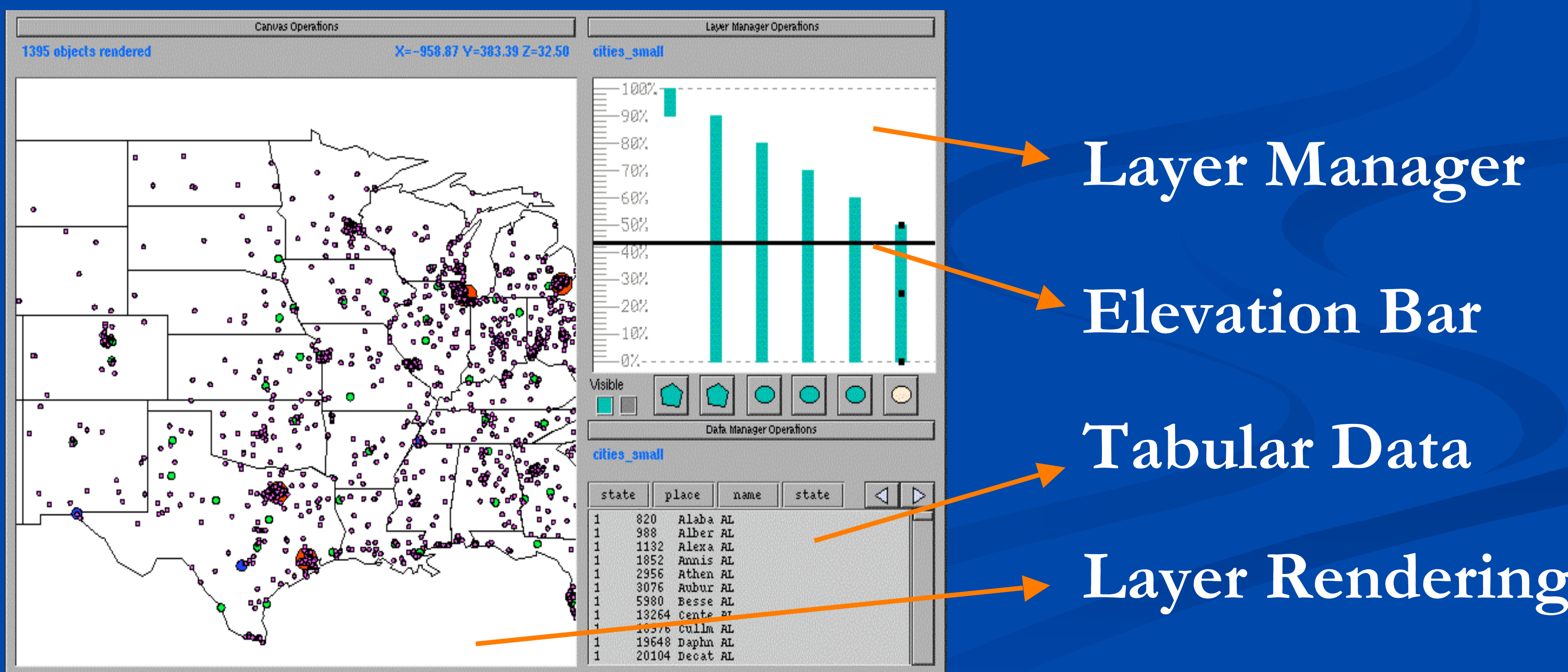
Constant Information Density in Zoomable Interfaces

Allison Woodruff, James Landay, Michael Stonebraker

The DataSplash Environment

- Direct-manipulation interface for constructing pannable/zoomable database visualizations
- Users can specify how much information is displayed at different elevations by a *layer manager*



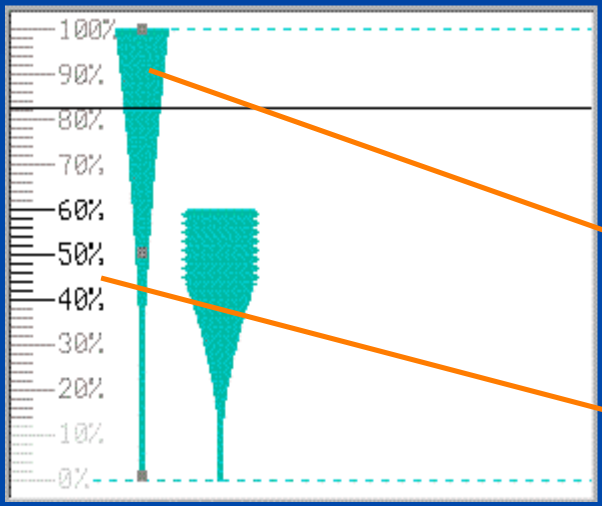
The Problem

- The *Principle of Constant Information Density* – Number of objects per display unit should be constant -> Amount of information should remain constant as users pan and zoom
- DataSplash's users have difficulty constructing *well-formed applications* that conforms to this principle, displaying constant level of detail at all elevations.

The Solution - "Measure, Visualize, Bound"

- Give users visual feedback about information density as they create each layer
- Guide users to maintain constant density

Visual Information Density Adjuster

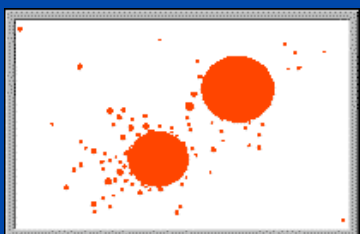


- Measures
  - Density Metrics: number of objects or number of vertices
  - Other density functions can be defined
- Visualizes
  - Width of layer bars encodes density at a given elevation
  - Color of the elevation gauge indicates whether a level is too dense
- Bounds
  - Enforcing density boundaries is left to visualization designers

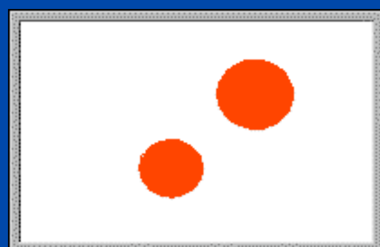
Semi-automatic Adjustment of Layer Density

- *Modification Functions*: modifying a layer's density via
  - Creating views of data table (select/join)
  - Changing the graphical presentation of data

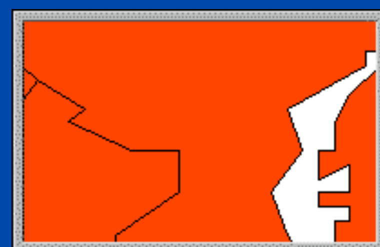
Original Visualization



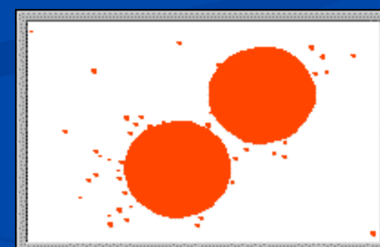
Select



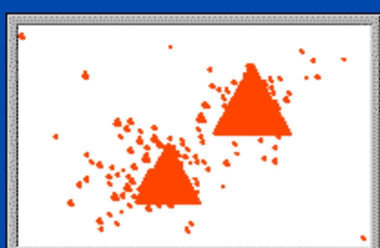
Aggregate



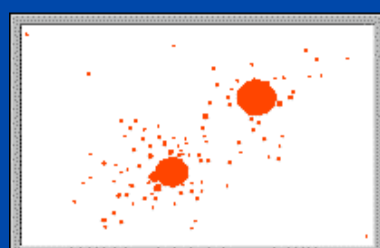
Reclassify



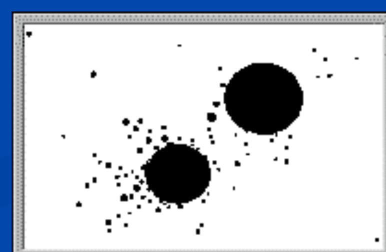
Chg Shape



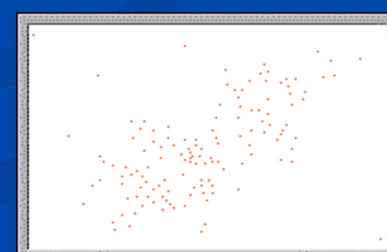
Chg Size



Chg Color



Remove Attribute Assoc.



Critique

Strengths

- Comprehensive description of techniques
- Extensive considerations of problems and possible solutions
- Encoding density with width is intuitive, because the cumulative width of all layers at a zoom level = cumulative density

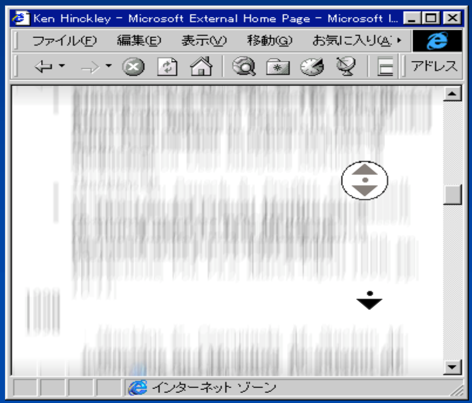
Weaknesses

- A lot of repetition
- Pilot trial added as an after-thought and only mildly relevant to the paper’s topic

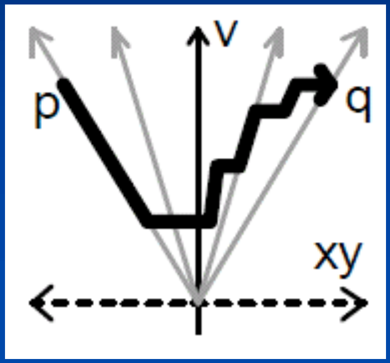
Speed-dependent Automatic Zooming for Browsing Large Documents

Takeo Igarashi & Ken Hinckley

Rate-Based Scrolling – Scroll faster as you move your mouse faster

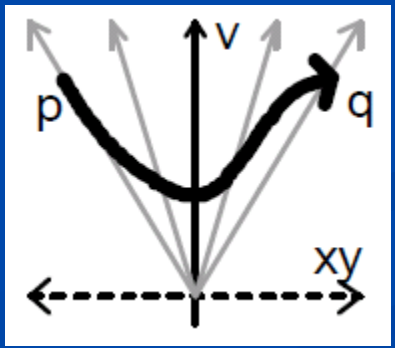


Problem1:
- Motion Blur (Excessive Visual Flow)



Problem 2:
- Multiple pan/zoom needed

SDAZ – Automatic zoom-out to cover more distance instead of scrolling faster



SDAZ Implementation

- Mouse speed simulated by displacement of mouse cursor
- Scroll/Zoom is engaged by holding down a mouse button
- Releasing the mouse button will trigger a zoom-in with the center of the screen as reference
- The scale is first calculated

$$scale = s0(dy\text{-}d0)(d1\text{-}d0)$$

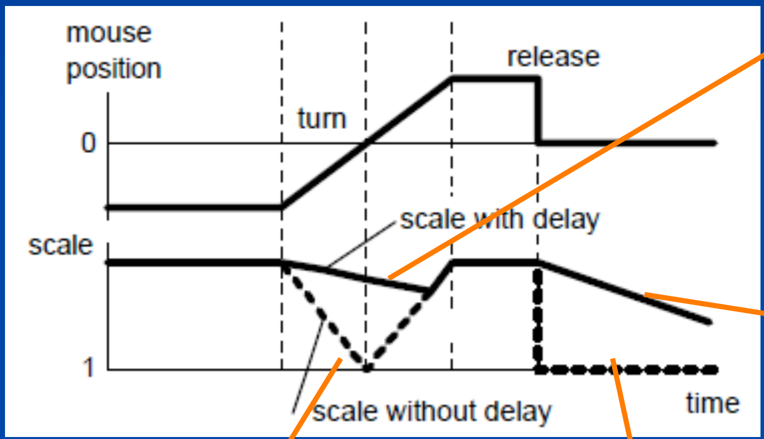
s0, d0, d1 = const: minimum scale, starting mouse movement, maximum mouse movement

- Then scrolling speed is calculated

$$Scrolling\ Speed = v0\ /\ scale$$

v0 = const: initial scrolling speed

Reverse and Cessation Problems



Introduce a zoom-in delay factor to avoid "swellings" when changing direction

Introduce a constant default zoom-in rate for when the user simply stop holding down the mouse button.

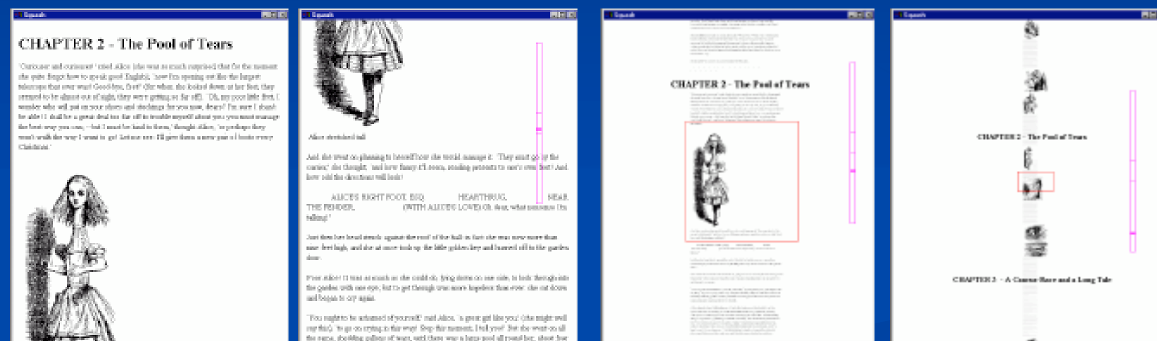
Sudden drops when reverse scrolling direction

Sudden catapulting downward when button is lifted

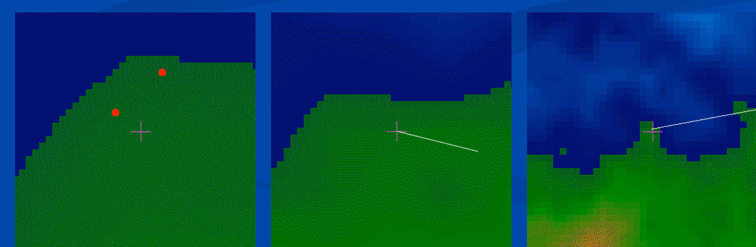
Test Applications

Slow scrolling → Fast Scrolling

Web-browser with semantic zooming



Map viewer



Other Applications

- Image Browser
- Dictionary with semantic zooming (word-skip)
- Sound editor (zooming the waveform)

Usability Studies

- Web-browser: SDAZ vs. Scrollbars
  - Task completion time: roughly equal
  - Subjective preference: SDAZ
  - Video game players performed better
  - Constant flow of text can cause dizziness
  - Isometric input (joysticks) might improve performance, but not tried
- Map Viewer: SDAZ vs. manual zoom-in/out buttons
  - Task completion time: mixed to negative (for SDAZ)
  - Subjective preference: roughly equal
  - Overshoot and course-correction problem
  - Many subject develops coping strategies

Critique

Strengths

- Works well for 1D apps like web or image browser
- Requires no extra screen real estate
- Requires very simple input device
- Good for mobile!

Weaknesses

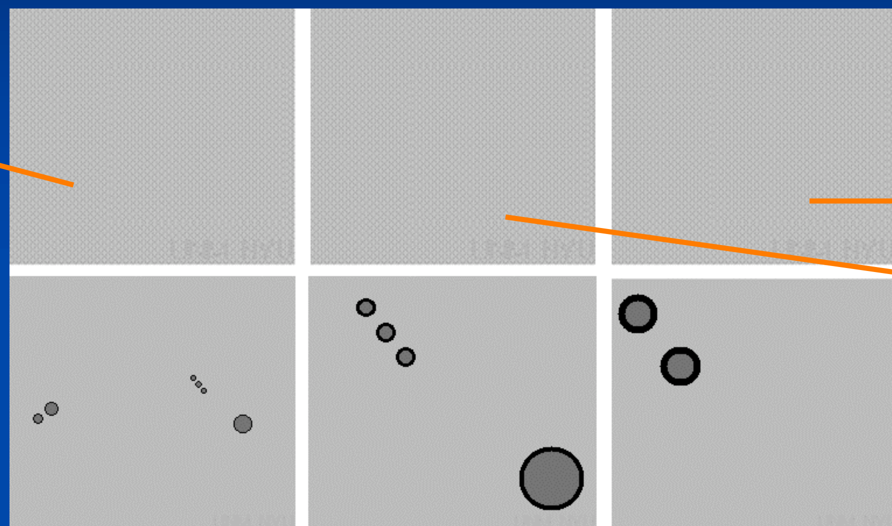
- Demanding high-dexterity, especially for 2D apps
- Unclear whether performance comes from SDAZ or semantic-zooming

Critical Zones in Desert Fog: Aids to Multiscale Navigation

Susanne Jul & George W. Furnas

Desert Fog

Does this view contain anything?



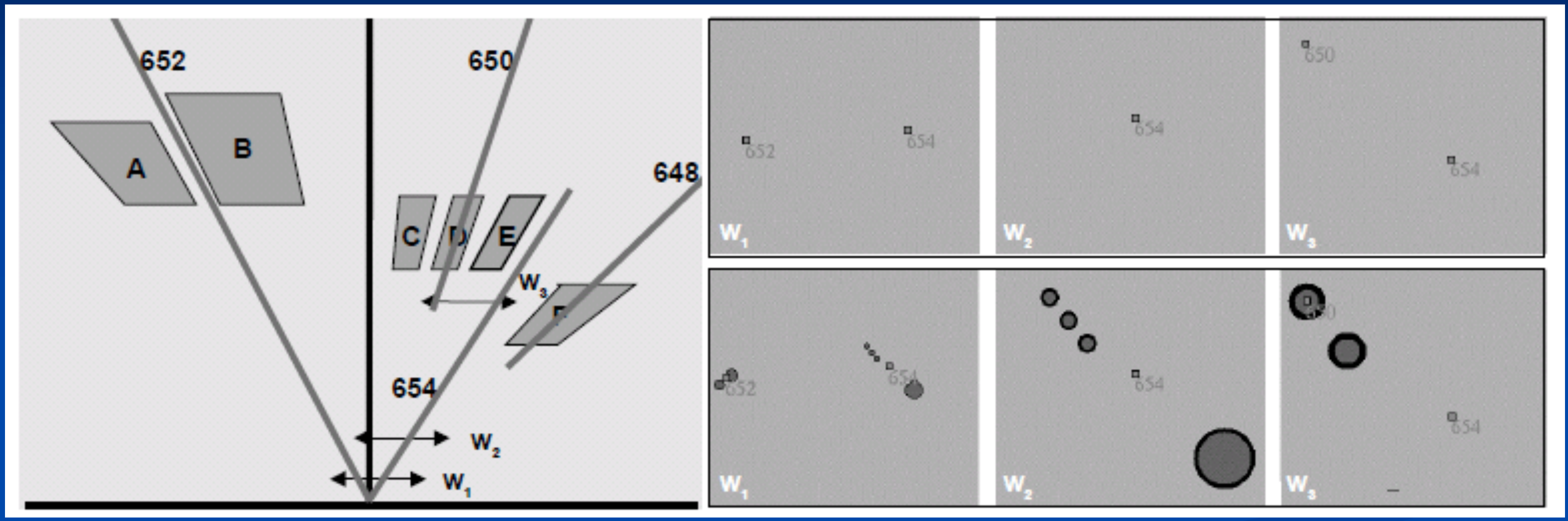
How can this view look like the other one? (minimum object rendering size)

Where do I go from here? (zoom out/in? pan?)

Can be mitigated at the info design/embedding stage

Particularly bad when encountered at navigation time

Fighting Desert Fog – Residues of Objects

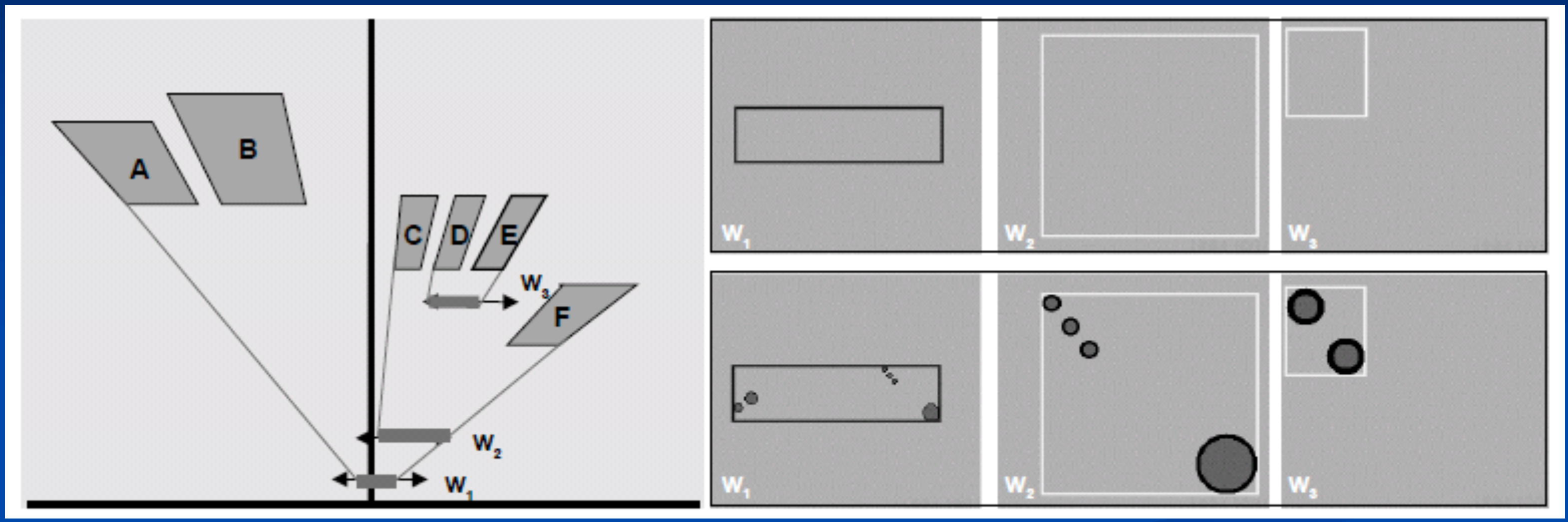


Multiscale Residue of Objects: red squares visible at all scales

Objects are clustered spatially, recursively to reduce the number of residues as you zoom out

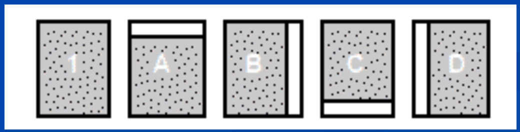
Problems: placement of landmarks, landmarks changing position during zoom-in, landmark can suggests false semantic associations

Fighting Desert Fog – Residues of Views (Ztracker)



Critical Zones: residues of interesting views, zooming in reveals more interesting views (and critical zones representation of them)

Calculating 1 crit-zone: Bounding box of all objs in current view

Sub-divide and recurse: 

Critical Zone rectangle changes color when covers all world objects

View Navigation Analysis

- *View-navigation theory* provides a characterization of the properties that make an information structure navigable, adapted for spatial data
- *Viewing-graph* a d-graph, nodes = views, links = traversible paths between views
- A *traversible world*
  - Short path must exists between all nodes
  - All nodes must have small number of outlinks
  - "Small" and "Short" is relative to the complexity of the viewing graph

Navigation Requirements

- All views must have good residue on all nodes
- All views must have small outlink info
- *Good residue*: correctly points out the shortest link to a node

=> In a zoomable world, merely providing residues solve the desert fog problem, because the lack residue means zoom-out

- *outlink-info*: the representation of the residue. E.g. a text label
- *Small*: Relative to number of overall views? Or navigator's info processing capabilities?

=> Grouping such as landmarking and ZTracker

Critique

Strengths

- Novel concept: providing residue of views, not objects
- Thorough treatment of the subject from an implementation pov and a theoretical pov

Weaknesses

- Ztracker algorithm might be expensive. Some heuristics?
- Repeating diagrams with small differences makes navigating the paper confusing
- More examples of desert fog please?

Q&A

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