

towards a visual  
understanding of patient data

gabriel aldana  
03-19-2019

“i make pretty things”



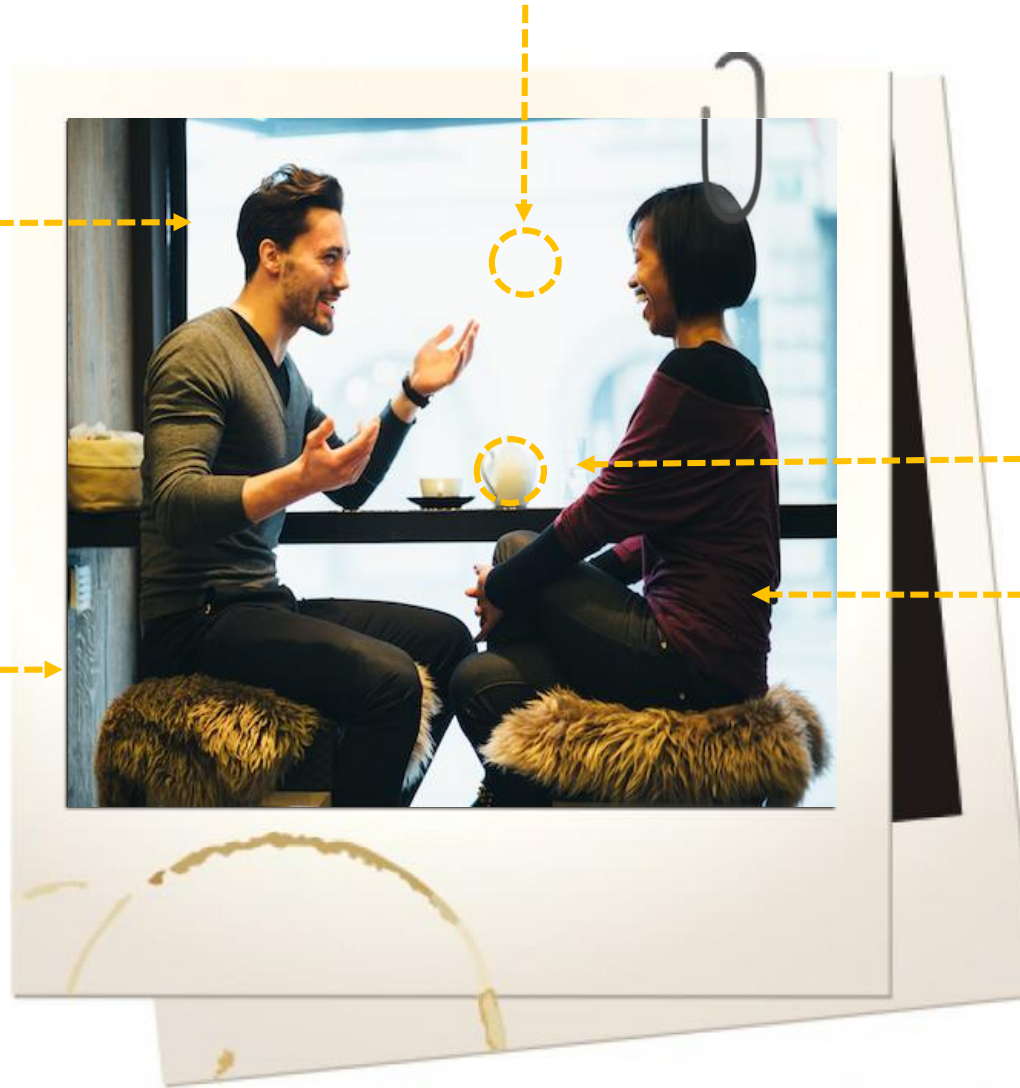
rainy day in spring

gurl look  
at my hair!

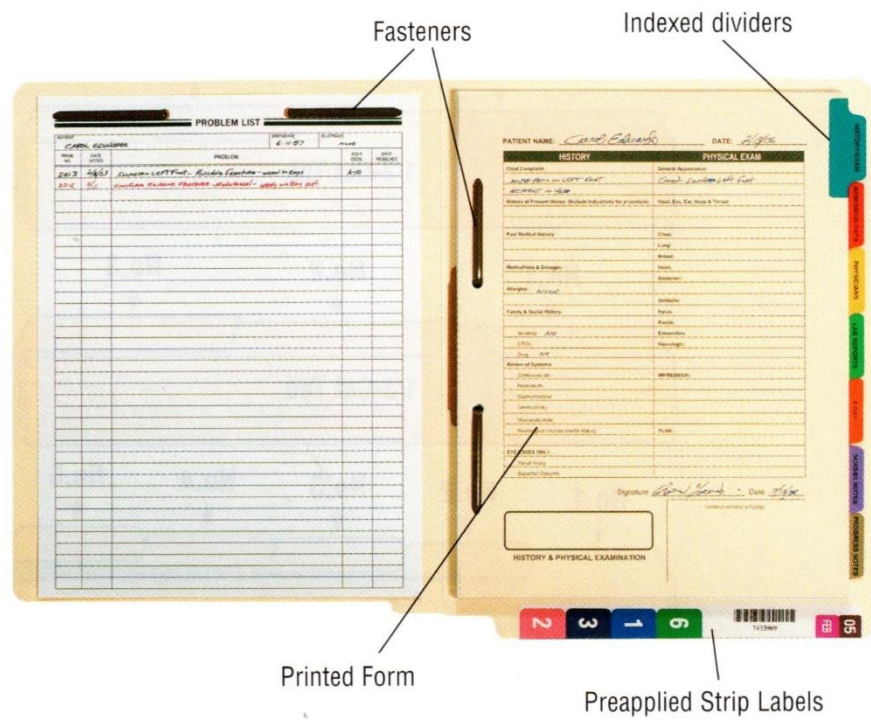
it was my  
favorite coffee  
shop near  
campus

she introduced  
me to soy lattes

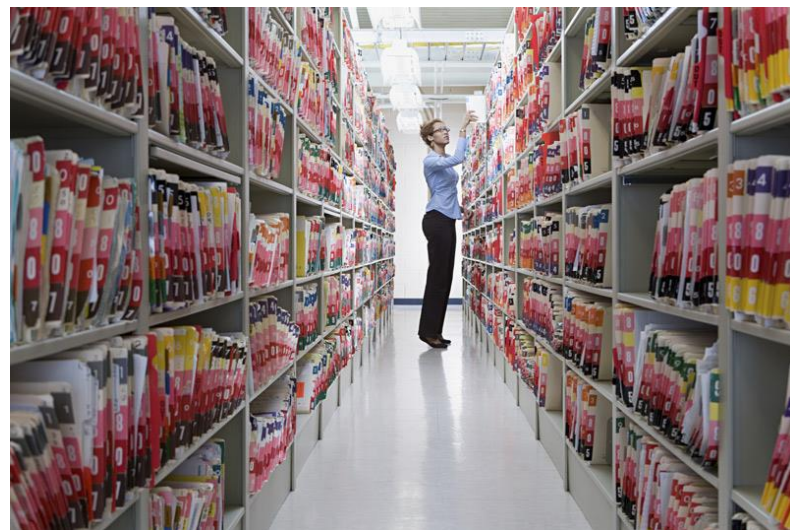
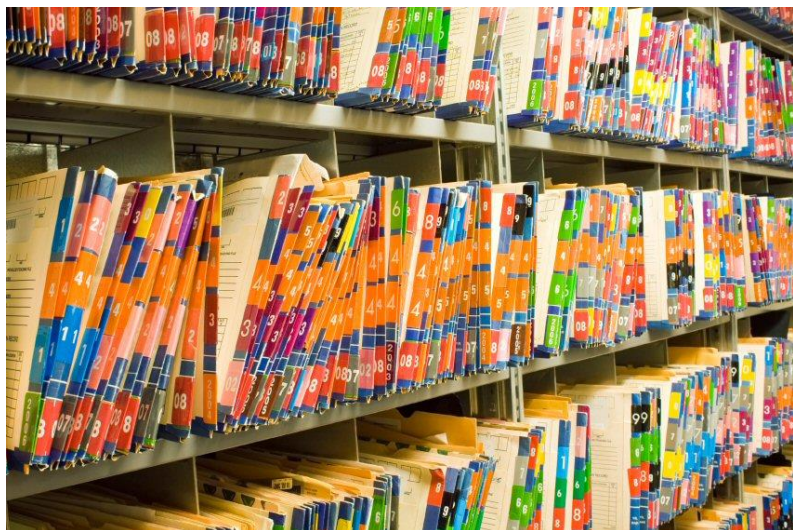
i wore my  
favorite  
blouse











Hyperspace - FAMSDBON PC F - WITS - KTAZD1910 WITSSDM

Desktop Action Patient Care Scheduling Billing CRM/CM Reports Report Mgmt Tools Admin Help

Back Forward Home Schedule In Basket Chart Encounter Tel Enc Message Enc Secure Panel Mgmt

Epic Home

Smith, John W

MRN: 000017701887 Age: 30 year Sex: M PCP: Spero, Robert David (M) Allergies: Sulfu Class, Acarbose, 5-alpha Reductas Alert: N Spec Fest: N kp.org: Inactive

1/22/2009 visit with TEST DUMMY MD

Images Questionnaires Admin Benefits Inquiry References SmartSets Open Orders Preview AVS Print AVS

Allergies: Sulfu Class, Acarbose, 5-alpha Reductase Inhibitors, Acetaminophen + Propoxyphene Napsylate Reviewed on 2/27/2009

Last Vitals: BP: 120/80 P: 60 T: T Src: Resp: 22 W: 190 lbs (86.183 kg) H: 5' 10" (1.778 m)

BMI: 27.26 kg/m2, BSA: 2.06 m2, Exercise Vitals: 180 mins/wk

Height: 5' 10" (1.778 m)

Peak Flow

Charting

Chief Complaint

Nursing Notes

Vitals

Exercise Vitals

Review Exercise VS

Med. Document

BestPractice

History

Progress Note

SmartSets

Dx and Orders

Pt. Instructions

LOS

Follow-up

Close Encounter

Exercise Vitals - Exercise Vitals (SHIFT+F6 to enter comments)

Instant Taken:

Date: 4/30/2009

Time: 1149

Exercise Level of Effort

Days per week of moderate to strenuous exercise (like a brisk walk)

On average, minutes per day of exercise at this level

Restore Close F9 Cancel Previous F7 Next F8

Review Exercise Vitals

Mark as Reviewed Last Reviewed by SHARMA, PANKAJ on 4/24/2009 at 12:36:26 PM

Medication Documentation

Current Prescriptions	Taking?	Start Date	End Date
ATENOLOL 100 MG ORAL TAB TAKE 1 TABLET ORALLY DAILY		4/29/2009	
ATENOLOL 100 MG ORAL TAB 1 TAB PO DAILY		4/29/2009	5/29/2011

Provider: William Lewis (M.D.) Sperling

Provider: William Lewis (M.D.) Sperling

Hotkey List

Exit Workspace

Navigator Hotkeys



Hyperspace - FAMSDBON PC F - WITS - KTAZD1910 WITSSDM

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Back Forward Home Schedule In Basket Chart Encounter Tel Enc Message Enc Secure Panel Mgmt

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Charting

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Instant Taken:

Date: 4/30/2009

Time: 1149

Exercise Level of Effort

Days per week of moderate to strenuous exercise (like a brisk walk): 0 1 2 3 4 5 6 7

On average, minutes per day of exercise at this level: 10 20 30 40 50 60 90 120 150 or greater

Restore Close F9 Cancel Previous F7 Next F8

Review Exercise Vitals

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Current Prescriptions	Taking?	Start Date	End Date
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Provider: William Lewis (M.D.) Sperling

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Hotkey List

Exit Workspace

Navigator Hotkeys

HyperSpace FAMSDON PC F WITS JCTA701910 WITSSON

Desktop Action Patient Care Scheduling Billing CRM/CM Reports Report Mgmt Tools Admin Help

Back Forward Home Schedule In Basket Chart Encounter Tel Enc Message Enc Secure Panel Mgmt

Epic Home

Smith, John W 000017701887 30 year M Spero, Robert David (M) \*Sulfa Class, Acarbose, 5-alpha Reductas\* Alert Spec Fest kp.org Inactive

1/22/2009 visit with TEST DUMMY MD

Images Questionnaires Admin Benefits Inquiry References SmartSets Open Orders Preview AVS Print A/S

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Height 5' 10" (1.778 m)

Peak Flow

Charting

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Nursing Notes

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BestPractice

History

Progress Note

SmartSets

Dx and Orders

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LOS

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Close Encounter

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Instant Taken:

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On average, minutes per day of exercise at this level

Restore Close F9 Cancel Previous F7 Next F8

Review Exercise Vitals

Mark as Reviewed Last Reviewed by SHARMA, PANKAJ on 4/24/2009 at 12:36:26 PM

Medication Documentation

Current Prescriptions

Atenolol 100 MG ORAL TAB

TAKE 1 TABLET ORALLY DAILY

Atenolol 100 MG ORAL TAB

1 TAB PO DAILY

Taking? Start Date End Date

4/29/2009

Provider: William Lewis (M.D.) Sperling

4/29/2009 5/29/2011

Provider: William Lewis (M.D.) Sperling

Hotkey List

Exit Workspace

Navigator Hotkeys



ugh so many tabs...

**Smith, John W** 000017701887 30 year M Spero, Robert David (M) \*Sulfa Class, Acarbose, 5-alpha Reductas\* Alert Spec Fest kp.org Inactive

1/22/2009 visit with TEST DUMMY MD

**Allergies:** Sulfa Class, Acarbose, 5-alpha Reductase Inhibitors, Acetaminophen + Propoxyphene Napsylate Reviewed on 2/27/2009

Last Vitals: BP: 120/80 P: 60 T: T Src: Resp: 22 W: 190 lbs (86.183 kg) H: 5' 10" (1.778 m)  
BMI: 27.26 kg/m2, BSA: 2.06 m2, Exercise Vitals: 180 mins/wk

Height 5' 10" (1.778 m)  
Peak Flow

**Exercise Vitals - Exercise Vitals (SHIFT+F6 to enter comments)**

Instant Taken:  
Date: 4/30/2009  
Time: 1149

**Exercise Level of Effort**

Days per week of moderate to strenuous exercise (like a brisk walk): 0 1 2 3 4 5 6 7 0

On average, minutes per day of exercise at this level: 10 20 30 40 50 60 90 120 150 or greater 0

Restore Close F9 Cancel Previous F7 Next F8

**Review Exercise Vitals**

✓ Mark as Reviewed Last Reviewed by SHARMA, PANKAJ on 4/24/2009 at 12:36:26 PM

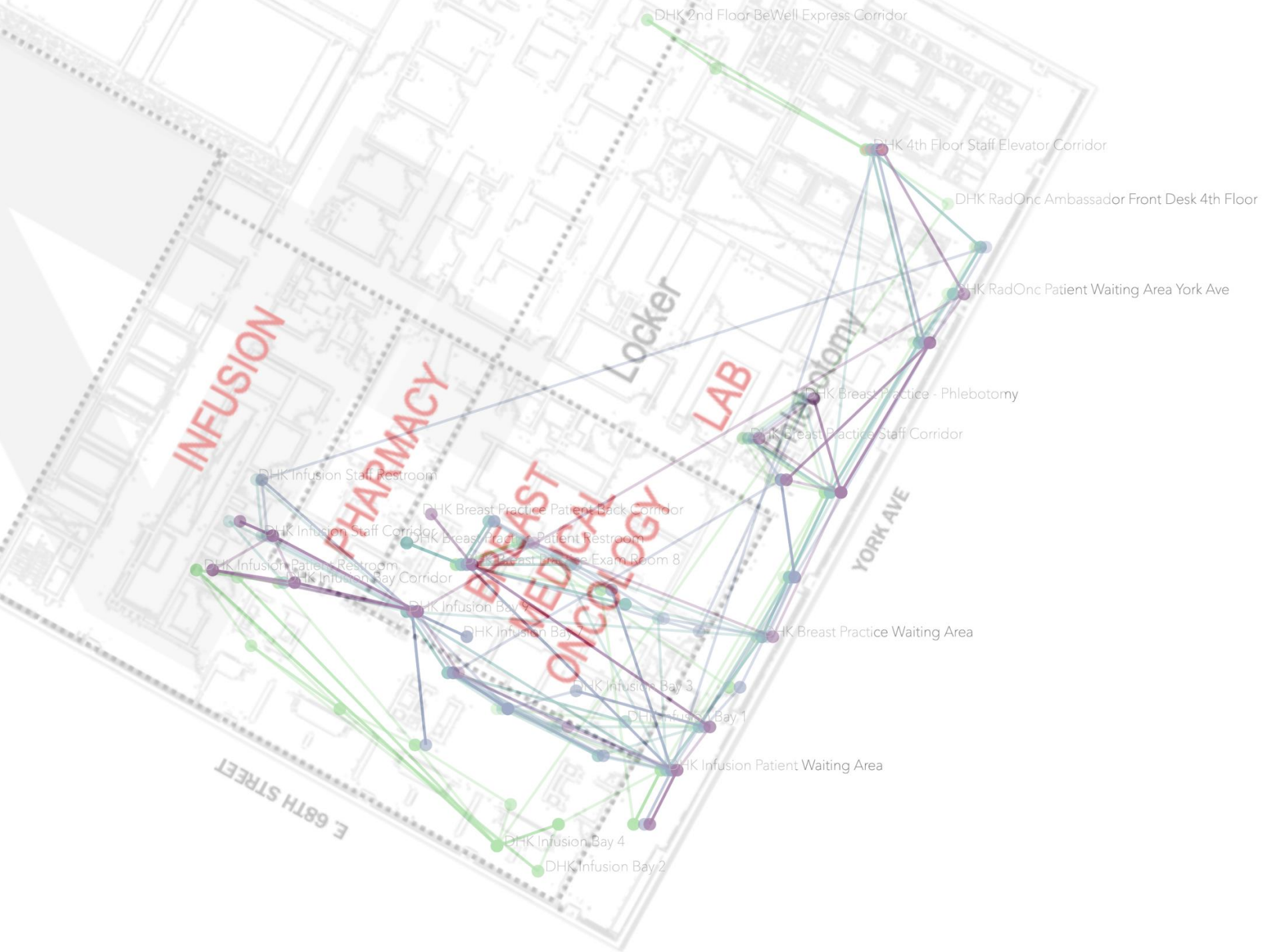
**Medication Documentation**

Current Prescriptions	Taking?	Start Date	End Date
ATENOLOL 100 MG ORAL TAB TAKE 1 TABLET ORALLY DAILY		4/29/2009	
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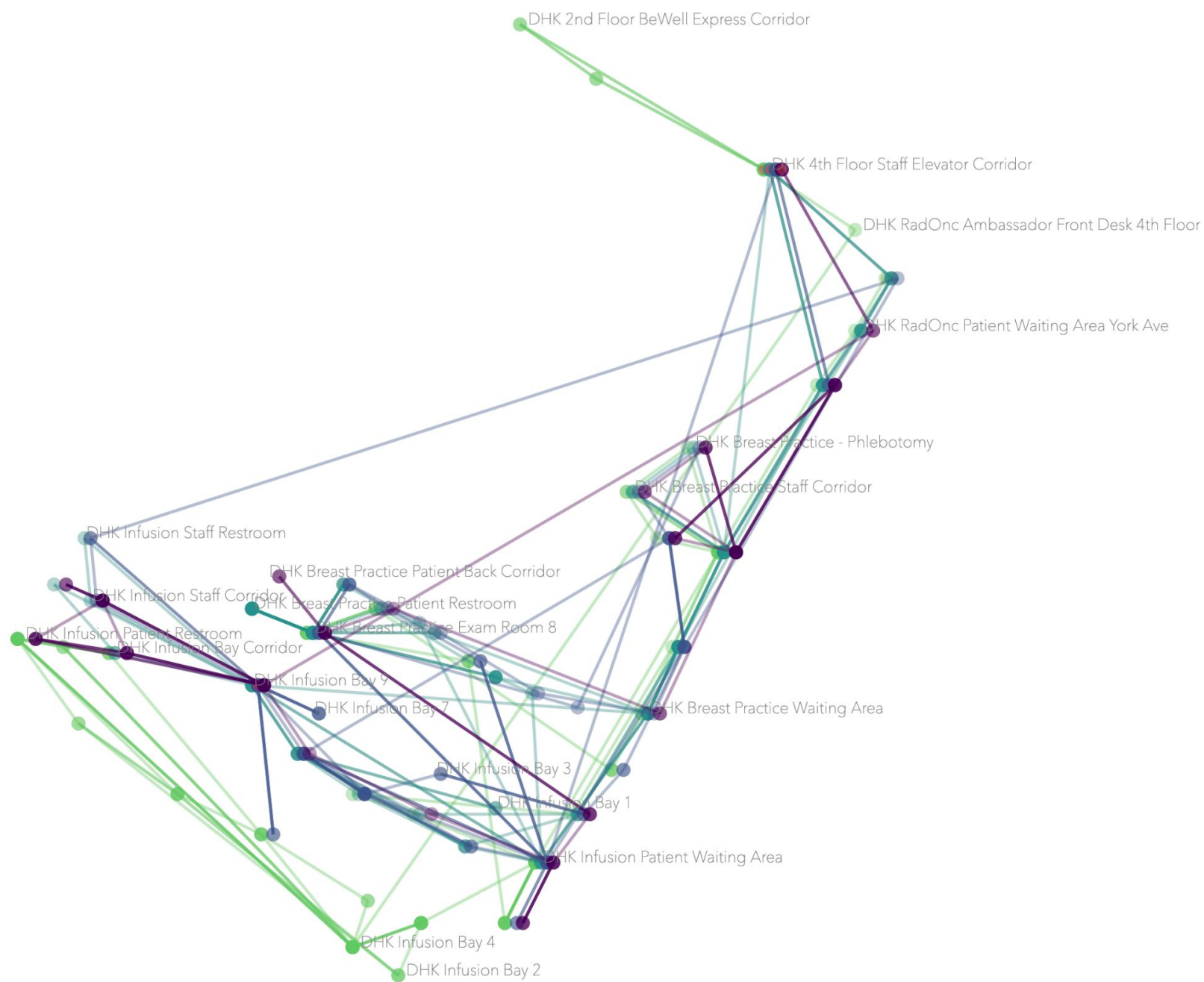
Provider: William Lewis (M.D.) Sperling

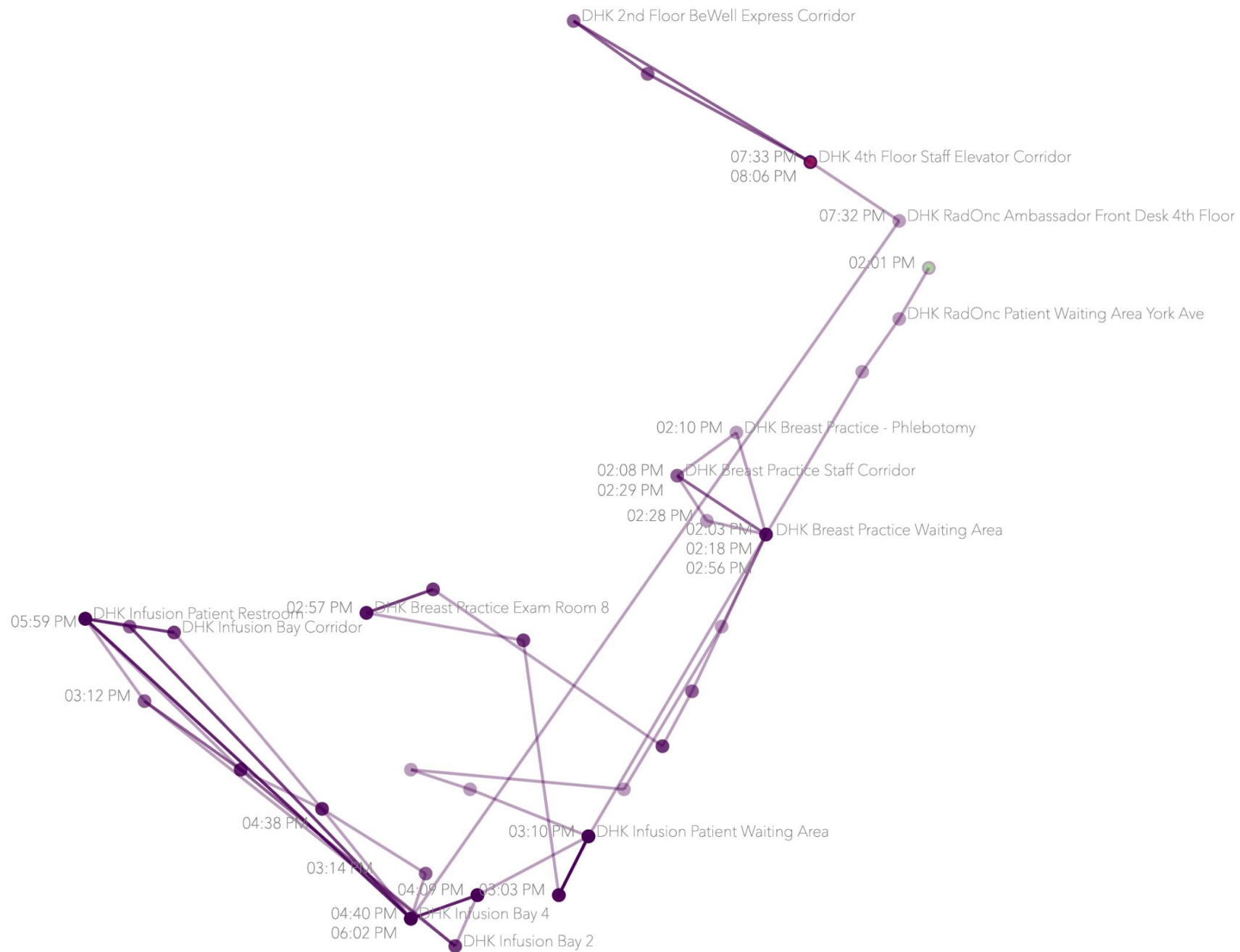
think about a list of patient visits for a particular month

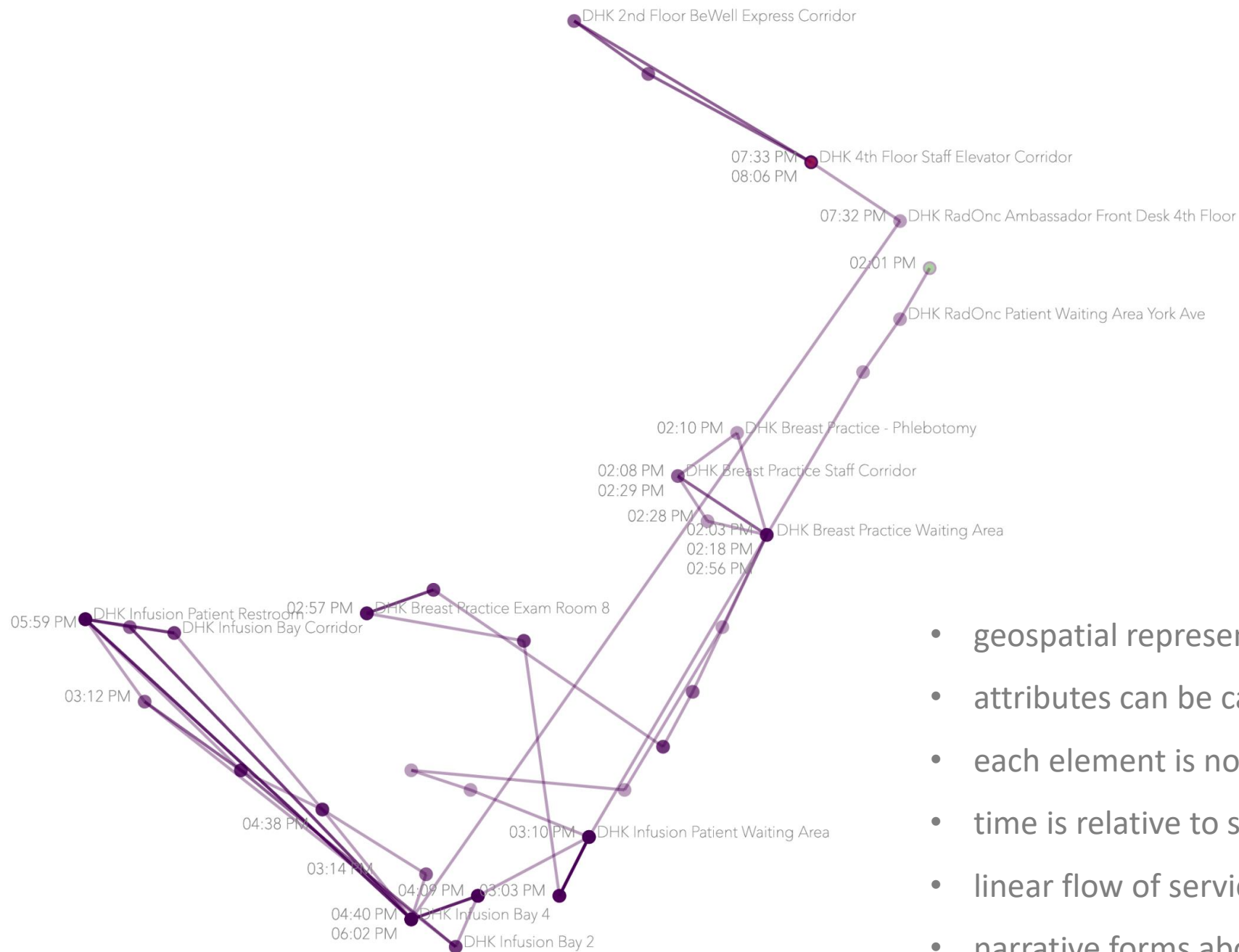
mrn	account	event_time	location	location_name
12345678	G00000001	1/7/2019 2:03:06 PM	A-KC-04:402A.1	DHK Breast Practice Waiting Area
12345678	G00000001	1/7/2019 2:03:36 PM	A-KC-04:400D.2	DHK Infusion Patient Waiting Area
12345678	G00000001	1/7/2019 2:03:52 PM	A-KC-04:400D.2	DHK Infusion Patient Waiting Area
12345678	G00000001	1/7/2019 2:03:52 PM	A-KC-04:400F.6	DHK Infusion Bay Corridor
12345678	G00000001	1/7/2019 2:04:12 PM	A-KC-04:400F.5	DHK Infusion Bay Corridor
12345678	G00000001	1/7/2019 2:04:22 PM	A-KC-04:400D.1	DHK Infusion Patient Waiting Area
12345678	G00000001	1/7/2019 2:04:32 PM	A-KC-04:402B.1	DHK Breast Practice Waiting Area
12345678	G00000001	1/7/2019 2:04:37 PM	A-KC-04:402A.1	DHK Breast Practice Waiting Area
12345678	G00000001	1/7/2019 2:08:20 PM	A-KC-04:400E.11	DHK Breast Practice Staff Corridor
12345678	G00000001	1/7/2019 2:10:37 PM	A-KC-04:415A	DHK Breast Practice - Phlebotomy
12345678	G00000001	1/7/2019 2:18:14 PM	A-KC-04:402A.1	DHK Breast Practice Waiting Area
12345678	G00000001	1/7/2019 2:28:53 PM	A-KC-04:400E.9	DHK Breast Practice Staff Corridor
12345678	G00000001	1/7/2019 2:29:34 PM	A-KC-04:400E.11	DHK Breast Practice Staff Corridor
12345678	G00000001	1/7/2019 2:29:54 PM	A-KC-04:402A.1	DHK Breast Practice Waiting Area
12345678	G00000001	1/7/2019 2:56:37 PM	A-KC-04:413.3	DHK Breast Practice Exam Patient Corridor
12345678	G00000001	1/7/2019 2:56:47 PM	A-KC-04:413.3	DHK Breast Practice Exam Patient Corridor
12345678	G00000001	1/7/2019 2:56:47 PM	A-KC-04:411	DHK Breast Practice Exam Room 8
12345678	G00000001	1/7/2019 2:56:52 PM	A-KC-04:411	DHK Breast Practice Exam Room 8
12345678	G00000001	1/7/2019 2:57:02 PM	A-KC-04:411	DHK Breast Practice Exam Room 8
12345678	G00000001	1/7/2019 2:57:12 PM	A-KC-04:411	DHK Breast Practice Exam Room 8
12345678	G00000001	1/7/2019 3:02:22 PM	A-KC-04:413.6	DHK Breast Practice Exam Patient Corridor
12345678	G00000001	1/7/2019 3:02:22 PM	A-KC-04:411	DHK Breast Practice Exam Room 8
12345678	G00000001	1/7/2019 3:02:27 PM	A-KC-04:413.6	DHK Breast Practice Exam Patient Corridor
12345678	G00000001	1/7/2019 3:02:32 PM	A-KC-04:413.6	DHK Breast Practice Exam Patient Corridor
12345678	G00000001	1/7/2019 3:03:13 PM	A-KC-04:400D.3	DHK Infusion Patient Waiting Area
12345678	G00000001	1/7/2019 3:03:18 PM	A-KC-04:400D.3	DHK Infusion Patient Waiting Area
12345678	G00000001	1/7/2019 3:03:48 PM	A-KC-04:400D.2	DHK Infusion Patient Waiting Area



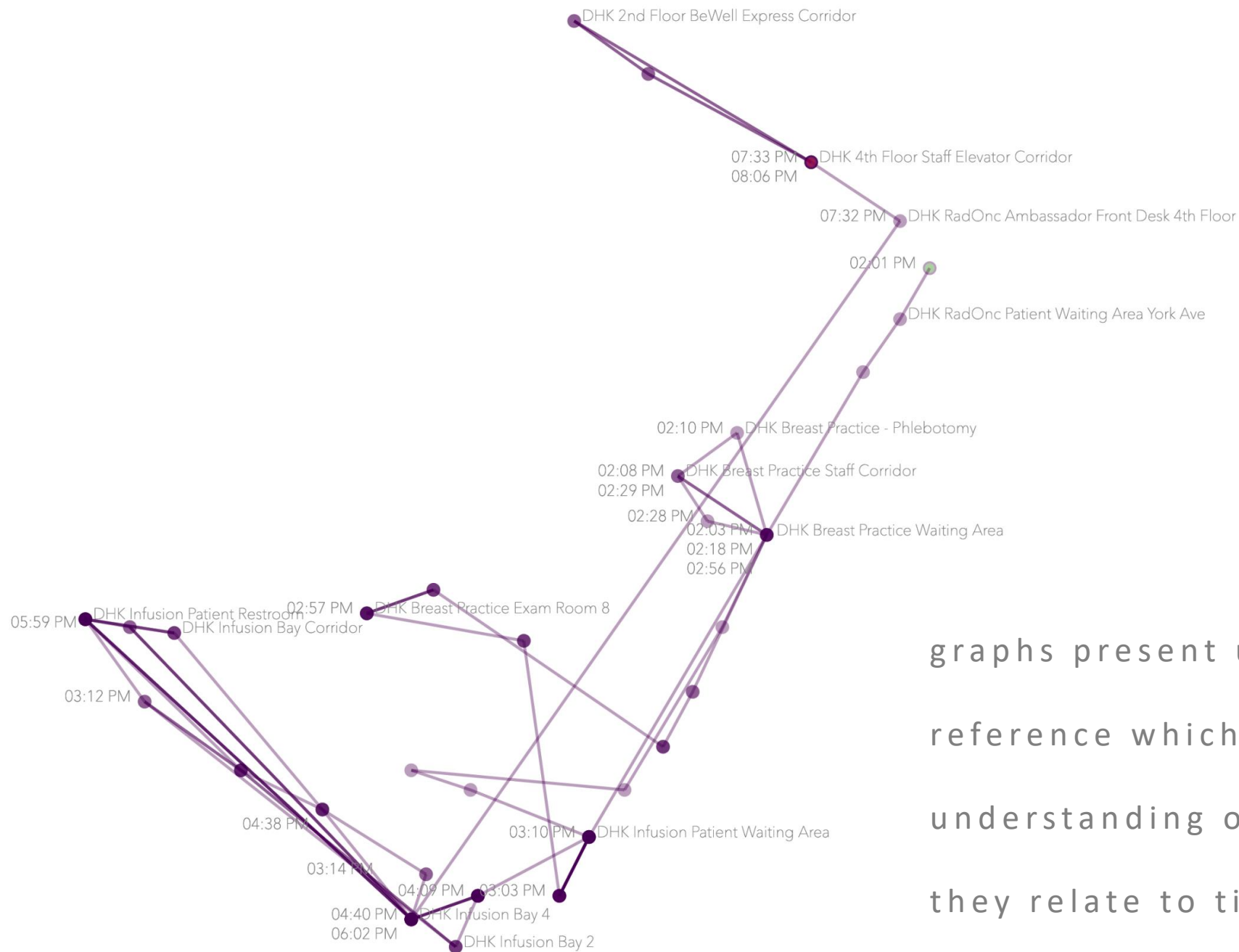








- geospatial representation
- attributes can be categorized (allows for filtering)
- each element is not weighted equally
- time is relative to space and other time values
- linear flow of services for a visit
- narrative forms about a patient's journey



graphs present us with a visual  
reference which utilize our  
understanding of data elements as  
they relate to time

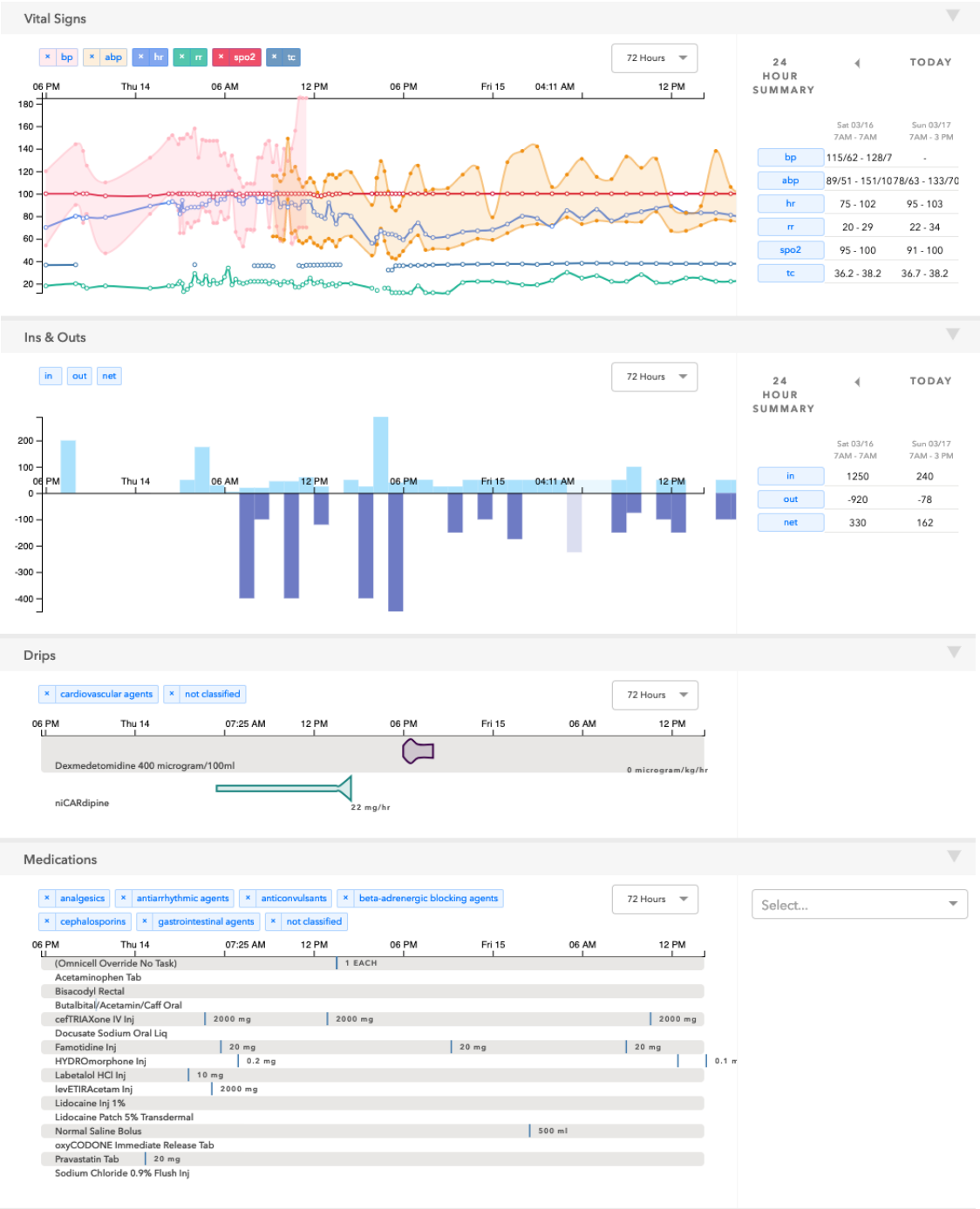
Name: xxxxxxxxxxxx   Age:53 Y   DOB: xx/xx/xx   MRN:xxxxxxxx   Room:xxxxxxxx   Admit Date:6/15/2017   Code Status:Full Code   Attending Provider: xxxxxxxxxxxxxxxxxxxxxxxx   Tele Intermediate 53F with hx of HTN, prior meth use who presents with 2 weeks of acute CP, SOB, orthopnea admitted for rule out ACS, new afib with rvr as well as new onset heart failure with volume overload (06/15 2211)			
<b>Active Issues:</b> Illness Severity: Stable  #Acute on chronic HFREF - s/p R heart cath 6/20, diuresing - Furosemide 80 BID, carvedilol/enalapril/spironolactone  #Afib/RVR - s/p TEE/DCCV 6/20, remains in sinus, on apixaban  #Hypertension - On enalapril as well as spiro/carvedilol, plus PRN PO hydralazine; also very volume overloaded, diuresing as above Edited by: xxxxxxxxxxxxxxxxxxxxxxxx at 6/20/2017 1717 <b>To-Do:</b> [ ] Follow up PM BMP, replete K<4, Mg<2  FYI undergoing CT coronaries tonight Edited by: xxxxxxxxxxxxxxxxxxxxxxxx MD at 6/20/2017 1717 <b>If/Then:</b> If hypertensive, written for PO hydralazine If flips back into afib/RVR, can give IV metoprolol for HR>110 If any new neuro symptoms, s/p TEE/DCCV 6/20, consider stroke and get stat head CT Edited by: xxxxxxxxxxxxxxxxxxxxxxxx MD at 6/20/2017 1717	<b>Vitals (Last 24 Hrs):</b> Temp: [36.6 °C (97.9 °F)-37.3 °C (99.1 °F)] BP: (89-136)/(62-88) MAP: [71 mmHg-104 mmHg] Pulse: [68-86] Heart Rate: [71-95] Resp: [16-18] SpO2: [89 %-99 %]  <b>Diet:</b> Diet Carbohydrate Controlled/Low Sodium/Low Saturated Fat  <b>I/O:</b> <b>Current Shift:</b> 06/20 1900 - 06/21 0659 In: 240 [P.O.:240] Out: 2350 [Urine:2350] <b>Prior 3 shifts:</b> In: 868.7 [P.O.:600; I.V.:268.7] Out: 9600 [Urine:9600]	<b>Labs(Last 24 Hrs):</b> <b>CBC(WBC/HGB/HCT/PLT):</b> <b>BMP(NA/CL/BUN/GLU):</b> 139/103/52/155 (05/21 0520) <b>K/CO2/Cr:</b> 4.5/25/0.84 (06/21 0520) <b>LFT/Alb:</b> <b>Ca/MG/PO4:</b> 8.8/2.5/-- (06/21 0520) <b>PT/PTT/INR:</b> <b>CK/CKMB/TNI:</b> <b>POC Glucose:</b> 155 (06/21 0520)  <b>Medications:</b> <b>Continuous:</b>	<b>Medications:</b> <b>Scheduled:</b> albuterol-ipratropium, 3 mL, Q4H While awake apixaban, 5 mg, BID aspirin, 81 mg, QAM with Brkfast atorvastatin, 80 mg, NIGHTLY carvedilol, 12.5 mg, BID furosemide, 80 mg, TID hydroCHLOROthiazide, 25 mg, QAM custom INV drug, 1 Tab, BID custom INV drug, 1 Tab, BID melatonin, 3 mg, DAILY spironolactone, 25 mg, BID



Name: xxxxxxxxxxxx   Age: 53 Y   DOB: xx/xx/xx   MRN: xxxxxxxx   Room: xxxxxxxx   Admit Date: 6/15/2017   Code Status: Full Code   Attending Provider: xxxxxxxxxxxxxxxxxxxx   Tele Intermediate			
53F with hx of HTN, prior meth use who presents with 2 weeks of acute CP, SOB, orthopnea admitted for rule out ACS, new afib with rvr as well as new onset heart failure with volume overload (06/15 2211)			
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can we improve the way in which patient data is presented?

presenting **Ocelot** ...  
towards a visual understanding  
of patient data



[ { ... } , { ... } , { ... } ]

name:

path:

parse:

pills:

panel:

chart:

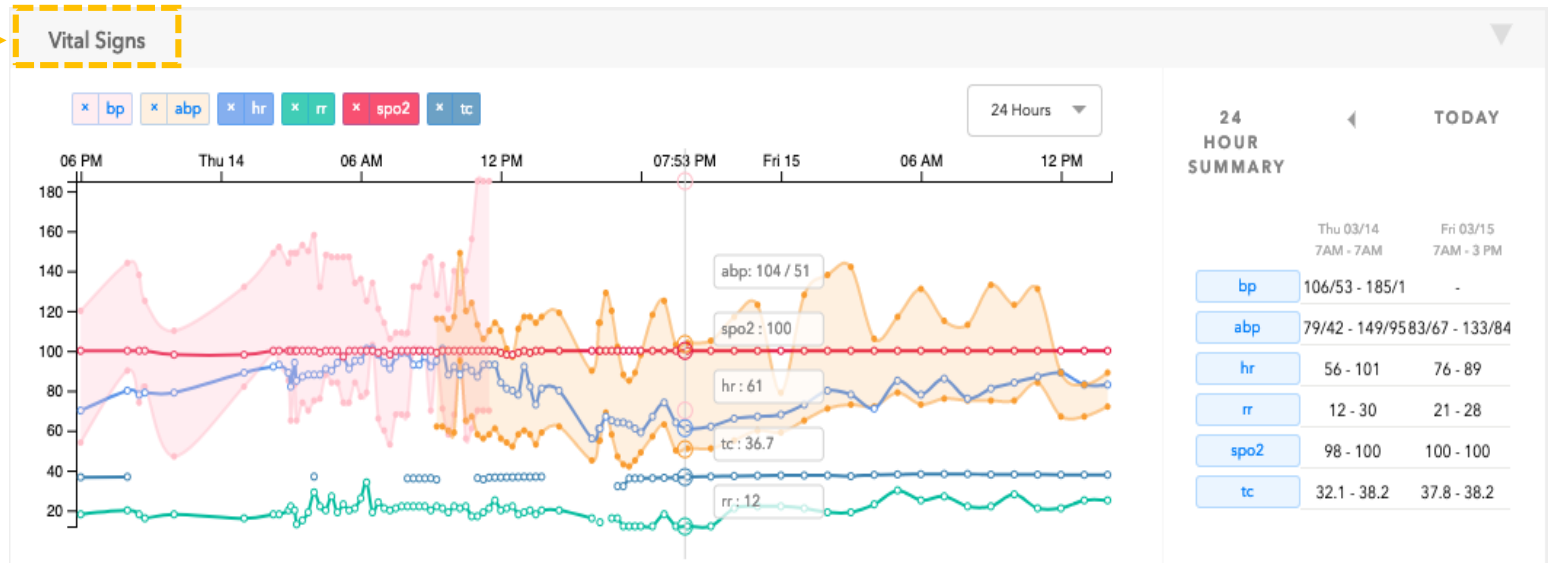
zoom:

cursor:

times:

toggle:

update:



handlebars



name:

path:

parse:

pills:

panel:

chart:

zoom:

cursor:

times:

toggle:

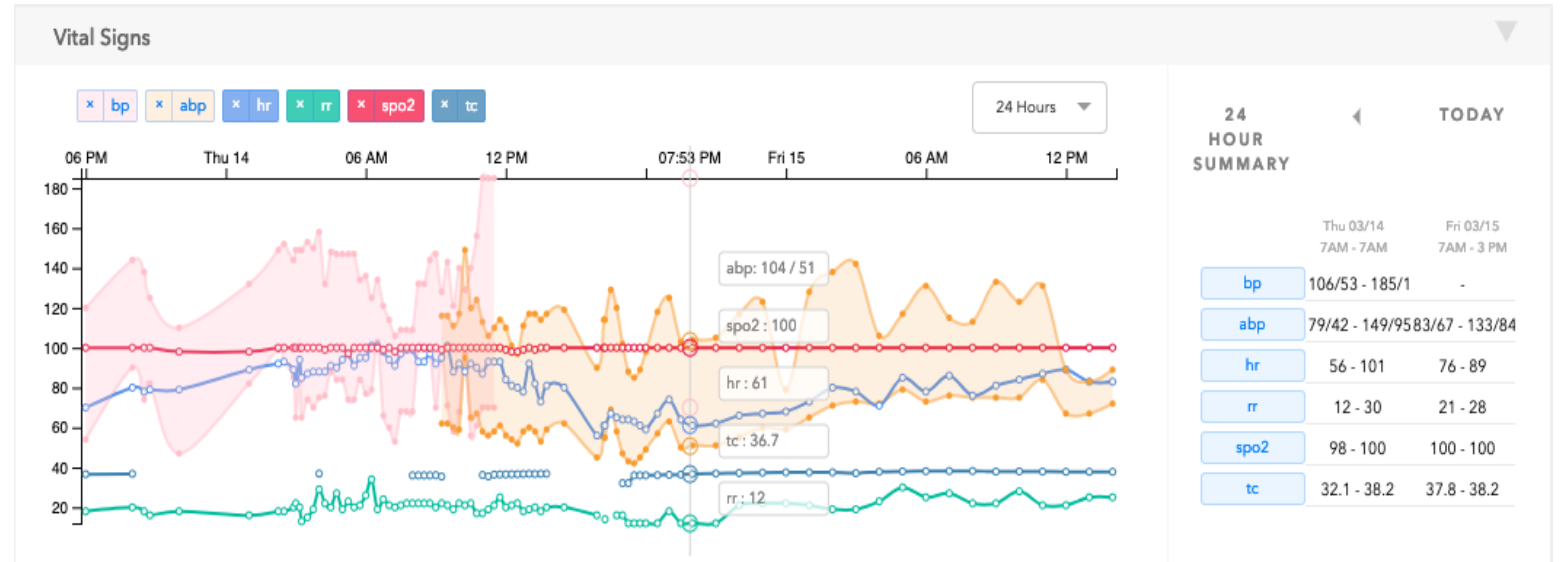
update:

data source:

either a file or a web service

```
{ path: "vitals.csv" }
```

```
{ path: "scroll.nyp.org/vitals" }
```





name:

path:

parse:

pills:

panel:

chart:

zoom:

cursor:

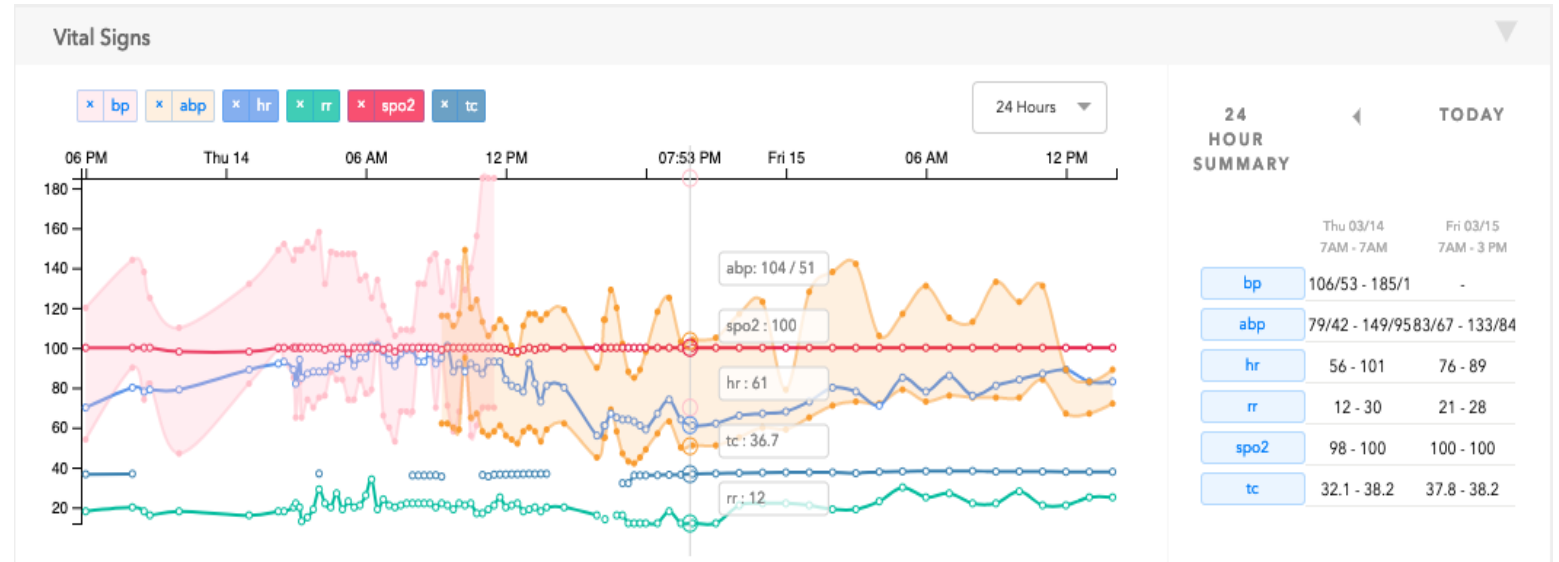
times:

toggle:

update:

parsing the data:

restructuring or transforming the data  
objects to fit the graph



name:

path:

parse:

pills:

panel:

chart:

zoom:

cursor:

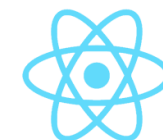
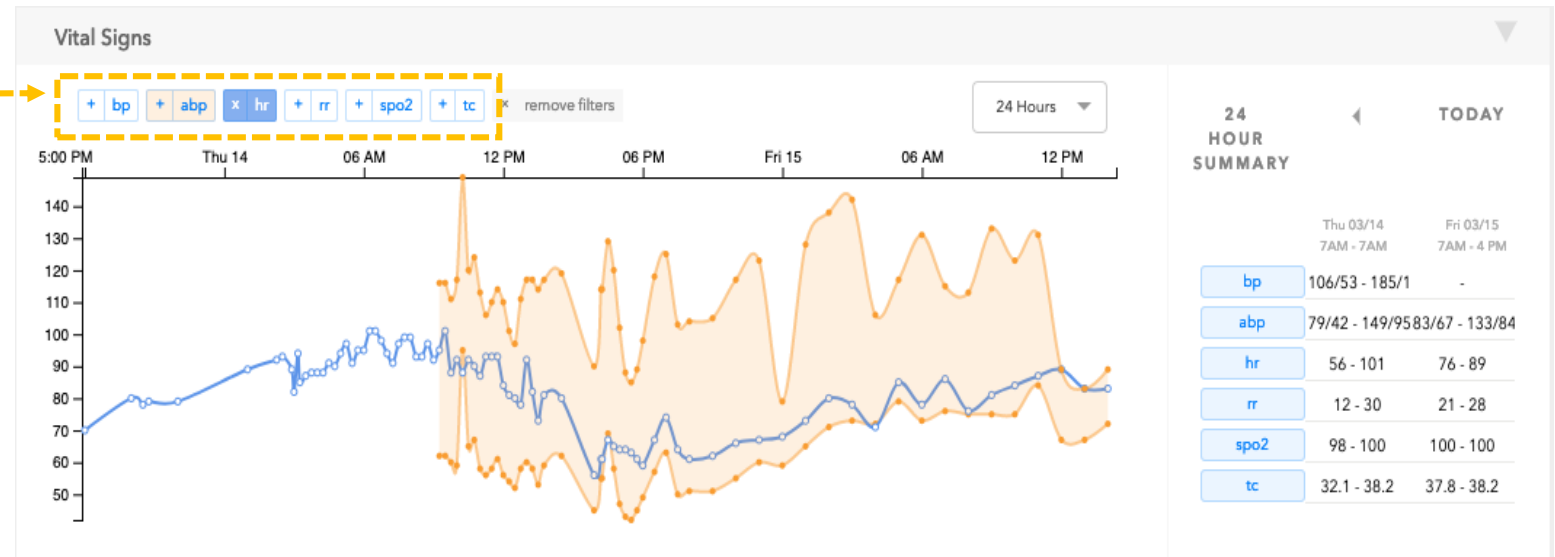
times:

toggle:

update:

interactive buttons:

click-enabled features allowing for  
filtering of one-value or multi-selection



React



name:

path:

parse:

pills:

panel:

chart:

zoom:

cursor:

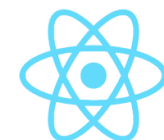
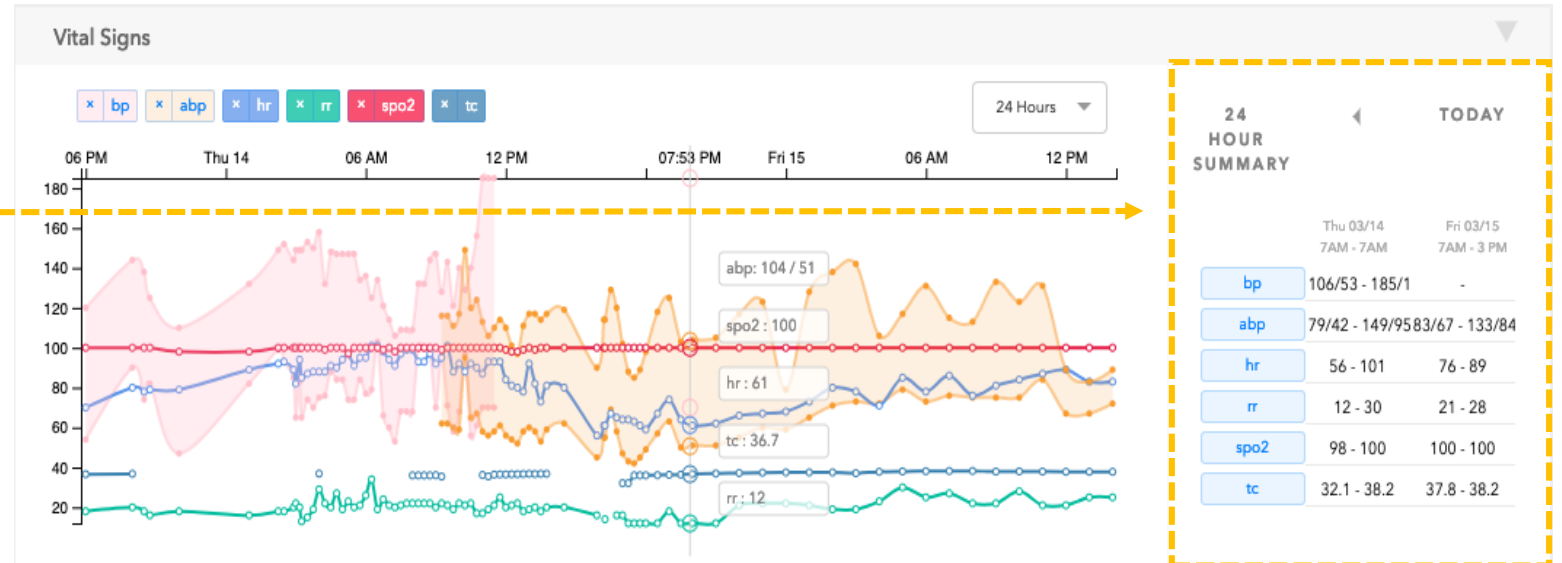
times:

toggle:

update:

summary panel:

scrollable table breaking down min-max value for every 24 hours



React

name:

path:

parse:

pills:

panel:

chart:

zoom:

cursor:

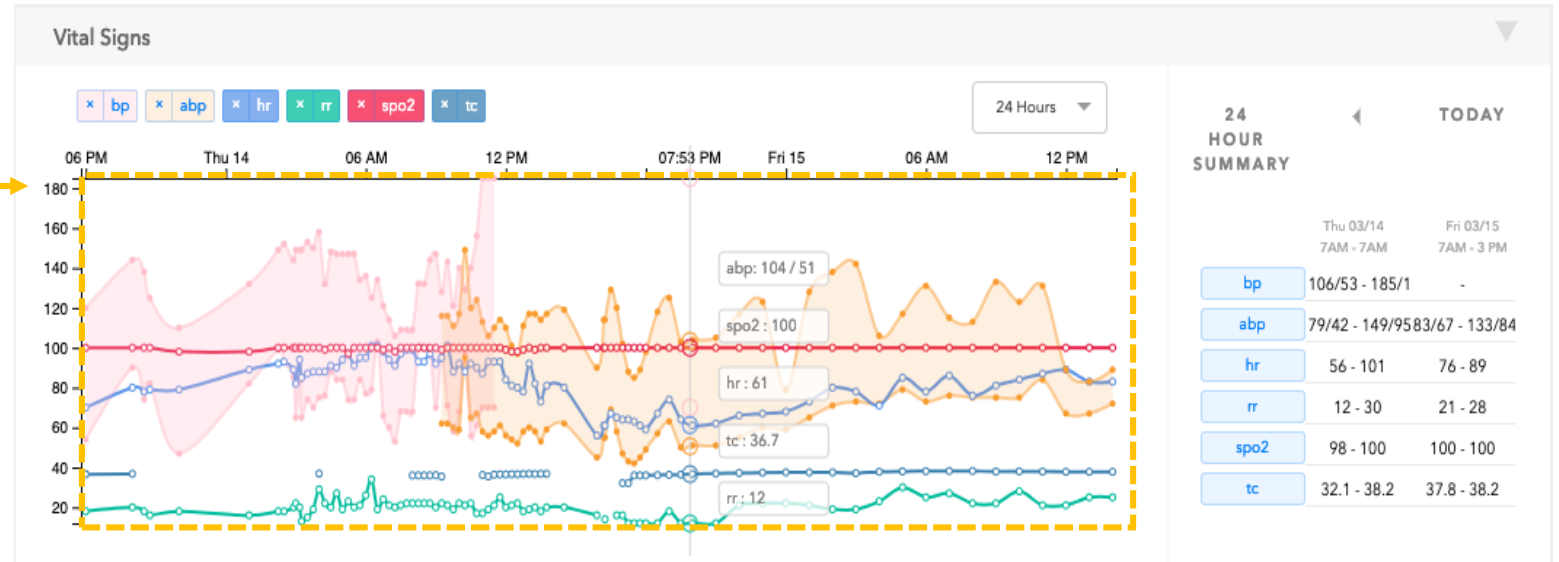
times:

toggle:

update:

d3.js chart:

customizable open-source chart for visual presentation of data



name:

path:

parse:

pills:

panel:

chart:

zoom:

cursor:

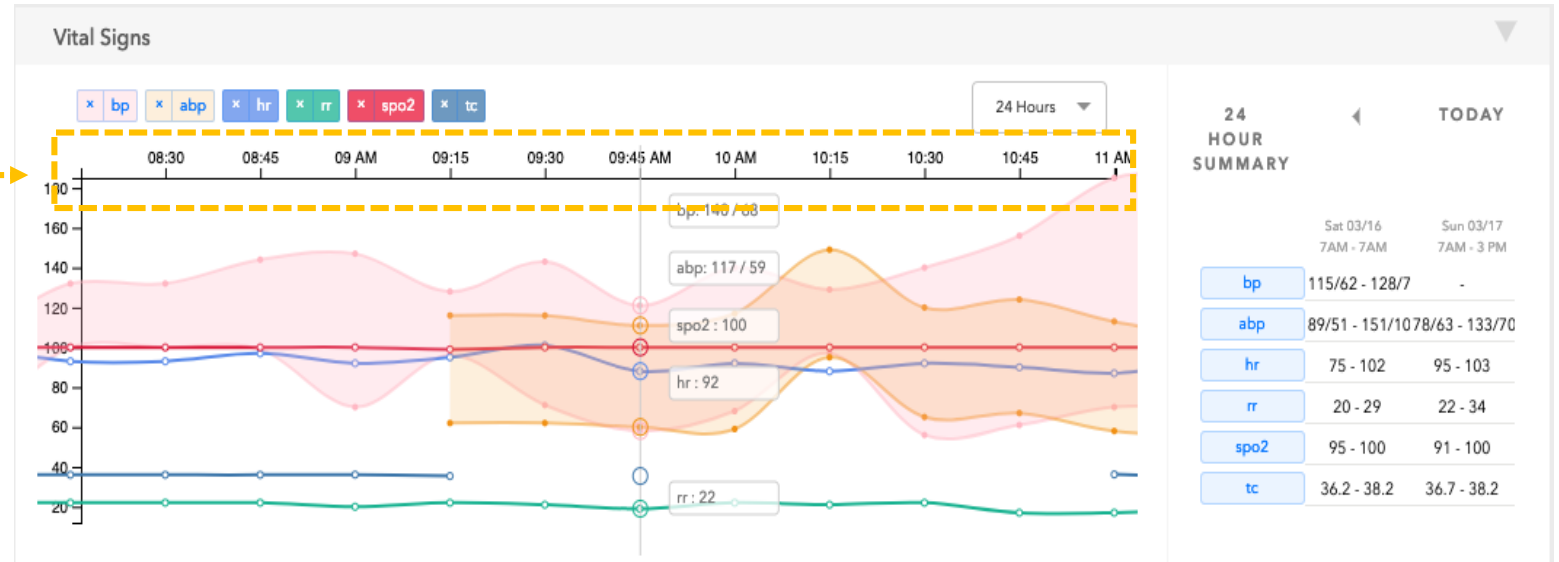
times:

toggle:

update:

zooming + panning:

event-listener which rescales the x-axis,  
allowing for time interval interaction





name:

path:

parse:

pills:

panel:

chart:

zoom:

cursor:

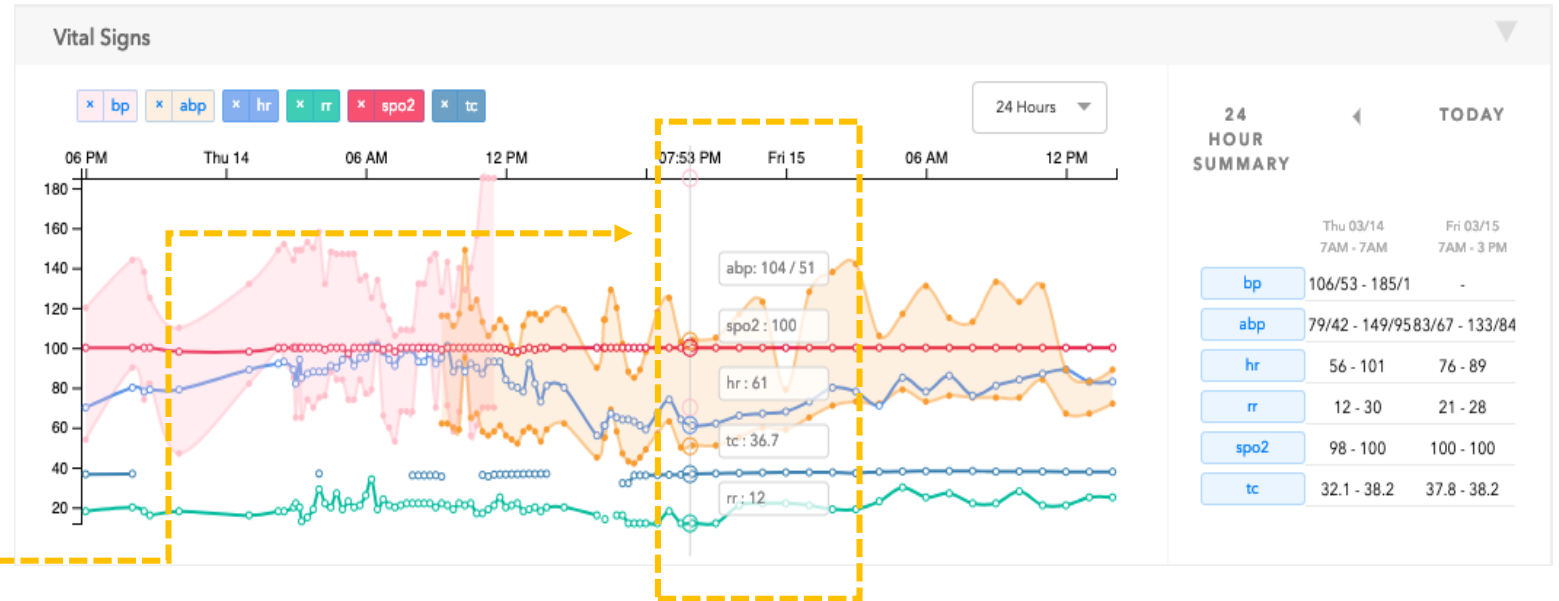
times:

toggle:

update:

tooltip mouse-over:

tooltip intersects time-axis for all  
modules to derive corresponding y-values



name:

path:

parse:

pills:

panel:

chart:

zoom:

cursor:

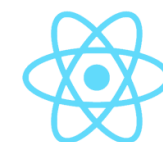
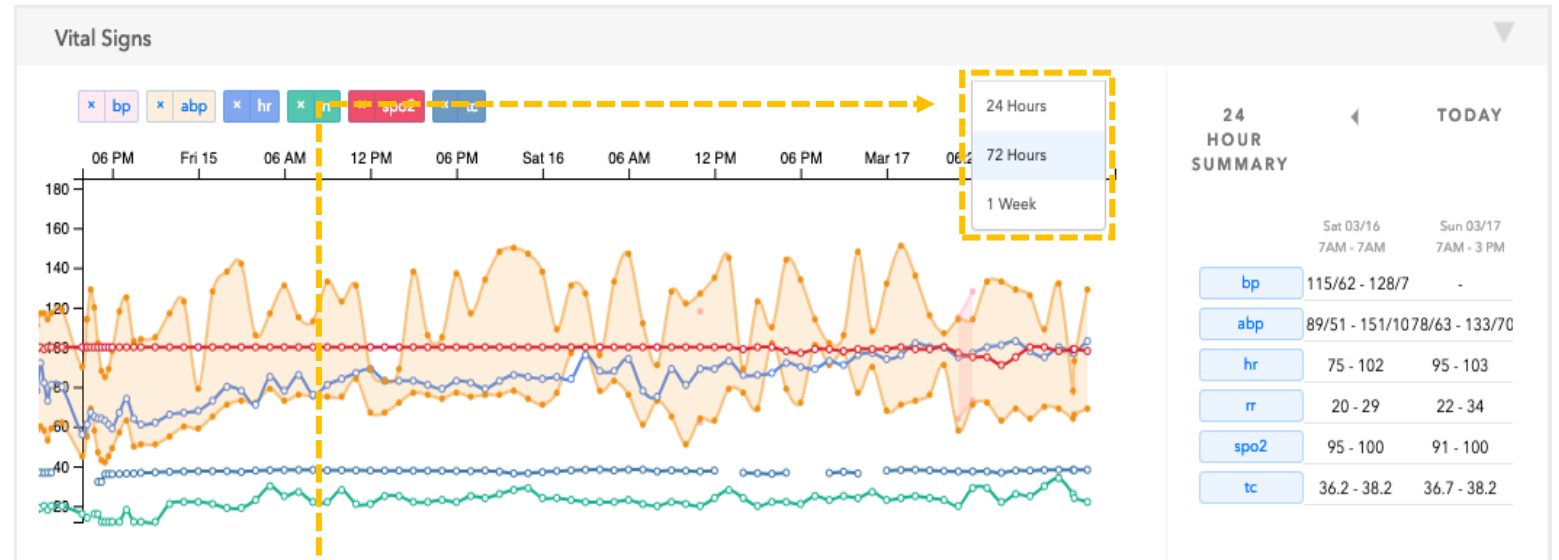
times:

toggle:

update:

time-period selection:

dropdown list selection immediately  
zooms into corresponding time-frame



React

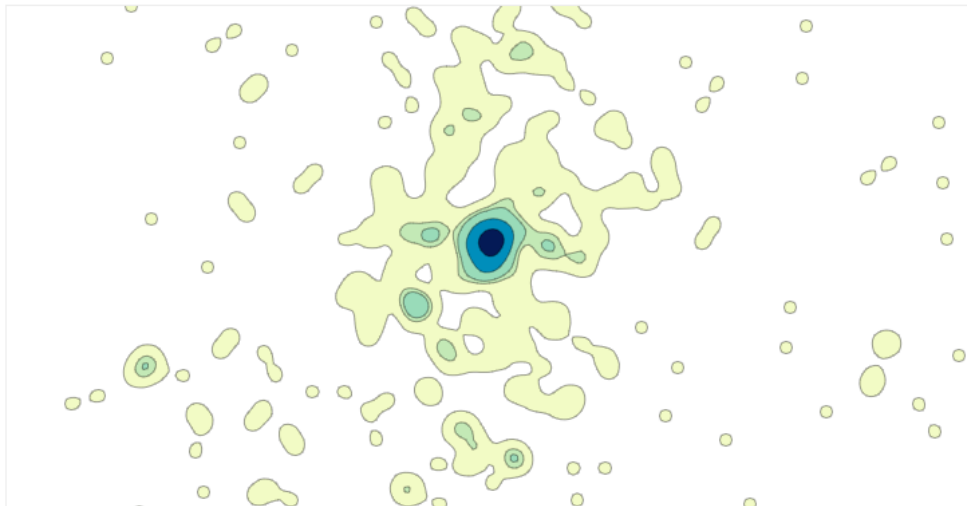


```
chart : function() {  
  let data = this['data'];  
  return multiLineTimeSeries()  
    .x(d => new Date(d['date']))  
    .y(d => d['value'])  
    .xDomain([  
      d3.timeHour.offset(new Date(), -24),  
      new Date()])  
    .yDomain([d3.min(data), d3.max(data)])  
},
```

[bl.ocks.org/mbostock](https://blocks.org/mbostock)

[blockbuilder.org/search](https://blockbuilder.org/search)

# Goocy Force Layout N-body Problem with Contours



A combination of Mike Bostock's [NBody Problem](#) using a Force Layout, combined with one of his point [density contours](#) examples. Here's a quick [canvas](#) mock up - and [here's](#) a trippier one when you forget to clean the canvas each tick.

[Open](#)

Using contours might allow for some sort of alternative [goocy effect](#) with nodes when splitting or merging nodes.

## # LICENSE

This block appears to have [no license](#). Please contact [the author](#) to request a license.

## # index.html

```
<!DOCTYPE html>
<meta charset="utf-8">
<style>

</style>
<svg width="960" height="500"></svg>
<script src="https://d3js.org/d3.v4.min.js"></script>
<script src="https://d3js.org/d3-contour.v1.min.js"></script>
<script src="https://d3js.org/d3-scale-chromatic.v1.min.js"></script>
</script>

var svg = d3.select("svg");
var width = svg.attr("width");
var height = svg.attr("height");

var nodes = d3.range(500).map(function() {
  return {}
});

var color = d3.scaleSequential(d3.interpolateYlGnBu)
  .domain([0, 0.016]); // Points per square pixel.

svg.append("g")
  .attr("fill", "none")
  .attr("stroke", "#000")
  .attr("stroke-width", 0.5)
  .attr("stroke-linejoin", "round")
  .selectAll("path")
  .data(d3.contourDensity()
    .x(function(d) { return d.x; })
    .y(function(d) { return d.y; })
    .size([width, height])
    .thresholds([0.02, 0.06, 0.08, 0.16, 0.32, 0.64, 1.28])
    .bandwidth(10)
    (nodes))
  .enter().append("path")
  .attr("fill", function(d) { return color(d.value); })
  .attr("d", d3.geoPath());

var simulation = d3.forceSimulation()
  .force("charge", d3.forceManyBody().strength(0.05))
  .force("center", d3.forceCenter(width / 2, height / 2))
  .alphaDecay(0)
  .velocityDecay(0)
  .nodes(nodes)
  .on("tick", ticked);

function ticked() {

svg.selectAll("path")
  .data(d3.contourDensity()
    .x(function(d) { return d.x; })
    .y(function(d) { return d.y; })
    .size([width, 960])
    .thresholds([0.02, 0.06, 0.08, 0.16, 0.32, 0.64, 1.28])
    .bandwidth(10)
    (nodes))
  .attr("fill", function(d) { return color(d.value); })
  .attr("d", d3.geoPath());

}

</script>
```

[ { ... } , { ... } , { ... } ]



settings.js:

a file defining functions and customized  
values and attributes to pass to methods

```
[ { ... } , { ... } , { ... } ]
```

modular + portable:

users can design their own  
modules; swapping data and building their  
own collections or customized interfaces

joanne's : [ {...}, {...} ]

ryan's : [ {...}, {...}, {...}, {...} ]

natalie's : [ {...}, {...}, {...}, {...}, {...} ]

zach's : [ {...}, {...} ]

ben's : [ {...}, {...}, {...} ]

name:

path:

parse:

pills:

panel:

chart:

zoom:

cursor:

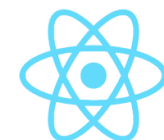
times:

toggle:

update:

toggle component:

button feature which swaps data source  
or restructures data



React

name:

path:

parse:

pills:

panel:

chart:

zoom:

cursor:

times:

toggle:

update:

update graph:

read a new data source and update graph values with corresponding dataset



looking forward:

application + utility



the novelty of this application  
is a stacked view with a shared  
x-axis





we can inspect a specific point  
in time or a certain time range

8:30am: patient experiences increased heart rate for next 12 hours



8:30am: patient experiences increased heart rate for next 12 hours



- we can stack existing (or create new) modules on top of one another to derive clinical meaning from data

8:30am: patient experiences increased heart rate for next 12 hours



- we can stack existing (or create new) modules on top of one another to derive clinical meaning from data
- we can feed new data points from insight we derive from our understanding of patient state

all we need is...

all we need is...

timestamp + values



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