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Segmentifier: Interactive Refinement of Clickstream Data

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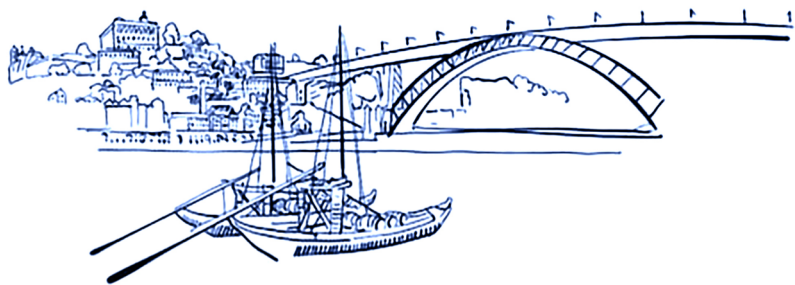
† Kabam



Introduction: *E-commerce*

E-commerce

- Build mobile apps for large e-commerce companies
- Understand the importance of good websites for revenue

E-commerce

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- Understand the importance of good websites for revenue

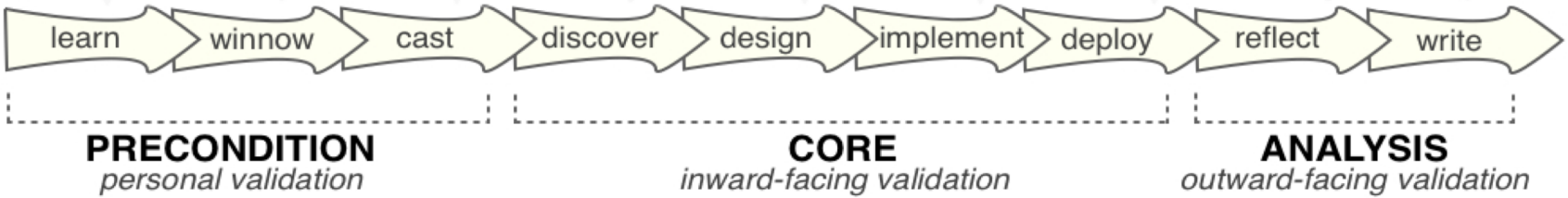
Goals

- **Increase traffic**
  - number of users on a site
- **Reduce abandonment**
  - number of users leaving the site
- **Increase consumer engagement**
  - time users spend on the site
  - chances that a user returns to the site
- **Increase conversion rate**
  - odds a user purchases

Process

Followed Design Study Methodology [Sedlmair 2012]:

- **Precondition Phase** (5 months) : interviews with 12 employees
- **Core Phase** (11 months): Iterative design and implementation
- **Analysis Phase** (3 months): Reflect and write



Research Contributions

- Thorough **characterization of task and data abstraction** for clickstream data analysis
  - **High-Level Segmentifier Analysis Model** abstracts iterative process
    - View, Refine, Record, Export, Abandon, Conclude

- **Segmentifier: novel analytics interface** for refining data segments and viewing characteristics before downstream fine-grained analysis
  - Rich set of views showing both *derived attributes* and *raw sequence details*
  - *Filtering* and *Partitioning* through visual queries
    - Quantitative attributes
    - Custom sequences of events aggregated according to a novel three-level hierarchy
  - Detailed glyph based *visual history* of the automatically recorded refinement process showing the provenance of each segment in terms of its analysis path

- Preliminary **evidence of utility** from:
  - *Usage Scenario* with real world data
  - *Case Study* with industry analyst

What are the **Data and Task Abstractions** for *Clickstream Data Analysis?*

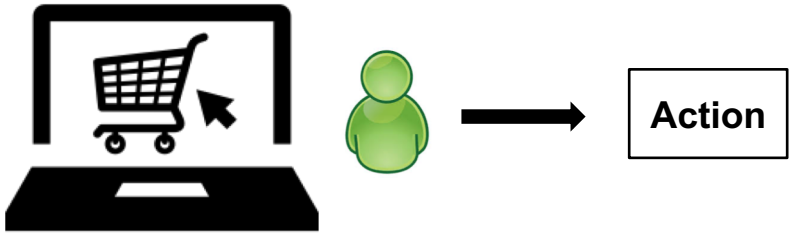
Clickstream Data

Clickstream Analysis Tasks

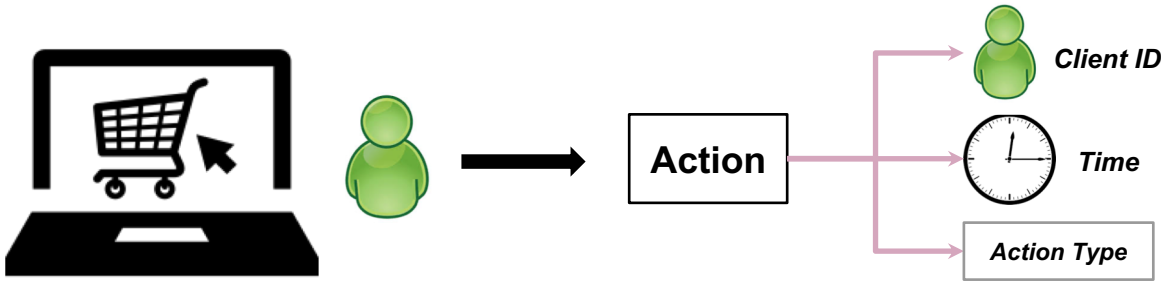
Segmentifier Analysis Model

What is ***Clickstream Data***?

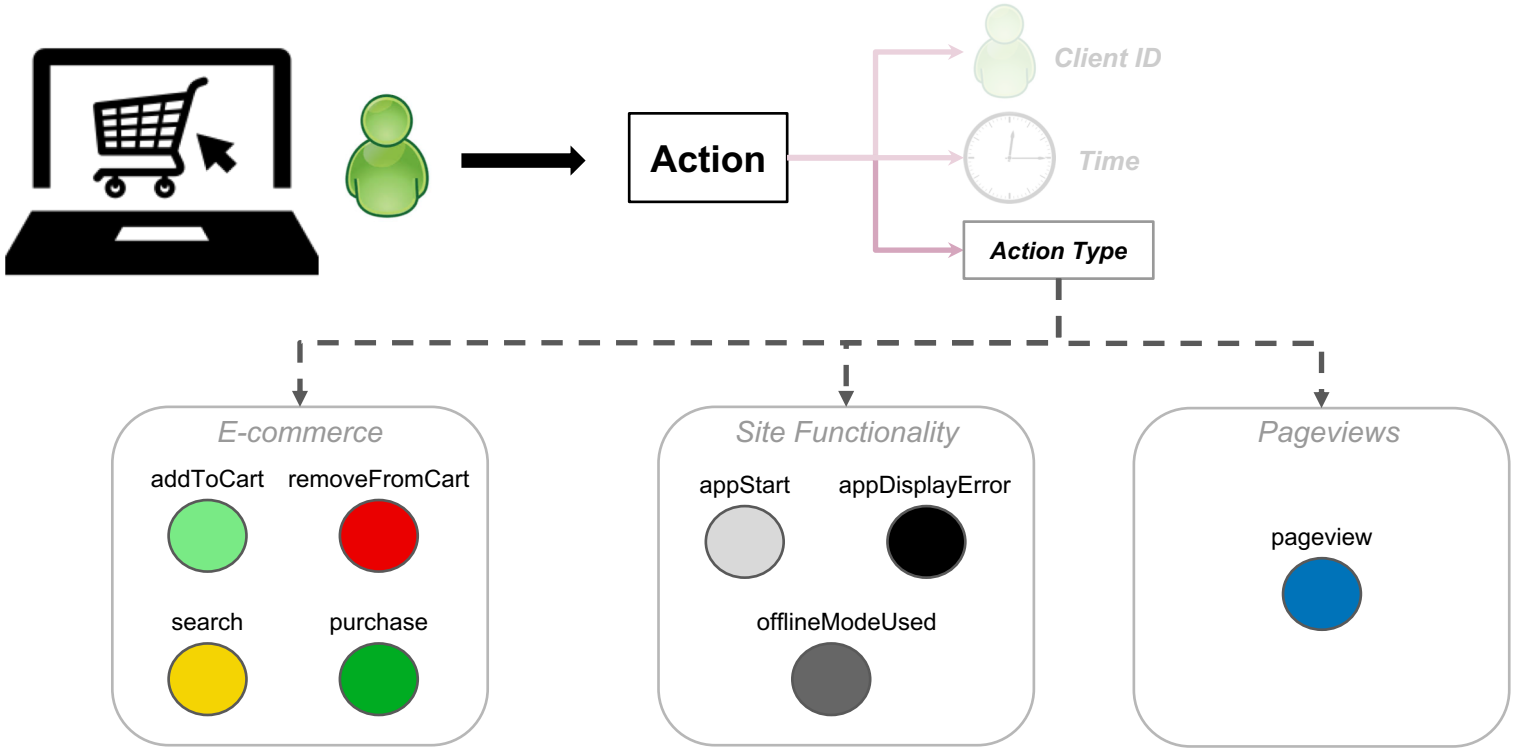
Data: *Actions*



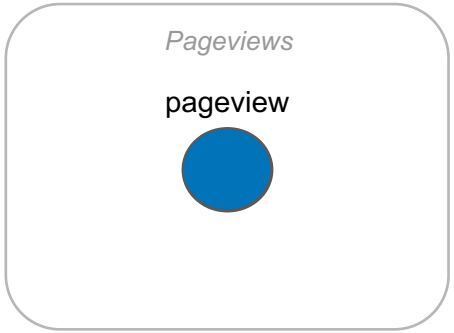
Data: *Action Attributes*



Data: *Action Types*



Action Hierarchy



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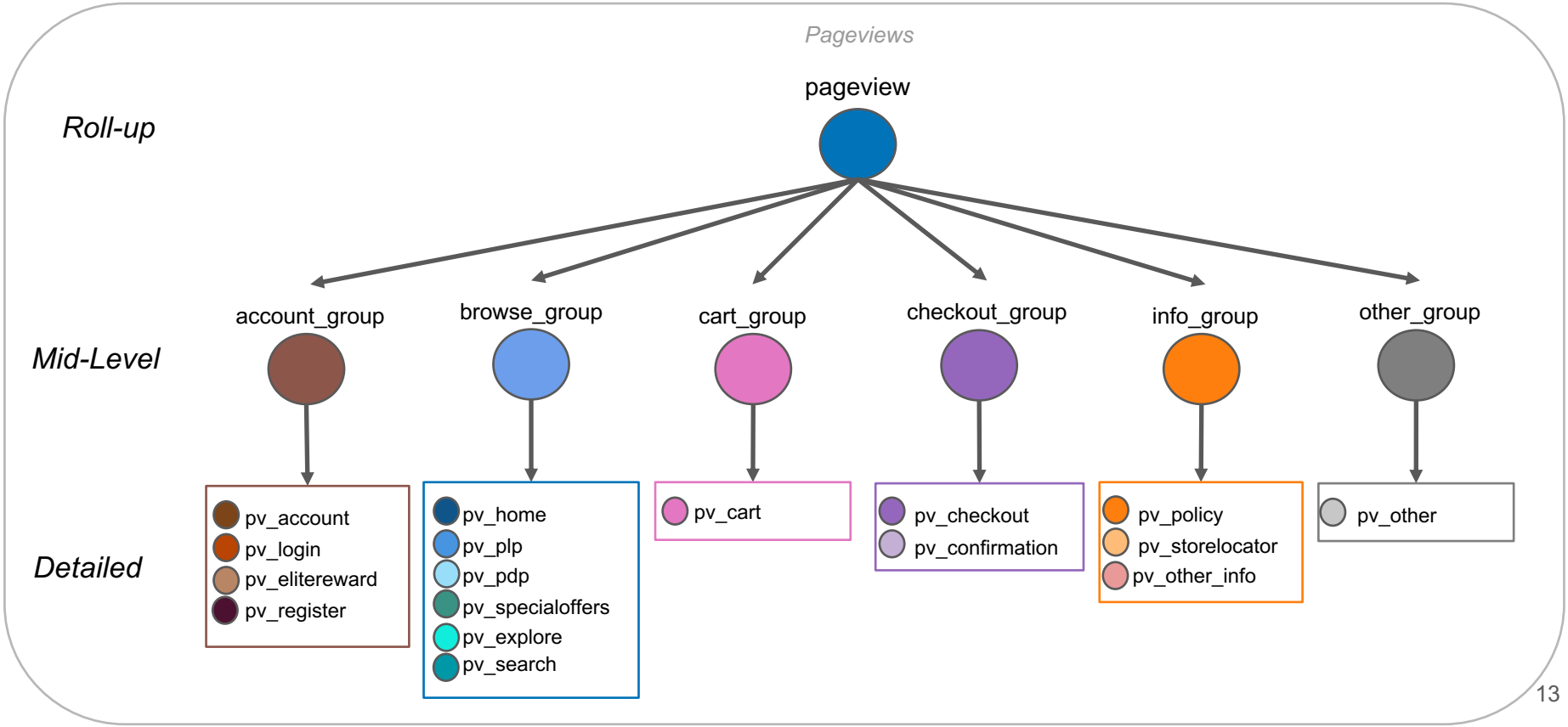
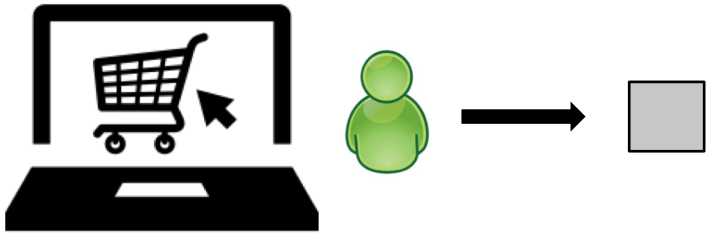
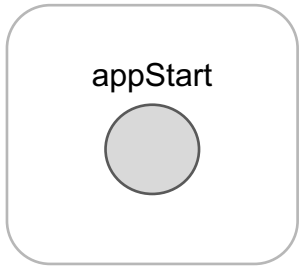


Data: *Sequences*





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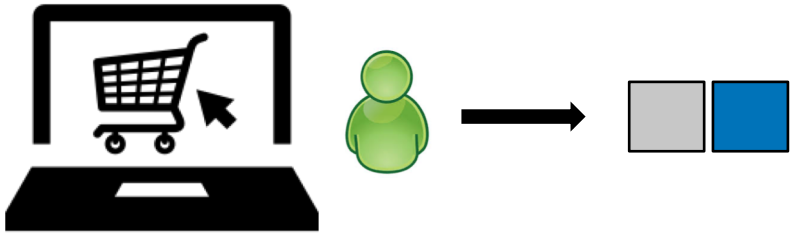
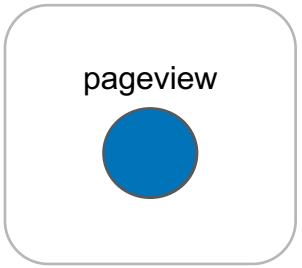
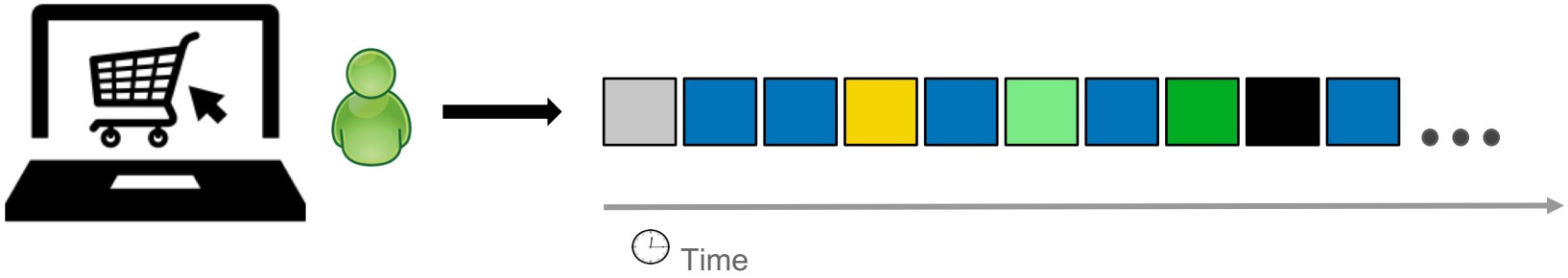


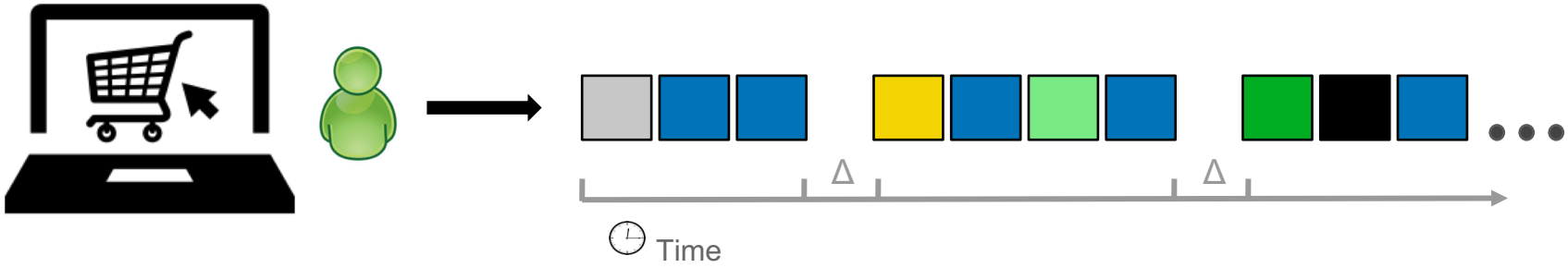


Data: *Client Sequences*



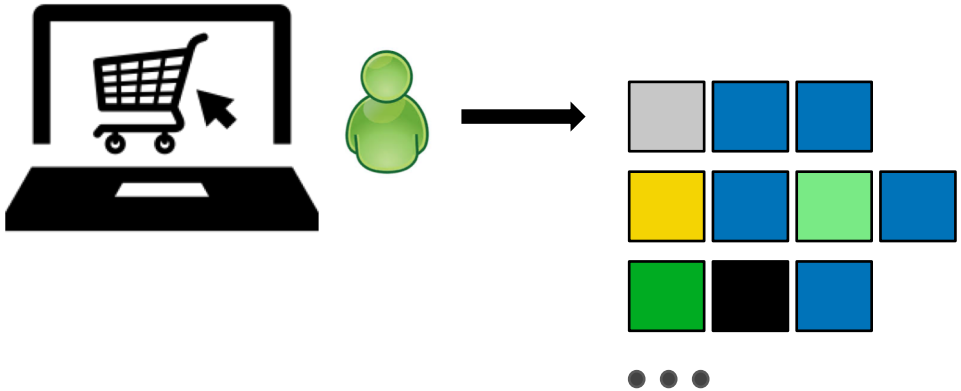
***Client Sequences*:** all actions performed by a single user

Data: *Session Sequences*



***Session Sequences*:** all actions performed by a single user within a defined amount of time (Δ) from each other. Δ is usually 30 min.

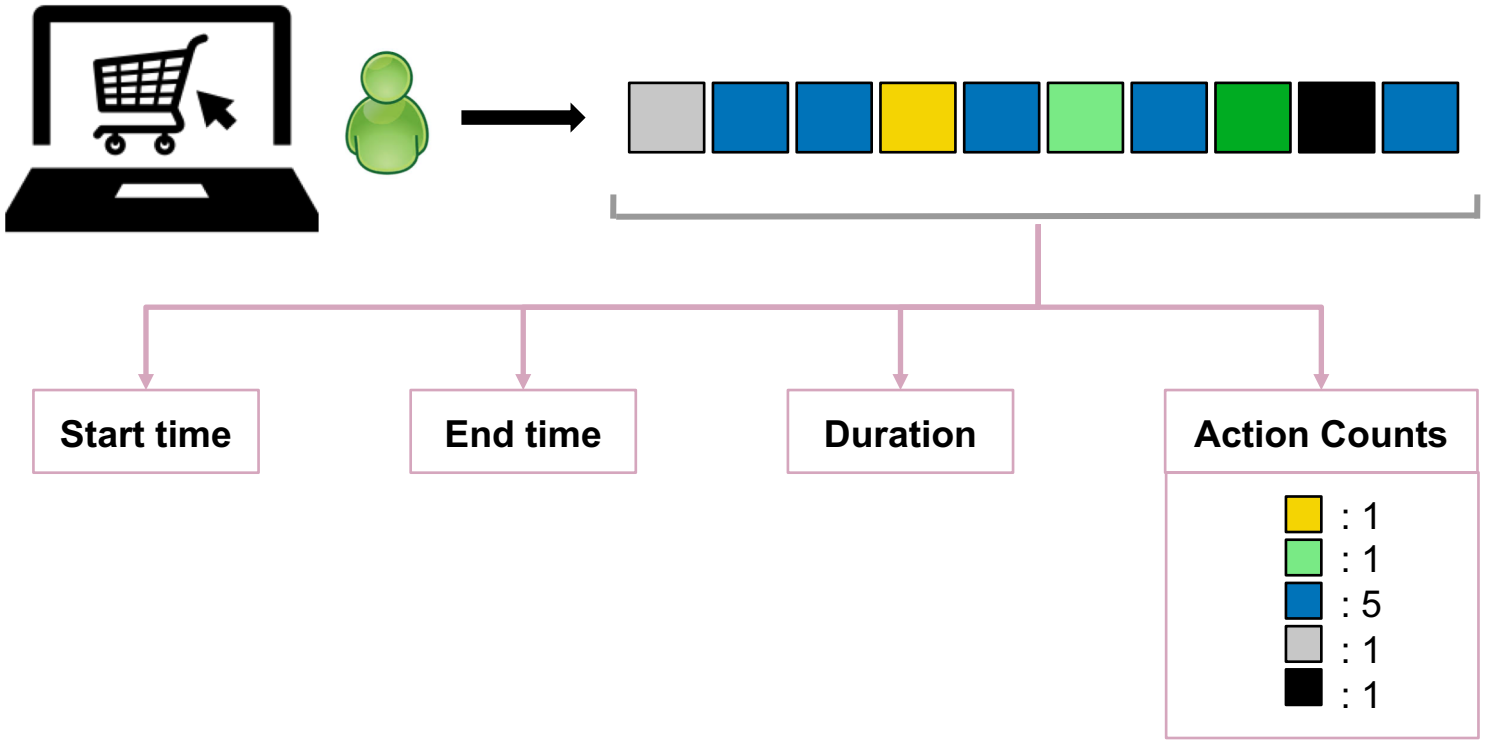
Data: *Session Sequences*



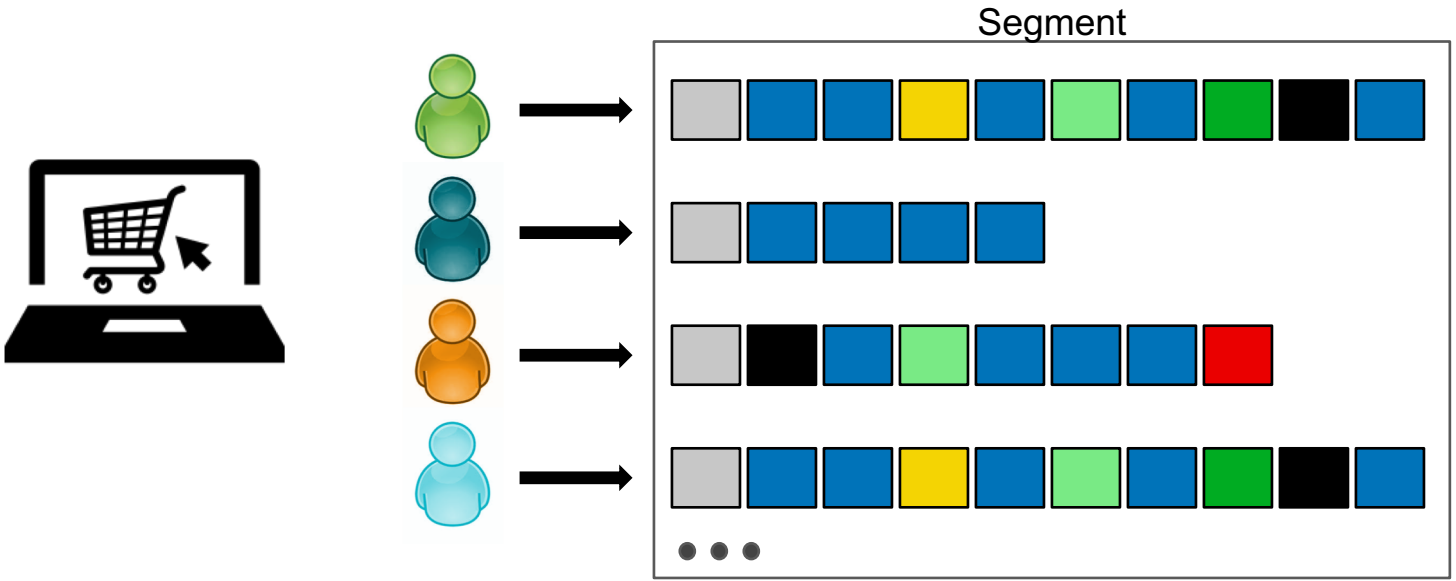
Multiple Sequences
per user

***Session Sequences*:** all actions performed by a single user within a defined amount of time (Δ) from each other. Δ is usually 30 min.

Data: *Sequence Attributes*

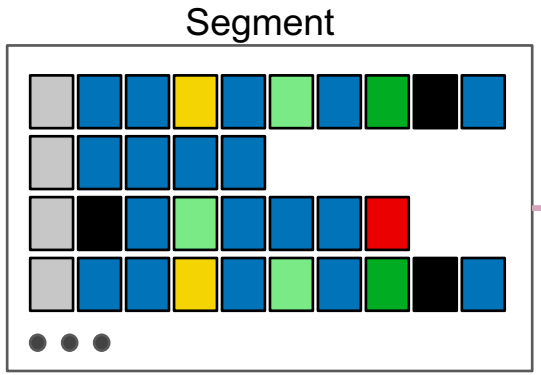


Data: *Segments*



***Segment*:** any set of sequences

Data: *Segment Attributes*



Size

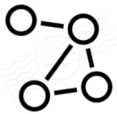
Counts of sequences:
Absolute, Relative

Sequence Related

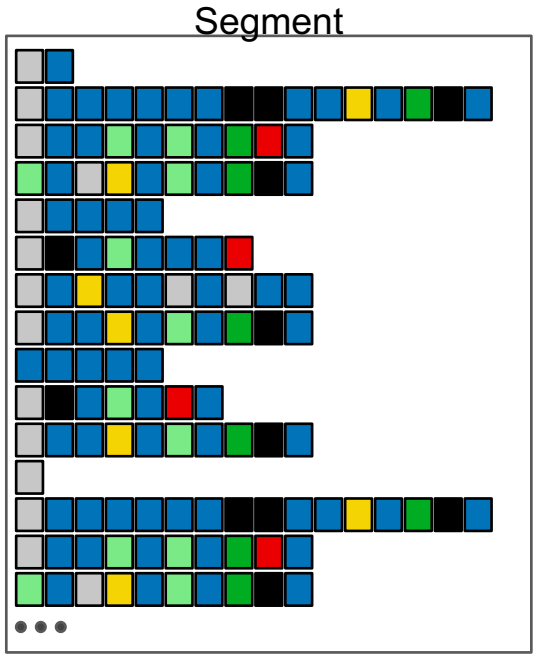
Sequence Distributions:
Start Time, Duration, Action Counts

Action Related

Action Distributions:
Action Transitions:
action before, action after



Real-world Clickstream Data



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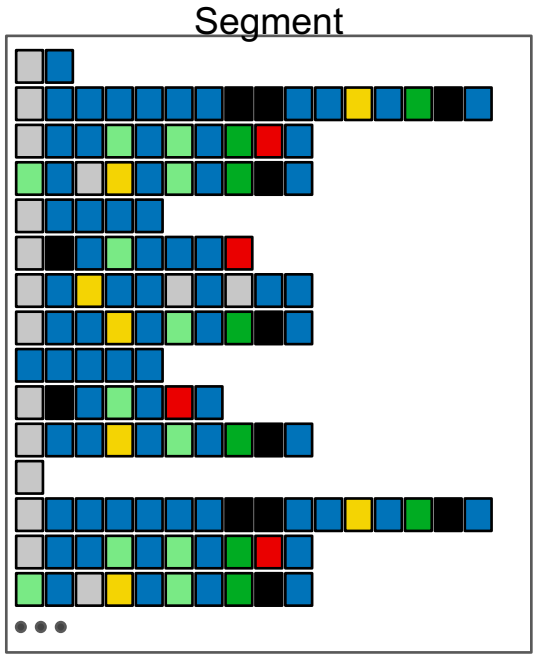
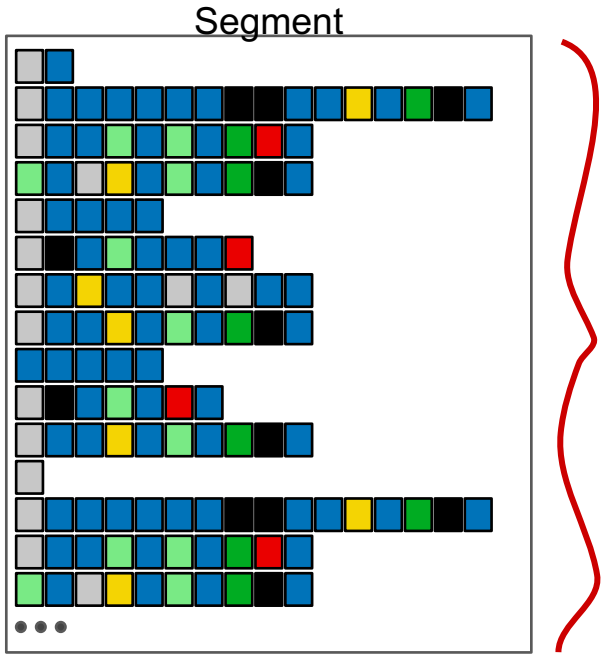


Scale is huge

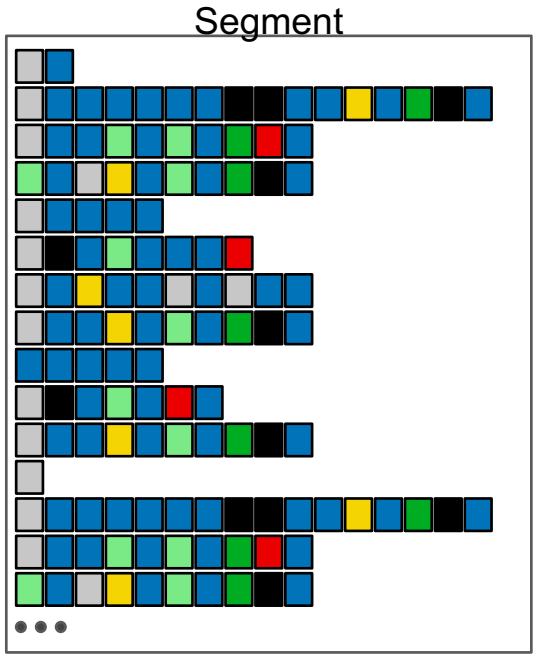
Real-world Clickstream Data



Scale is huge

Variability is high

Real-world Clickstream Data



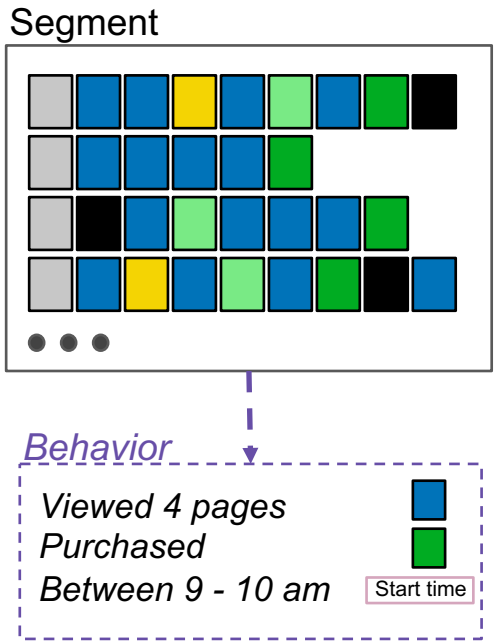
Scale is huge

Variability is high

Most work **fails** when applied to real-world data.

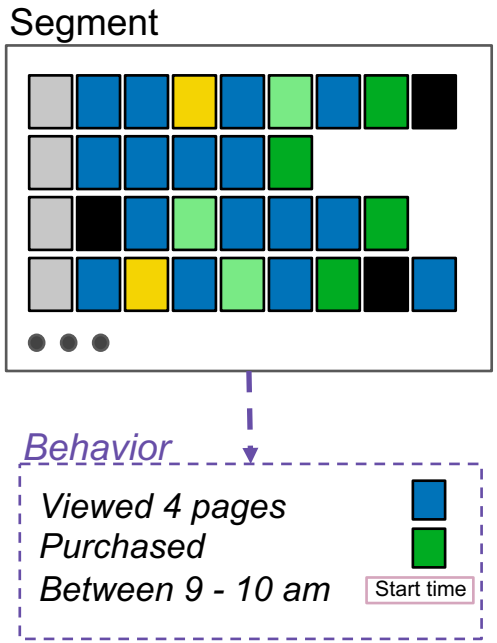
What are
Clickstream Data Analysis Tasks?

Tasks: Segment Behavior



Behavior: set of attribute constraints

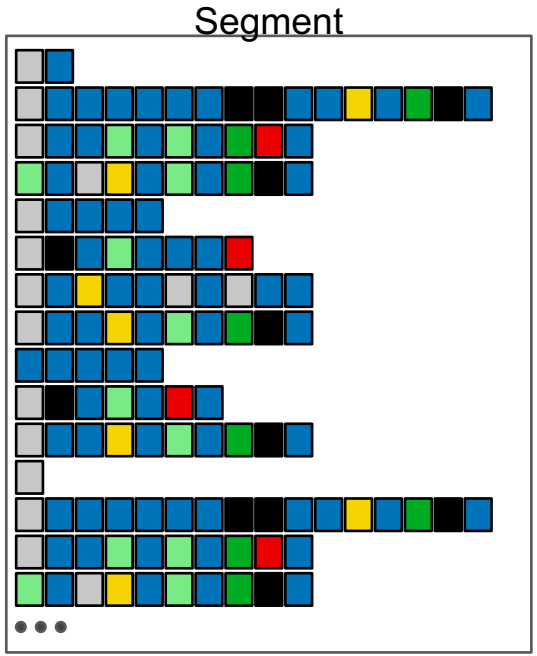
Tasks: Segment Behavior



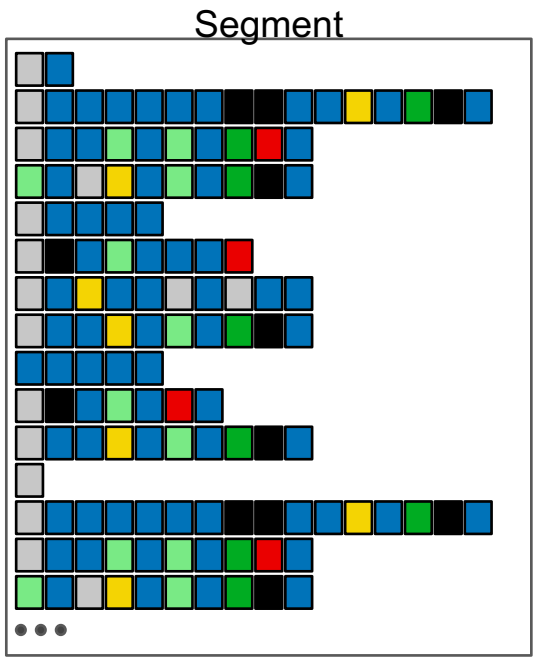
Behavior: set of attribute constraints

- **Expected**
  Users add to cart before purchasing
- **Unexpected**
  No purchases on a certain month
- **Favorable**
  Purchased
- **Unfavorable**
  Bounced

Tasks: Task Abstraction

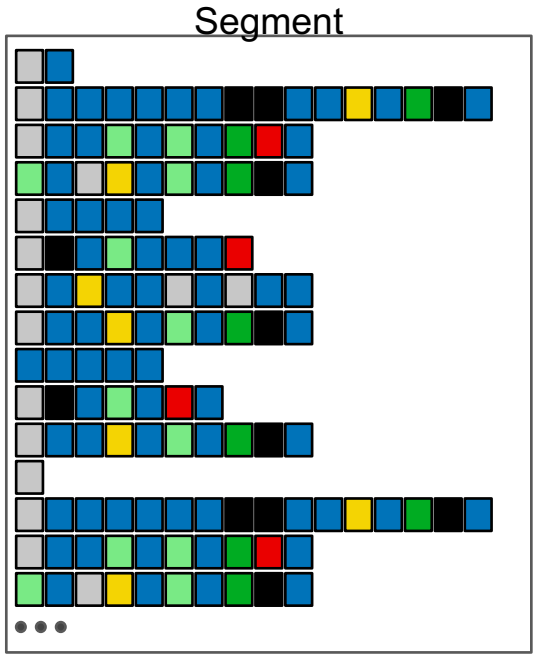


Tasks: Task Abstraction



1. **Identify:** Find some set of sequences that constitutes interesting *behavior*

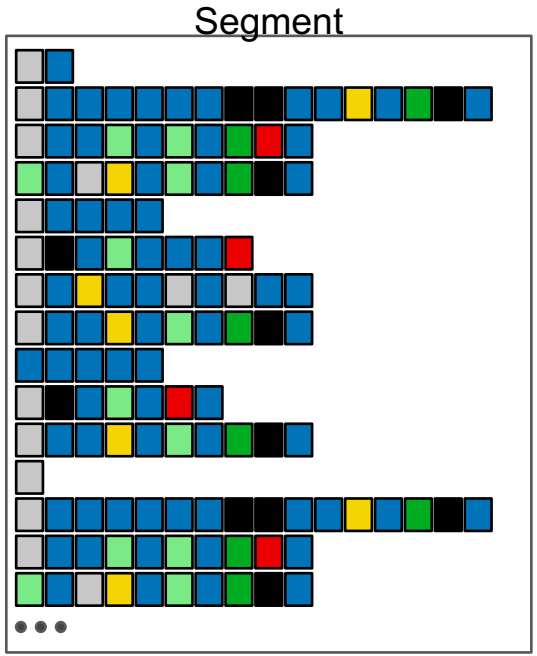
Tasks: Task Abstraction



1. **Identify:** Find some set of sequences that constitutes interesting *behavior*

2. **Drilldown:** Distinguish more specific *behaviors* to further partition a segment previously defined by looser constraints

Tasks: Task Abstraction



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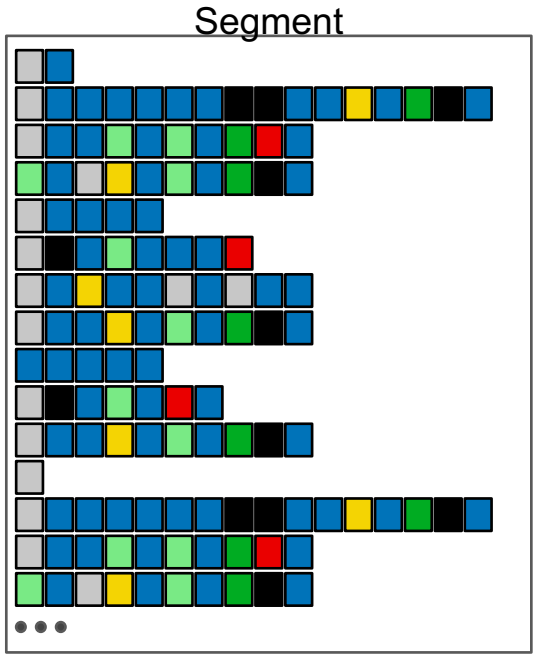
3. **Frequency:** Determine how many sequences are in the segment defined by a *behavior*

Tasks: Task Abstraction



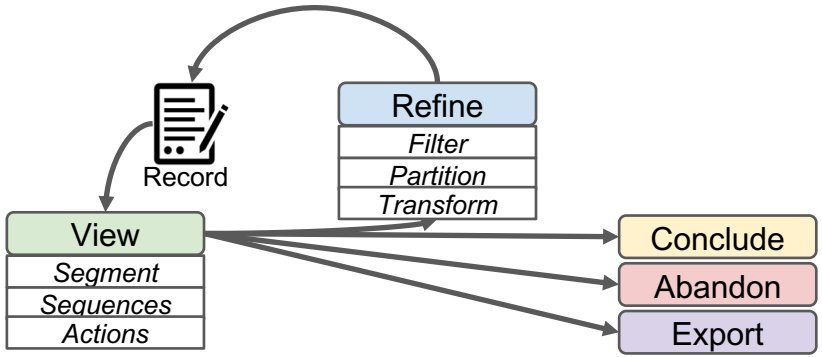
1. **Identify:** Find some set of sequences that constitutes interesting *behavior*
2. **Drilldown:** Distinguish more specific *behaviors* to further partition a segment previously defined by looser constraints
3. **Frequency:** Determine how many sequences are in the segment defined by *behavior*
4. **Ordering** within sequence: Match if one action subsequence occurs before (or after) another action subsequence in a sequence

High-Level Segmentifier Analysis Model

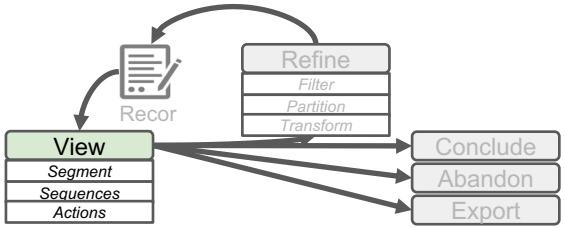
High-Level Segmentifier Analysis Model

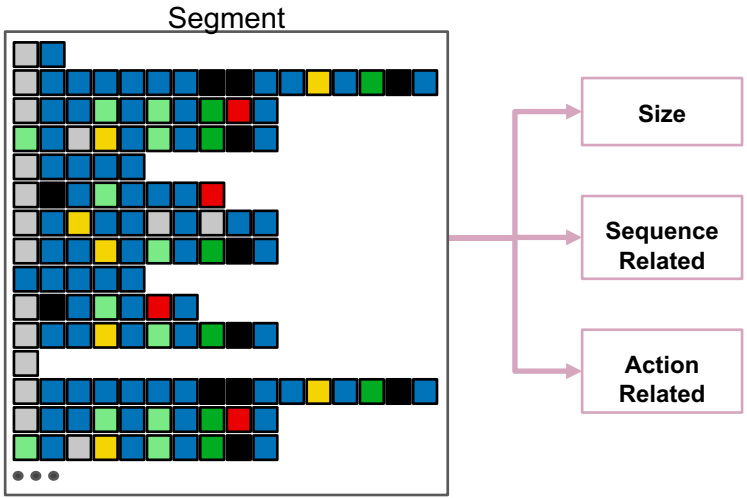
General idea:

Combine domain knowledge with computational support to iteratively view and refine large, noisy clickstream segments into segments that lead to **actionable insights** or more effective **downstream analysis**



High-Level Segmentifier Analysis Model

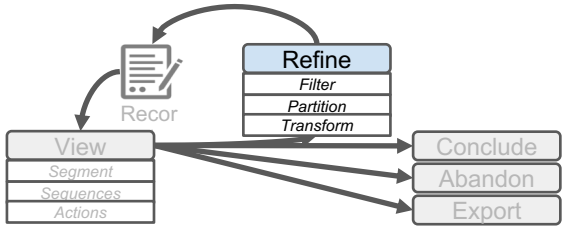


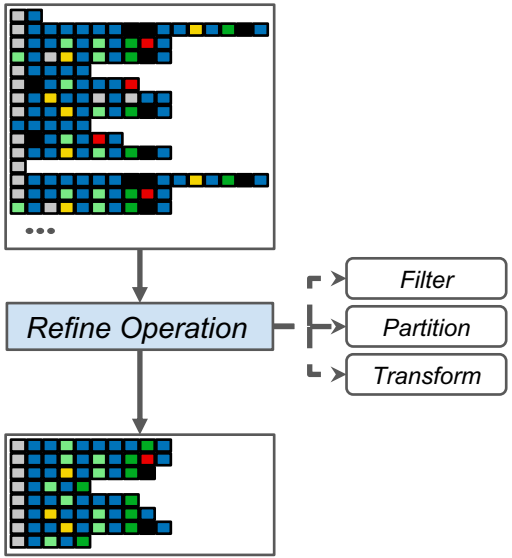


View

- Gives Insight into underlying data of segment
  - Action Attributes
  - Sequence Attributes
  - Segment Attributes
- Leads to:
  - Insights
  - New ways on how to *refine*
  - Whether segment should be *abandoned*
  - Whether segment should be *exported*

High-Level Segmentifier Analysis Model

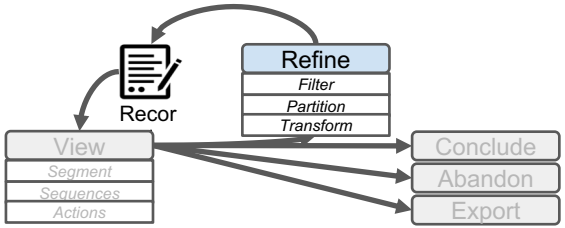


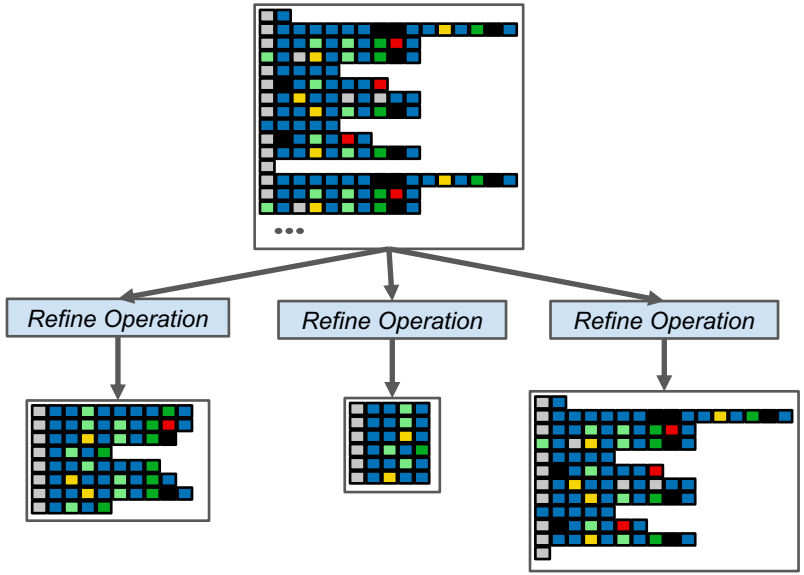


Refine

- Apply operation to create new segments
- Type of Refinements
  - *Filter*
  - *Partition*
  - *Transform*

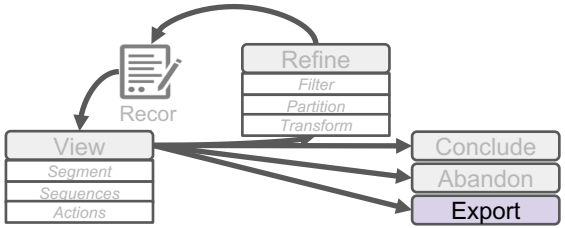
High-Level Segmentifier Analysis Model

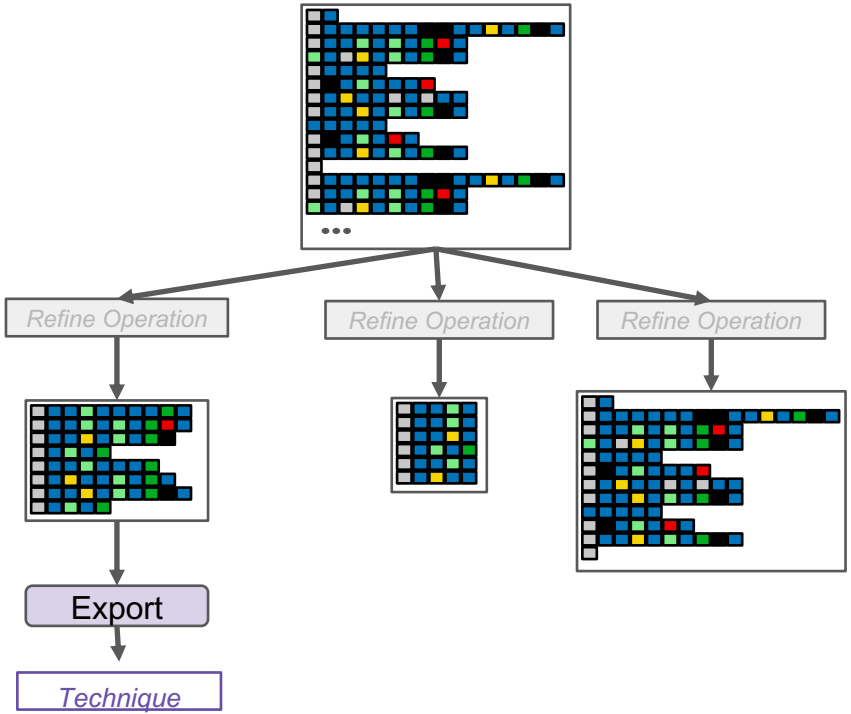




- Record all refinement steps automatically
- Keep track of questions asked and hypotheses tested
- Ability to create and view multiple segments from the same segment

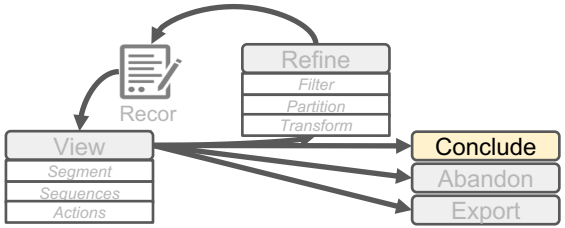
High-Level Segmentifier Analysis Model

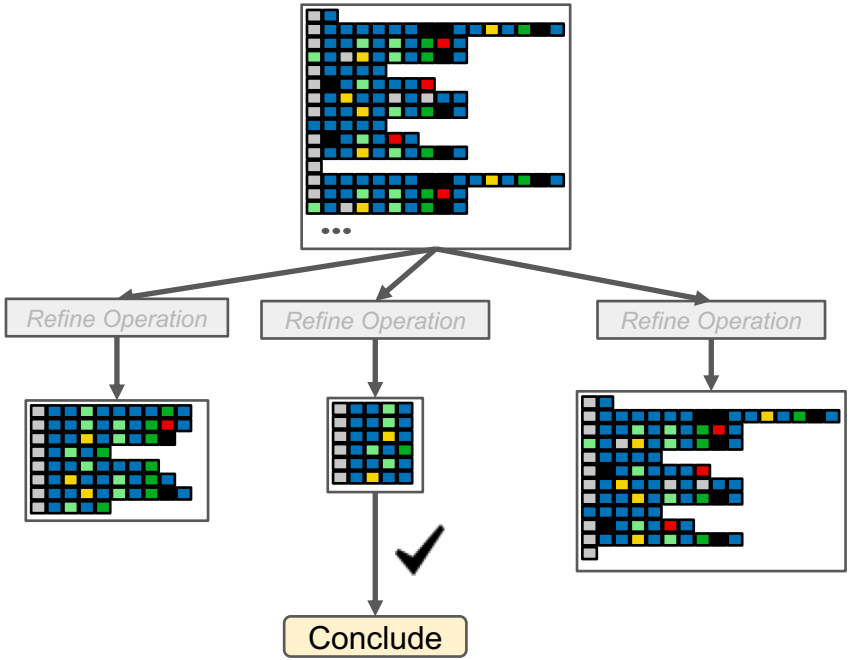




- Export refined segments for further downstream analysis, to more specific tools:
  - Pattern mining
  - Clustering

High-Level Segmentifier Analysis Model

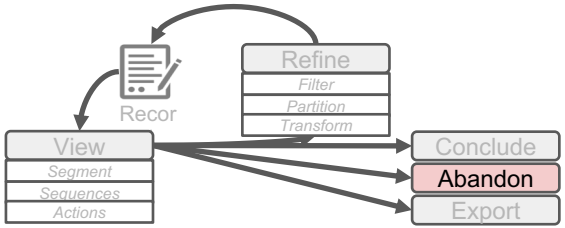




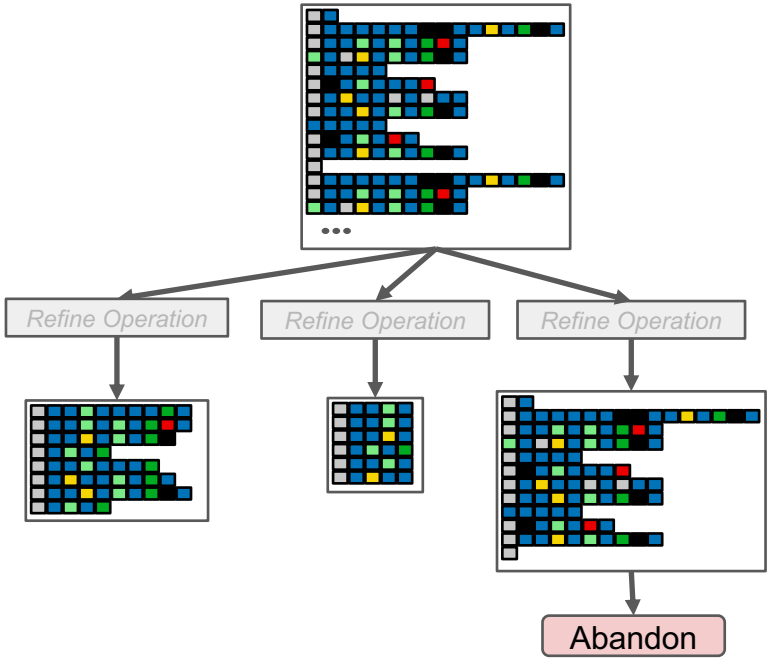
Conclude

- Discover actionable insight by *viewing* segment

High-Level Segmentifier Analysis Model



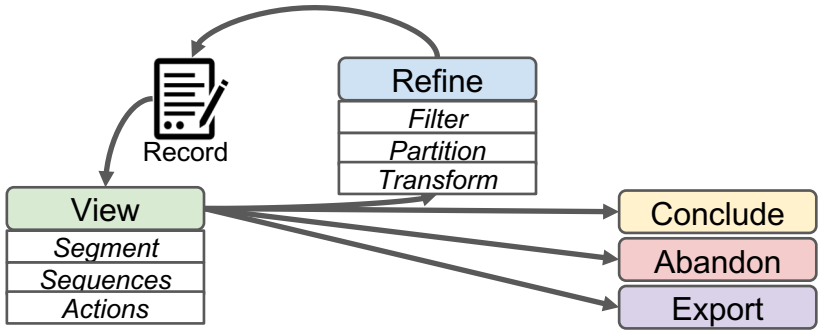
Abandon



- By *viewing* the segment, analyst *abandons* if:
  - No actionable insights
  - No further ways to *refine*
  - Not suitable for *export*

High-Level Segmentifier Analysis Model

- Take a *giant, noisy dataset* and refine it into *small, clean segments* appropriate for each *task*
- Bridge the gap between *real-world data* and other techniques
- Encapsulates the design rationale of **Segmentifier**



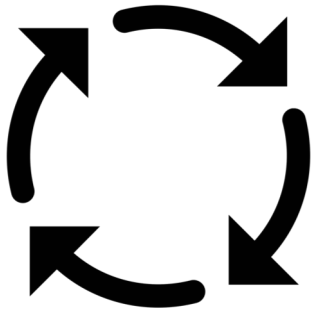
How to solve these goals with **Visual Analytics**?

Visual Analytics

Other Related Work

Our Framework

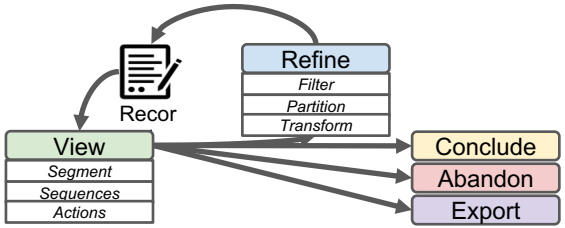
Why Visual Analytics?



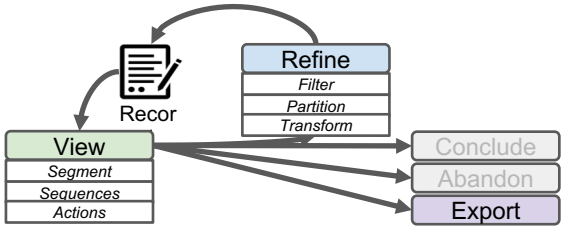
- Automation would be nice...
  - Put data in, actionable results appear
- … but it is not realistic
  - Many possible questions, data-driven interplay between finding answers and generating new questions
- Human-in-the-loop visual data analysis
  - Integrate computing power of machine with intuition of domain experts

What **Visual Analytics Systems** exist for **Clickstream Data Analysis**?

Related Work



Related Work



Export

Post-Export: Specific Techniques

- Clustering: [Wei 2012]. Pattern Mining: CoreFlow [Liu 2017], Frequence [Perer 2014]
- Require small, clean datasets

View

View Sequences: Event Sequence Visual Overviews

- CareFlow [Perer 2013]
- Limited ability to refine segments or view segment attributes

Refine

Refine: Visual Query Systems

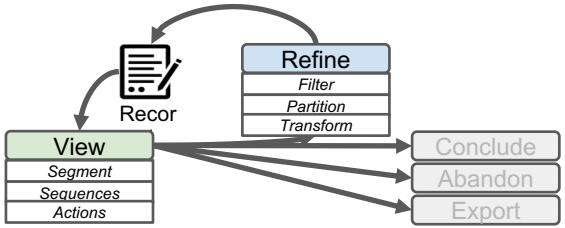
- COQUITO [Krause 16], (s|qu)eries [Zgraggen 2015]
- No ability to view attributes

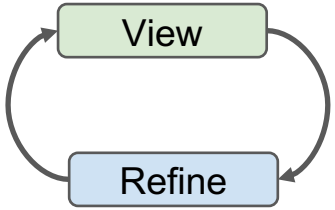
Record

Record: Graphical Histories

- Graphical histories help remember analysis path [Heer 2008]

Related Work





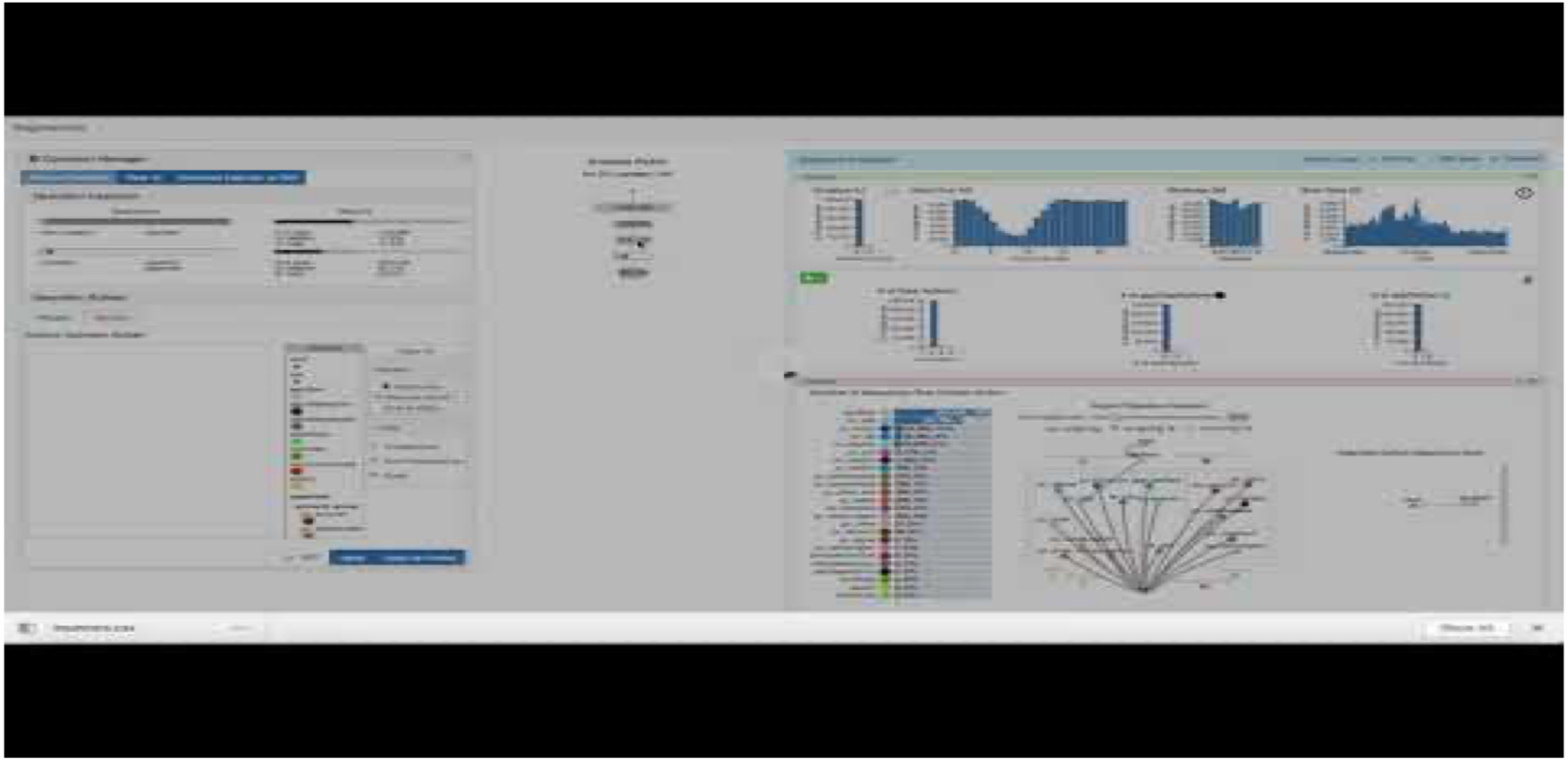
View and Refine: Filtering Sequences To Segments

- SessionViewer [Lam 2007], EventFlow [Munroe 2013] , EventPad [Cappers 2018]
- Lack of segment attributes
- Lack of ability to record analysis path
- Focus is on looking at the level of detail of the sequences which is unscalable

Our Solution

The Segmentifier Interface

The Segmentifier Interface



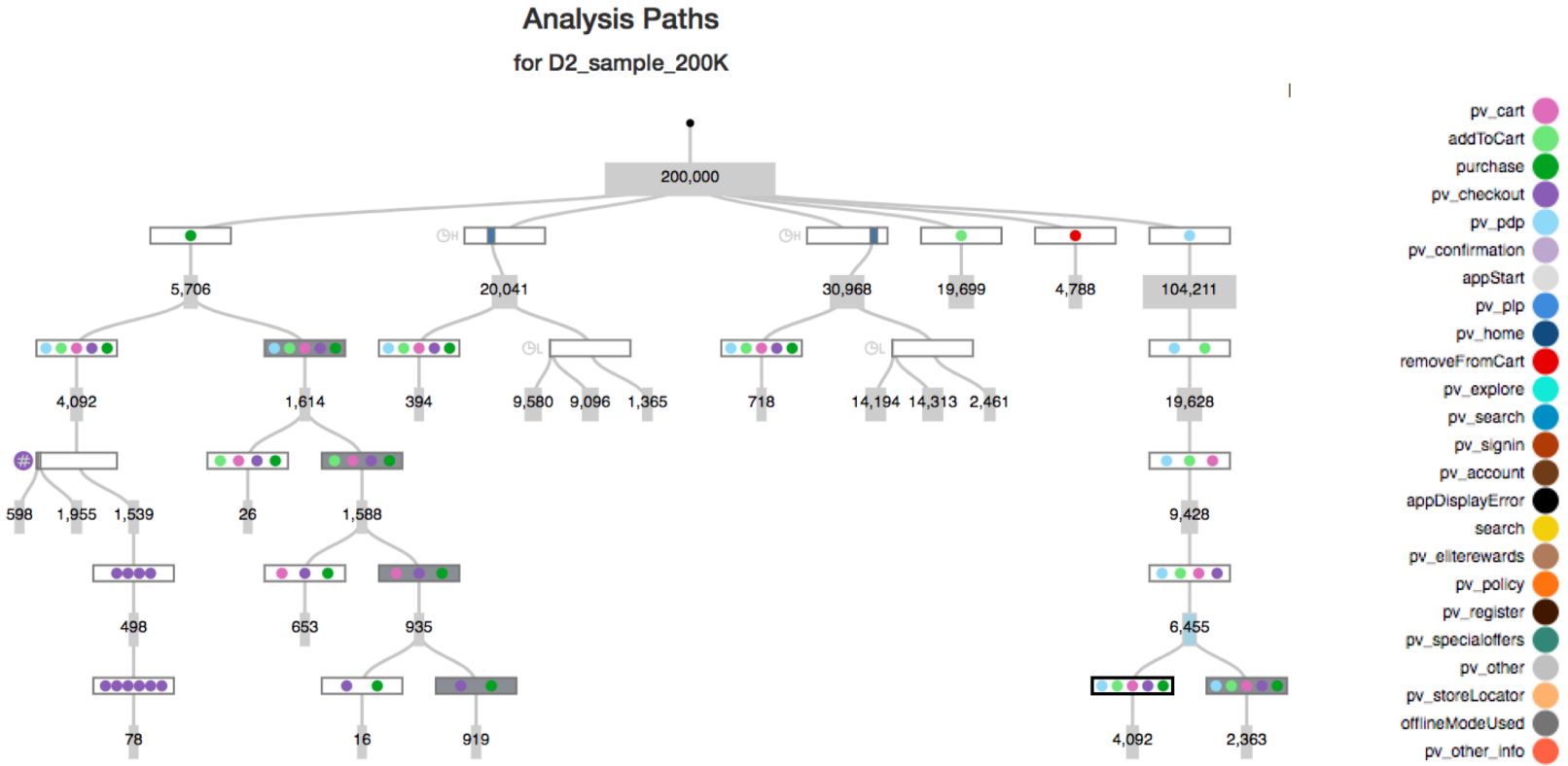
https://www.youtube.com/watch?v=TobYDFeISOg&t=20s

Results

Case Study #1

- 2 hour chauffeured analysis
- With industry data analyst
- Purpose:
  - One month post launch report
  - Discover actionable insights and improvements for customer
- Data
  - Session sequences
  - 200K sequences

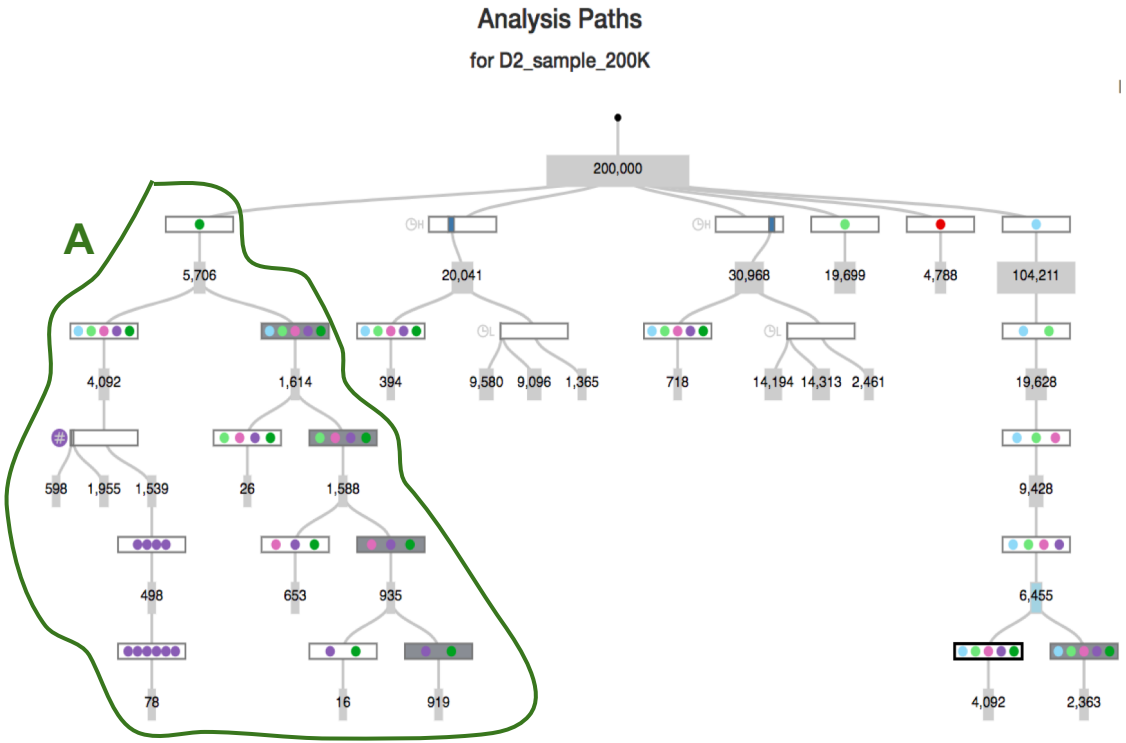
Case Study #1


Analysis Paths
for D2_sample_200K
200,000
5,706
20,041
30,968
19,699
4,788
104,211
4,092
1,614
394
9,580
9,096
1,365
718
14,194
14,313
2,461
19,628
598
1,955
1,539
26
1,588
9,428
498
653
935
6,455
78
16
919
4,092
2,363
pv_cart
addToCart
purchase
pv_checkout
pv_pdp
pv_confirmation
appStart
pv_plp
pv_home
removeFromCart
pv_explore
pv_search
pv_signin
pv_account
appDisplayError
search
pv_eliterewards
pv_policy
pv_register
pv_specialoffers
pv_other
pv_storeLocator
offlineModeUsed
pv_other_info

Case Study #1: *Analysis A*

A Analyze Purchasing Behavior

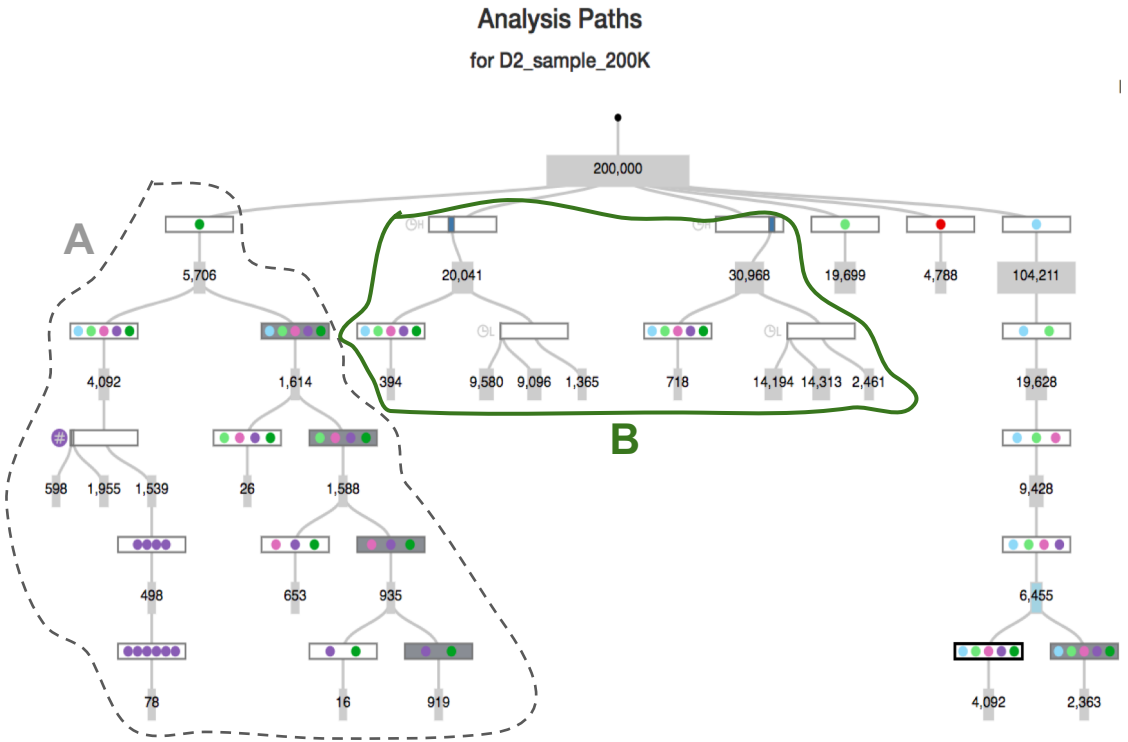
- 12% of sessions contain more checkout pages than necessary
- 30% of users actually exit the site and return later to complete their purchase



Case Study #1: *Analysis B*

B Compare Morning vs Night

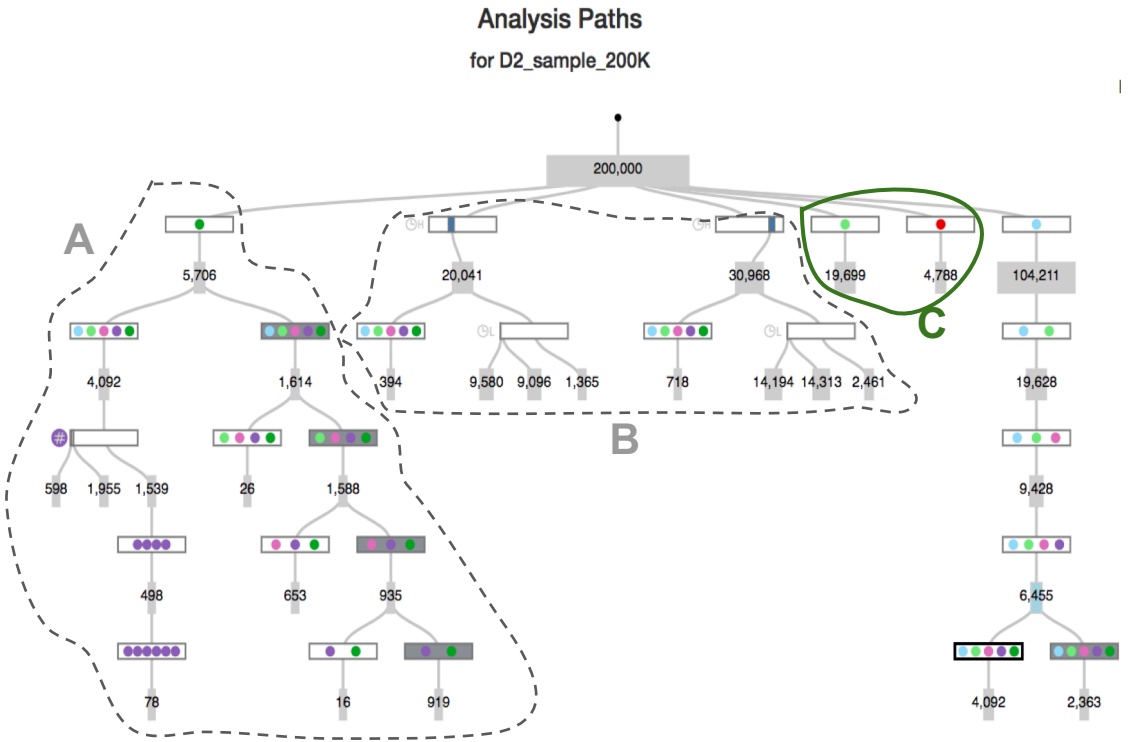
- No significant difference for percentage of sessions that contain full purchasing funnel
- No significant difference for number of actions



Case Study #1: *Analysis C*

C Analyze add and remove from cart behavior

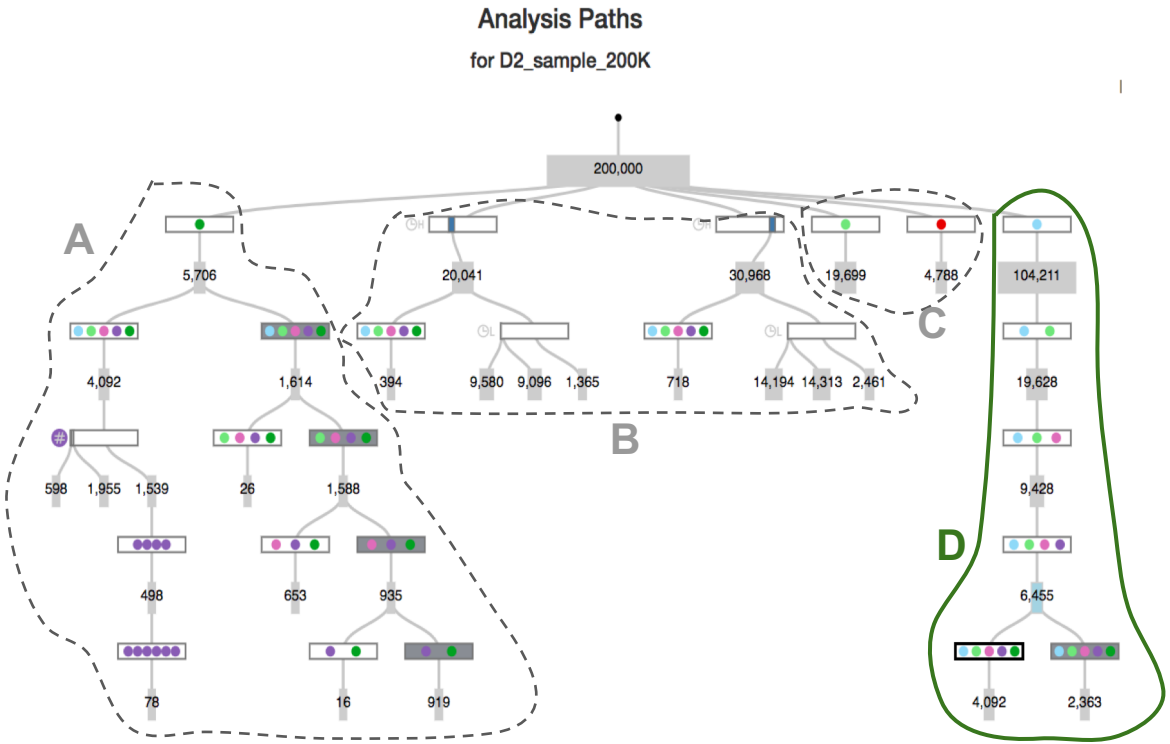
- No insight for add to cart behavior
- 30% of users who removed from cart exited the session and most likely did not come back



Case Study #1: *Analysis D*

D	Analyze purchasing funnel

- 20% of people who get to checkout will not end up purchasing



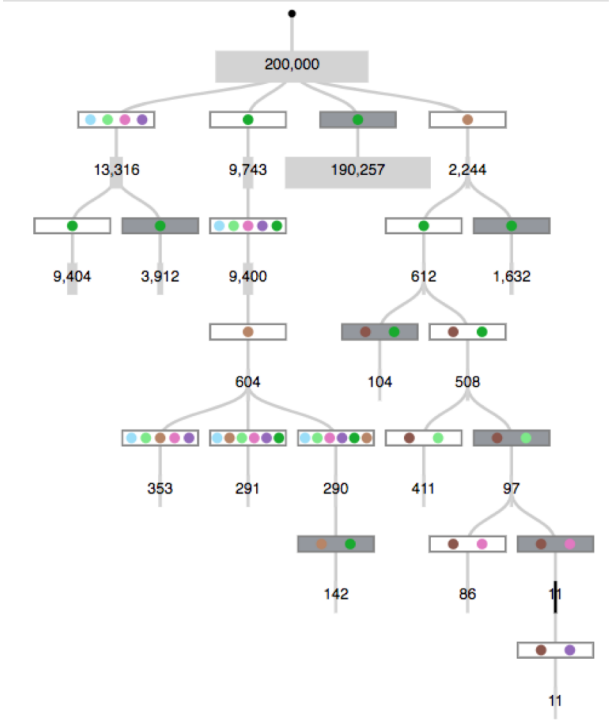
Case Study #2

- 2 hour chauffeured analysis
- With industry data analyst
- Purpose:
  - Revisit some questions from last analysis using **client sequences**
- Data
  - **Client sequences**
    - Much longer
    - Capture longitudinal behavior
  - 200K sequences

Case Study #2

Summary of Insights

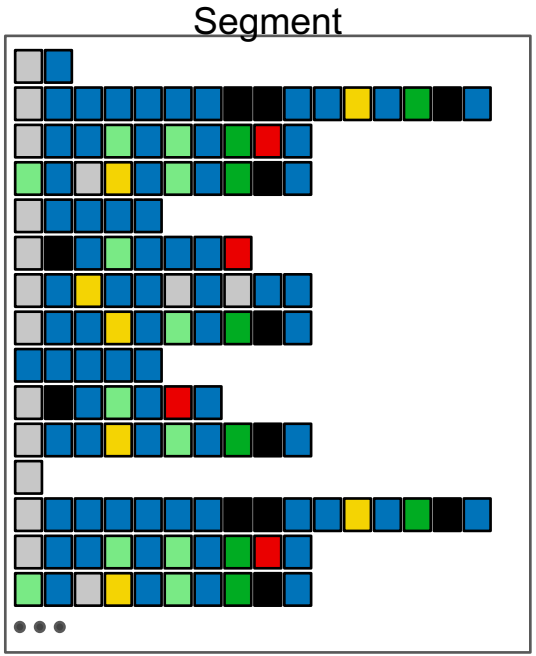
- 25% who remove from cart at checkout stage, exit and never purchase
- appStart action triggered before cart page
- Awards page analysis:
  - 1% signed up
  - 27% purchased
  - Longer sequences



Discussion

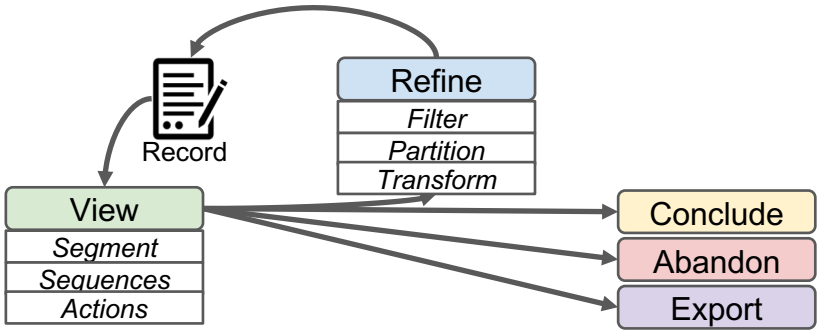
Discussion

- Goal is **Scalability**
  - Initial iterative visual refinement of large segments into useful ones
  - Attributes that align with analyst's intuitions about interesting behavior
  - Quick forming and testing of hypotheses
  - **Result:** more effective fine-grained downstream analysis



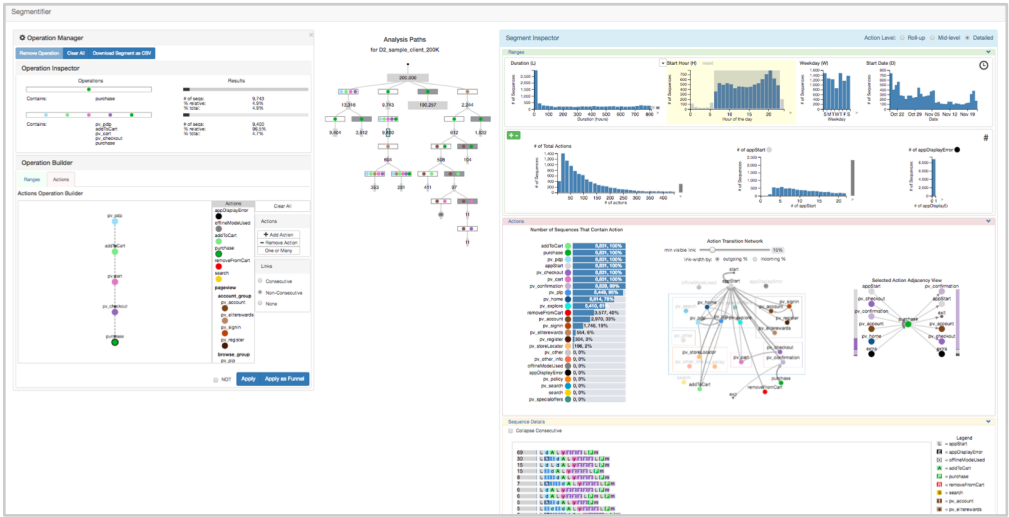
Conclusions

- Thorough **characterization of task and data abstraction** for clickstream data analysis



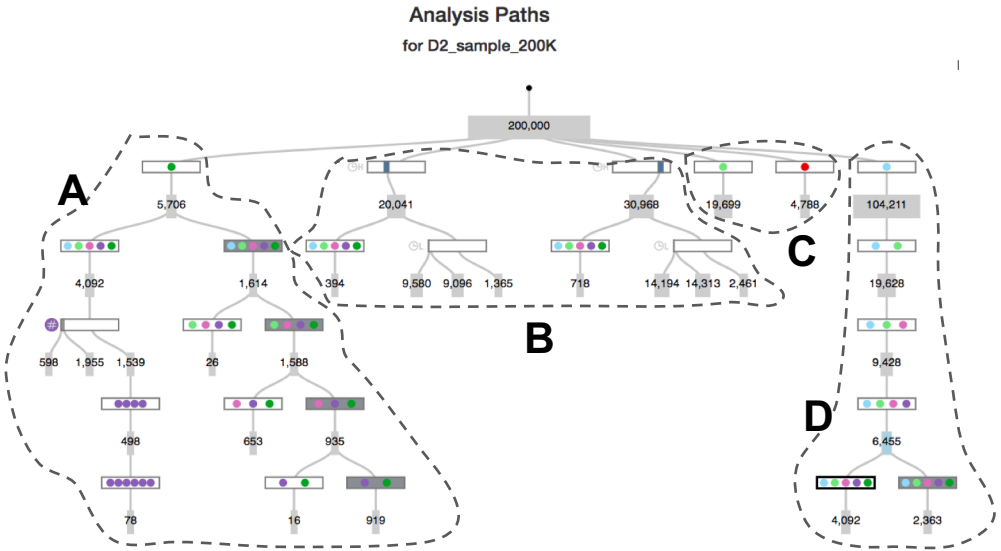
Conclusions

- Thorough **characterization of task and data abstraction** for clickstream data analysis
- **Segmentifier: novel analytics interface** for refining data segments and viewing characteristics before downstream fine-grained analysis



Conclusions

- Thorough **characterization of task and data abstraction** for clickstream data analysis
- **Segmentifier: novel analytics interface** for refining data segments and viewing characteristics before downstream fine-grained analysis
- Preliminary **evidence of utility**



Segmentifier:
Interactive Refinement of Clickstream Data

Kimberly Dextras-Romagnino, k.dextras.romagnino@gmail.com
Tamara Munzner, tmm@cs.ubc.ca, @tamaramunzner

More info: http://www.cs.ubc.ca/labs/imager/tr/2019/segmentifier/

Affiliations

UBC

DESIGNING for PEOPLE

KABAM

Special Thanks

Mobify

MITACS

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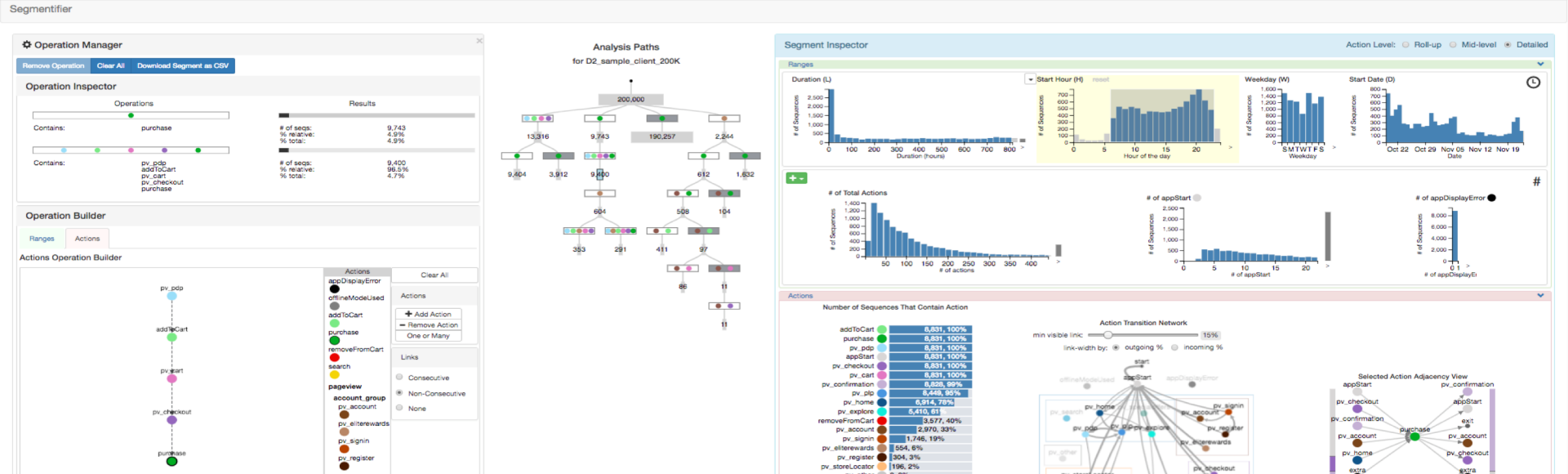


Backup Slides

Operation Manager

Remove Operation | Clear All | Download Segment as CSV

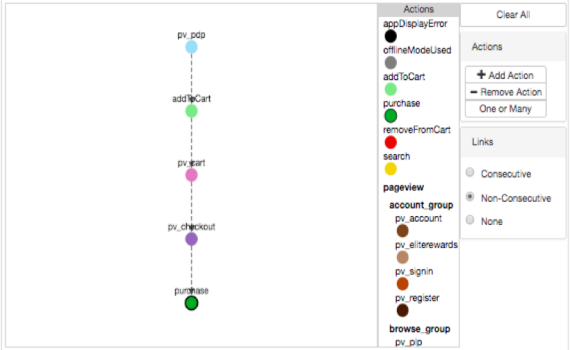
Operation Inspector

Operations		Results	
Contains:	purchase	# of seqs: % relative: % total:	9,743 4.9% 4.9%
Contains:	pv_pdp addToCart pv_cart pv_checkout purchase	# of seqs: % relative: % total:	9,400 96.5% 4.7%

Operation Builder

Ranges | Actions

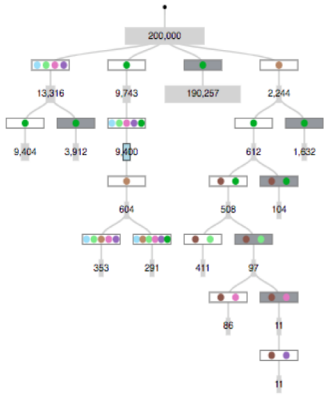
Actions Operation Builder



NOT | Apply | Apply as Funnel

Analysis Paths

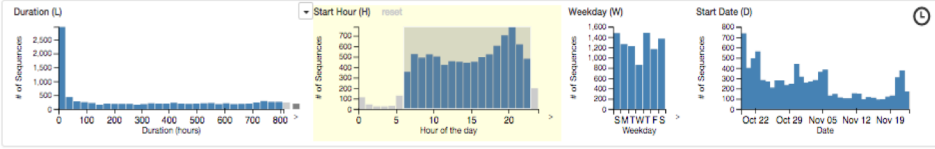
for D2_sample_client_200K

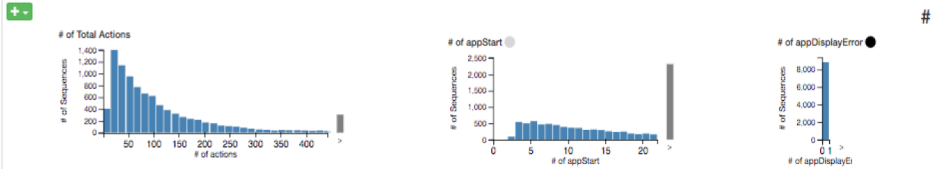


Segment Inspector

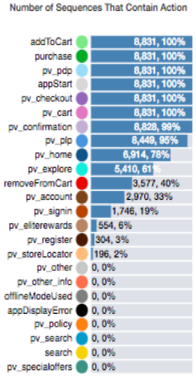
Action Level: Roll-up | Mid-level | Detailed

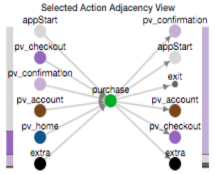
Ranges





Actions





Sequence Details

Collapse Consecutive

Tasks: Actionable Results

Actionable Result: result or insight found through analysis that can be acted on

Result ⇒ *Action*

Actionable Results

Identify successful trends	⇒	Optimize
Identify problems	⇒	Fix/Improve
Identify groups of common behavior	⇒	Personalize experience
Identify site metrics/benchmarks	⇒	Keep track of state of website

Tasks: Actionable Results

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Result ⇒ *Action*

Actionable Results

Identify successful trends	⇒	**Optimize**
Identify problems	⇒	Fix/Improve
Identify groups of common behavior	⇒	Personalize experience
Identify site metrics/benchmarks	⇒	Keep track of state of website

Domain-Specific Questions

How many users purchase? What path did they choose?

Tasks: Actionable Results

Actionable Result: result or insight found through analysis that can be acted on

Result ⇒ Action

Actionable Results

Identify successful trends	⇒	Optimize
Identify problems	⇒	**Fix/Improve**
Identify groups of common behavior	⇒	Personalize experience
Identify site metrics/benchmarks	⇒	Keep track of state of website

Domain-Specific Questions

How many bounce (exit after viewing one page)?

Tasks: Actionable Results

Actionable Result: result or insight found through analysis that can be acted on

Result ⇒ *Action*

Actionable Results

Identify successful trends	⇒	Optimize
Identify problems	⇒	Fix/Improve
Identify groups of common behavior	⇒	**Personalize experience**
Identify site metrics/benchmarks	⇒	Keep track of state of website

Domain-Specific Questions

Can you classify different types of buying behaviors?

Tasks: Actionable Results

Actionable Result: result or insight found through analysis that can be acted on

Result ⇒ Action

Actionable Results

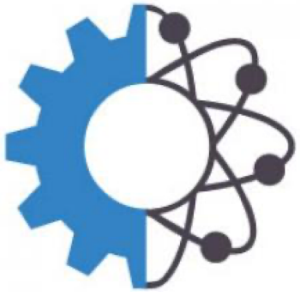
Identify successful trends	⇒	Optimize
Identify problems	⇒	Fix/Improve
Identify groups of common behavior	⇒	Personalize experience
Identify site metrics/benchmarks	⇒	**Keep track of state of website**

Domain-Specific Questions

What is the average number of sessions in a month? Was this month abnormal?

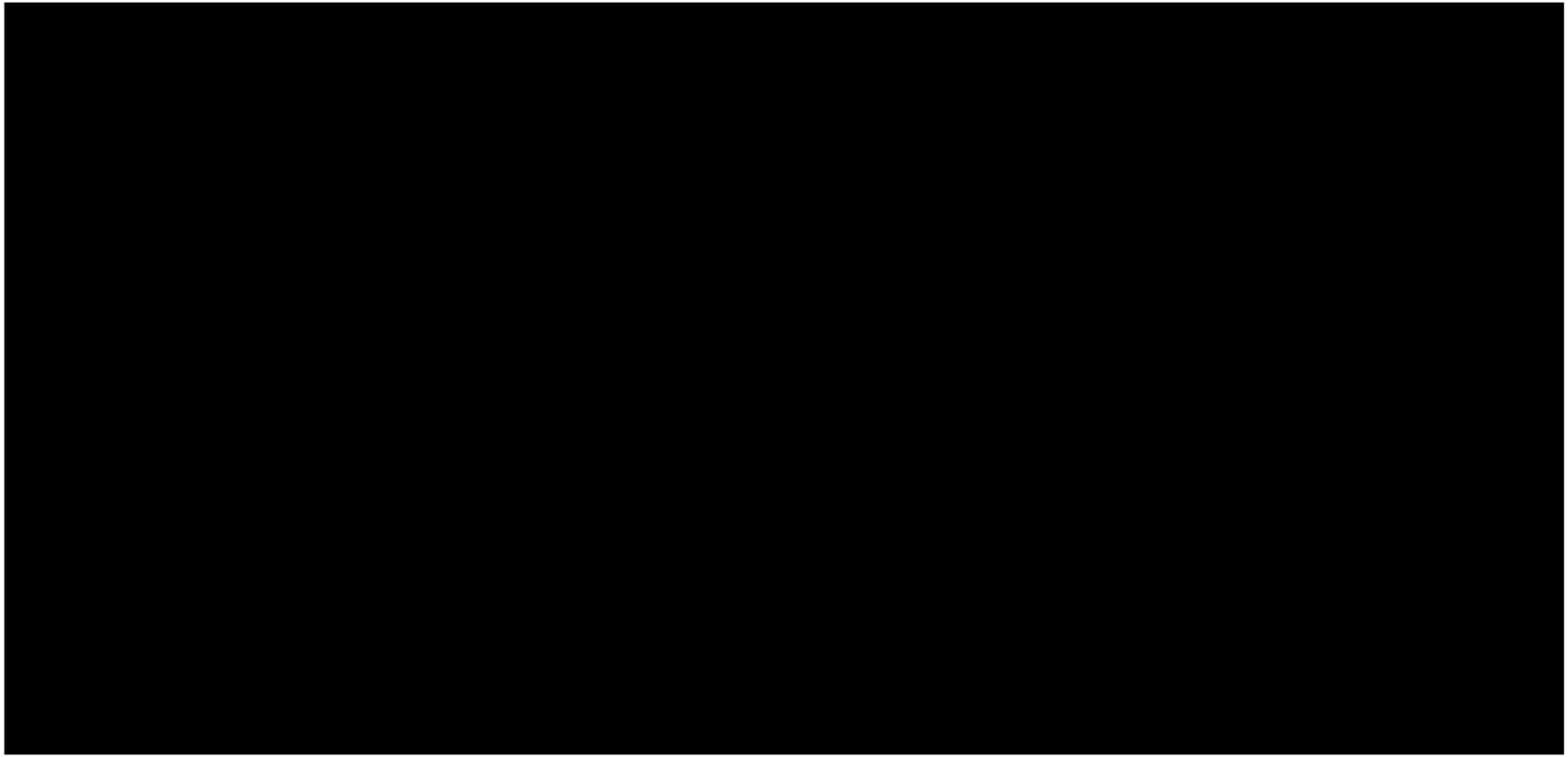
Discussion + Future Work

- Focus on agile and iterative development of design
  - Modest engineering effort to achieve base level of usability to test design concept
    - Loading times
    - Processing time
  - Goal:
    - Proof of concept that design works for target tasks
    - Not (premature) engineering optimization
  - Future work:
    - Engineering optimization for this final design



Extra Slides

The Segmentifier Interface

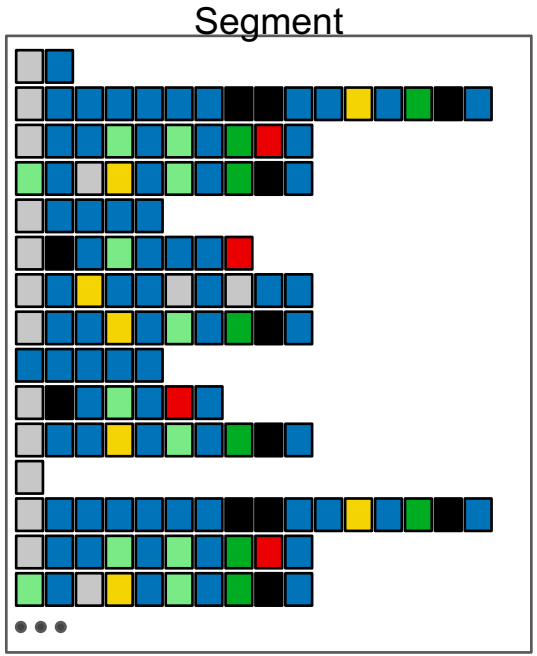


https://www.youtube.com/watch?v=TobYDFeISOg&t=24s

Research Method: Mobify

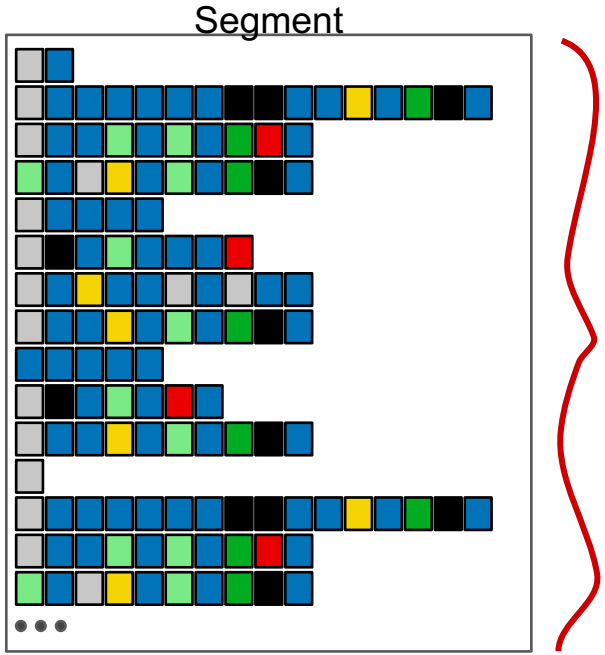
- **Pre-condition** Phase
  - Period of 5 months
  - Met with 12 employees
- **Core** Phase
  - Data and Task Abstraction
  - Design interface
  - Implement interface
- **Analysis** Phase
  - Formulate Framework
  - Write Paper/Thesis

Real-world Clickstream Data



Scale is huge

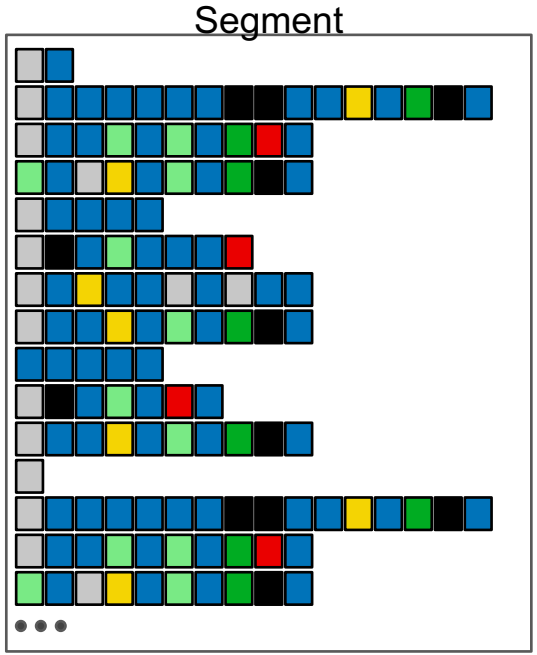
Real-world Clickstream Data



Scale is huge

Variability is high

Real-world Clickstream Data



Scale is huge

Variability is high

Most work **fails** when applied to real-world data.

Technique

Most techniques have data requirements to work effectively

Exploratory

Most focus on analyzing sequences.
Too many to view at once.

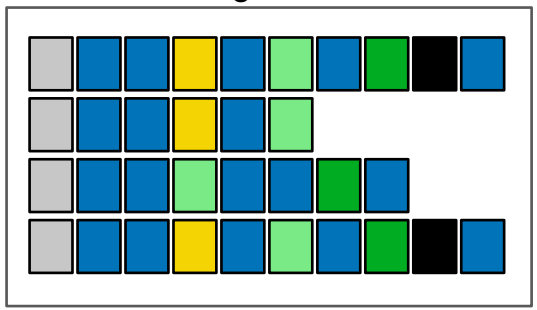
Related Work: Problems

Technique

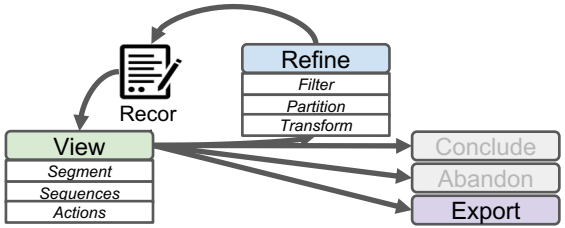
Exploratory

Evaluated using small, clean datasets

Segment



Related Work



Export

Post-Export: Specific Techniques

- Clustering [Wei et al.], Pattern Mining (CoreFlow [Liu et al.], Frequence [Perer et al.]
- Require small, clean datasets

View

View Sequences: Event Sequence Visual Overviews

- CareFlow [Perer et al.]
- Can't refine segments or view segment attributes

Refine

Refine: Visual Query Systems

- i.e. COQUITO [KPS16], (s|qu)eries [ZDFD15], DecisionFlow [GS14], PatternFinder [FKSS06], and SparqlFilterFlow [HLBE14]

Record

Record: Graphical Histories

i.e.

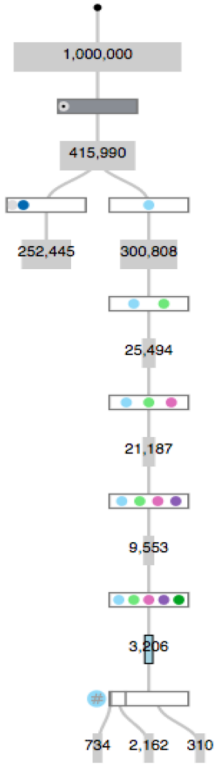
Tasks: Task Abstraction

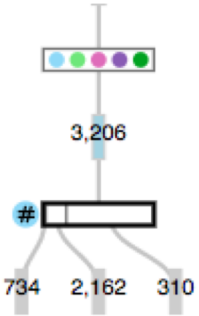
- **T1) Identify:** Find some set of sequences that constitutes interesting behavior
  - consumers in loyalty program browse longer
- **T2) Drilldown:** Distinguish more specific behaviors to further partition a segment previously defined by looser constraints
  - check if purchasers fall into natural groups by time of day
- **T3) Frequency:** Determine how many sequences are in the segment defined by behavior X
  - check ratio of bouncers to non- bouncers
- **T4) Ordering** within sequence: Match if action subsequence X occurs before (or after) action subsequence Y in a sequence
  - verify that all users add to cart before purchasing

Discussion + Future Work

- Understandable segments:
  - Each possible refinement operation corresponds to one attribute constraint
  - In contrast to clustering, pattern mining that have uninterpretable results for this scale of noisy data

- Segmentifier explicitly supports refinement through both filtering and partitioning.
  - Encourages subsequent analysis
  - Allows comparison
  - Future comparison work





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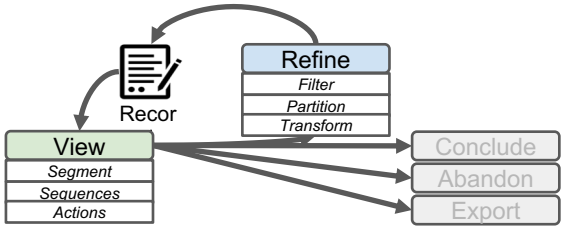

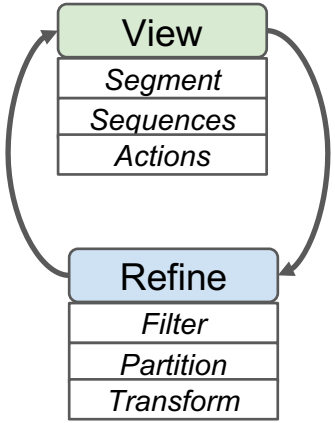

View and Refine: Filtering Sequences To Segments

- SessionViewer [Lam 2007], EventFlow [Munroe 2013] , EventPad [Cappers 2018]
- Lack of segment attributes
- Lack of ability to record analysis path