Immersive Analytics

CMPM 290A, F2018

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tl;dr

- Investigates the discipline of what is recently started to be called **Immersive Analytics**

- Intersection of *Data Visualization* and *Virtual Reality*
    - where Data Visualization refers to InfoVis, SciVis, Visual Analytics
    - and where Virtual Reality can refer to VR/AR/MR/XR

- Explores how new immersive technologies can be used to augment the process of analyzing data

About Me

- Assistant professor in UCSC's Computational Media Department

- Teach courses on data visualization, computer graphics, and computational media research

Research Interests

Main areas:
- Visualization & Visual Analytics
- Computer Graphics
- VR / AR
- New Media Arts

Also:
- Applied ML,
- Digital humanities,
- HCI, Network science,
- Data sonification, etc.

Research Communities

- ACM SIGGRAPH 2018 Arts Papers Chair
- IEEE VIS Program committee member for 2018-2021
- IEEE VIS Arts Program, General Chair, 2013-2017
- ACM/EG Computational Aesthetics Papers Chair 2016; Arts Chair 2015

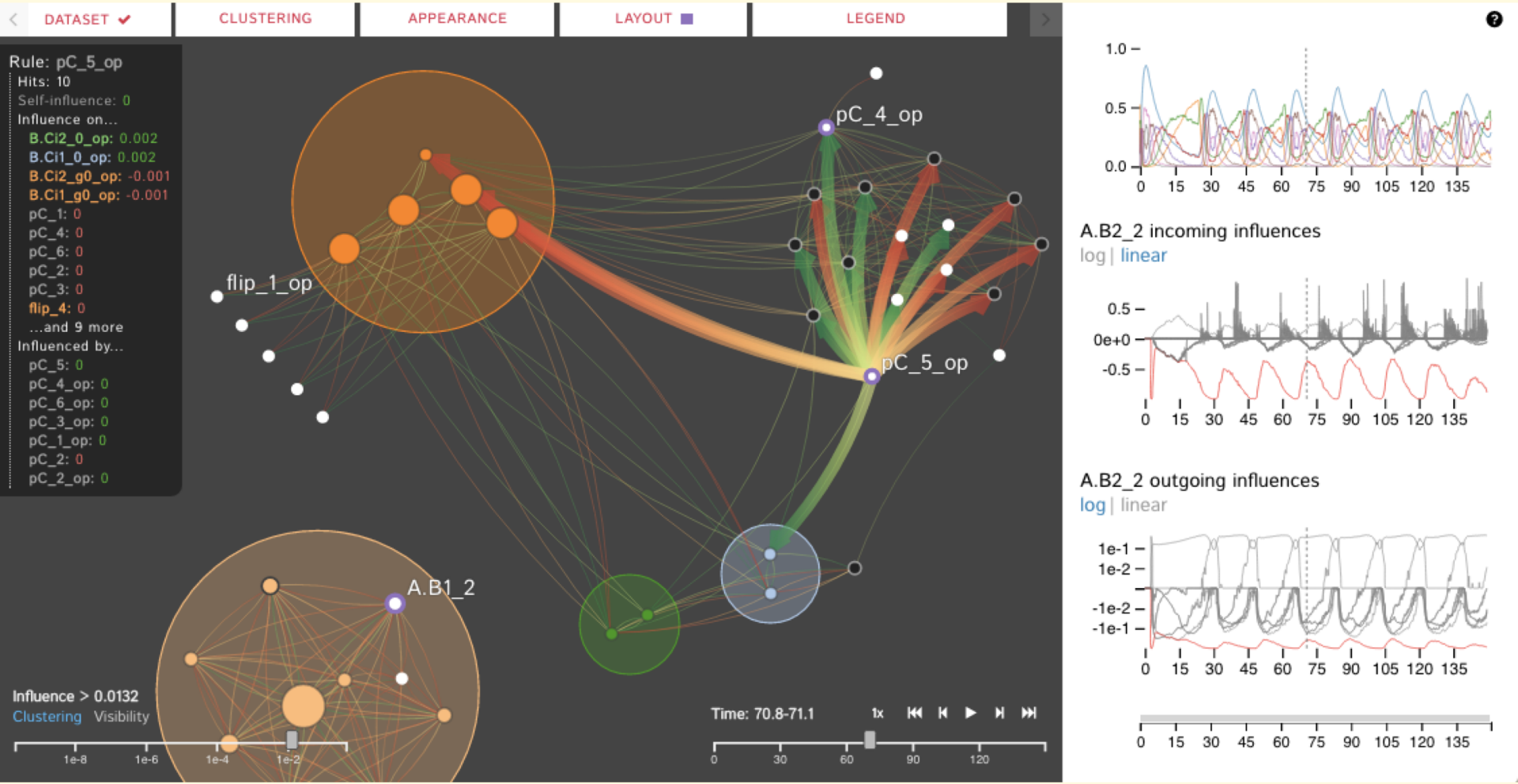
- Also contribute to ISEA, VR, NIME, ICMC, CHI, UIST, and others

Recent Research Projects

- Focus on novel ways to represent and analyze dynamic, complex networks

- Collaborate with scientists to design visualization tools to make it easier to reason about their data

- Enormous and essential opportunity for creative, computational researchers and artists to investigate issues related to “big data”


DATASET
CLUSTERING
APPEARANCE
LAYOUT
LEGEND
Rule: pC_5_op
Hits: 10
Self-influence: 0
Influence on...
B.Ci2_0_op: 0.002
B.Ci1_0_op: 0.002
B.Ci2_g0_op: -0.001
B.Ci1_g0_op: -0.001
pC_1: 0
pC_4: 0
pC_6: 0
pC_2: 0
pC_3: 0
flip_4: 0
...and 9 more
Influenced by...
pC_5: 0
pC_4_op: 0
pC_6_op: 0
pC_3_op: 0
pC_1_op: 0
pC_2: 0
pC_2_op: 0
flip_1_op
pC_4_op
pC_5_op
A.B1_2
Influence > 0.0132
Clustering Visibility
1e-8 1e-6 1e-4 1e-2
Time: 70.8-71.1
1x
0 30 60 90 120
1.0
0.5
0.0
0 15 30 45 60 75 90 105 120 135
A.B2_2 incoming influences
log | linear
0.5
0e+0
-0.5
0 15 30 45 60 75 90 105 120 135
A.B2_2 outgoing influences
log | linear
1e-1
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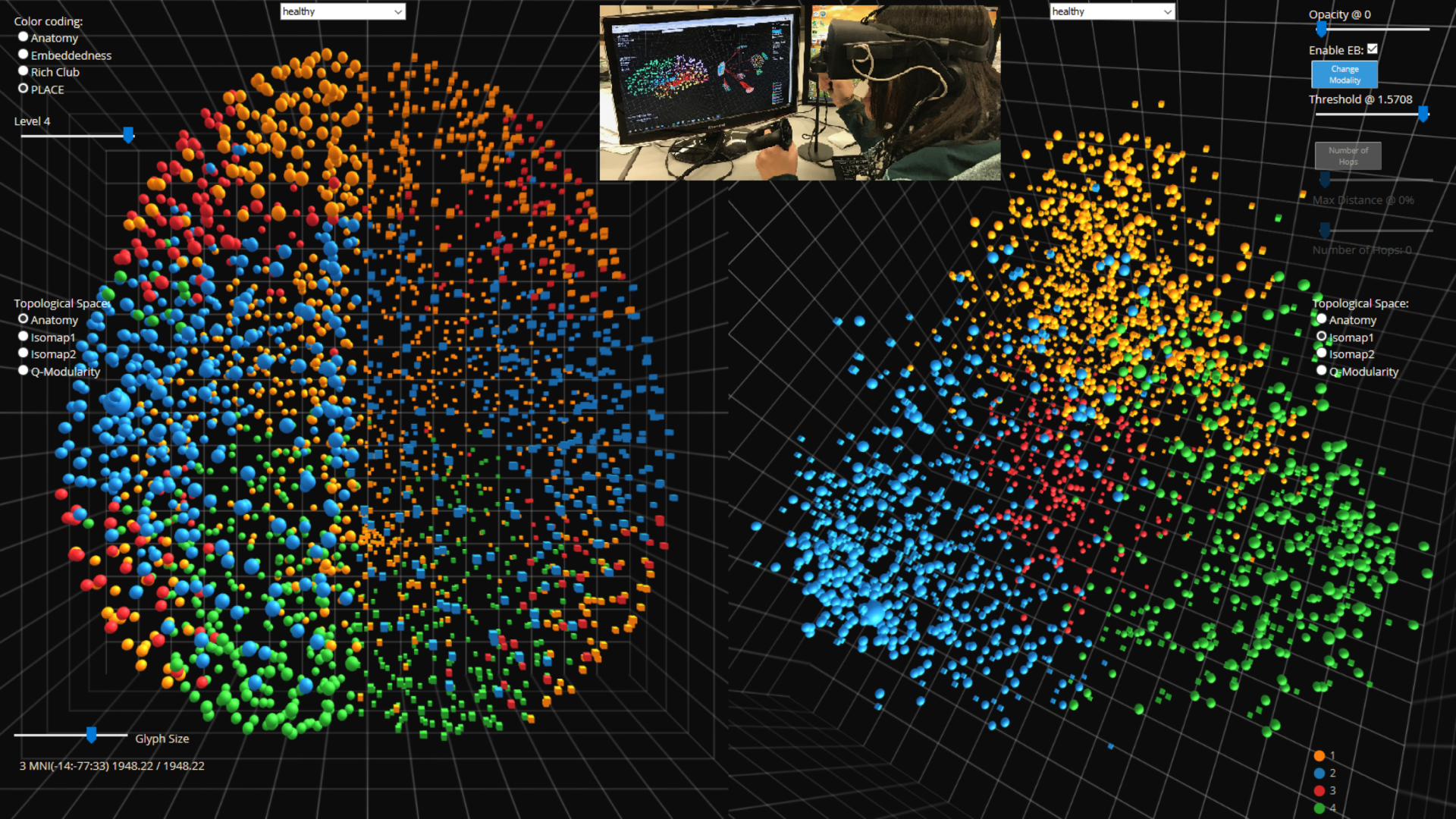
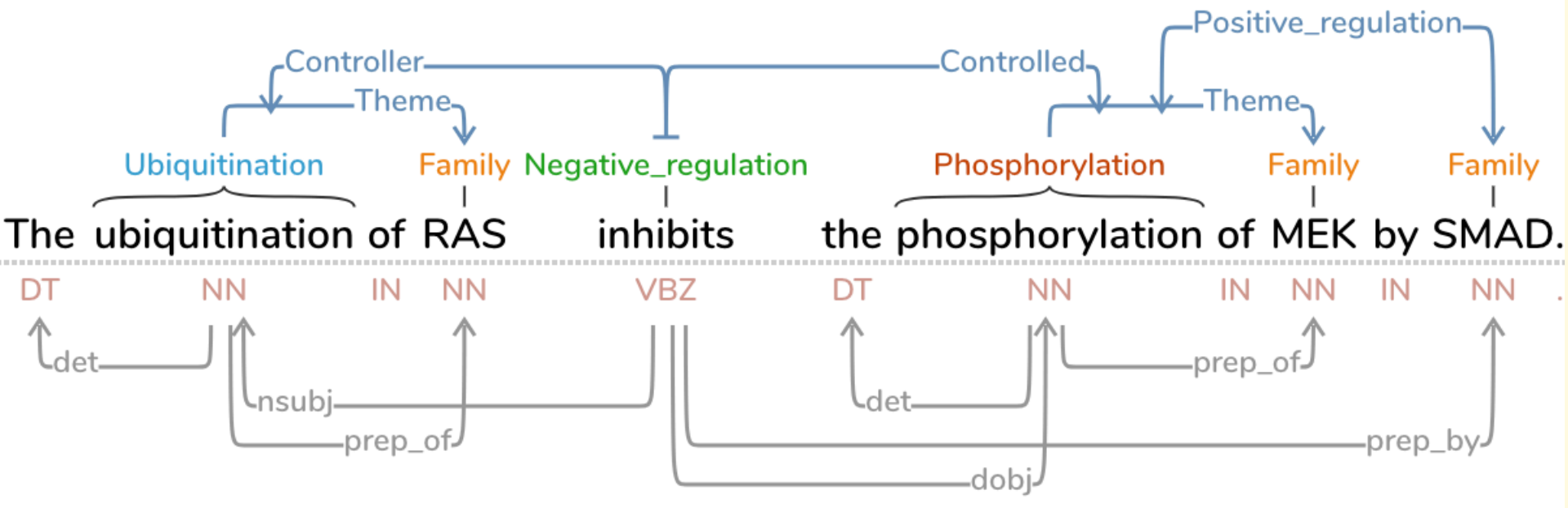

healthy
Color coding:
Anatomy
Embeddedness
Rich Club
PLACE
Level 4
Topological Space:
Anatomy
Isomap1
Isomap2
Q-Modularity
Glyph Size
3 MNI(-14:-77:33) 1948.22 / 1948.22
healthy
Opacity @ 0
Enable EB:
Change Modality
Threshold @ 1.5708
Number of Hops
Max Distance @ 0%
Number of Hops: 0
Topological Space:
Anatomy
Isomap1
Isomap2
Q-Modularity
1
2
3
4


Positive_regulation
Controller
Controlled
Theme
Theme
Ubiquitination
Family
Negative_regulation
Phosphorylation
Family
Family
The ubiquitination of RAS inhibits the phosphorylation of MEK by SMAD.
DT
NN
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VBZ
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NN
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NN
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det
nsubj
prep_of
det
prep_of
prep_by
dobj

Object 3
Edit object

File	None
Volume	N/A
Position X	-522.21
Position Y	67.38
Altitude	117.89
# of cones	2

Cone 1 of 2

File	chirps.wav
Volume	2.00 dB
Spread	0.50
Longitude	152°
Latitude	-19°

Remove Cone

Add cone

Trajectory

Speed	5 m/s

Delete

Creative Research

- New forms of representation and interaction

- AR / VR, Deep Learning

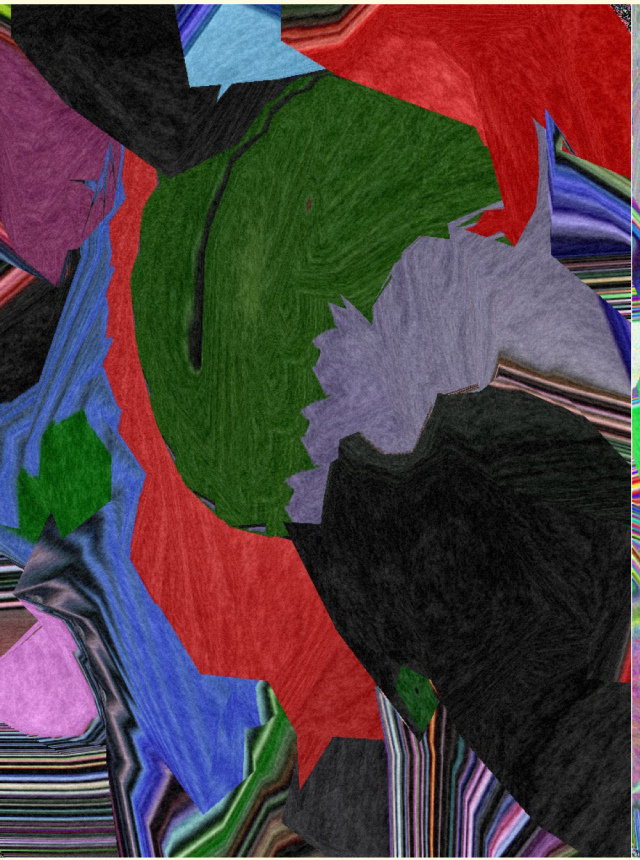
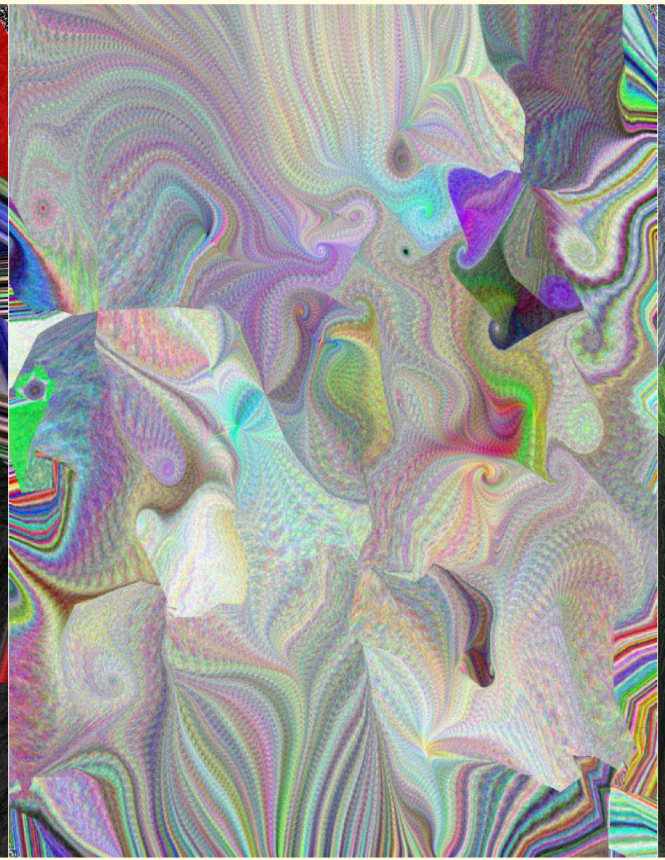
- Design thinking / Graphic design / Interactive design

Computational Art

- Using computational media to create interactive artworks

- Visualizing archives, cultural datasets

- Algorithmic, generative graphics



Mágico
Literario
Olvidado
Periodístico
Mítico

That menaced not to slay us,
Equally perish from our Practise —
Vouches, with hyperbolic archness —
Believing what we don't believe

Whose Summer set in Summer, till
By an Adieu —
Just how long — cheated eyes will turn
I wonder if They bore it long —
Are even as Thyself —
By Six, the Flood had done —
Late — when I take my place in summer
Event ineffable —

Which she was taught
Where Air is Where —
well to see —

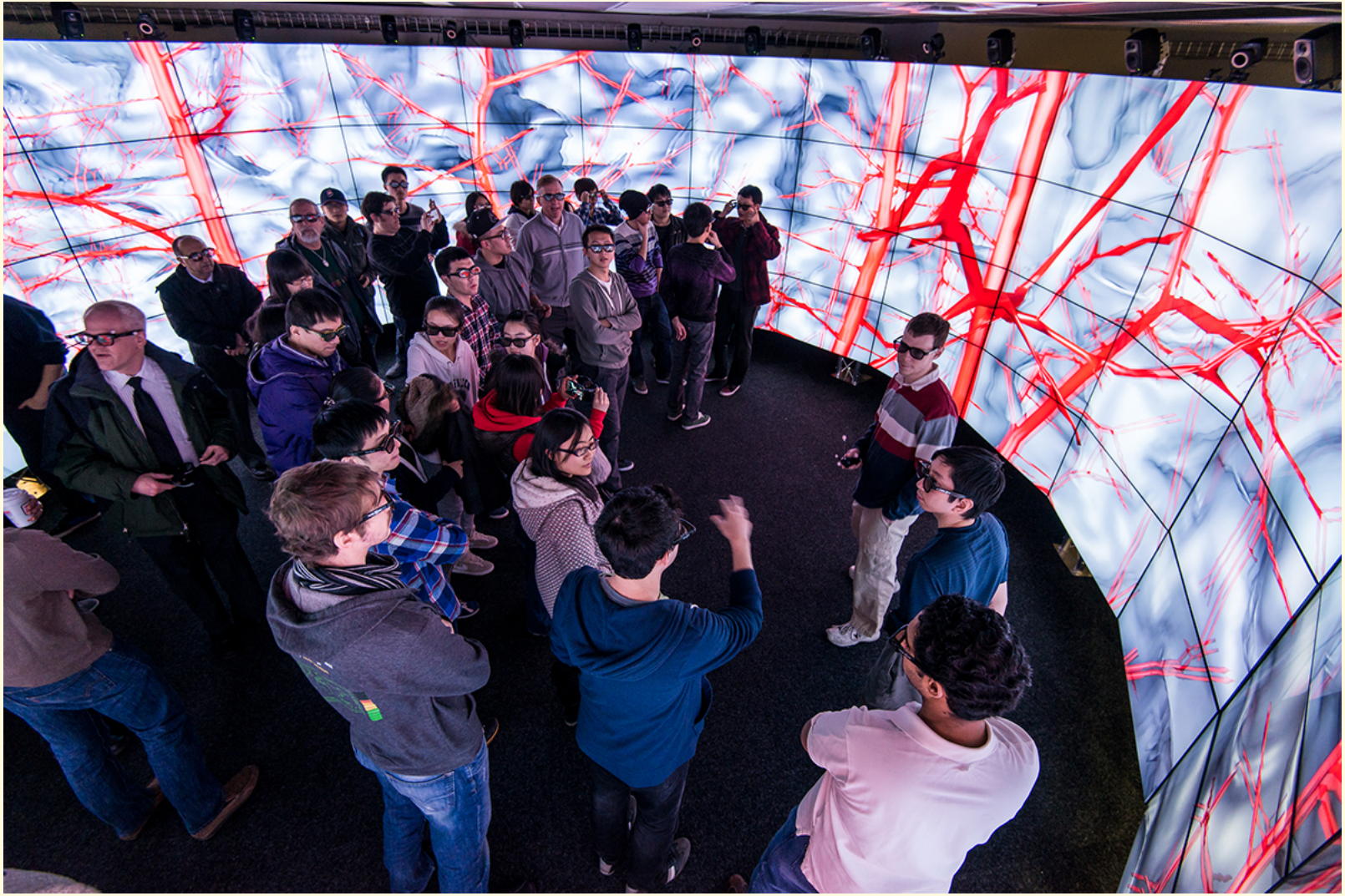

BRITANNICA

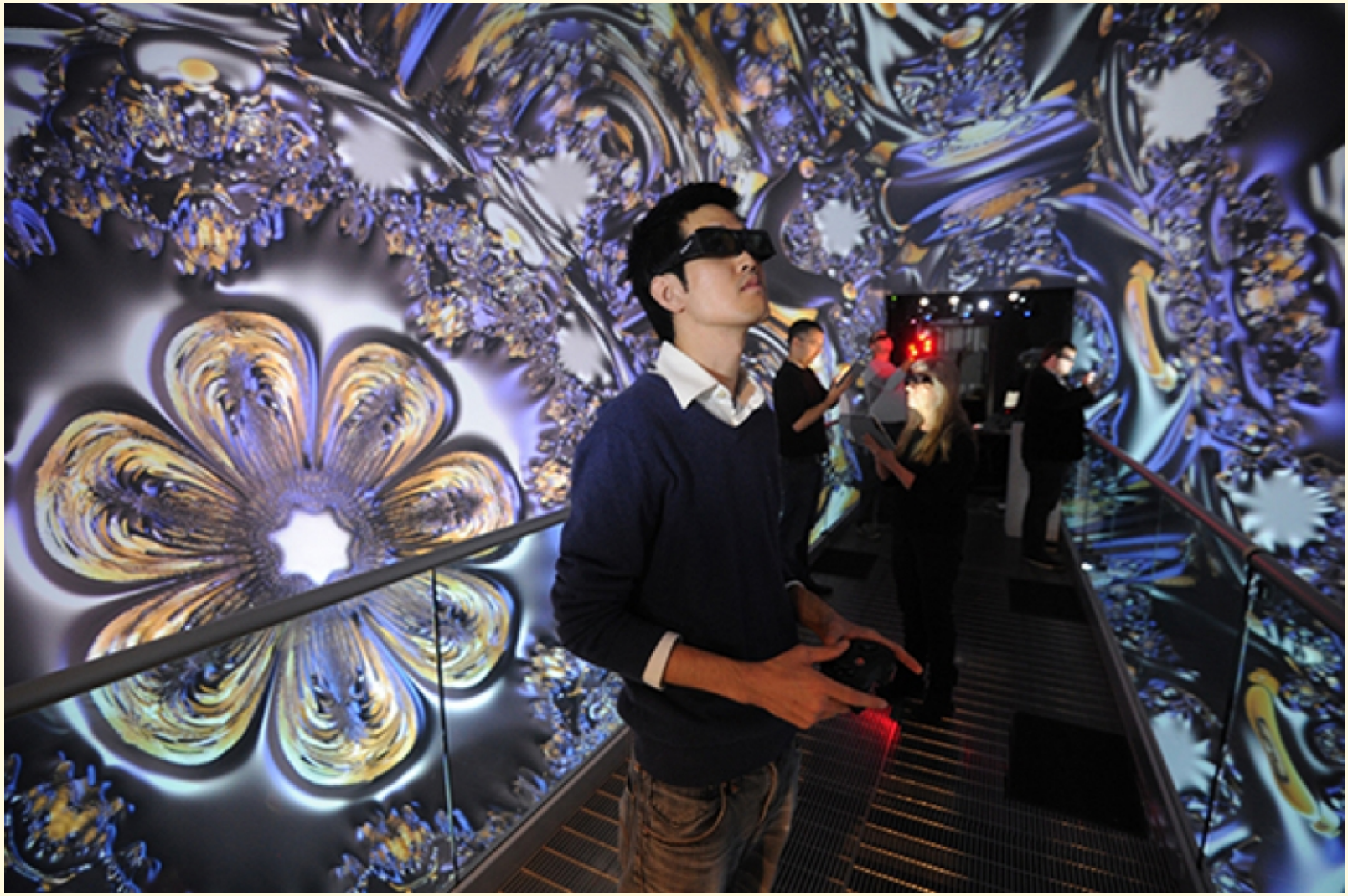
Virtual Reality

- EVL

- AlloSphere


Set End
Set Start
Reset Bounds





Who are you?

- What department are you in? How far along are you?
- What are you experiences with VR / Data Vis?
- What's the most interesting dataset you have worked with?
- Are you familiar with Unity? D3.js? Vuforia?
- What programming language do you know and/or like to use?

What is this course about?

- Investigates the discipline of what is recently started to be called **Immersive Analytics**

- Intersection of *Data Visualization* and *Virtual Reality*
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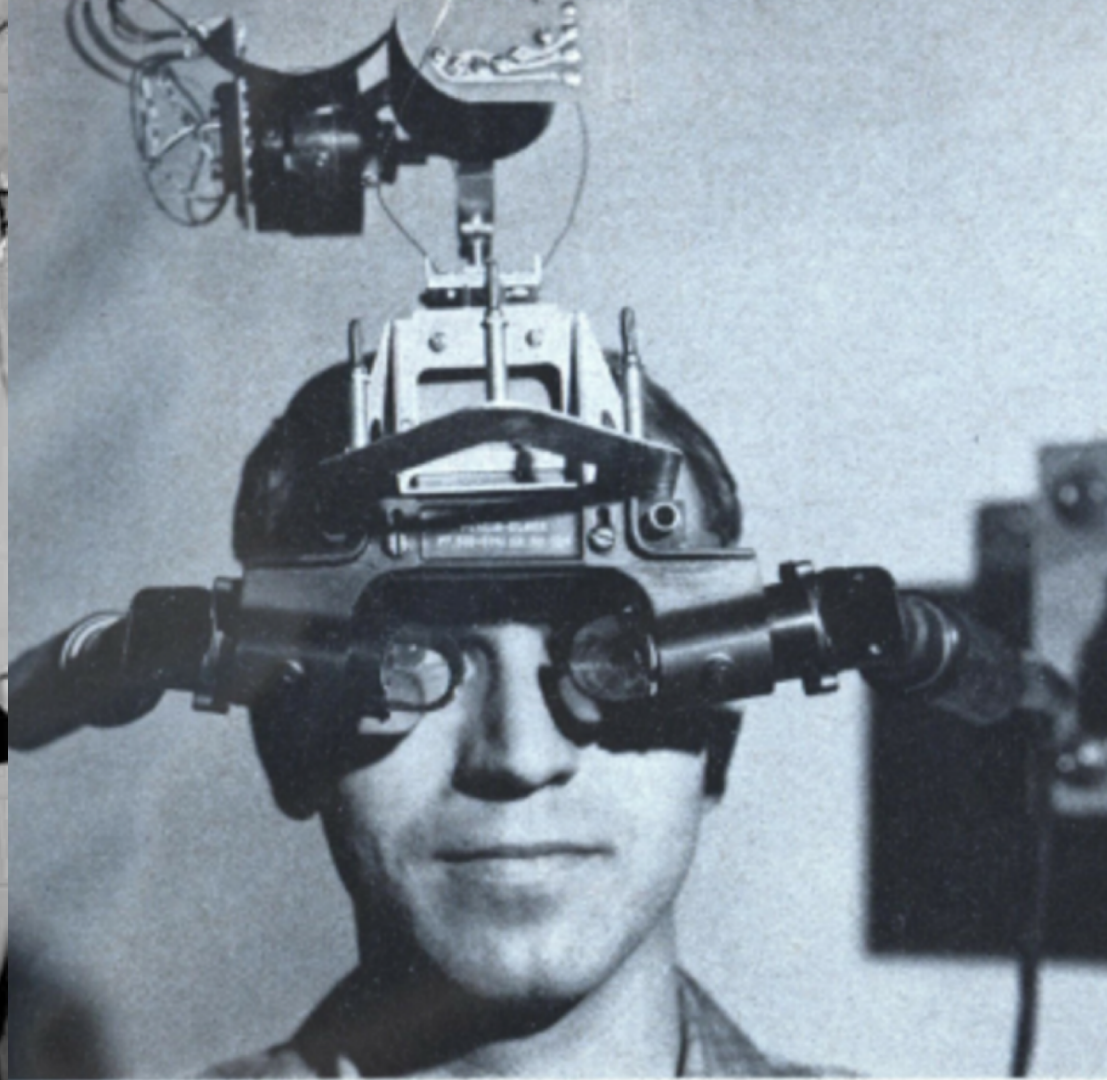

Steve Mann's "wearable computer" and "reality mediator" inventions of the 1970s have evolved into what looks like ordinary eyeglasses.

(a)
1980

(b)
Mid 1980s

(c)
Early 1990s

(d)
Mid 1990s

(e)
Late 1990s

“Immersive”

What does **immersion** mean?

- Used to describe the sense of “reality” or “hyper-reality” that VR/AR/MR systems can provide
- Many examples in sci-fi literature and tv, from Star Trek’s *Holodeck* to Gibson’s *Neuromancer* to Spielberg’s *Minority Report* and *Ready Player One*
- Not just in terms of how it looks, but how it responds (interactive)
- Not just visual spaces, what about touch (haptics), sound (sonification)
- Not just in terms of simulating our senses, but stimulating our minds…

Relevant dictionary definitions?

(a) submerged in liquid

(b) deep mental involvement

“Immersive”

Immersion = absorption, attention, concentration, engrossment, enthrallment, …

When do you feel the most immersed?

… Sports, reading a book, having a good conversation, being close with someone, solving a problem, playing music, being absorbed in a game?

What did this immersion allow you to do?

… To focus, be creative, be inspired, collaborate, think clearer, think and act faster, be more decisive, innovate, be more engaged, use more of your senses, feel connected, get in a state of flow?

Is immersion always good?

… Social media addiction?

“Immersive”

What is the relationship between sensory fidelity and the ability to concentrate or to feel absorbed or feel present?

- Aren’t the most engaging activities actually ones that require us to filter things out, to ignore most reality, to accentuate only certain relevant aspects of reality, to focus

- If you’re focused on one point, does it imply that you are *not* focused on something else – Or can we design an experience where everything is simultaneously in focus?

“Analytics”

What does **analytics** mean?

- Used to describe a collection of techniques that extract meaning and provide insight into data

- Can include a range of activity related to a **data analysis** pipeline: collecting, cleaning, sorting, filtering, representing, editing, processing, classifying, comparing, speculating, simulating, predicting, pattern matching, interpreting, communicating …

“Analytics”

Research in the field of **Information Visualization** explores how particular representations and interactions facilitate the discovery of meaningful patterns in complex data

- Have a clearly identified problem, with clearly delineated tasks
- Figure out the relevant data that needs to be represented to support those tasks
- Experiment with the best visual encodings and visual design to accurately and usefully represent that data

If you understood the data, then (maybe) you wouldn’t need to visualize it!

- except for communication / public outreach / pedagogical purposes…

“Analytics”

Difference between information visualization and infographics:

- infographics communicate a clear interpretation of data, and, ideally provide a means by which you can verify that interpretation

- information visualization tools make it possible for the user to find meaningful patterns in data that lead to new interpretations, new hypotheses

“Analytics”

Big Data crisis…

- So much data! Overwhelms our ability to make sense of it
- New types of data:

Temporal, heterogeneous, ephemeral, probabilistic, interpretive, uncertain, inferred, simulated… At quantum, astronomical scales

Every discipline at this university is facing issues and has opportunities related data representation– Dealing with data is in some ways the defining issue of the contemporary “information age” we live in.

How can the judicious use of new interactive display technologies help us to more effectively reason about data?

CG vs VIS approaches to representation

Broadly speaking, Computer Graphics focuses on representing the world with as much fidelity as possible, or faking it so that it appears that way.

- ex. Kajiya's "The Rendering Equation"

Broadly speaking, Visualization focuses on representing only the most relevant aspects of the world, usually abstracted in some ways so that it's easier to reason about the underlying structure or processes of some aspect of the world

- ex. Tufte's data to ink ratio

I.e., *as much* representation as possible vs. *as little* representation as possible

What is this course about?

- Explore when these different approaches to representation are useful for understanding data

- Utilize a “vis” approach to virtual reality (i.e., not a “holodeck” approach)

- Imagine and prototype new opportunities at the intersection of Information Visualization and Virtual Reality

Course Expectations

- Come to class!
- Do a series of smaller projects throughout the quarter
- Do a larger final project that explores the intersection of data and virtual reality, where the data is related to an active creative and/or scientific exploration.

(I will provide a list of collaborators for you to choose from, or there's a chance that you can convince me to work with data that you've found yourself.)

- Larger project involves:
  - creating working immersive analytics software tool
  - a formal write-up in the style of a conference paper

- Small assignments are to be done individually, large project to be done as part of a small team

Course Details

- Join the CMPM 290A Slack channel at: https://ucsc-immersive.slack.com

- Office Hours are held on Wednesday from 11:30am to 12:30pm in E2-259

- Received an equipment grant from Microsoft, I have an Acer “Microsoft MR” headset for each of you

Homework, pt 1

Reading

- Read Novak's *Liquid Architecture*
- Read Chandler et al.'s *Immersive Analytics*

Coding

- Investigate AR and VR capabilities in Unity

Homework, pt 2

Writing

- **Observe and describe a variety of experiences where you feel particularly immersed–** in any or all of the senses we discussed today. Were you reading an article, having a deep thought on your own, hearing or playing music, playing a game, solving a problem? Were you passively observing or actively involved? What aspects made these activities engaging? compelling? captivating? What elements were involved? What techniques were in operation?

- **Observe and describe times when you are engaged in some forms of analyzing.** Were you working on homework? Are you making a decision about what bus to catch? What show to watch? Are you making judgements about your friends or family? How do you decide what to order at a restaurant? How do you approach solving a difficult technical problem? Do you have certain analysis habits? Do you notice other people approaching problems in different ways? How do you know that your approach is the effective? Do you use multiple approaches?