VIS 2019

You can't always sketch what you want: Understanding Sensemaking in Visual Query Systems

Doris Jung-Lin Lee, John Lee, Tarique Siddiqui,
Jaewoo Kim, Karrie Karahalios, Aditya Parameswaran

planet
star
light curve
brightness
time

Long-term (1880-2017) global warming compared to short-term temperature trends
average global temperature (°F)
59
58
57
56
15-YEAR TRENDS
°F per decade
1942-56
1956-70
1970-84
1984-98
1998-2012
-0.41
+0.02
+0.40
+0.40
+0.14
1880
1900
1920
1940
1960
1980
2000
2016

Dow Jones Industrial Average (1927 to 1932)
450
400
350
300
250
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100
50
0
10/29: Day of the
Stock Market Crash
1/3/1927
7/3/1927
1/3/1928
7/3/1928
1/3/1929
7/3/1929
1/3/1930
7/3/1930
1/3/1931
7/3/1931
1/3/1932
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MY
OVERALL
HEALTH
TIME
THE DAY I REALIZED
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xkcd.com

Astronomy Use Case

Visual Query Systems (VQSs)

TimeSearcher [Hochheiser & Shneiderman 2004]
QuerySketch [Wattenberg 2001]
QueryLines [Ryall et al. 2005]
SoftSelect [Holz & Feiner 2009]
Google Correlate [Mohebbi 2011]

TimeSketch [Eichmann & Zgraggen 2015]
SketchQuery [Correll & Gleicher 2016]
Zenvisage [Siddiqui et al 2017]
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Outline

1) Methodology

Motivation: Challenge of VQS adoption
Our Approach: User-Centered Design Process

2) Study Findings

Taxonomy
Usage observation and analysis
Design guidelines

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Problem

Domain Problem Characterization

Data Operation/Abstraction Design

Encoding Interaction Design

Algorithmic Design

User

Munzner, *A Nested Model for Visualization Design and Validation* (TVCG 2009)

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Phase I
Need-Finding

Phase II
Prototyping

Phase III
Evaluation

Our Approach

Interviews & Contextual Inquiry

Participatory Design

Grounded Evaluation

Outcome

Understanding Users, Datasets, Challenges

Zenvisage++

VQS Sensemaking Model

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VQS Sensemaking Model

Phase I: Need-Finding → **Phase II: Prototyping** → **Phase III: Evaluation**

class	solvent_id	ip	ea	vis	bp	fp
class-43225001	43225001_43250000_22416	-9.15	-0.63	5.53	643.61	428.87
class-43225001	43225001_43250000_22417	-9.12	-0.71	6.37	639.49	428.94
class-43225001	43225001_43250000_22418	-9.53	0.77	1.61	516.14	349.46
class-43225001	43225001_43250000_22437	-8.83	-0.67	4.94	607.13	413.19
class-43225001	43225001_43250000_22444	-9.15	-0.9	6.21	615.99	412.69
class-43225001	43225001_43250000_22457	-8.9	-0.65	4.59	624.72	416.35
class-43225001	43225001_43250000_22458	-8.64	-0.53	5.61	651.03	432.89
class-43225001	43225001_43250000_2246	-8.91	0.34	3.17	563.3	381.54
class-43225001	43225001_43250000_22510	-8.81	-0.63	4.92	629.1	423.83
class-43225001	43225001_43250000_22511	-8.35	-0.34	6.62	689.63	459
class-43225001	43225001_43250000_2284	-9.11	0.17	8.55	658.24	439.03
class-43225001	43225001_43250000_22962	-9.85	-1.04	4.49	599.27	404.17
class-43225001	43225001_43250000_22963	-9.84	-0.93	5.15	568.47	387.9
class-43225001	43225001_43250000_22964	-9.81	-1.13	3.72	544.42	372.24
class-43225001	43225001_43250000_22965	-10.14	1.01	2.24	556.46	380.02
class-43225001	43225001_43250000_22966	-10.11	-0.81	6.28	618.57	419.3
class-43225001	43225001_43250000_22979	-10.08	-0.87	6.31	613.53	416.53
class-43225001	43225001_43250000_22982	-10.07	-0.8	5.2	606.96	411.3
class-43225001	43225001_43250000_2514	-9.05	0.18	10.99	675.5	451.11
class-43225001	43225001_43250000_2550	-9	0.23	6.06	666.47	442.59
class-43225001	43225001_43250000_2617	-9.05	0.23	5.71	660.17	438.99
class-43225001	43225001_43250000_2656	-9.16	0.2	5.48	664.76	440.64
class-43225001	43225001_43250000_2713	-9.22	-1.11	15.5	765.17	504.34
class-43225001	43225001_43250000_2723	-9.1	-0.6	7.9	635.63	431.73
class-43225001	43225001_43250000_2725	-9.13	-0.66	13.81	680.61	459.02
class-43225001	43225001_43250000_2726	-8.9	-0.67	7.62	634.24	432.58

Astronomy

Genetics

Material Science

Phase I: Need-Finding
Phase II: Prototyping
Phase III: Evaluation
Start of material science collaboration
scatterplot view
-9
-10
-11
-12
-2.0
-1.5
-1.0
Start of astronomy collaboration
DARK ENERGY SURVEY
Start of genetics collaboration
Minimum Similarity cutoff
consider x-range option
dynamic class creation
constraints filtering
query by pattern loading
Start of ZV++ Development
3 month
6 month
9 month
1 year
1 year & 3 month
display similarity score
query by input equations
$y = x^2$
custom KMeans cluster size
disable original sketch query
dynamic class aggregation table
Data Export
error bars, flip y axis
auto_mag by mjd57000
22.0
22.2
22.4
-450
-400
-350
objid_cycle_band: 368162439:1 [R] (0.288)
Material Science
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Phase I: Need-Finding | Phase II: Prototyping | Phase III: Evaluation

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Phase I: Need-Finding → Phase II: Prototyping → Phase III: Evaluation

9 scientists from 3 domains, average 6+ years of experience

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Taxonomy of Sensemaking Process and Key Capabilities in VQSs

Top-down

Pattern Specification

What is the shape of the pattern query?

Match Specification

How should the pattern query be matched with other visualizations?

Bottom-up

Result Querying

What other vizzes "look similar" to the selected pattern?

Recommendation

What are the key patterns in this dataset?

Context Creation

View Specification

What data to visualize and how should it be displayed?

Slice-and-Dice

How does navigating to another data subset change the query result?

Top-down

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How should the pattern query be matched with other visualizations?

Similarity

- Euclidean Distance
- Segmentation
- DTW
- MVIP

Aggregate

- Sum
- Average
- None

Cluster Size: 3

Number of Results: 50

Similarity Cutoff: 0

Data Smoothing: None

Smoothing Const

Filter Constraint: e.g. mag>20

Results

Representative patterns

Top-down

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Context Creation

View Specification

X : Time
Y : Expression
Z : Gene

What data to visualize and how should it be displayed?

Slice-and-Dice

is_star = True

is_star = False

How does navigating to another data subset change the query result?

Context Creation

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What data to visualize and how should it be displayed?

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Bottom-up Data-Driven Inquiries via Recommendations

Bottom-up Data-Driven Inquiries via Recommendations

Narrow Search Space via Context Creation

Narrow Search Space via Context Creation

Finding: You can't always sketch what you want!

All sensemaking processes are **essential**.

How do participants transition between different sensemaking processes?

Astronomy **Material Science** **Genetics**

How do participants transition between different sensemaking processes?

Each sensemaking process fulfills a ***central goal*** in participants' analysis, while other sensemaking processes are used as *support*.

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Top-down 27%

Bottom up 17%

Context Creation 56%

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Finding: You can't always sketch what you want!

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Need to "*close the loop*" between all sensemaking processes

Methodology: Beyond the lab

User-centered design crucial for tool adoption

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Finding: Closing the loop

Towards integrative VQS

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zenvisage.github.io

Contact:

@dorisjlee

dorislee@berkeley.edu