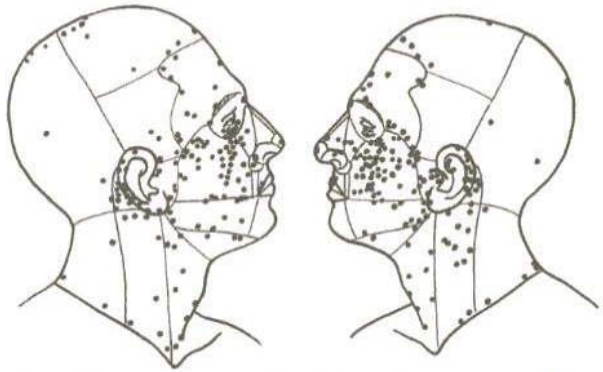


Abb. 1. Verteilung von 269 primären Melanomen auf Kopf und Hals

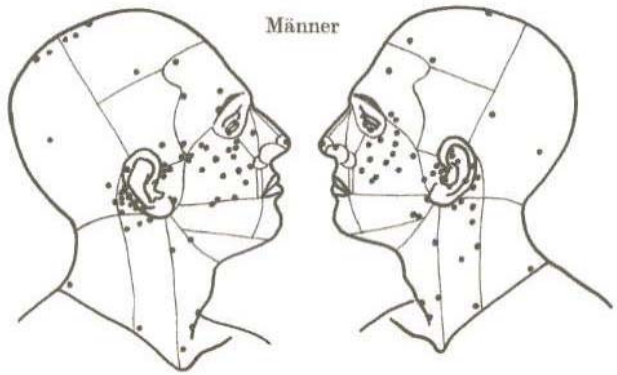


Abb. 2

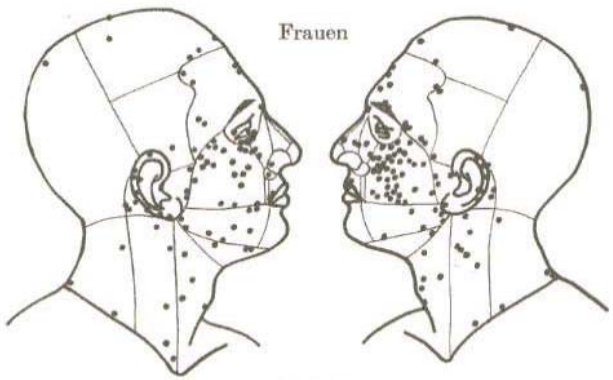
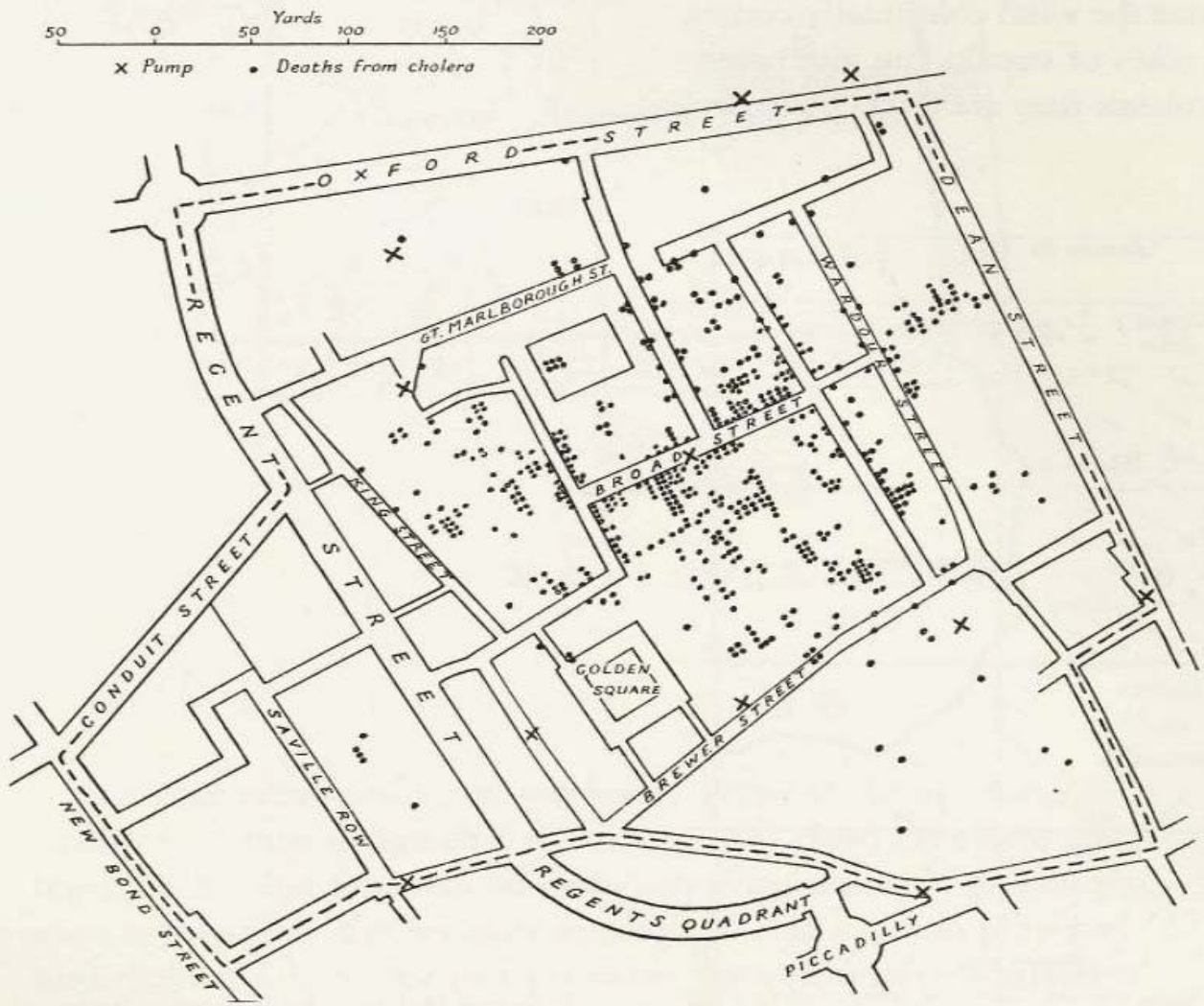
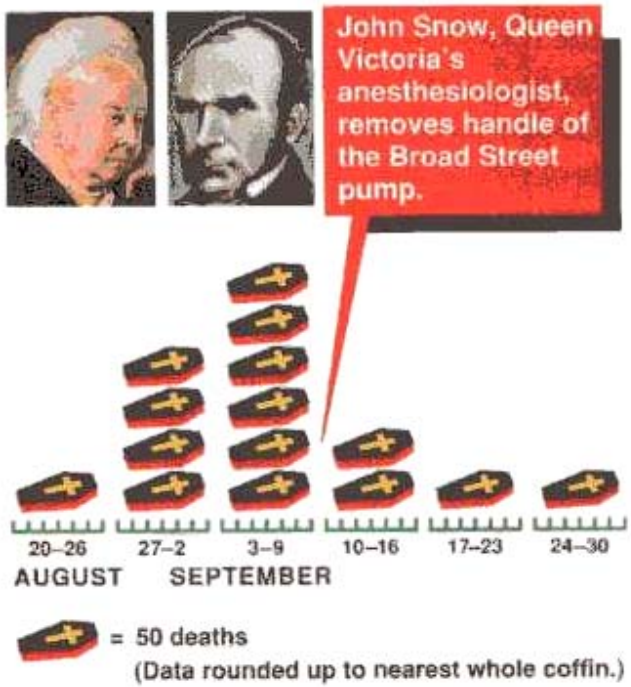


Abb. 3

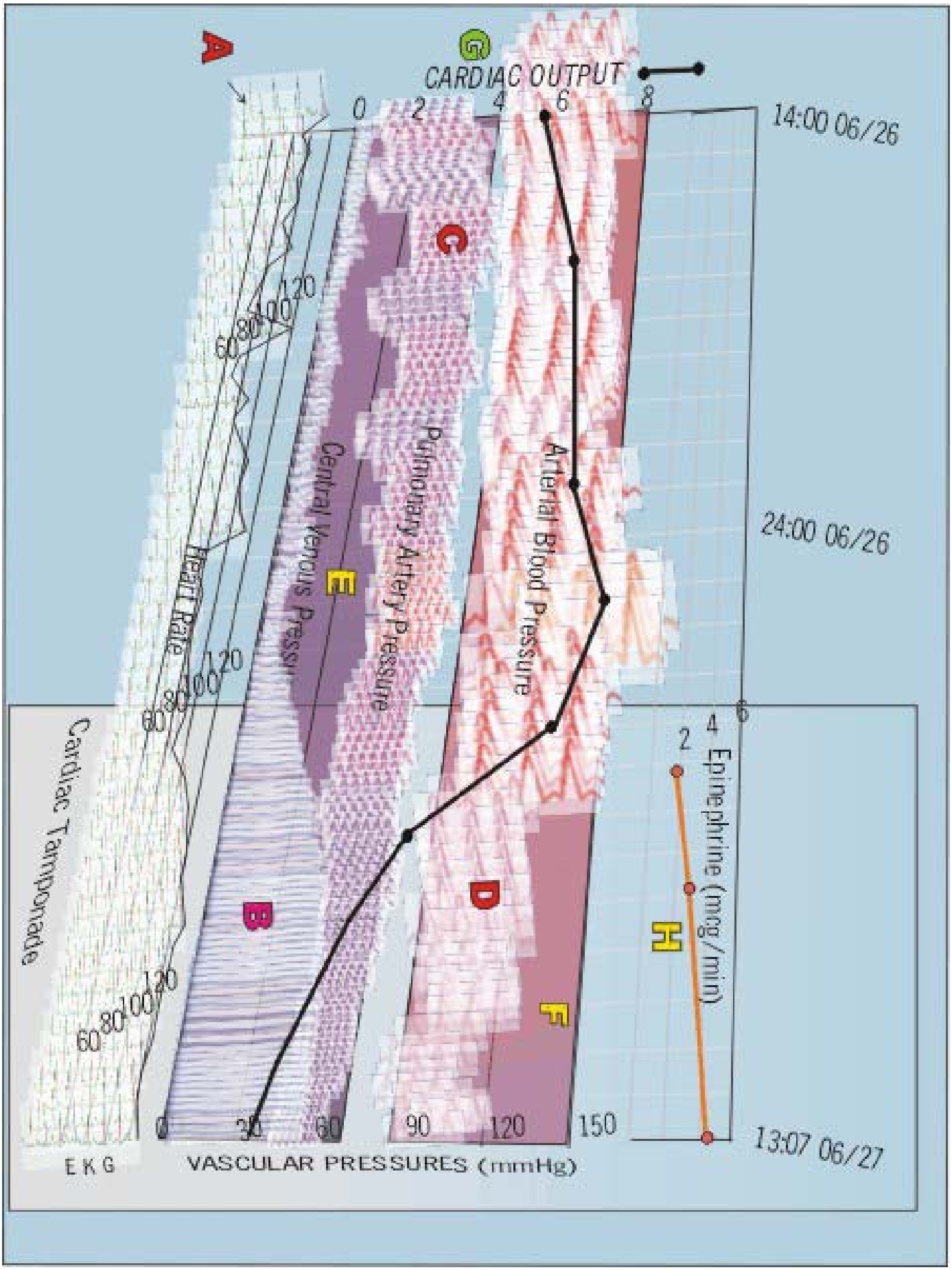
Abb. 2 u. 3. Differenzierung der Melanomverteilung nach Geschlechtern


50 0 50 100 150 200 Yards
× Pump • Deaths from cholera
OXFORD STREET
GT. MARLBOROUGH ST.
REGENT STREET
KING STREET
BROAD STREET
WARWICK STREET
DEAN STREET
CONDUIT STREET
GOLDEN SQUARE
BREWER STREET
SAVILLE ROW
NEW BOND STREET
REGENTS QUADRANT
PICCADILLY


John Snow, Queen Victoria's anesthesiologist, removes handle of the Broad Street pump.
20–26
27–2
3–9
10–16
17–23
24–30
AUGUST
SEPTEMBER
= 50 deaths
(Data rounded up to nearest whole coffin.)

Data map mockup

- 1. simultaneous presentation of all relevant data elements
- 2. graphical rather than numeric format
- 3. no filtering, minimal data reduction
- 4. faithful reproduction of waveforms
- 5. use of small multiples (reproduction of the same data element showing change over time)
- 6. use of multi-functioning elements (as described above)
- 7. emphasis on scalability (different information is conveyed when the image is seen at a microscopic level and a macroscopic level)
- 8. utilization of design principles that permit the development of reproducible visual patterns representing common pathophysiologic processes (e.g. intravascular volume depletion)
- 9. design of images that are susceptible to rotation (some data may be better understood in the vertical orientation as opposed to the horizontal, some clinicians prefer a specific orientation)
- 10. side by side depiction of monitored data with interventions permitting inferences about the relationship of cause to effect


A
G
CARDIAC OUTPUT
0
2
4
6
8
14:00 06/26
C
120
100
80
60
Heart Rate
Central Venous Pressure
E
Pulmonary Artery Pressure
Arterial Blood Pressure
24:00 06/26
120
100
80
60
Cardiac Tamponade
B
D
F
H
2
4
6
Epinephrine (mcg/min)
120
100
80
60
0
30
60
90
120
150
13:07 06/27
EKG
VASCULAR PRESSURES (mmHg)

Princeton Scalable Display Wall