Infovis: networks and trees

Thomas Torsney-Weir

Last time

we talked about viewing tablular data

- Information visualization is mapping abstract dimensions to spatial/visual
- Care needed to choose spatial mappings
- Single views form foundation of more elaborate visualizations

Other data types

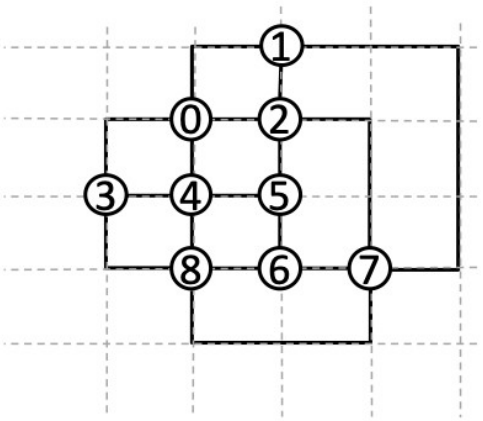
- Networks and trees
- Fields
- Geometry

Networks and trees

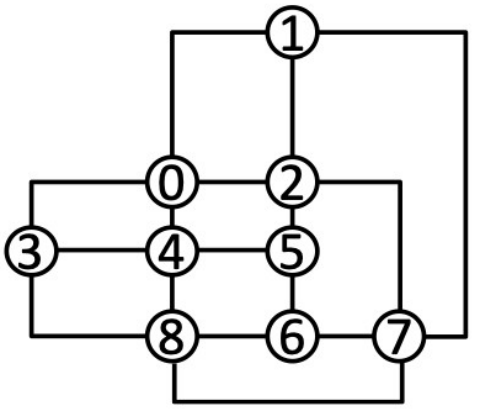
Low-level Tasks

- identify nodes
- determine connections
- find paths
- determine cliques

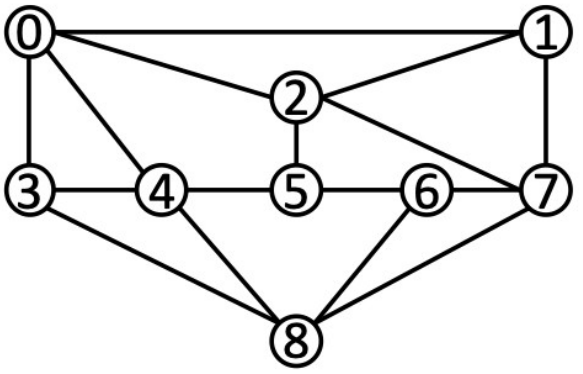
Node-link diagrams



grid-based



orthogonal



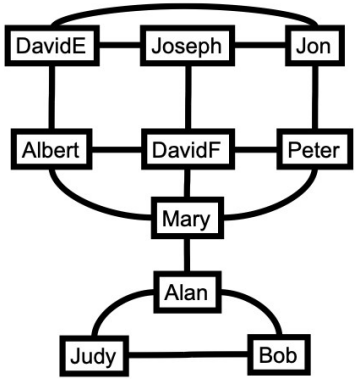
straight-line

Algorithms

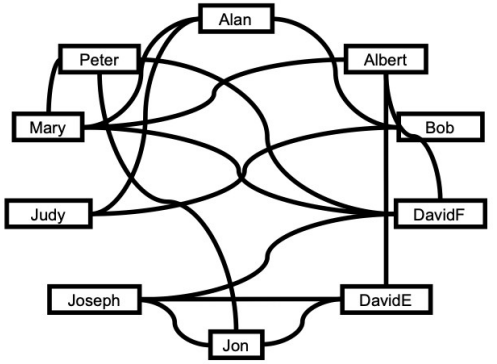
Algorithm to draw graphs nicely

- few edge crossings
- nodes well-separated
- minimize bends

Nice



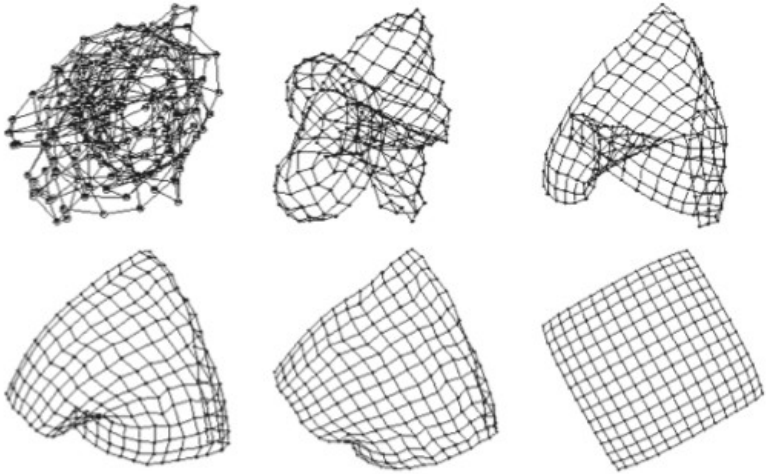
Not nice



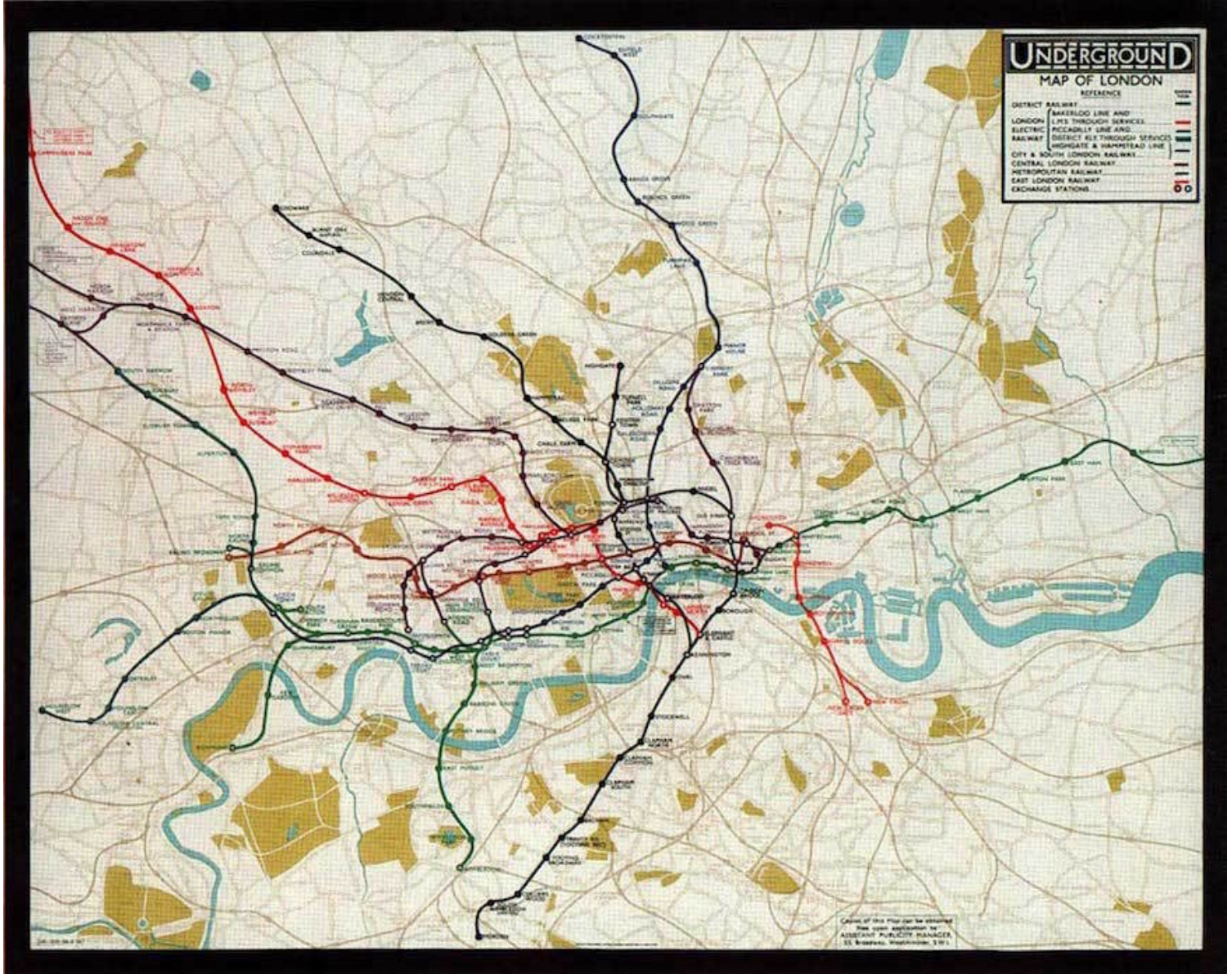
Purchase, Helen. "Which aesthetic has the greatest effect on human understanding?" Graph Drawing. 1997.

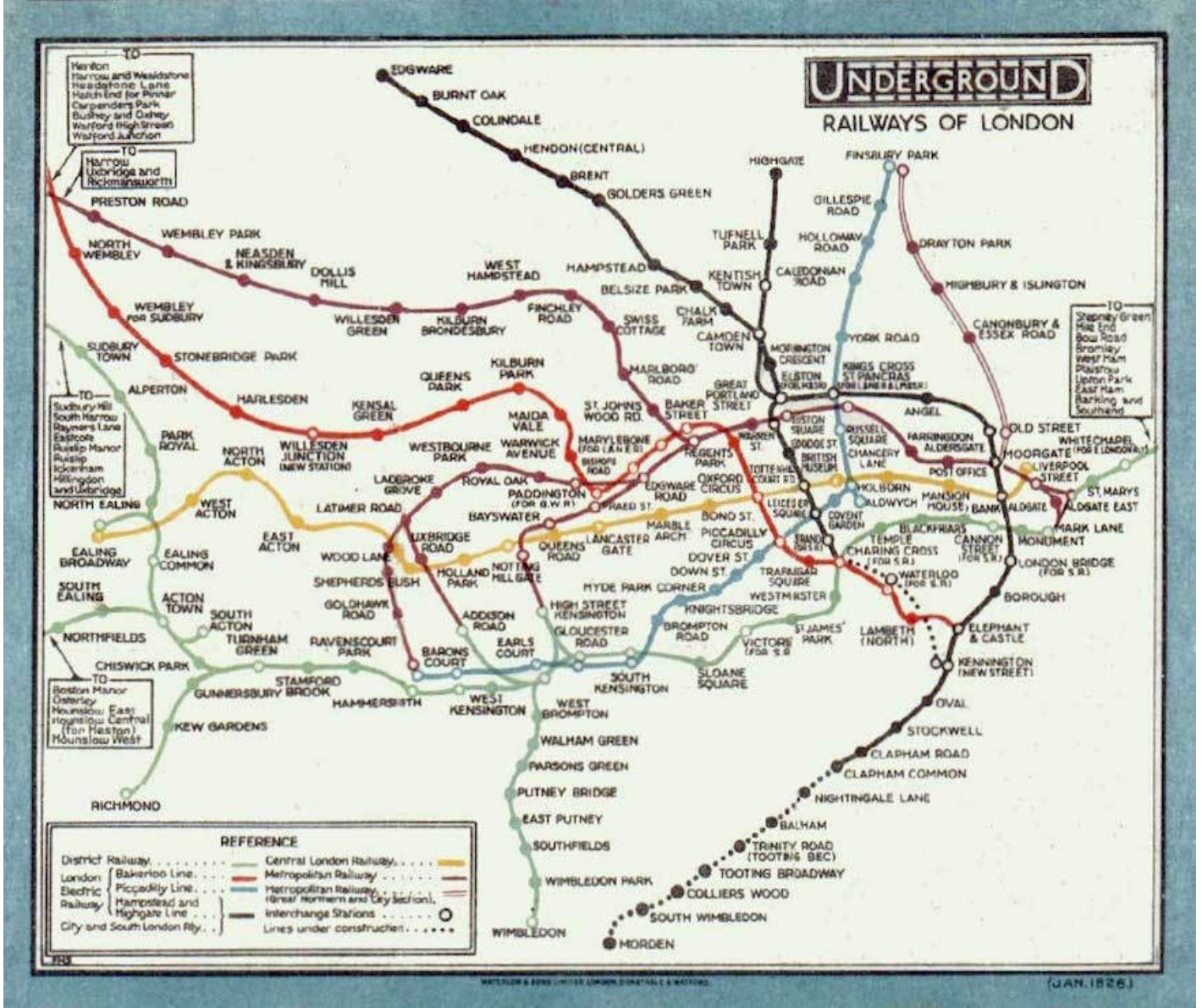
Force directed layouts

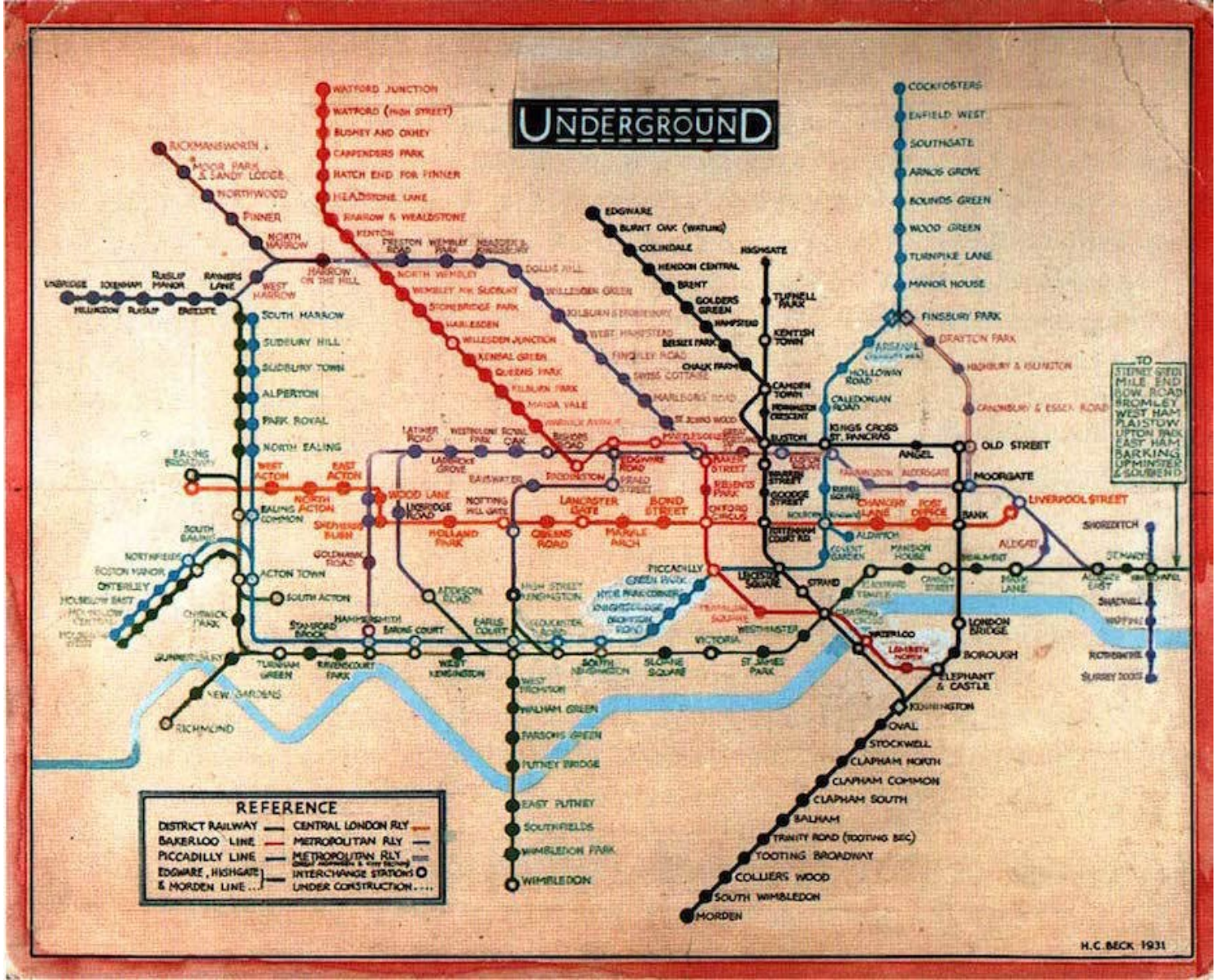
https://bl.ocks.org/mbostock/4062045



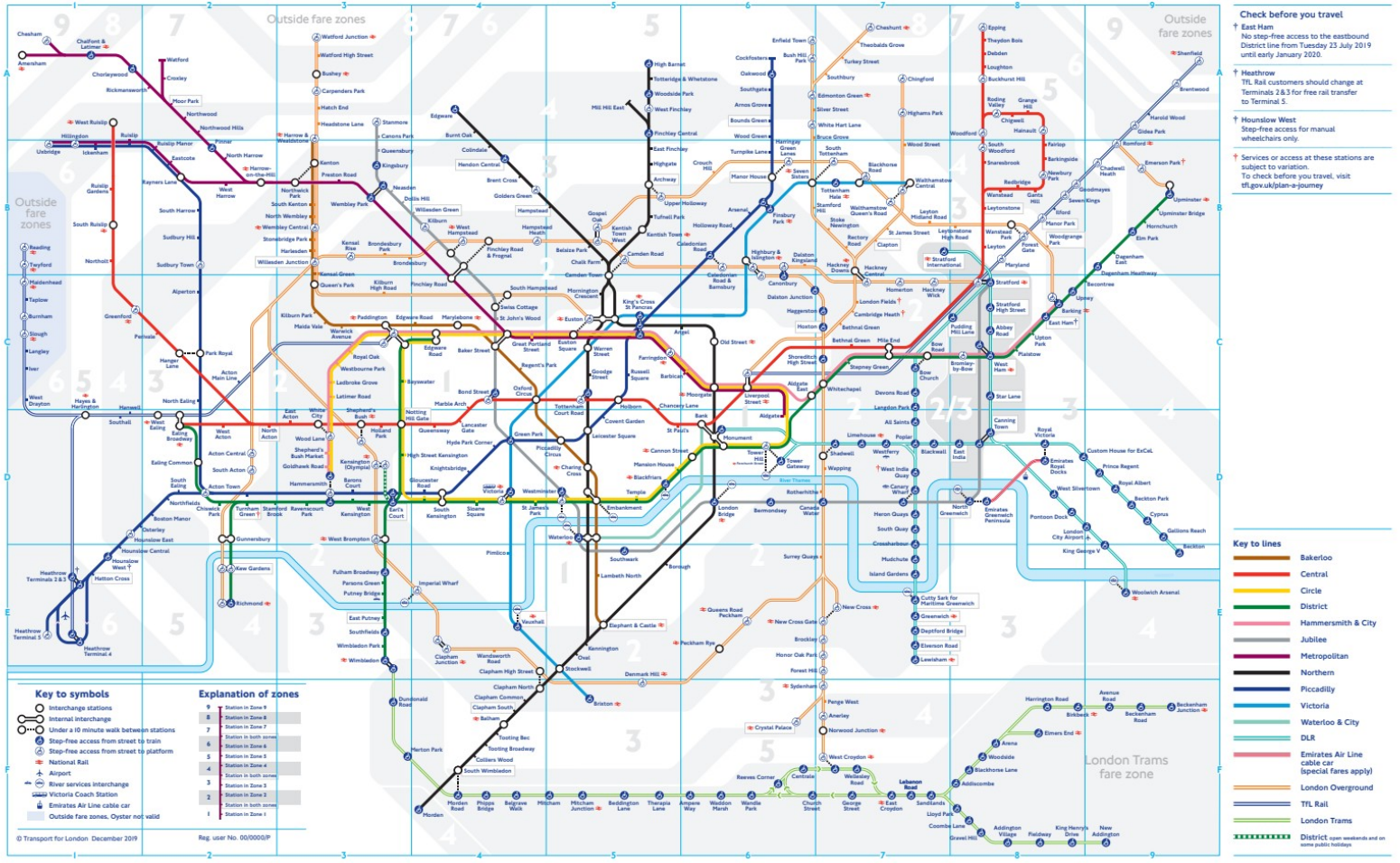
© Sander


UNDERGROUND
MAP OF LONDON
REFERENCE
DISTRICT RAILWAY
LONDON ELECTRIC RAILWAY
BAKERLOO LINE AND L.M.S. THROUGH SERVICES
PICCADILLY LINE AND DISTRICT R.E. THROUGH SERVICES
HIGHGATE & HAMPSTEAD LINE
CITY & SOUTH LONDON RAILWAY
CENTRAL LONDON RAILWAY
METROPOLITAN RAILWAY
EAST LONDON RAILWAY
EXCHANGE STATIONS


UNDERGROUND
RAILWAYS OF LONDON
EDGWARE
BURNT OAK
COLINDALE
HENDON (CENTRAL)
BRENT
GOLDERS GREEN
HIGHGATE
FINSBURY PARK
GILLESPIE ROAD
TUFNELL PARK
HOLLOWAY ROAD
DRAYTON PARK
HIGHBURY & ISLINGTON
CANONBURY & ESSEX ROAD
KENTISH TOWN
CALEDONIAN ROAD
HAMPSTEAD
BELSIZE PARK
WEST HAMPSTEAD
CHALK FARM
CAMDEN TOWN
YORK ROAD
KINGS CROSS ST PANCRAS
ANGEL
OLD STREET
MOORGATE
LIVERPOOL STREET
ST MARYS
ALDGATE EAST
WHITECHAPEL
MARK LANE
MONUMENT
LONDON BRIDGE (FOR S.R.)
BOROUGH
ELEPHANT & CASTLE
KENNINGTON (NEW STREET)
OVAL
STOCKWELL
CLAPHAM ROAD
CLAPHAM COMMON
NIGHTINGALE LANE
BALHAM
TRINITY ROAD (TOOTING BEC)
TOOTING BROADWAY
COLLIERS WOOD
SOUTH WIMBLEDON
MORDEN
WIMBLEDON
SOUTHFIELDS
EAST PUTNEY
PUTNEY BRIDGE
PARSONS GREEN
WALHAM GREEN
WEST BROMPTON
SOUTH KENSINGTON
SLOANE SQUARE
VICTORIA (FOR S.R.)
ST JAMES' PARK
LAMBETH (NORTH)
WATERLOO (FOR S.R.)
TRAFALGAR SQUARE
PICCADILLY CIRCUS
BOND ST.
OXFORD CIRCUS
REGENTS PARK
GREAT PORTLAND STREET
BAKER STREET
MARYLEBONE (FOR L.N.E.R.)
EDGWARE ROAD
PADDINGTON (FOR G.W.R.)
ROYAL OAK
BAYSWATER
LANCASTER GATE
QUEENS ROAD
NOTTING HILL GATE
HOLLAND PARK
MARBLE ARCH
DOWN ST.
DOVER ST.
HYDE PARK CORNER
KNIGHTSBRIDGE
HIGH STREET KENSINGTON
GLOUCESTER ROAD
EARLS COURT
BARONS COURT
ADDISON ROAD
BROMPTON ROAD
WEST KENSINGTON
HAMMERSMITH
SHEPHERDS BUSH
WOOD LANE
UXBRIDGE ROAD
LADBROKE GROVE
WESTBOURNE PARK
WARWICK AVENUE
MAIDA VALE
ST JOHN'S WOOD RD.
QUEENS PARK
KILBURN PARK
KILBURN
BRONDESBURY
WILLESDEN GREEN
SWISS COTTAGE
FINCHLEY ROAD
DOLLIS HILL
NEASDEN & KINGSBURY
WEMBLEY PARK
NORTH WEMBLEY
PRESTON ROAD
WEMBLEY FOR SUDBURY
SUDBURY TOWN
STONEBRIDGE PARK
ALPERTON
HARLESDEN
KENSAL GREEN
WILLESDEN JUNCTION (NEW STATION)
NORTH ACTON
PARK ROYAL
WEST ACTON
NORTH EALING
LATIMER ROAD
EAST ACTON
EALING BROADWAY
EALING COMMON
SOUTH EALING
ACTON TOWN
SOUTH ACTON
TURNHAM GREEN
GOLDHAWK ROAD
RAVENSCOURT PARK
STAMFORD BROOK
GUNNERSBURY
CHISWICK PARK
NORTHFIELDS
KEW GARDENS
RICHMOND
TO
Kenton
Harrow and Wealdstone
Headstone Lane
Hatch End for Pinner
Carpenders Park
Bushey and Oxhey
Watford High Street
Watford Junction
TO
Harrow
Uxbridge and Rickmansworth
TO
Sudbury Hill
South Harrow
Rayners Lane
Eastcote
Ruislip Manor
Ruislip
Ickenham
Hillingdon
and Uxbridge
TO
Boston Manor
Osterley
Hounslow East
Hounslow Central
(for Heston)
Hounslow West
TO
Stepney Green
Mile End
Bow Road
Bromley
West Ham
Plaistow
Upton Park
East Ham
Barking and
Southend
REFERENCE
District Railway
London Electric Railway
Bakerloo Line
Piccadilly Line
Hampstead and Highgate Line
City and South London Rly.
Central London Railway
Metropolitan Railway
Metropolitan Railway (Great Northern and City Section)
Interchange Stations
Lines under construction
(JAN. 1926)


UNDERGROUND
WATFORD JUNCTION
WATFORD (HIGH STREET)
BUSHEY AND OXHEY
CARPENDERS PARK
HATCH END FOR PINNER
HEADSTONE LANE
HARROW & WEALDSTONE
KENTON
NORTH WEMBLEY
STONEBRIDGE PARK
HARLESDEN
WILLESDEN JUNCTION
KENSAL GREEN
QUEENS PARK
KILBURN PARK
MAIDA VALE
WARWICK AVENUE
PADDINGTON
EDGWARE ROAD
LADBROKE GROVE
WESTBOURNE PARK
ROYAL OAK
BAYSWATER
NOTTING HILL GATE
LANCASTER GATE
QUEENSWAY
BOND STREET
MARBLE ARCH
OXFORD CIRCUS
HOLLAND PARK
GLOUCESTER ROAD
EARLS COURT
KENSINGTON (HIGH STREET)
HYDE PARK CORNER
KNIGHTSBRIDGE
BROMPTON ROAD
PICCADILLY CIRCUS
LEICESTER SQUARE
STRAND
TEMPLE
CHANCERY LANE
POST OFFICE
HOLBORN
TOTTENHAM COURT RD
GOODGE STREET
RUSSELL SQUARE
ALDWYCH
COVENT GARDEN
MANSION HOUSE
CANNON STREET
BANK
LIVERPOOL STREET
ALDGATE
ALDGATE EAST
BANK LANE
MONUMENT
WESTMINSTER
VICTORIA
SLOANE SQUARE
ST. JAMES' PARK
SOUTH KENSINGTON
WEST KENSINGTON
BARONS COURT
STAMFORD BROOK
RAVENSCOURT PARK
TURNHAM GREEN
GUNNERSBURY
KEW GARDENS
RICHMOND
ACTON TOWN
SOUTH ACTON
CHISWICK PARK
NORTH ACTON
EALING COMMON
EALING BROADWAY
WEST ACTON
EAST ACTON
SOUTH EALING
NORTH EALING
PARK ROYAL
ALPERTON
SUDBURY TOWN
SUDBURY HILL
SOUTH HARROW
NORTHOLT
GREENFORD
PERIVALE
HANGER LANE
WEST HARROW
HARROW ON THE HILL
NORTH HARROW
PINNER
NORTHWOOD
MOOR PARK & SANDY LODGE
RICKMANSWORTH
UXBRIDGE
HILLINGDON
IVER
RUISLIP
RUISLIP MANOR
EASTCOTE
WEST HAMPSTEAD
FINCHLEY ROAD
FROGNAL
HAMPSTEAD
GOLDERS GREEN
BRENT
HENDON CENTRAL
COLINDALE
BURNT OAK (WATLING)
EDGWARE
CHALK FARM
CAMDEN TOWN
KENTISH TOWN
TUFNELL PARK
HIGHGATE
ARCHWAY
HOLLOWAY ROAD
CALEDONIAN ROAD
BARNSBURY
CANONBURY & ESSEX ROAD
HIGHBURY & ISLINGTON
FINSBURY PARK
DRAYTON PARK
MANOR HOUSE
TURNPIKE LANE
WOOD GREEN
BOUNDS GREEN
ARNOS GROVE
SOUTHGATE
ENFIELD WEST
COCKFOSTERS
TO STEPNEY GREEN MILE END BOW ROAD BROMLEY WEST HAM PLAISTOW UPTON PARK EAST HAM BARKING UPMINSTER & SOUTHEND
KINGS CROSS ST. PANCRAS
EUSTON
EUSTON SQUARE
GOWER STREET
ANGEL
OLD STREET
MOORGATE
SHOREDITCH
LONDON BRIDGE
BOROUGH
ELEPHANT & CASTLE
WATERLOO
LAMBETH NORTH
KENNINGTON
OVAL
STOCKWELL
CLAPHAM NORTH
CLAPHAM COMMON
CLAPHAM SOUTH
BALHAM
TRINITY ROAD (TOOTING BEC)
TOOTING BROADWAY
COLLIERS WOOD
SOUTH WIMBLEDON
MORDEN
WIMBLEDON
WIMBLEDON PARK
SOUTHFIELDS
EAST PUTNEY
PUTNEY BRIDGE
PARSONS GREEN
WALHAM GREEN
WEST BROMPTON
REFERENCE
DISTRICT RAILWAY
BAKERLOO LINE
PICCADILLY LINE
EDGWARE, HIGHGATE & MORDEN LINE
CENTRAL LONDON RLY
METROPOLITAN RLY
METROPOLITAN RLY (SMALL ADDITIONAL 4 FEET RAILWAY)
INTERCHANGE STATIONS
UNDER CONSTRUCTION
H.C. BECK 1931

Tube map



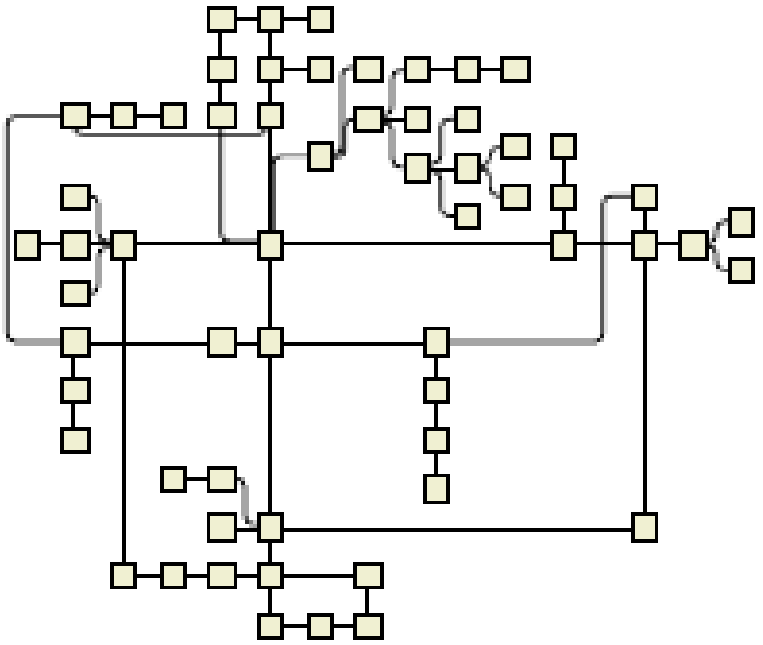
MAYOR OF LONDON

tfl.gov.uk | 24 hour travel information 0343 222 1234* | Check your travel tfl.gov.uk/travel-tools

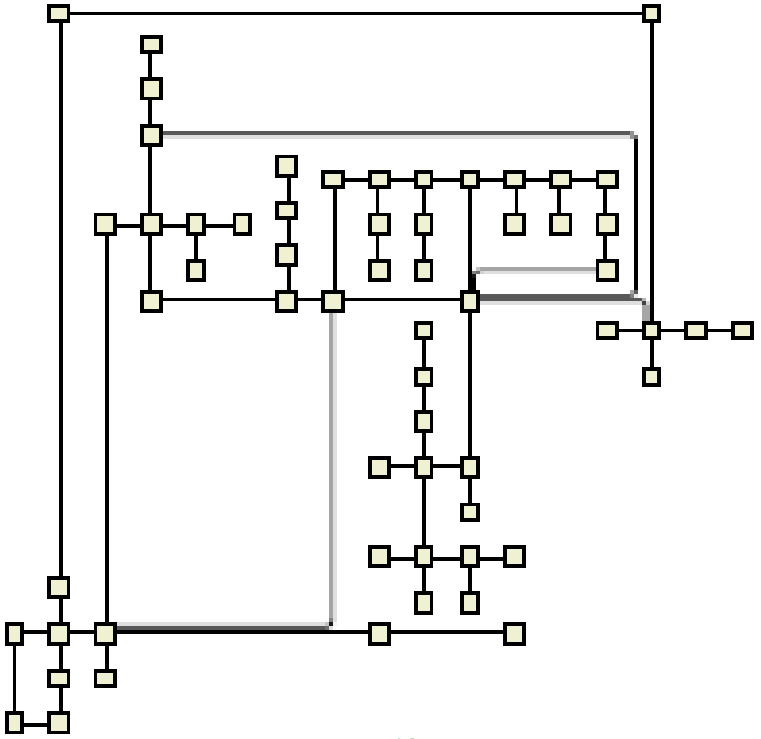
*Network charges may apply. See tfl.gov.uk/terms for details.

UNDERGROUND TRANSPORT FOR LONDON EVERY JOURNEY MATTERS

HOLA



HOLA



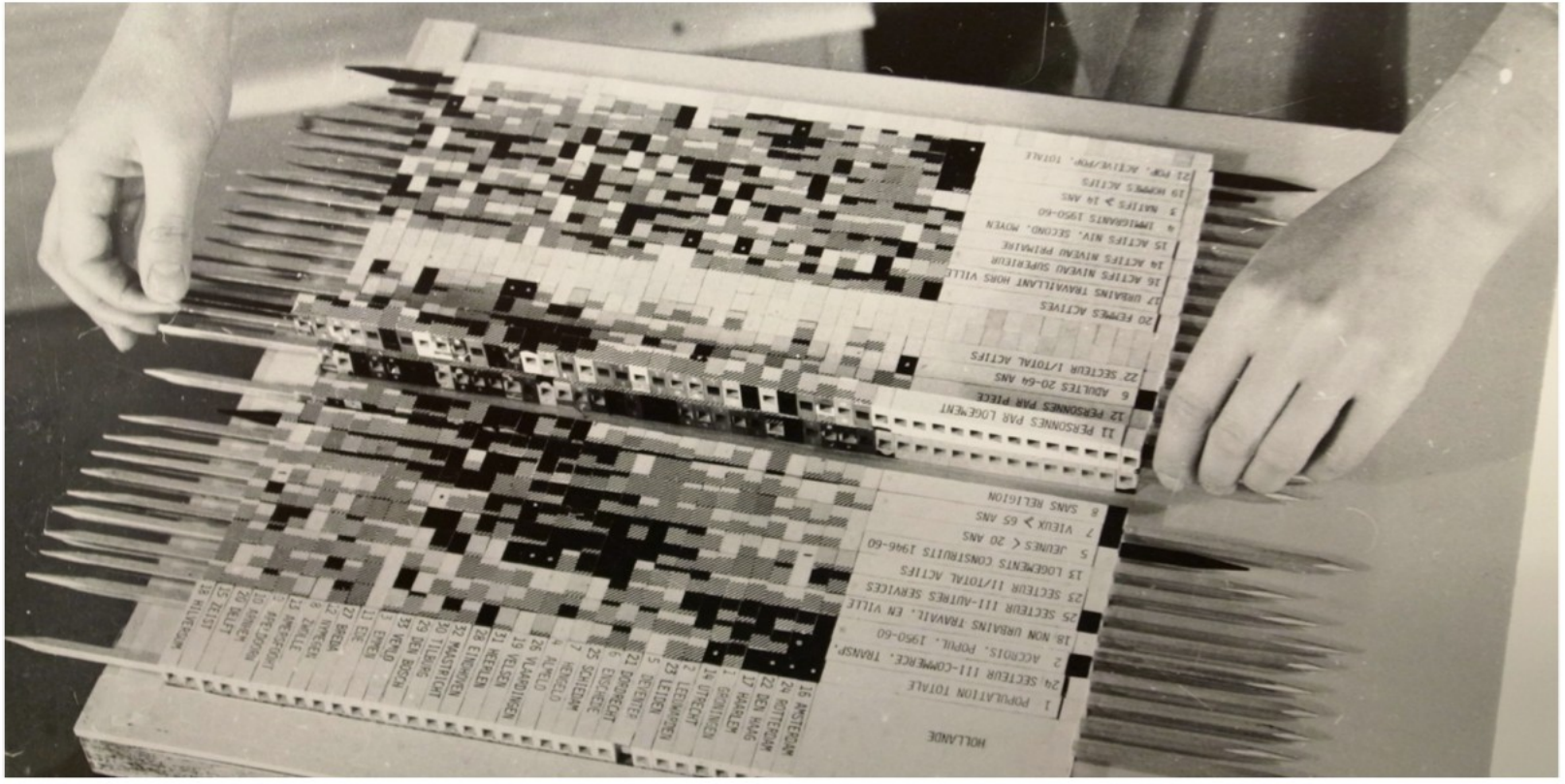
yFiles

Kieffer, Steve, Tim Dwyer, Kim Marriott, and Michael Wybrow. "HOLA: Human-like Orthogonal Network Layout," IEEE Transactions on Visualization and Computer Graphics. 2016.

Adjacency matrix

https://bost.ocks.org/mike/miserables/

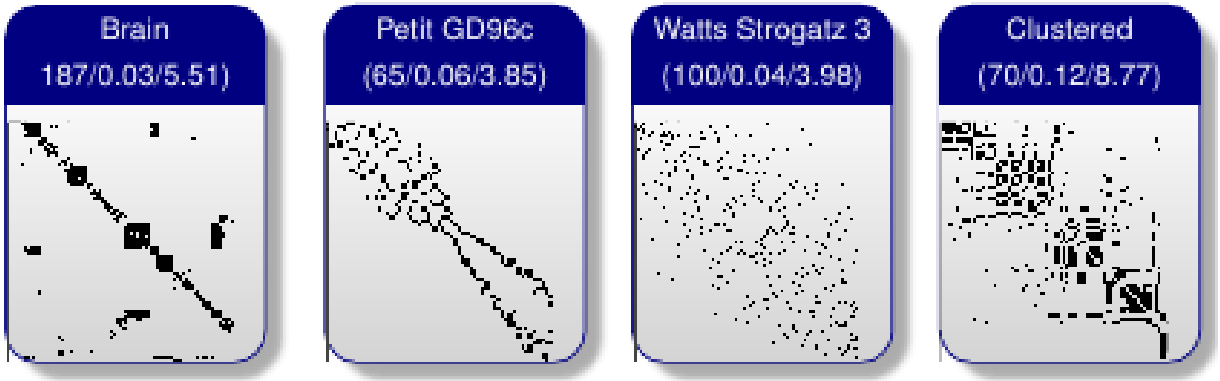
Physical reordering



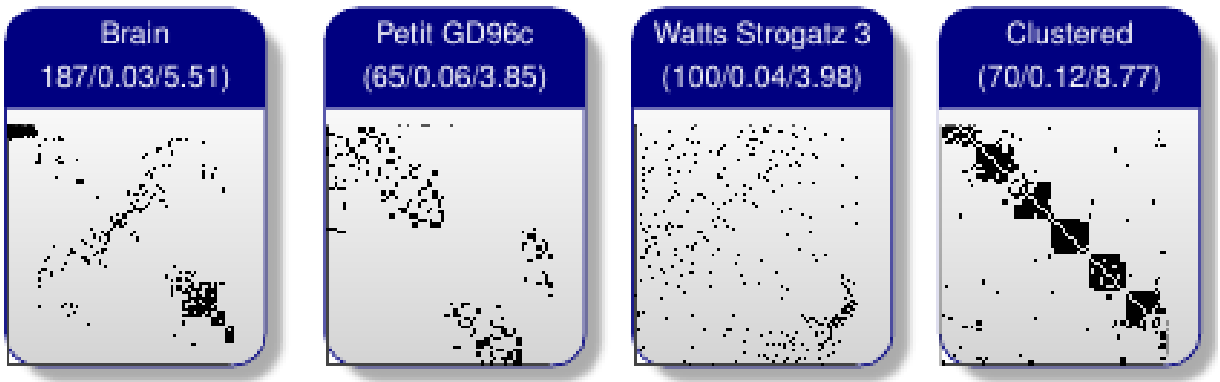
Jacques Bertin, 1968

http://www.aviz.fr/wiki/uploads/Bertifier/bertifier-authorversion.pdf

Algorithmic reordering



Angular Order of Eigenvectors [Fri02]



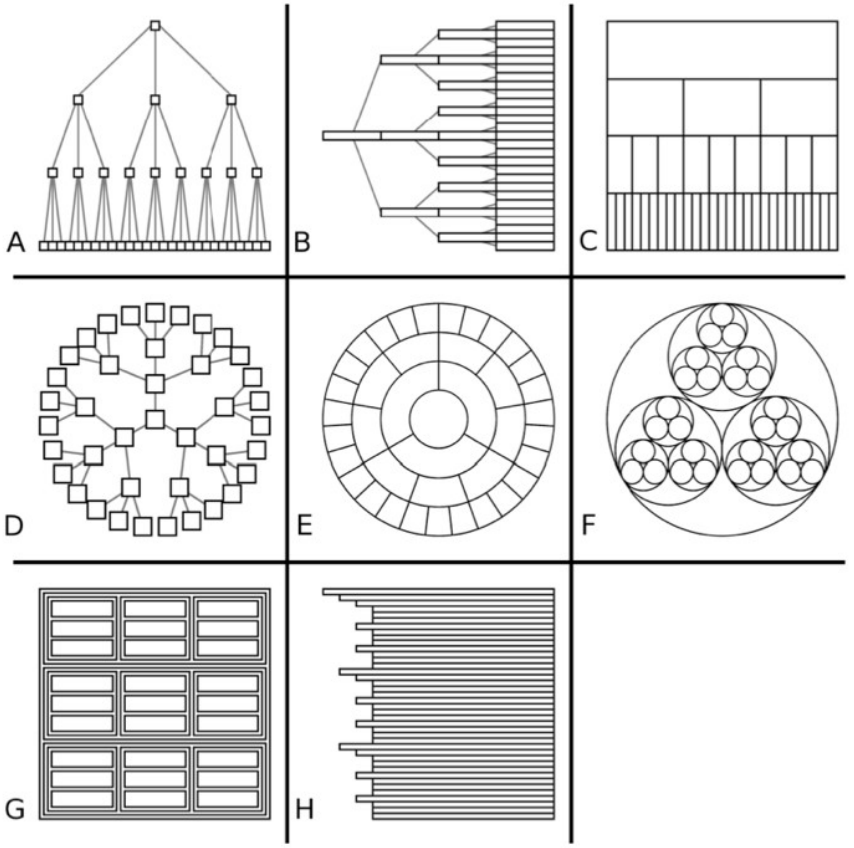
Rank-two Ellipse Seriation [Che02]

Behrisch, Michael, Benjamin Bach, Nathalie Henry Riche, Tobias Schreck, and Jean-Daniel Fekete. “Matrix Reordering Methods for Table and Network Visualization.” Computer Graphics Forum 35, no. 3 (2016): 693–716. https://doi.org/10.1111/cgf.12935.

Hierarchical data

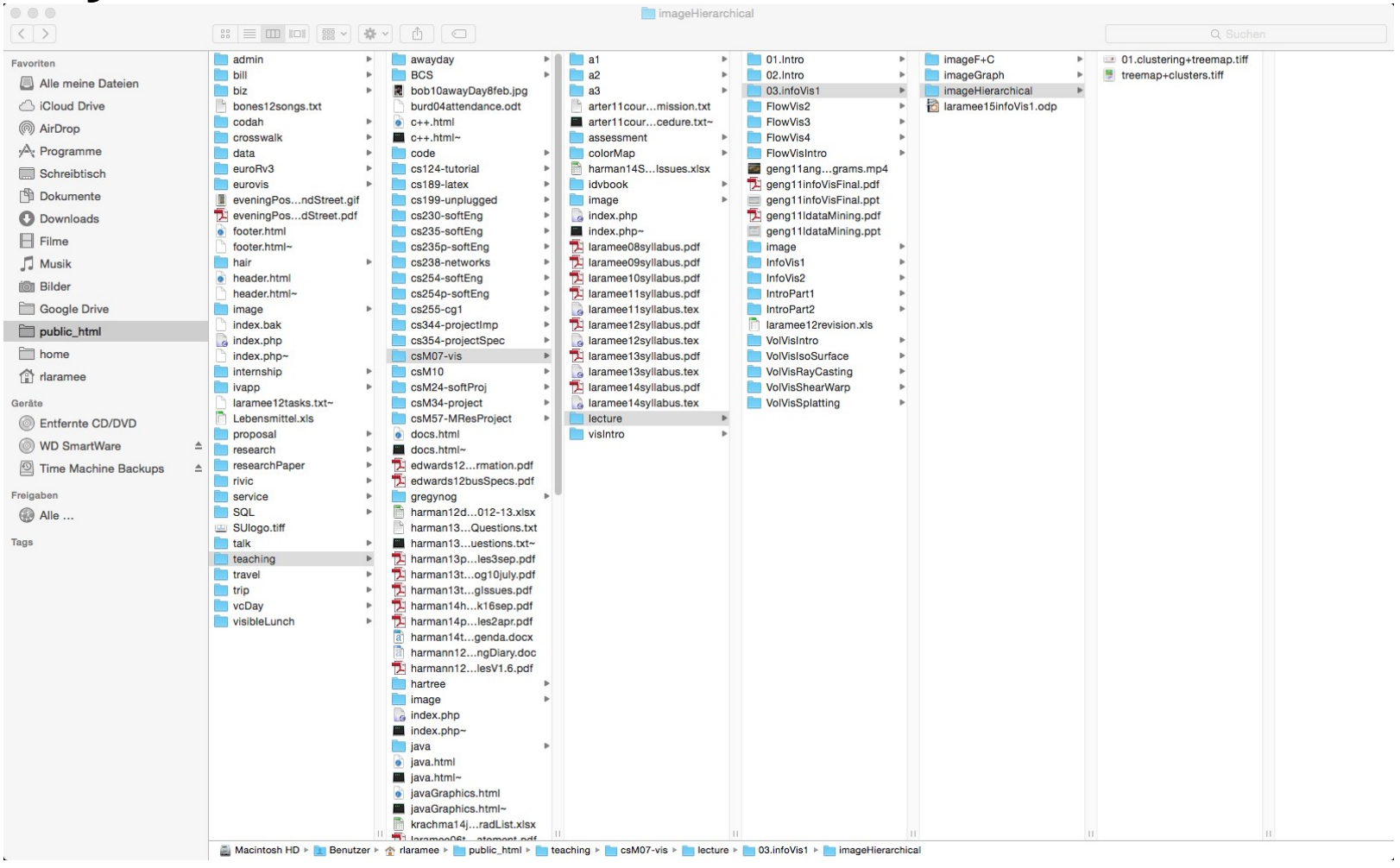
- trees
- file system browsers
- venn diagrams
- treemaps

Trees

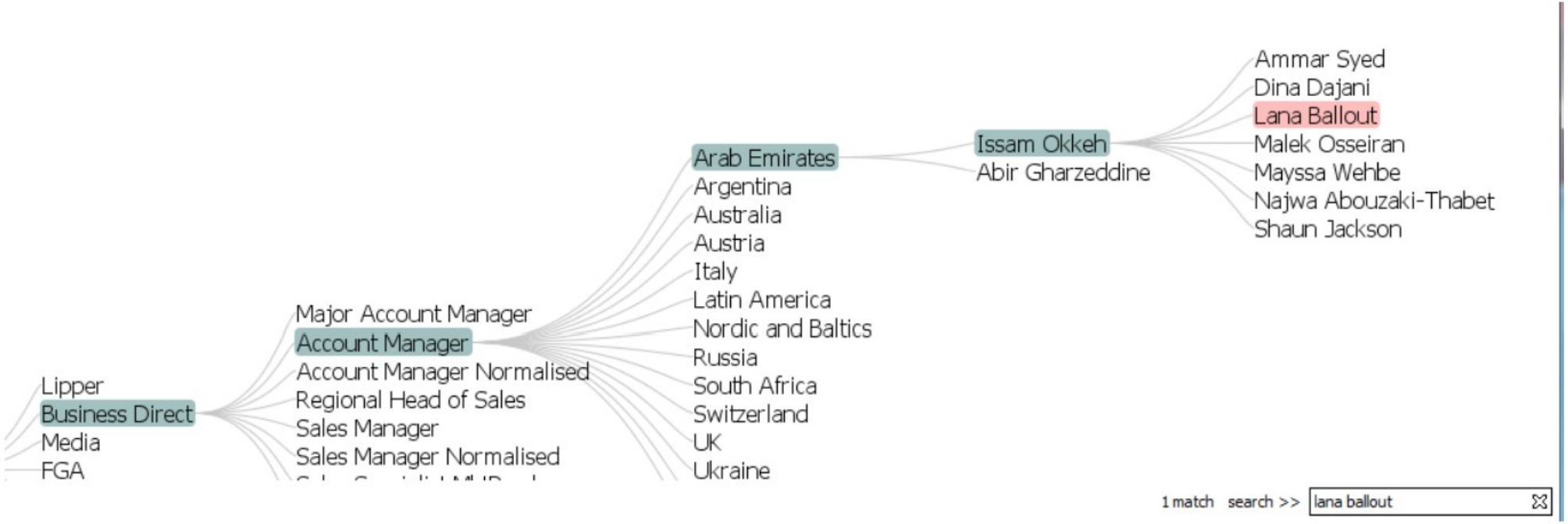


McGuffin, Michael J, and Jean-Marc Robert. "Quantifying the Space-Efficiency of 2D Graphical Representations of Trees," Information Visualization. 2010.

File system browser

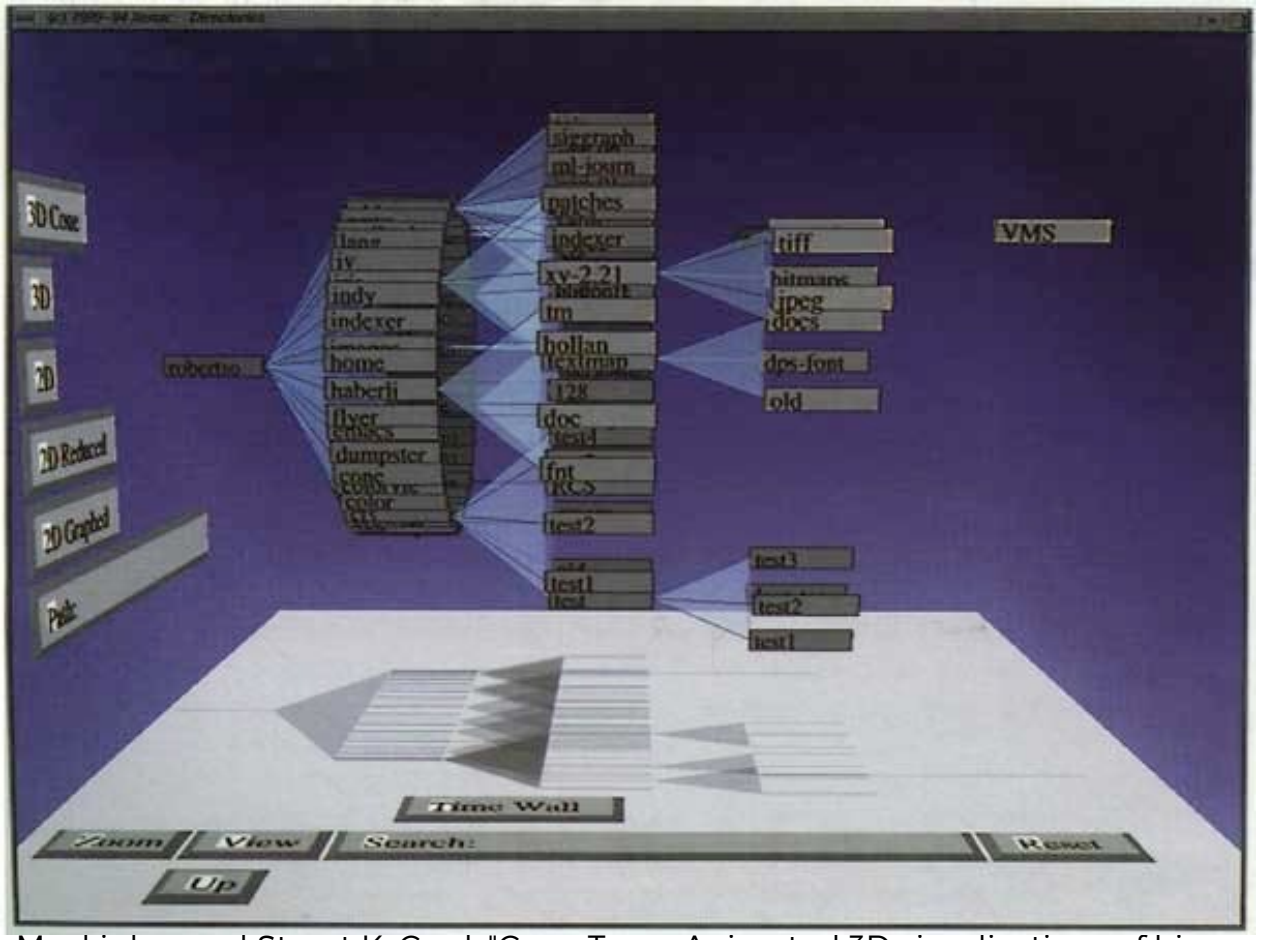


File system browser



Geng, Zhao, Robert S. Laramee, Fernando Loizides, and George Buchanan. "Visual Analysis of Document Triage Data." In Proceedings of the International Conference on Imaging Theory and Applications and International Conference on Information Visualization Theory and Applications, 1:151–63. Algrave, Portugal, 2011. https://doi.org/10.5220/0003320401510163.

Cone tree



Robertson, George G., Jock D. Mackinlay, and Stuart K. Card. "Cone Trees: Animated 3D visualizations of hierarchical information," Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. 1991.

Treemaps

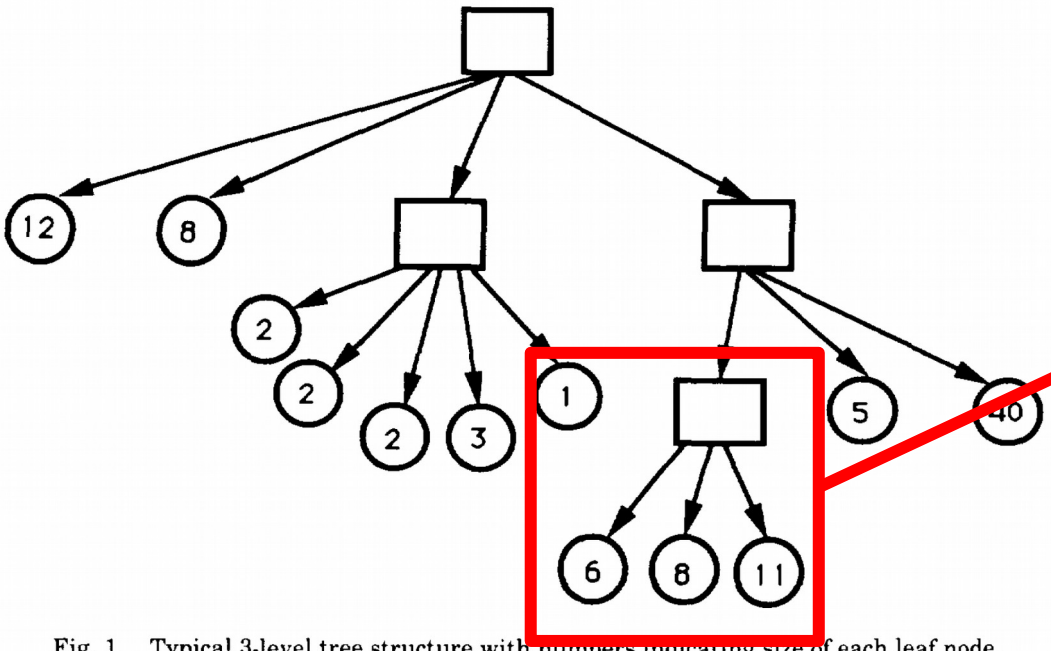


Fig. 1. Typical 3-level tree structure with numbers indicating size of each leaf node.

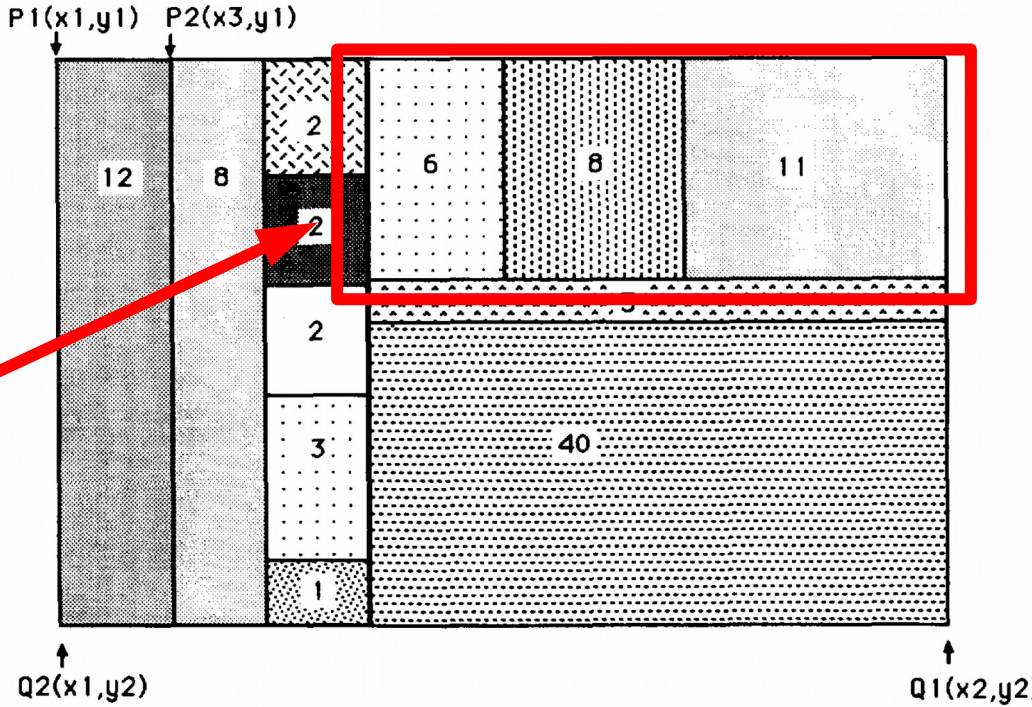


Fig. 2. Tree-map of Figure 1.

Johnson, Brian, and Ben Shneiderman. "Tree-Maps: A space-filling approach to the visualization of hierarchical information structures," Proceedings of the 2nd conference on Visualization '91. 1991.

Treemaps

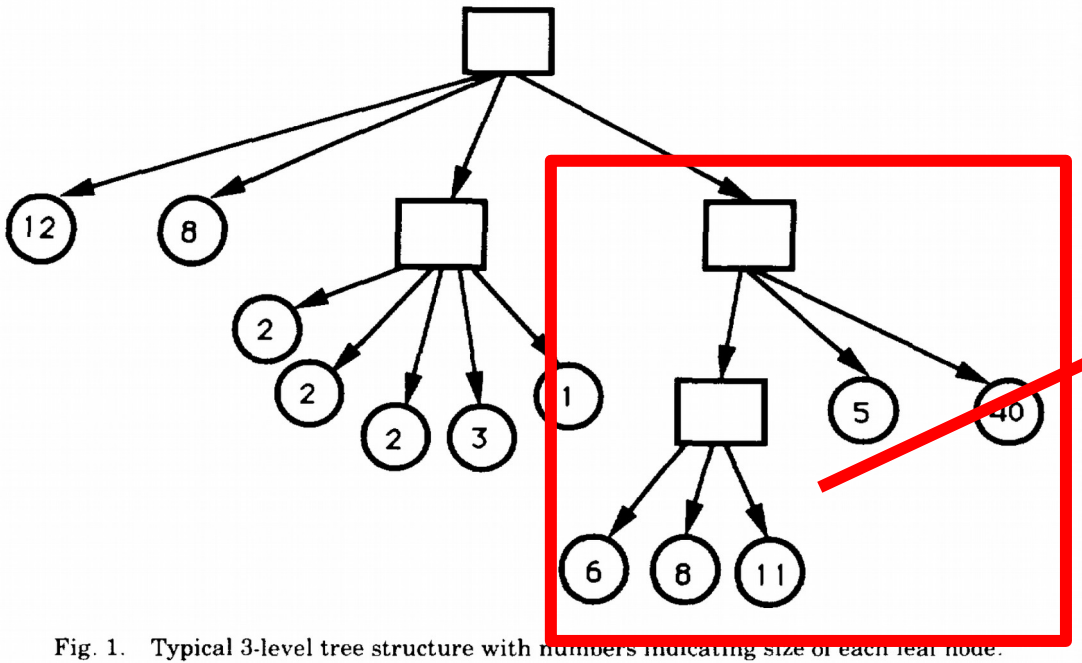


Fig. 1. Typical 3-level tree structure with numbers indicating size of each leaf node.

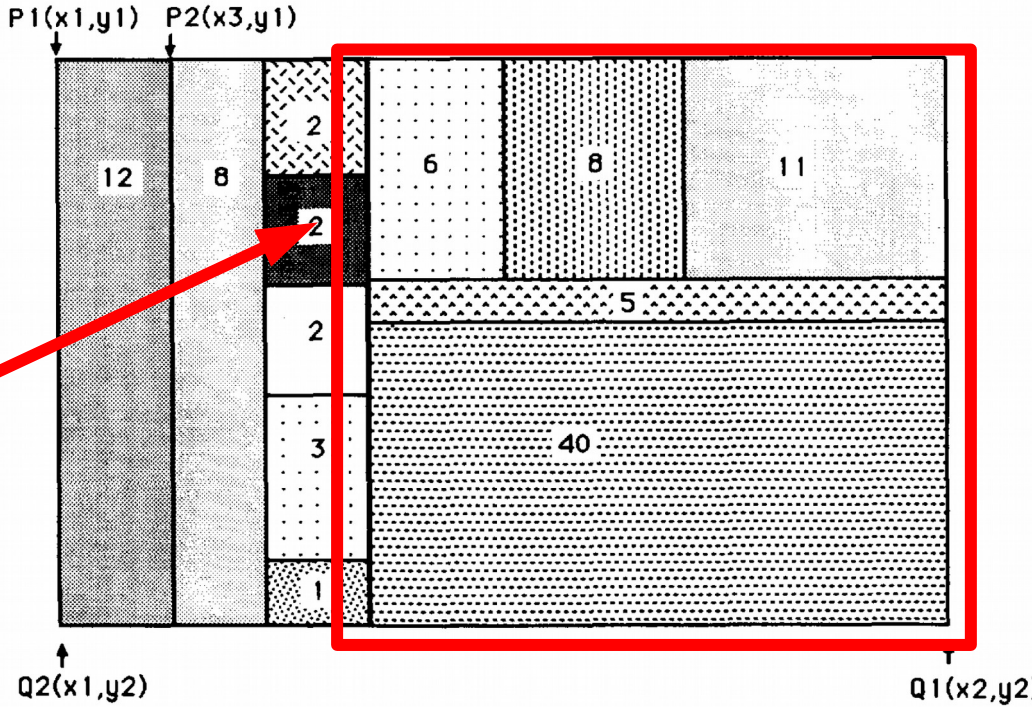
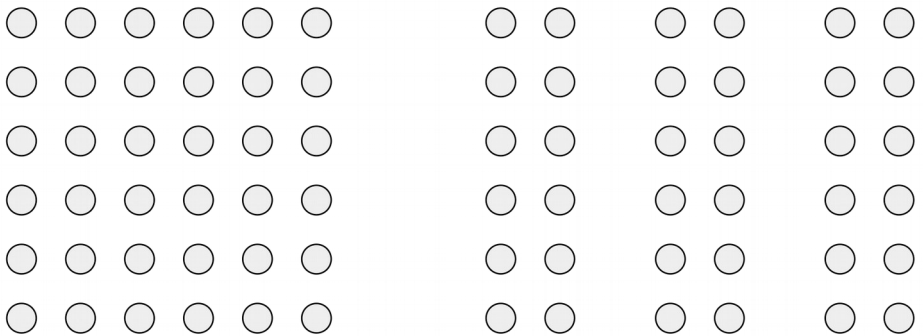


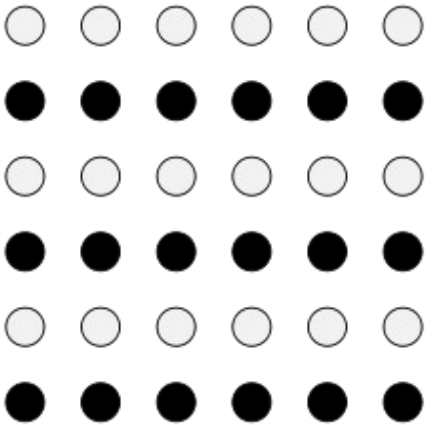
Fig. 2. Tree-map of Figure 1.

Johnson, Brian, and Ben Shneiderman. "Tree-Maps: A space-filling approach to the visualization of hierarchical information structures," Proceedings of the 2nd conference on Visualization '91. 1991.

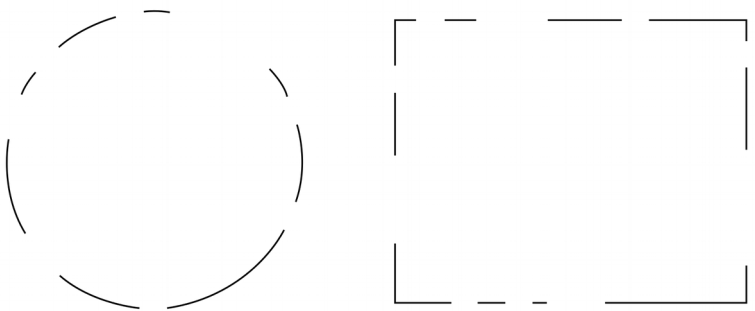
Gestalt principles



Grouping



Similarity



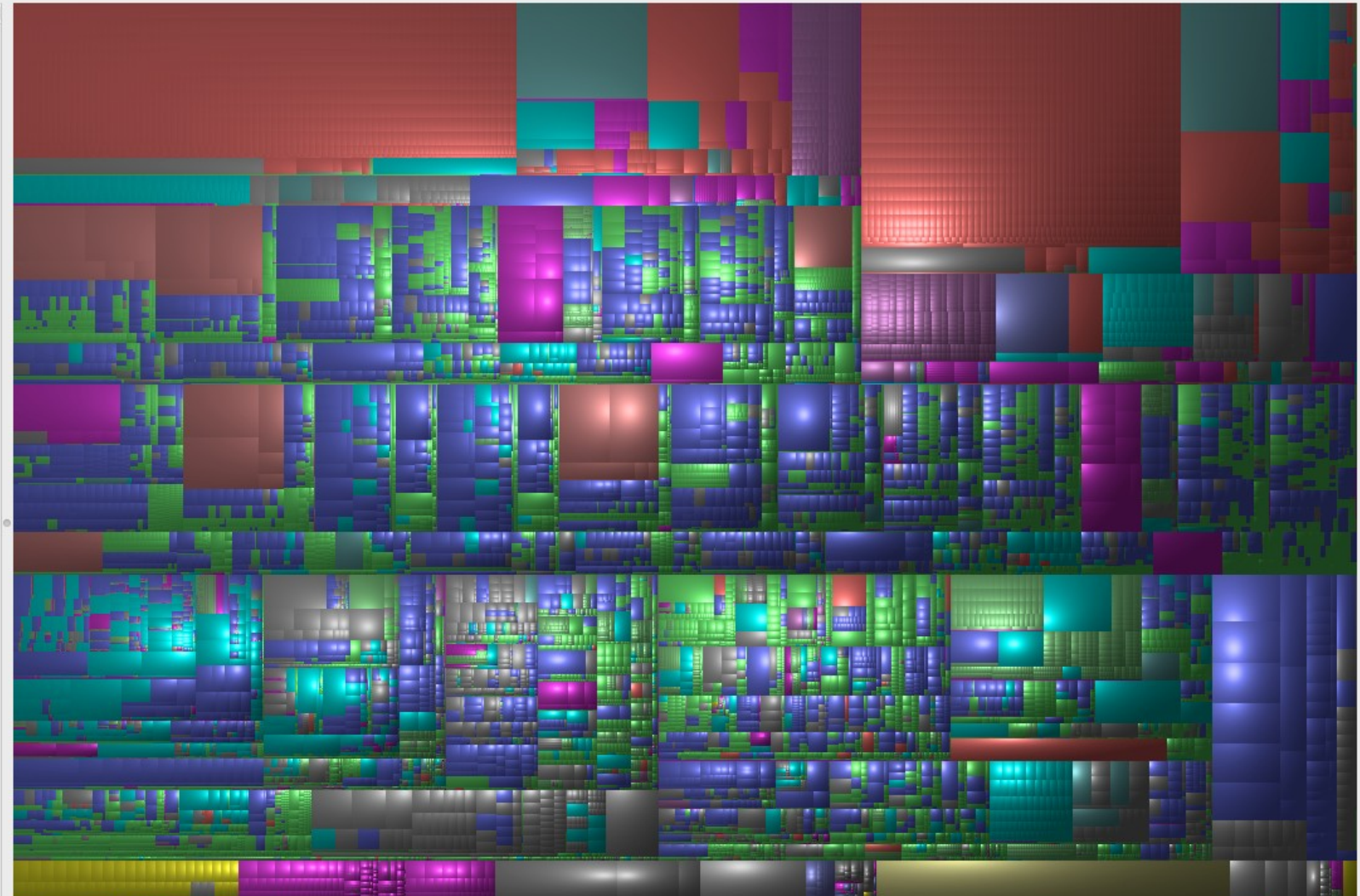
Closure

http://www.scholarpedia.org/article/Gestalt_principles

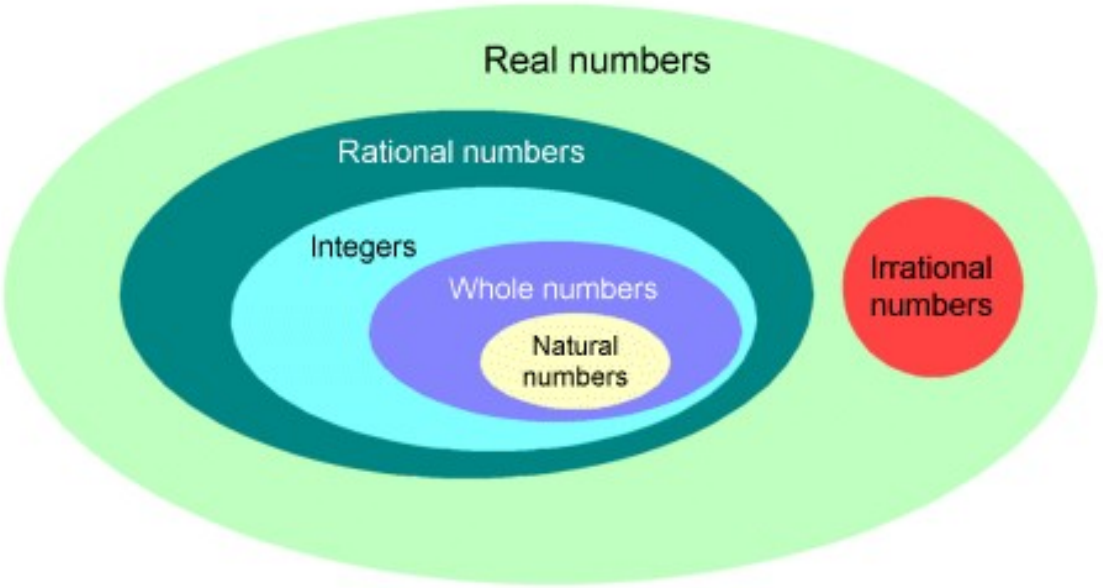
Macintosh HD (3.56,6 GB)

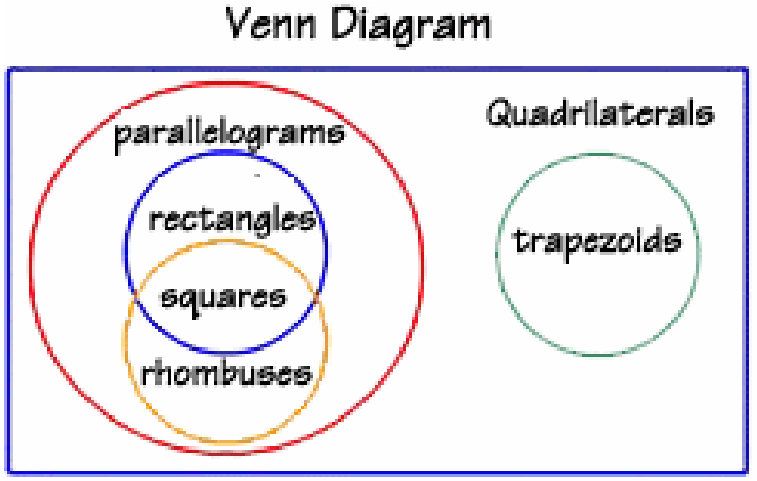
Zoom In Zoom Out Hide File Kind Statistic

Name	Size
Benutzer	3.14,8 GI
Programme	16,7 GB
private	9,9 GB
System	5,8 GB
Library	5,3 GB
usr	4,0 GB
opt	1.57,4 M
bin	4,5 MB
sbin	2,0 MB
.hotfiles.btree	128 kB
.DS_Store	6 kB
.OSInstallerMessages	1 kB
installer.failurerequests	313 Byte
Benutzerinformationen	49 Bytes
var	11 Bytes
tmp	11 Bytes
etc	11 Bytes
Volumes	1 Bytes
Network	0 Bytes
net	0 Bytes
home	0 Bytes
dev	0 Bytes
cores	0 Bytes
.vol	0 Bytes
.Trashes	0 Bytes
.Spotlight-V100	0 Bytes
.PKInstallSandboxManager	0 Bytes
.fseventsd	0 Bytes
.file	0 Bytes
.DocumentRevisions-V100	0 Bytes



Venn diagram





http://www.technologyuk.net/mathematics/about_numbers/real_numbers.shtml

Conclusion

Summary

- Node-link diagrams should minimize edge crossings and curved edges
- Adjacency matrix needs interactive reordering to show patterns
- Treemaps are a compact representation of trees