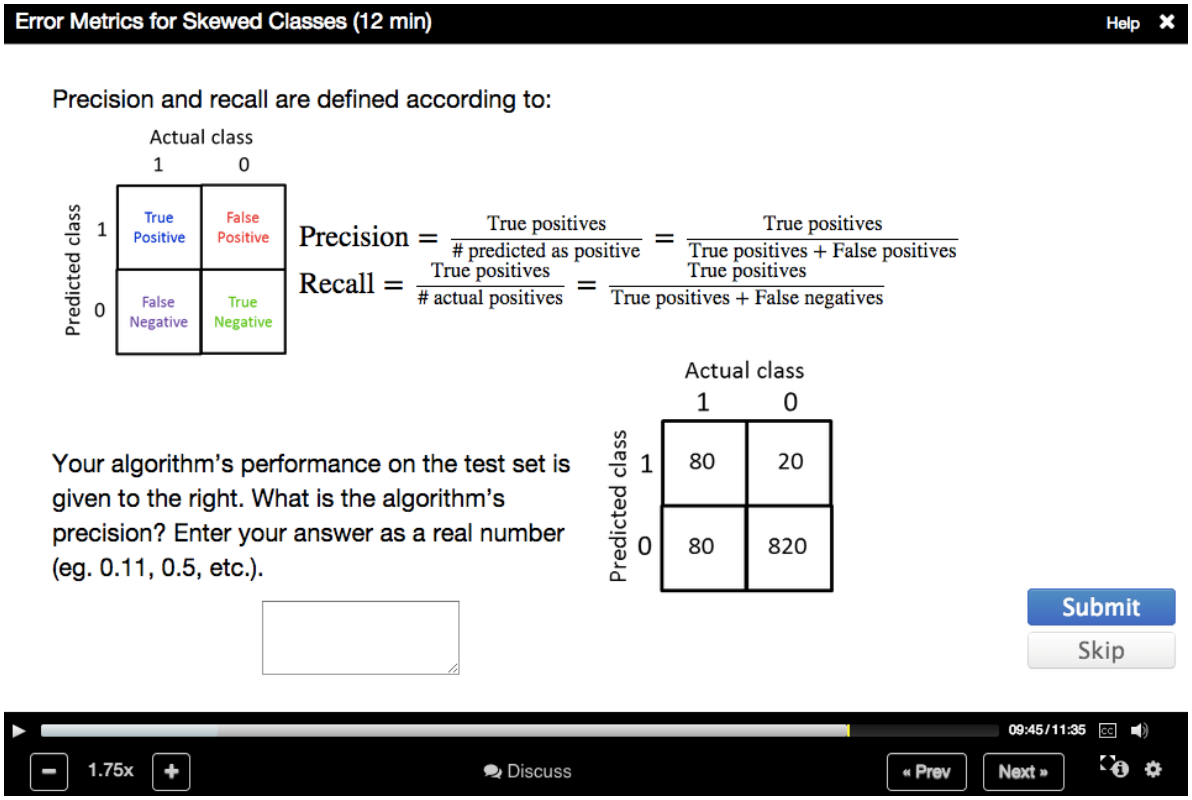
Effects of In-Video Quizzes on MOOC Lecture Viewing

Geza Kovacs

geza@cs.stanford.edu

In-video quizzes

- Assessments which are integrated into videos
  - Short, automatically graded questions



Why look at in-video quizzes?

- Lightweight, fast, integrated assessments
  - Lower barrier to engagement, vs external assessments
  - External assessments are often skipped – does the same apply to in-video quizzes?
- Allows us to observe interactions between assessments and viewing behaviors
  - Are there any viewing behaviors that appear to be optimized towards solving quizzes?
  - We often assume videos are watched linearly from start to end – is that still true in the presence of in-video quizzes, or do they influence navigation?

Related Work

- Many users only view videos, and don't do any assignments or exams [1]
  - Is this because they just don't want to do assessments, or because the assignments and exams are large and external to the video?
  - We'll find that in-video quizzes, in contrast to external assessments, have high engagement

[1] Ashton Anderson, Daniel Huttenlocher, Jon Kleinberg, and Jure Leskovec. "Engaging with massive online courses." *Proceedings of the 23rd international conference on World wide web*. ACM, 2014.

Related Work

- Peaks in video interaction events, such as seeking to different parts of the video, occur at points in the video such as slide transitions [2]
  - Are there also video interaction event peaks around in-video quizzes?
  - We'll find that the largest peaks in video interaction events are at in-video quizzes

[2] Juho Kim, Philip J Guo, Daniel T Seaton, Piotr Mitros, Krzysztof Z Gajos, and Robert C Miller. 2014. "Understanding in-video dropouts and interaction peaks in online lecture videos." *Proceedings of the first ACM conference on Learning@at Scale conference*. ACM, 31–40.

Related Work

- Certain key factors, such as video length, influence whether a user will stop watching a video before its end (*in-video dropout*) [2]
  - Does the presence of in-video quizzes influence in-video dropouts?
  - We'll find that in videos containing in-video quizzes, users watch a larger portion of the video before leaving

[2] Juho Kim, Philip J Guo, Daniel T Seaton, Piotr Mitros, Krzysztof Z Gajos, and Robert C Miller. 2014. "Understanding in-video dropouts and interaction peaks in online lecture videos." *Proceedings of the first ACM conference on Learning@at Scale conference*. ACM, 31–40.

Related Work

- Users sometimes navigate through the course materials in a non-linear fashion [3]
  - Does the presence of in-video quizzes influence how users navigate through the videos?
  - We'll find that users often review the preceding section if they have not yet answered the in-video quiz, and often seek forward to in-video quizzes

[3] Philip J Guo and Katharina Reinecke. 2014. "Demographic differences in how students navigate through MOOCs." *Proceedings of the first ACM conference on Learning@ scale conference*. ACM, 21–30.

Overview

- **Methodology: Dataset and event types**
- How do users interact with in-video quizzes?
  - What portion of viewers do in-video quizzes?
  - Do they answer quizzes correctly?
  - How long do they spend on in-video quizzes?
- How do in-video quizzes affect people's viewing and navigation behaviors?
  - Are videos with quizzes watched more?
  - Seeking behaviors around in-video quizzes
  - Quiz-driven video navigation strategies

Methodology: Dataset

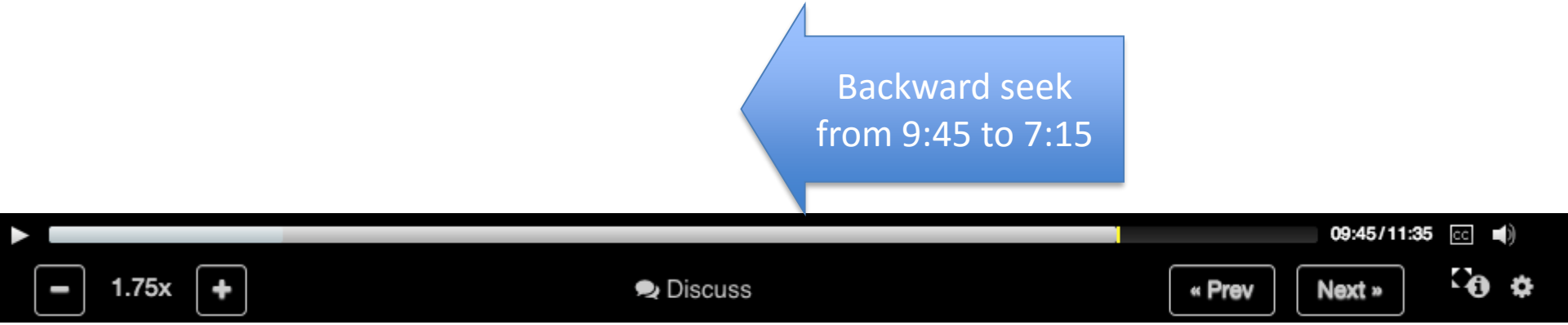
- Machine Learning course on Coursera, 4th offering (from 2014), which we will call ML4
  - 96,195 users registered
  - 61,453 started viewing at least 1 lecture
  - 8,615 earned a certificate

Methodology: Event Types

- *Seek*: A jump from one point to another in the video, either forward in time or backward

Methodology: Event Types

- *Seek*: A jump from one point to another in the video, either forward in time or backward

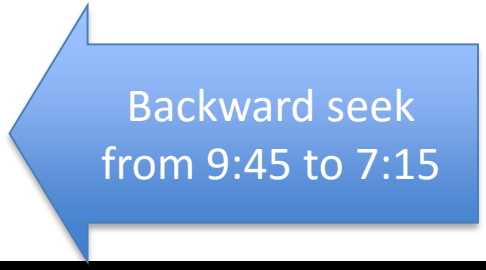


Methodology: Event Types

- *Seek*: A jump from one point to another in the video, either forward in time or backward
- *Seek chain*: To determine users' actual seek targets, we group together seeks that occurred within 5 seconds of each other into a *seek chain*.

Methodology: Event Types

- *Seek*: A jump from one point to another in the video, either forward in time or backward
- *Seek chain*: To determine users' actual seek targets, we group together seeks that occurred within 5 seconds of each other into a *seek chain*.

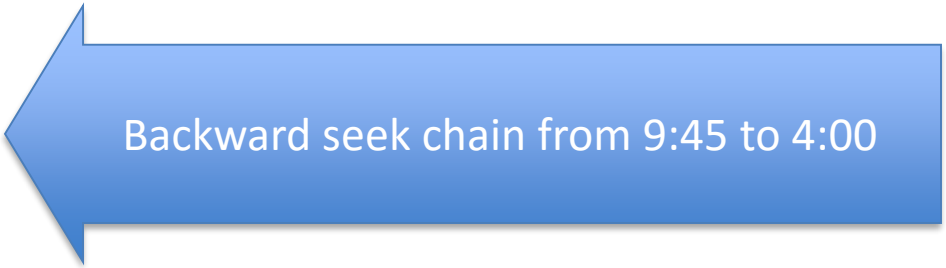


Methodology: Event Types

- *Seek*: A jump from one point to another in the video, either forward in time or backward
- *Seek chain*: To determine users' actual seek targets, we group together seeks that occurred within 5 seconds of each other into a *seek chain*.

Methodology: Event Types

- *Seek*: A jump from one point to another in the video, either forward in time or backward
- *Seek chain*: To determine users' actual seek targets, we group together seeks that occurred within 5 seconds of each other into a *seek chain*.



Methodology: Event Types

- *Viewed*: We can reconstruct whether a particular second of video has been viewed, by looking at the time elapsed between a play event and the following event.

Methodology: Event Types

- *Viewed*: We can reconstruct whether a particular second of video has been viewed, by looking at the time elapsed between a play event and the following event.

At 5:00pm, a play event occurs at point 2:00 in the video

Methodology: Event Types

- *Viewed*: We can reconstruct whether a particular second of video has been viewed, by looking at the time elapsed between a play event and the following event.

At 5:00pm, a play event occurs at point 2:00 in the video

One minute later (at 5:01pm) there is a pause at point 3:00 in the video

Methodology: Event Types

- *Viewed*: We can reconstruct whether a particular second of video has been viewed, by looking at the time elapsed between a play event and the following event.

At 5:00pm, a play event occurs at point 2:00 in the video

One minute later (at 5:01pm) there is a pause at point 3:00 in the video

The part of the video that was viewed was 2:00 through 3:00

Overview

- Methodology: Dataset and event types
- **How do users interact with in-video quizzes?**
  - What portion of viewers do in-video quizzes?
  - Do they answer quizzes correctly?
  - How long do they spend on in-video quizzes?
- How do in-video quizzes affect people's viewing and navigation behaviors?
  - Are videos with quizzes watched more?
  - Seeking behaviors around in-video quizzes
  - Quiz-driven video navigation strategies

How much do users interact with in-video quizzes?

- In videos containing an in-video quiz, what portion of the users who start watching the video will submit an answer to the in-video quiz?
  - 74% of users who begin watching the lecture will submit an answer to its in-video quiz (averaged over all lectures in ML4)

How often do users answer quizzes correctly?

- 76.0% of users who attempt a quiz will answer it correctly on the first try
- Of those who answer incorrectly, 76.5% will submit a correct answer in the next 30 minutes
  - So 94.4% of users answer correctly within 30 minutes of an attempt

How often do users answer quizzes correctly?

Type of interaction with in-video quiz	Percentage of users	Median time spent between initial and final answer (seconds)	Mean number of incorrect attempts
Answers in-video quiz correctly on first try	76.0%		
Answers in-video quiz incorrectly on first try	24.0%	13 (mean=31, σ=83)	1.54

How often do users answer quizzes correctly?

Type of interaction with in-video quiz	Percentage of users	Median time spent between initial and final answer (seconds)	Mean number of incorrect attempts
Answers in-video quiz correctly on first try	76.0%		
Answers in-video quiz incorrectly on first try	24.0%	13 (mean=31, σ=83)	1.54
Will not submit a correct answer within the next 30 minutes	23.5% (4.3% of total)	13 (mean=29, σ=71)	2.68
Will submit a correct answer within the next 30 minutes	76.5% (18.4% of total)	13 (mean=32, σ=85)	1.28

How often do users answer quizzes correctly?

Type of interaction with in-video quiz	Percentage of users	Median time spent between initial and final answer (seconds)	Mean number of incorrect attempts
Answers in-video quiz correctly on first try	76.0%		
Answers in-video quiz incorrectly on first try	24.0%	13 (mean=31, σ=83)	1.54
Will not submit a correct answer within the next 30 minutes	23.5% (4.3% of total)	13 (mean=29, σ=71)	2.68
Will submit a correct answer within the next 30 minutes	76.5% (18.4% of total)	13 (mean=32, σ=85)	1.28
Does not seek before submitting answer	90.9% (16.7% of total)	11 (mean=23, σ=53)	1.28
Makes a seek before submitting answer	9.1% (1.7% of total)	115 (mean=218, σ=278)	1.51

How often do users answer quizzes correctly?

Type of interaction with in-video quiz	Percentage of users	Median time spent between initial and final answer (seconds)	Mean number of incorrect attempts
Answers in-video quiz correctly on first try	76.0%		
Answers in-video quiz incorrectly on first try	24.0%	13 (mean=31, σ=83)	1.54
Will not submit a correct answer within the next 30 minutes	23.5% (4.3% of total)	13 (mean=29, σ=71)	2.68
Will submit a correct answer within the next 30 minutes	76.5% (18.4% of total)	13 (mean=32, σ=85)	1.28
Does not seek before submitting answer	90.9% (16.7% of total)	11 (mean=23, σ=53)	1.28
Makes a seek before submitting answer	9.1% (1.7% of total)	115 (mean=218, σ=278)	1.51
Backward seek	97.0% (1.6% of total)	116 (mean=217, σ=275)	1.51
Forward seek	3.0% (0.1% of total)	56 (mean=229, σ=367)	1.48

Overview

- Methodology: Dataset and event types
- How do users interact with in-video quizzes?
  - What portion of viewers do in-video quizzes?
  - Do they answer quizzes correctly?
  - How long do they spend on in-video quizzes?
- **How do in-video quizzes affect people's viewing and navigation behaviors?**
  - Are videos with quizzes watched more?
  - Seeking behaviors around in-video quizzes
  - Quiz-driven video navigation strategies

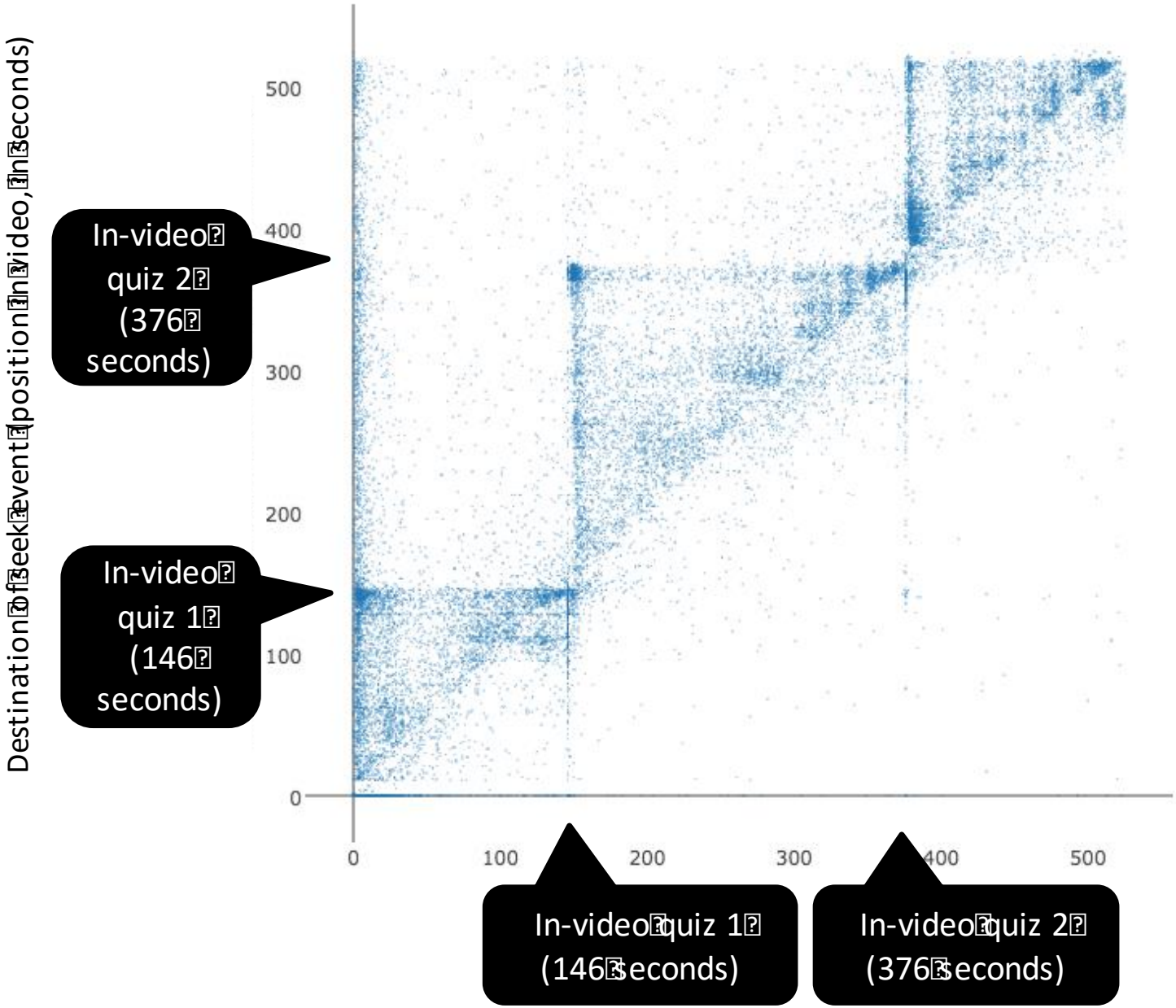
Are videos with more quizzes watched more?

- A larger percentage of the video is watched for videos that have an in-video quiz
  - 59.3% in videos with no in-video quizzes, vs 79.1% in videos with in-video quizzes
- More seeking occurs in videos that have an in-video quiz
  - 36.2% of viewers seek in videos with no in-video quizzes, vs 42.7% in videos with in-video quizzes

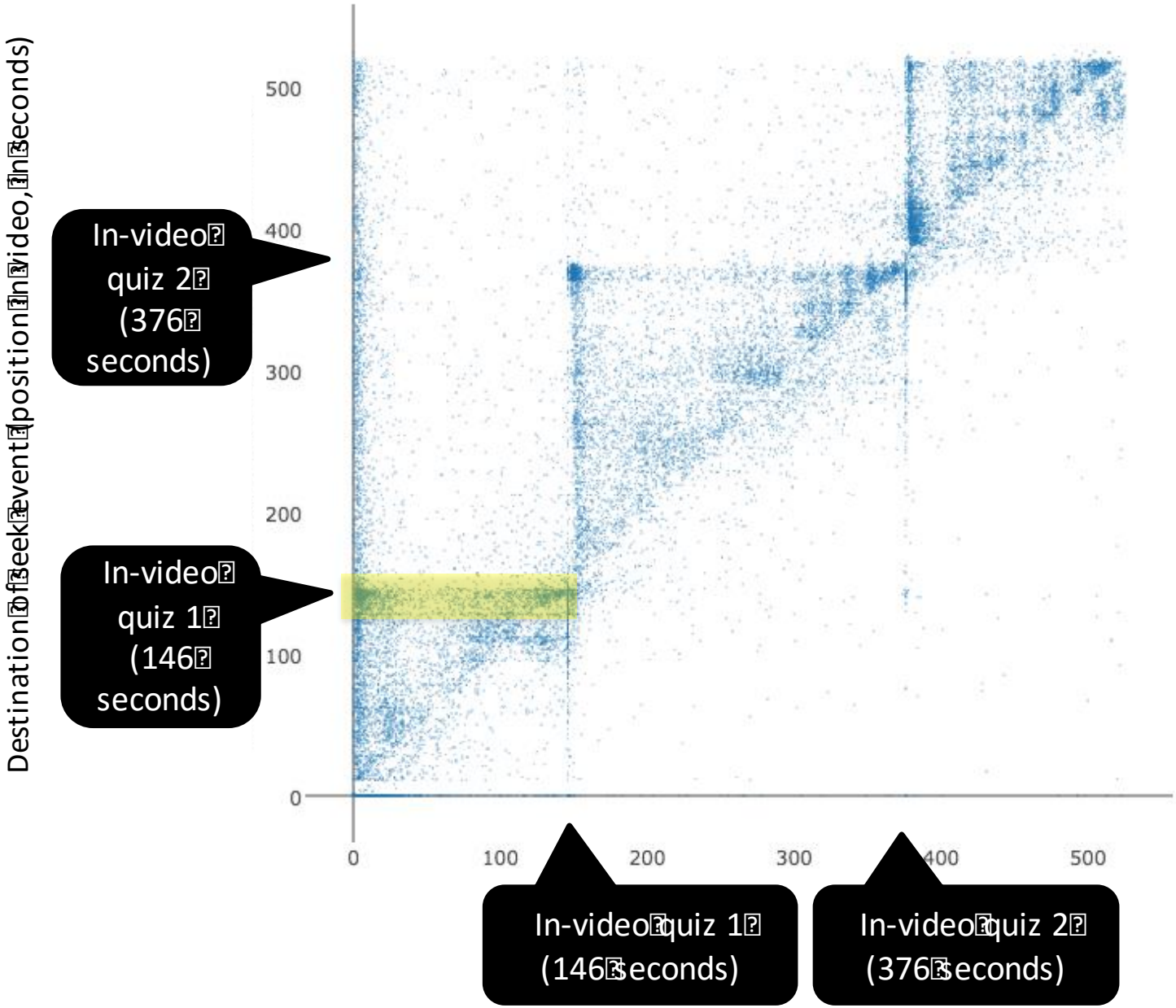
Seeking behaviors around in-video quizzes

- For illustration purposes our figures will look at Lecture 13 of ML4 (chosen because it has 2 in-video quizzes)
- In-video quizzes are a major source and destination for seek chains
- Seek chains rarely cross over in-video quizzes

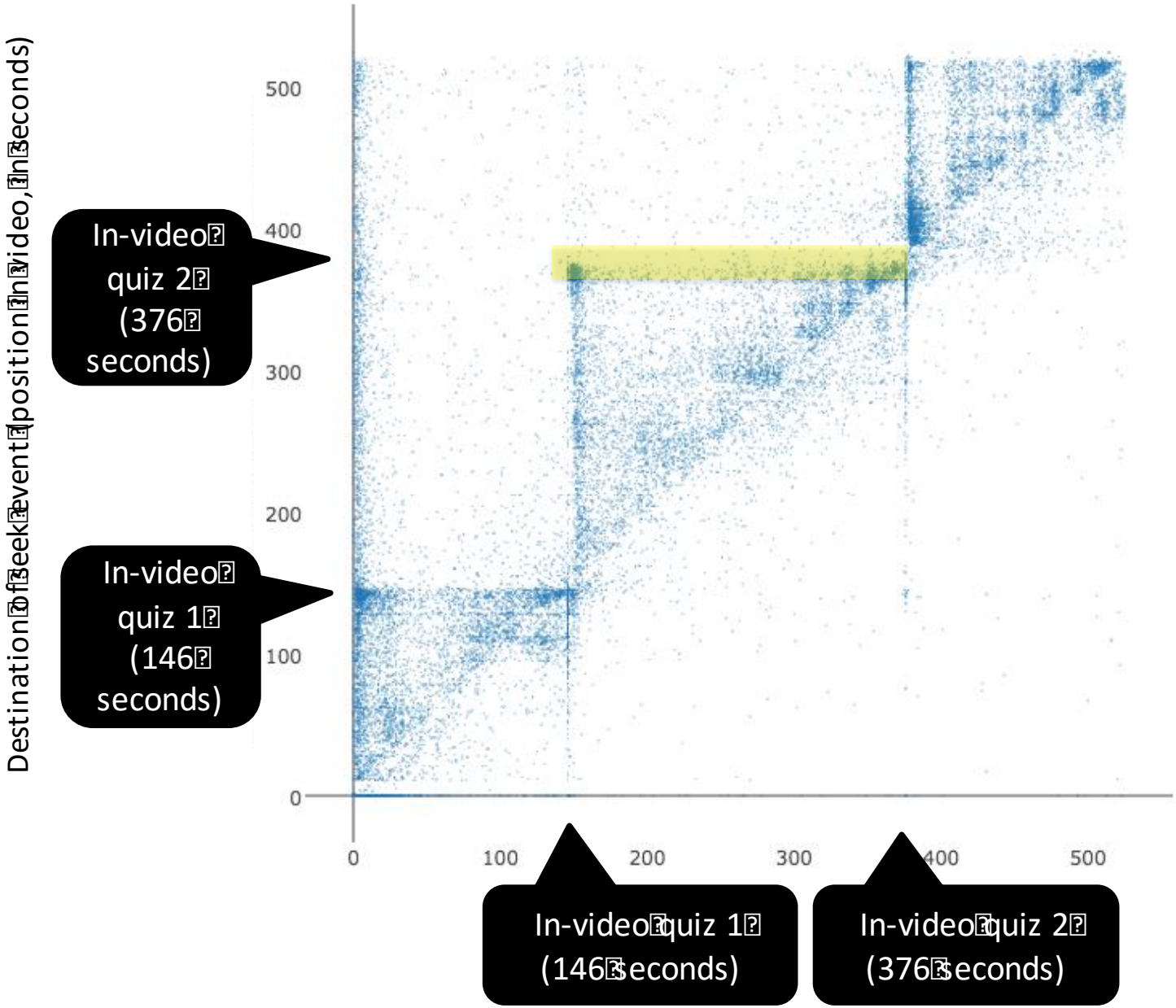
Seek Sources and Destinations in ML4 Lecture 13



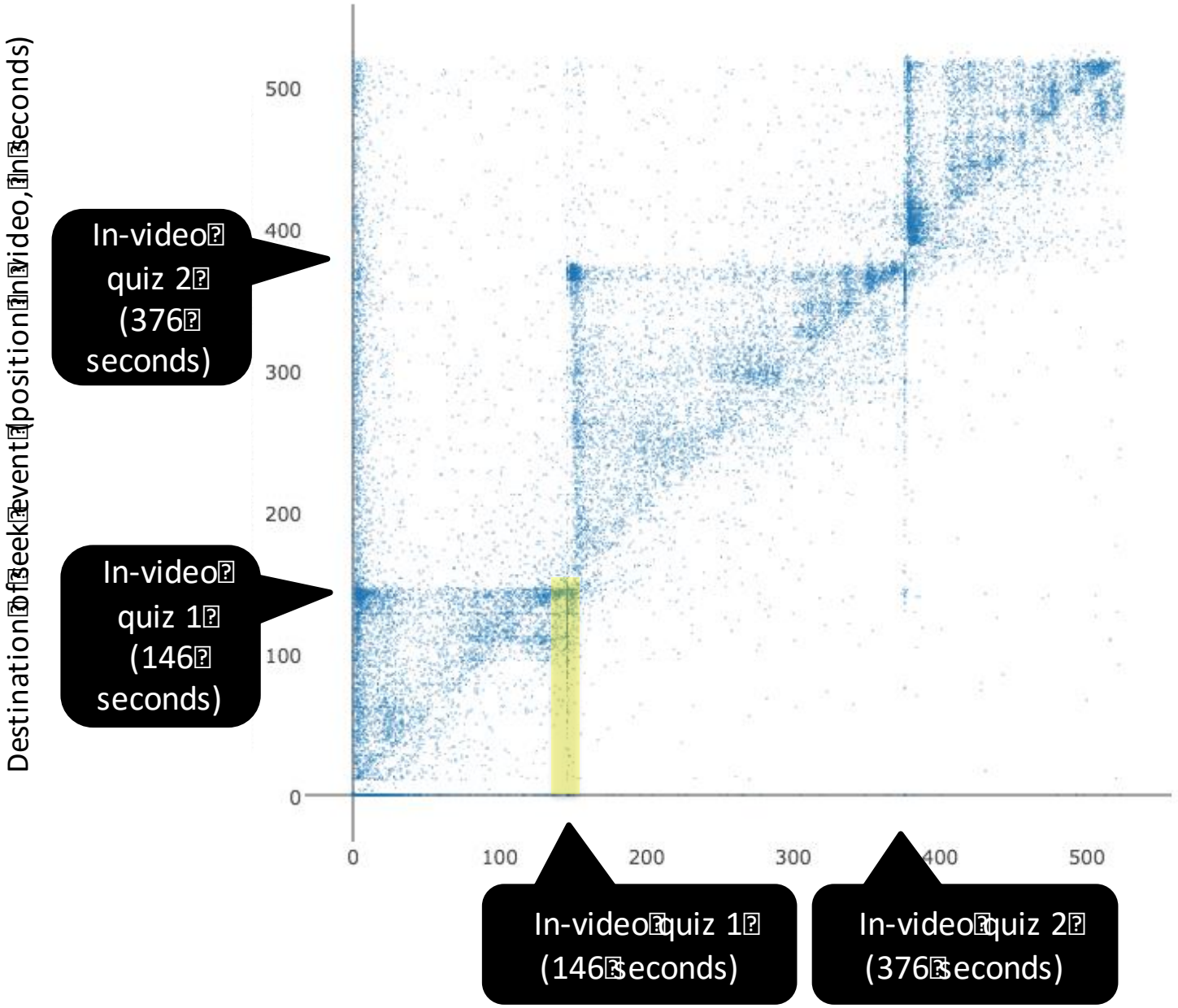
Seek Sources and Destinations in ML4 Lecture 13



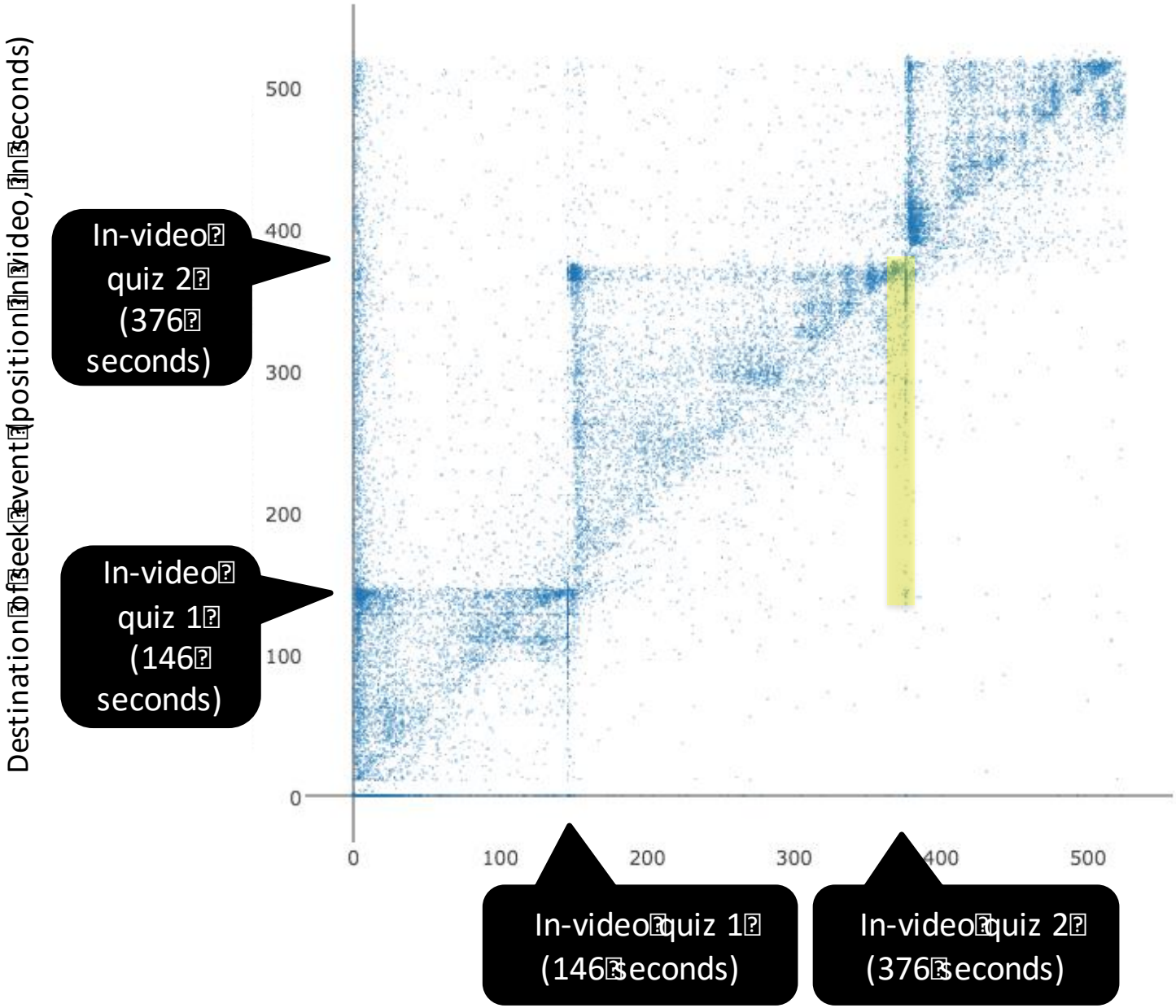
Seek Sources and Destinations in ML4 Lecture 13



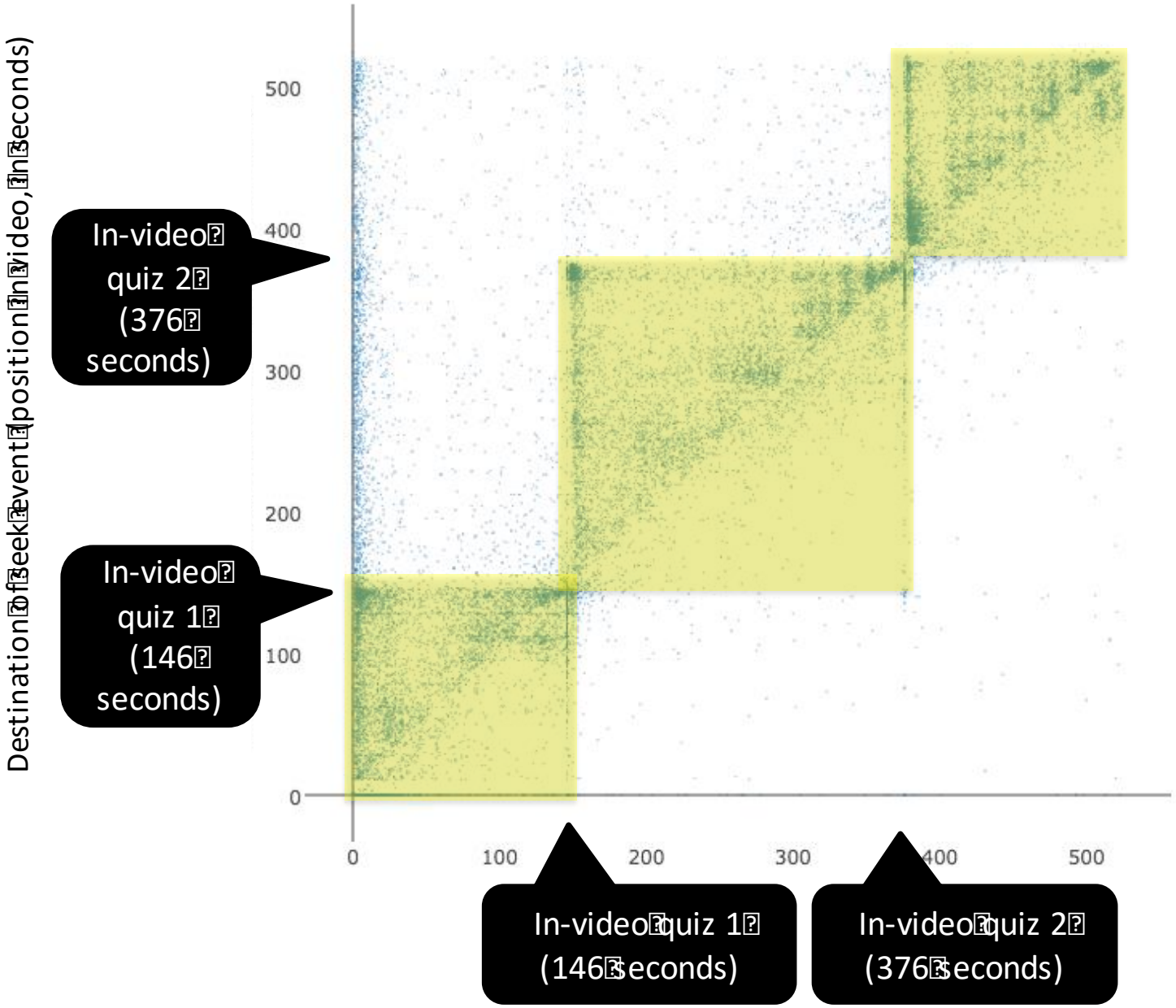
Seek Sources and Destinations in ML4 Lecture 13



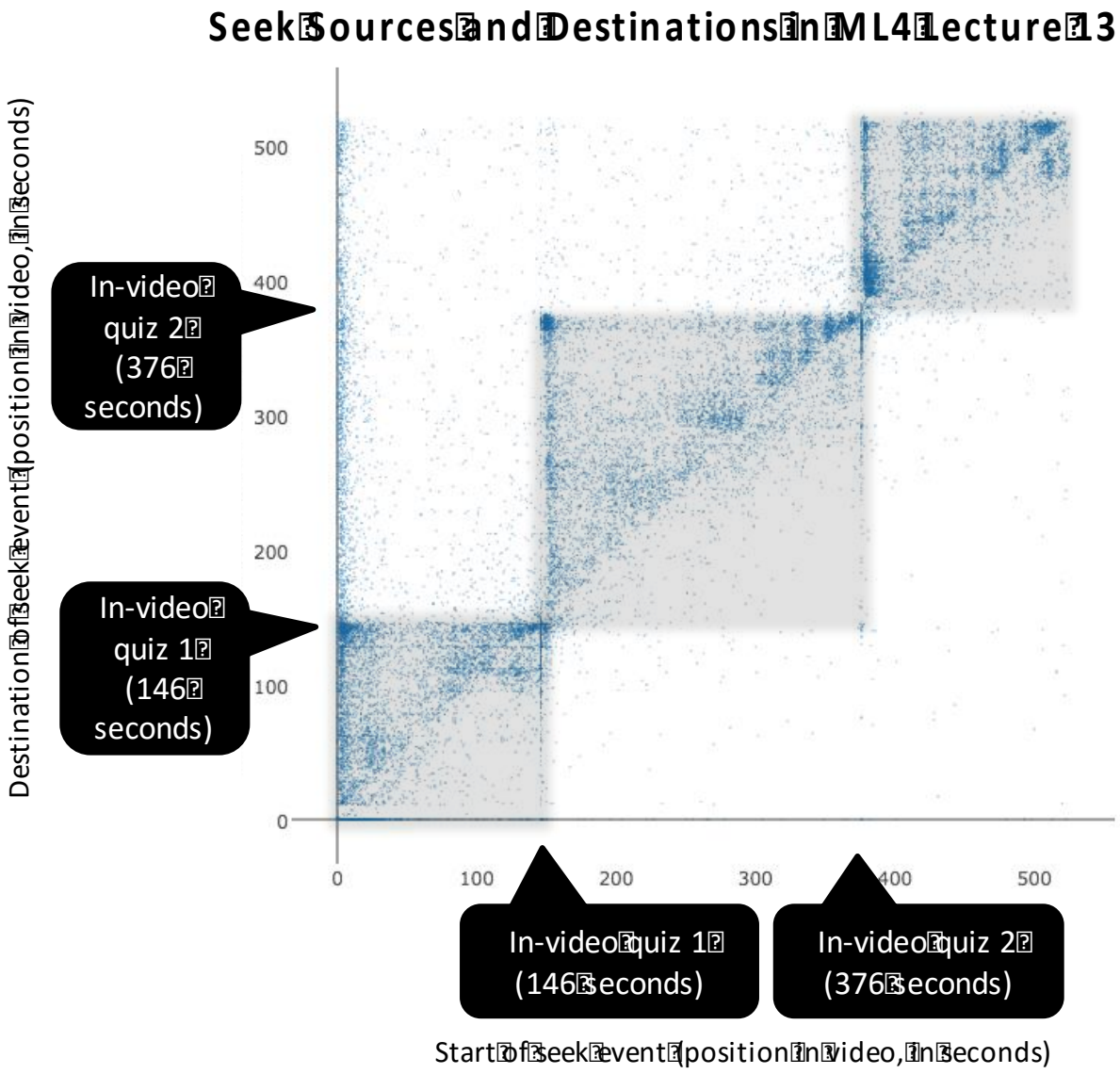
Seek Sources and Destinations in ML4 Lecture 13



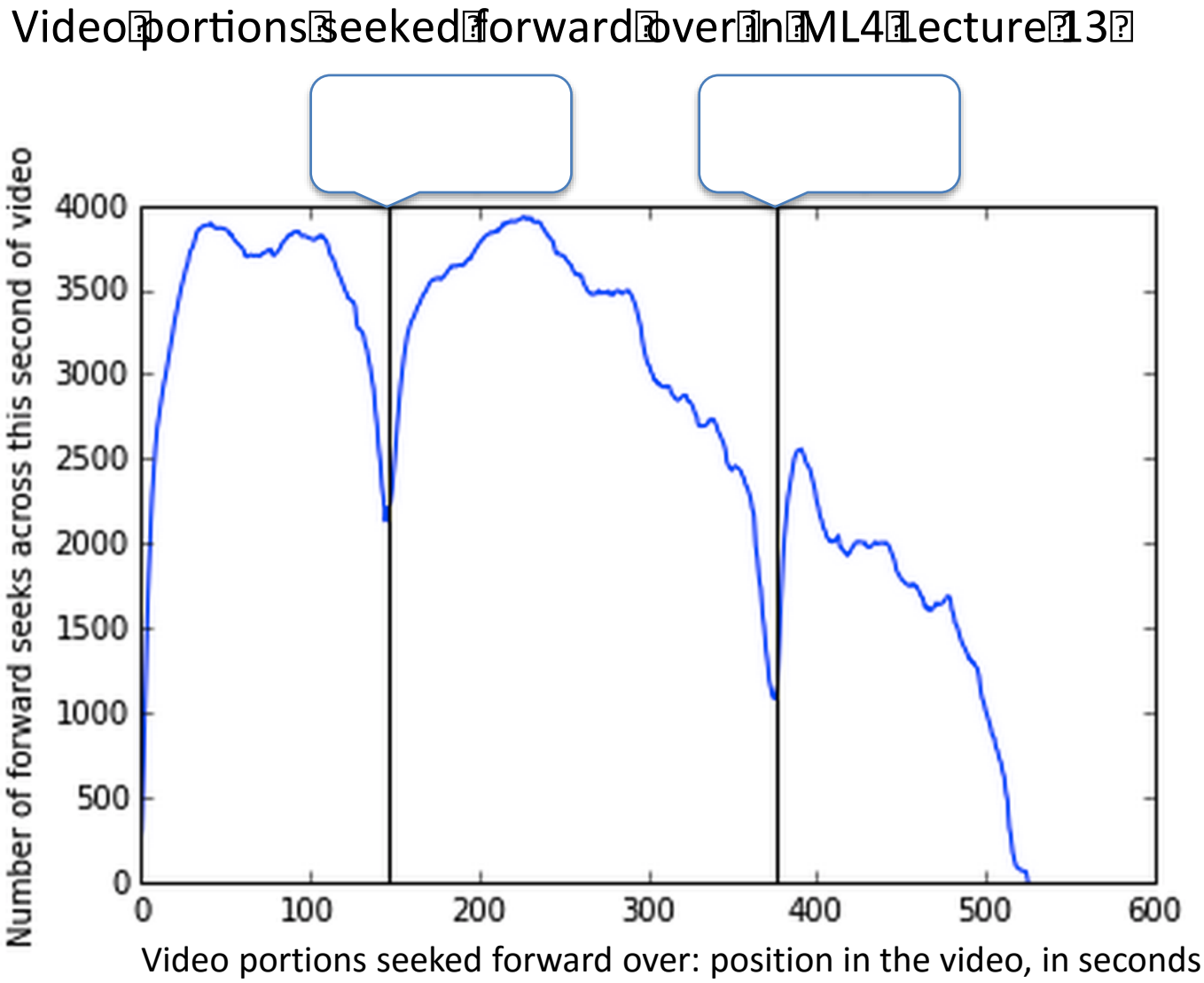
Seek Sources and Destinations in ML4 Lecture 13



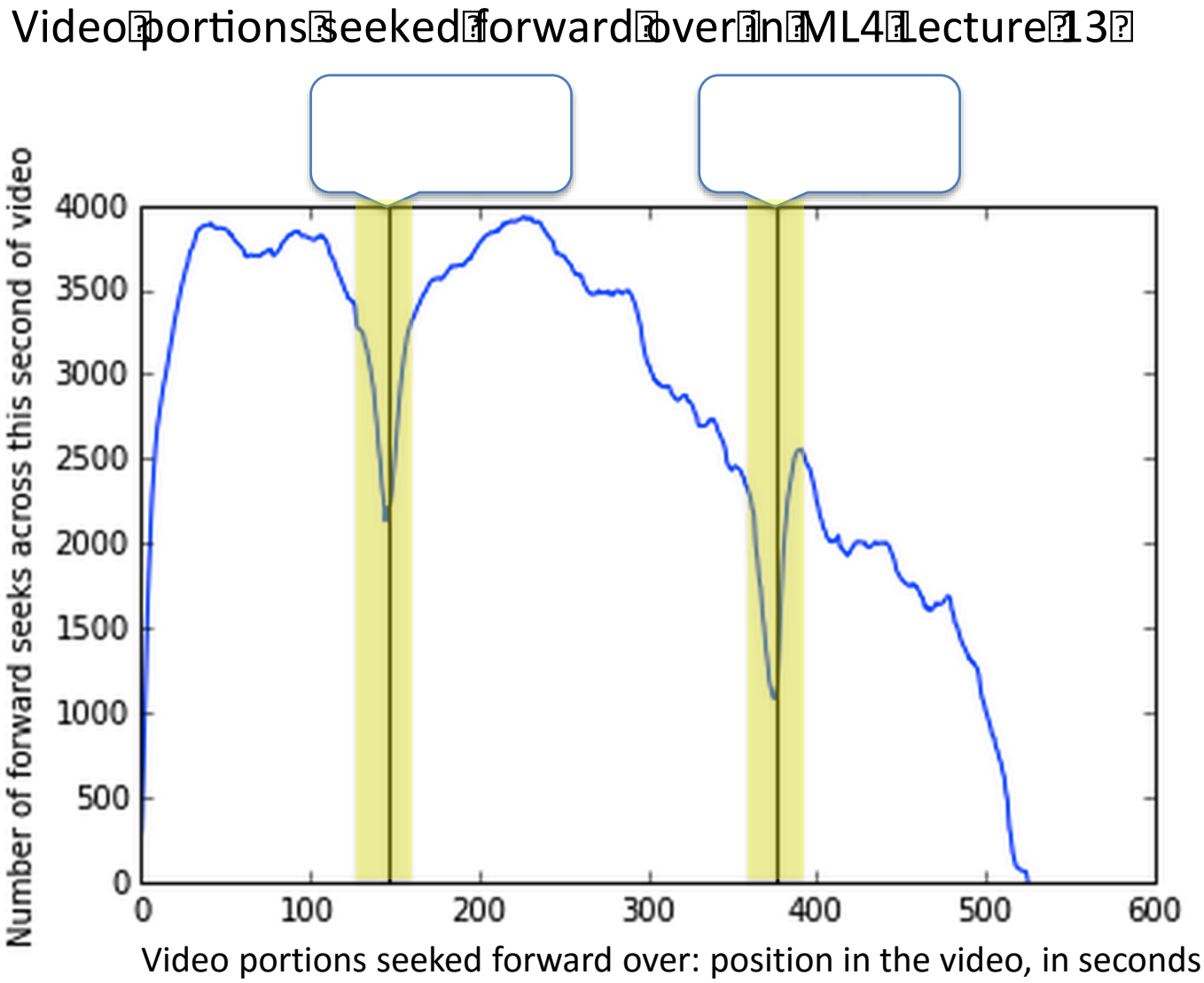
- Seeks tend to remain within sections delimited by the in-video quizzes



Seek chains do not tend to skip over in-video quizzes

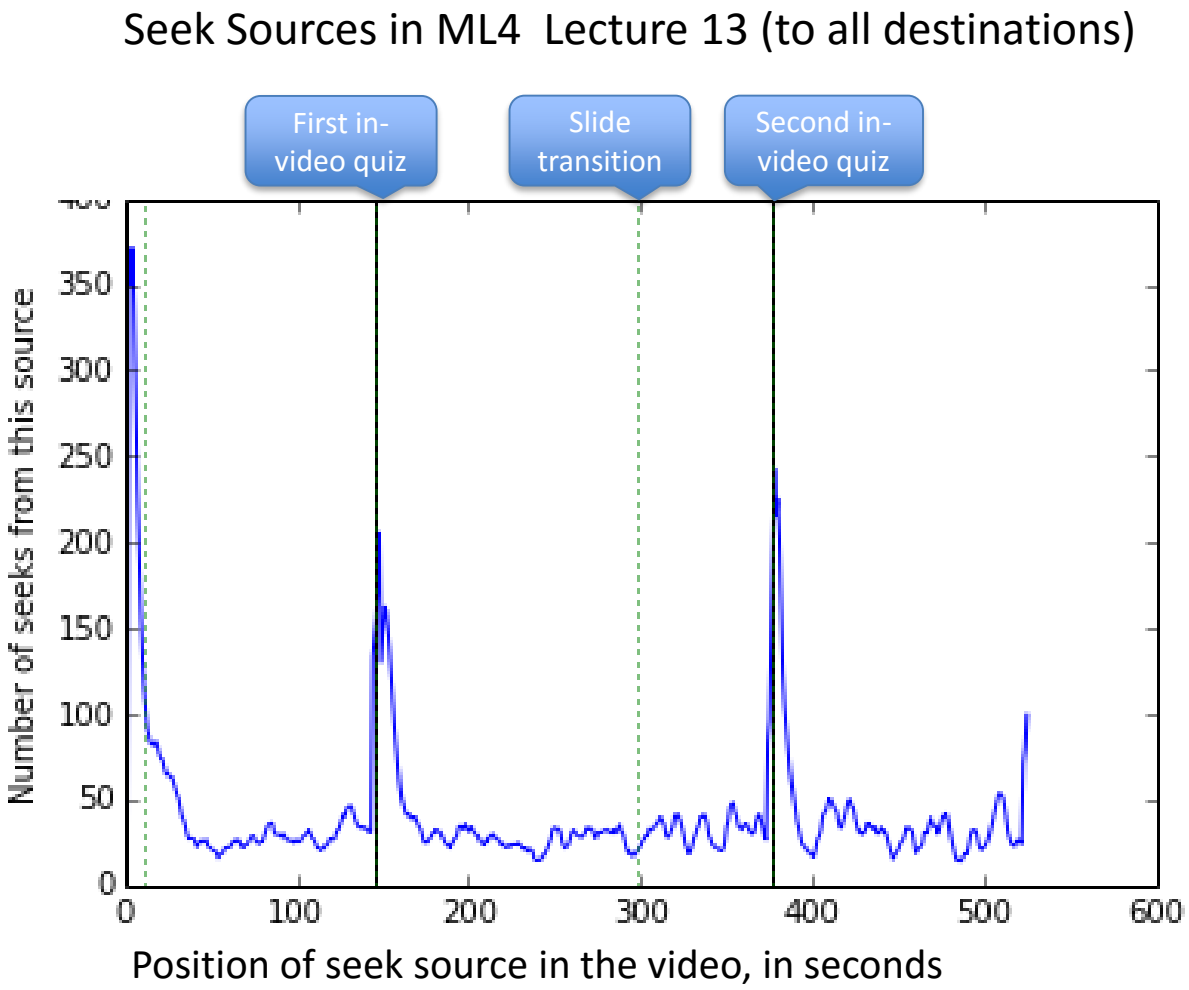


Seek chains do not tend to skip over in-video quizzes



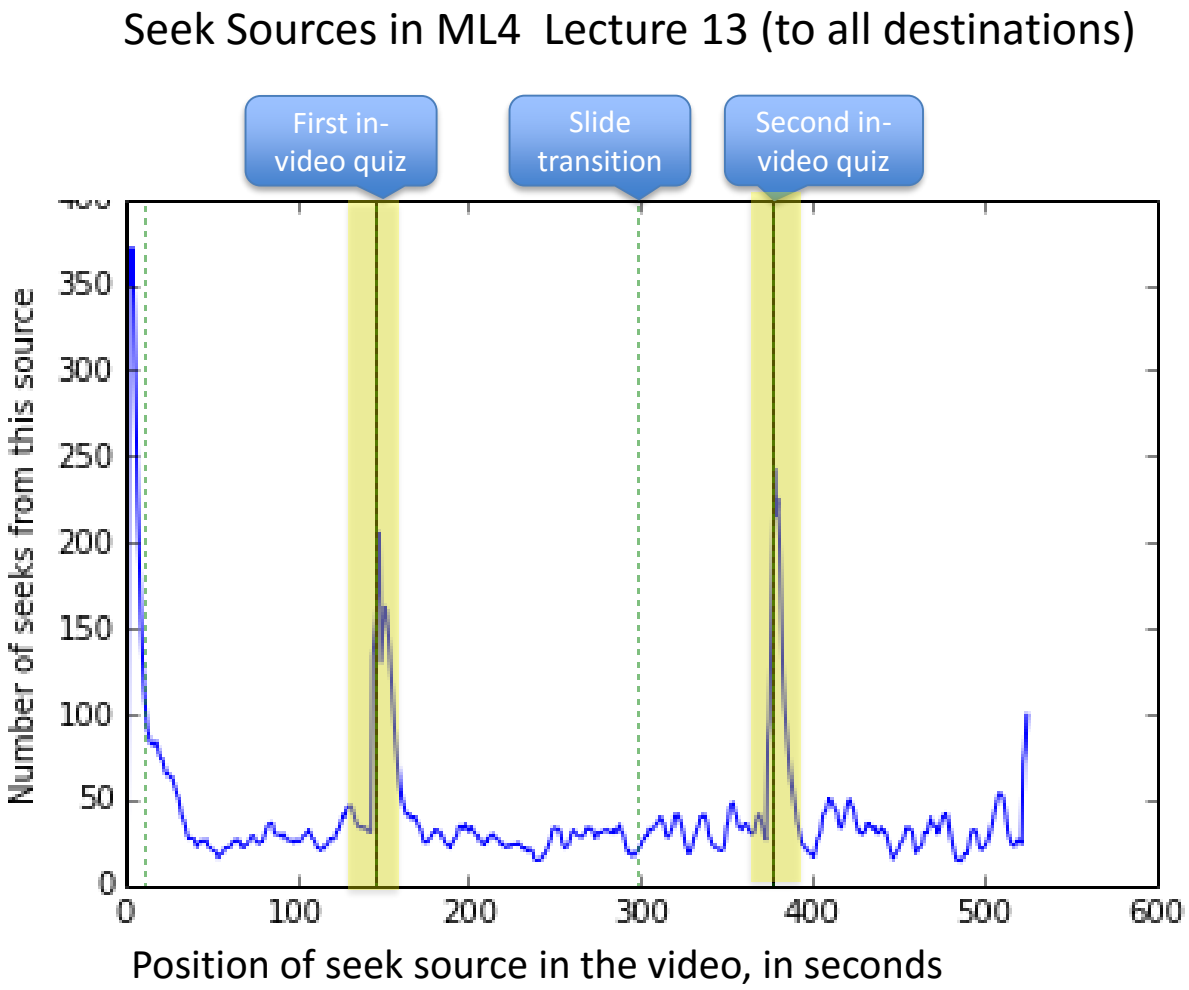
In-video quizzes are a major source of seek chains

Seek chains in the backward direction come from in-video quizzes at 55x frequency compared to any other second of video



In-video quizzes are a major source of seek chains

Seek chains in the backward direction come from in-video quizzes at 55x frequency compared to any other second of video

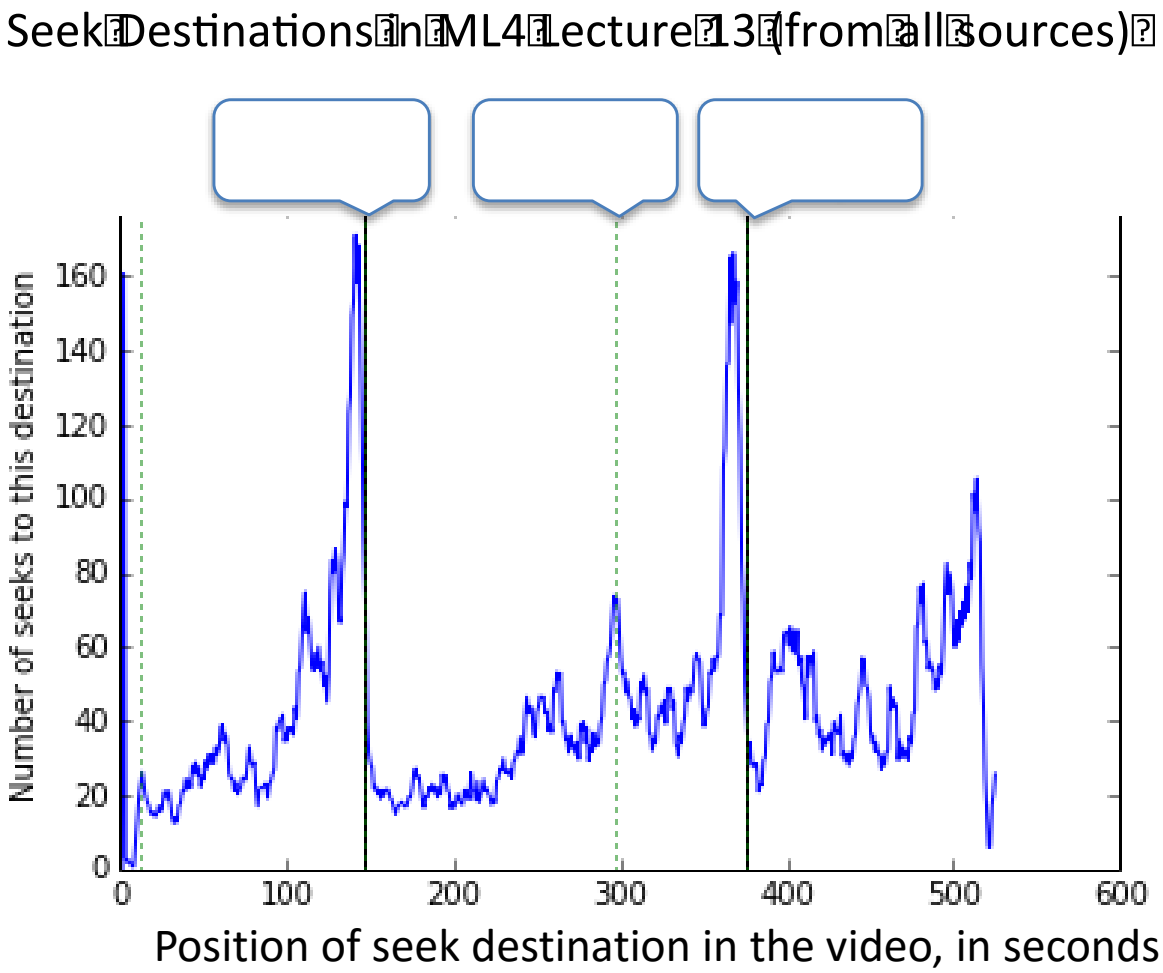


Why are users seeking back from in-video quizzes?

- Most (60.5%) of seek chains occur after the user has seen the question, but before they attempt to answer it.
- Another 14.4% seek back to review the preceding section after submitting an incorrect response
- Only 3.0% seek back after a correct response has already been submitted
- Suggests that they may be reviewing the video to help them answer the question

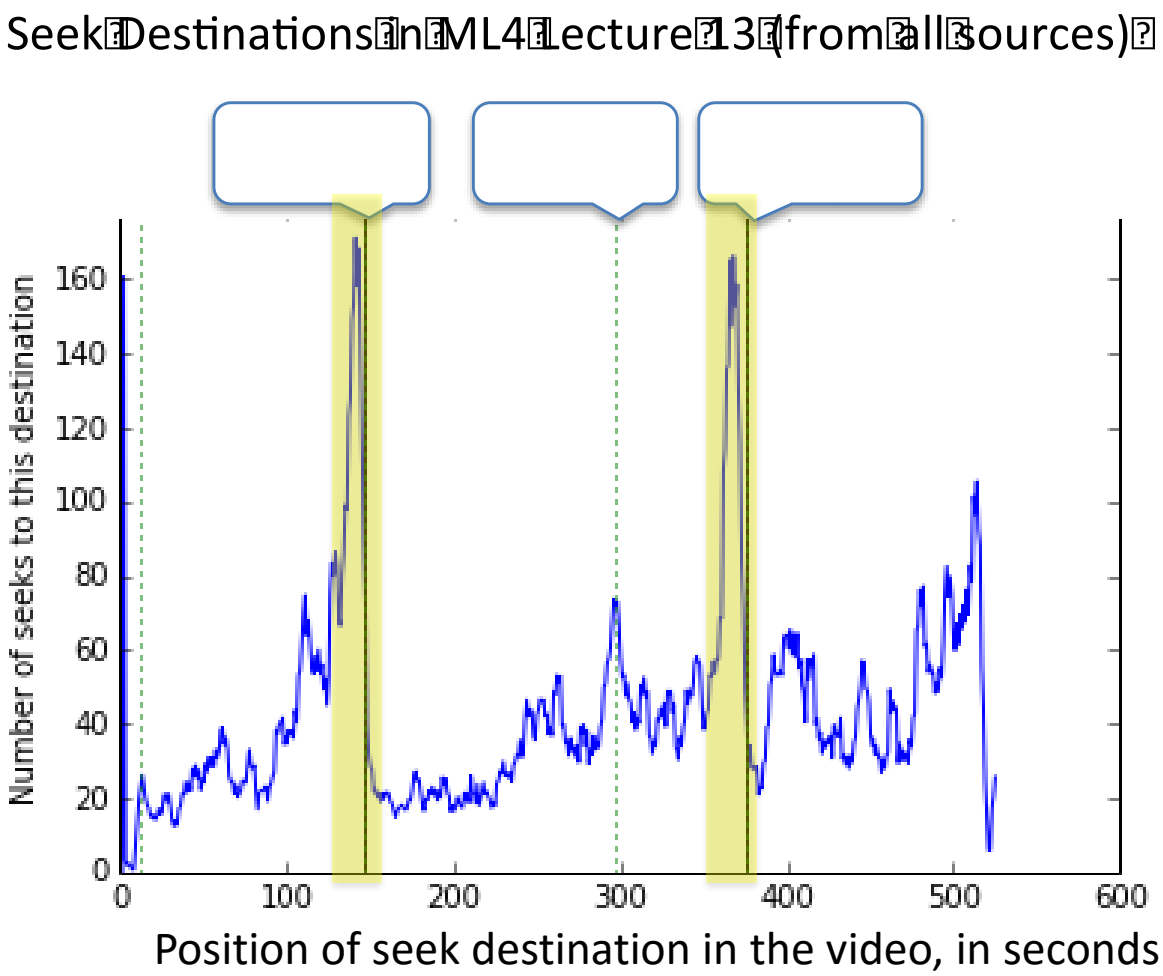
In-video quizzes are a major destination of seek chains

Seek chains in the forward direction go to the immediately following in-video quiz at 4x frequency compared to any other second of video



In-video quizzes are a major destination of seek chains

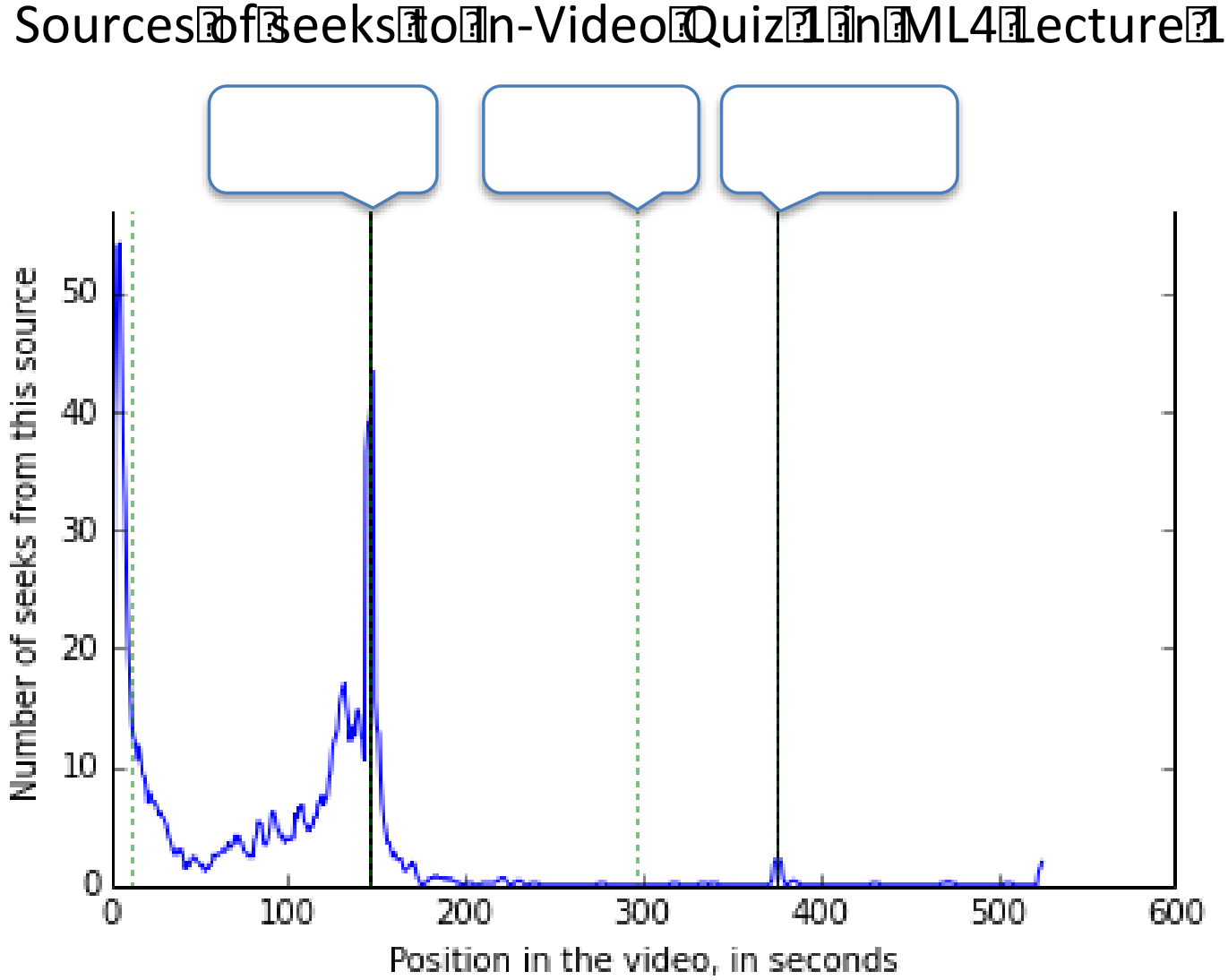
Seek chains in the forward direction go to the immediately following in-video quiz at 4x frequency compared to any other second of video



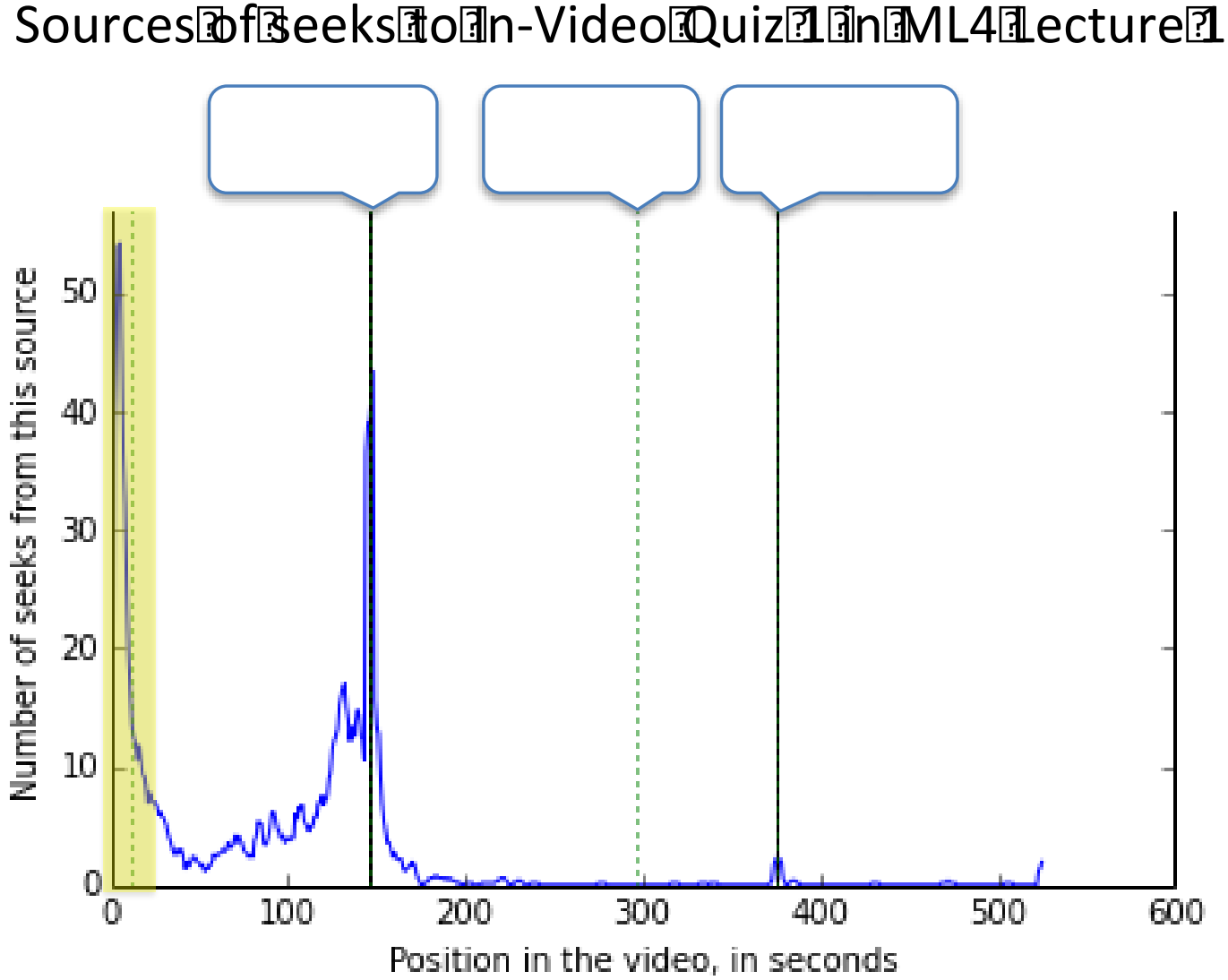
Why might users be seeking forward to in-video quizzes?

- To preview the in-video quiz prior to watching the section (quiz-driven viewing strategy)
- Returning to answer the in-video quiz after they have seeked back to the preceding section

Seeks to in-video quizzes occur primarily from the preceding section and start

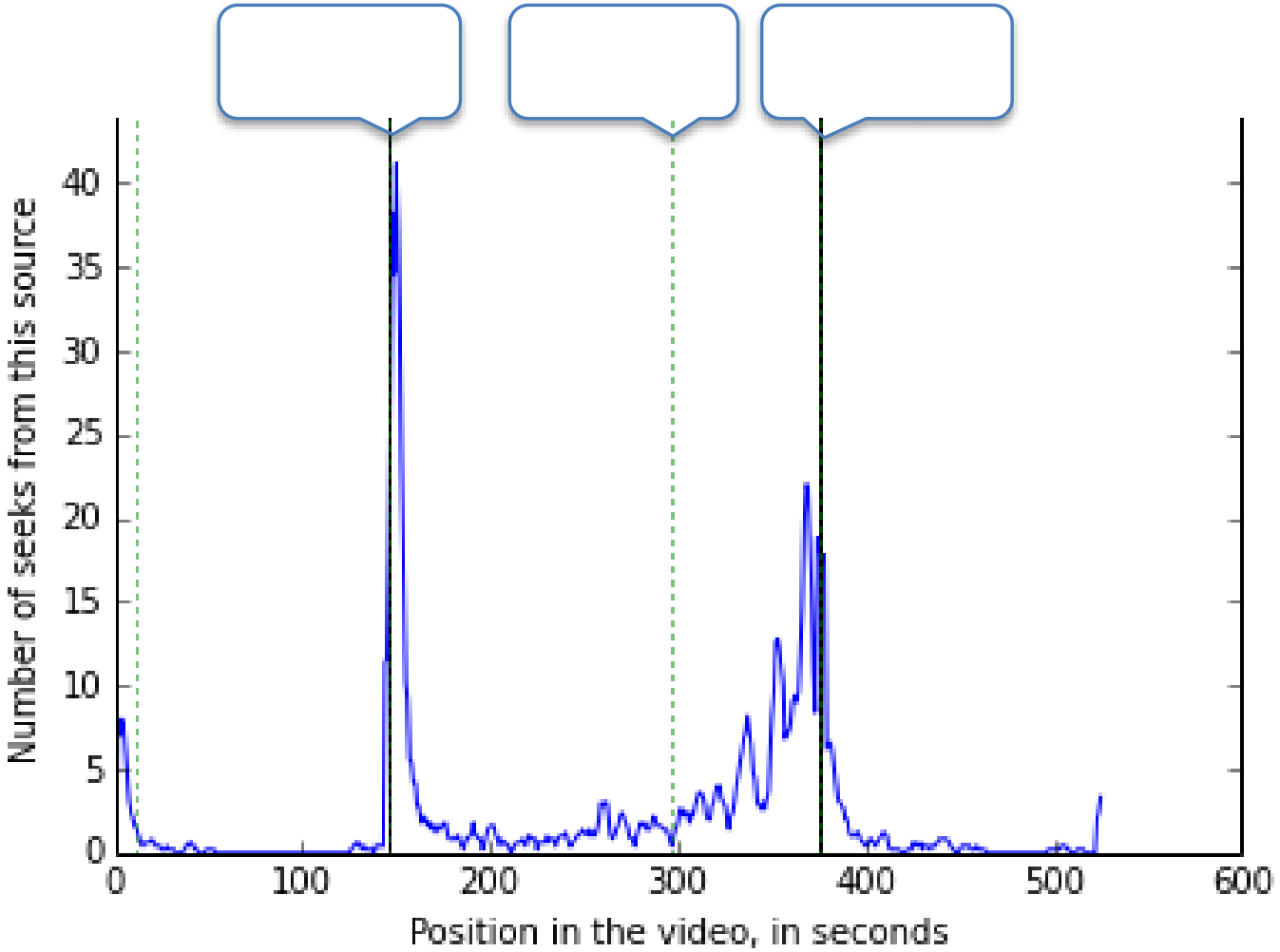


Seeks to in-video quizzes occur primarily from the preceding section and start



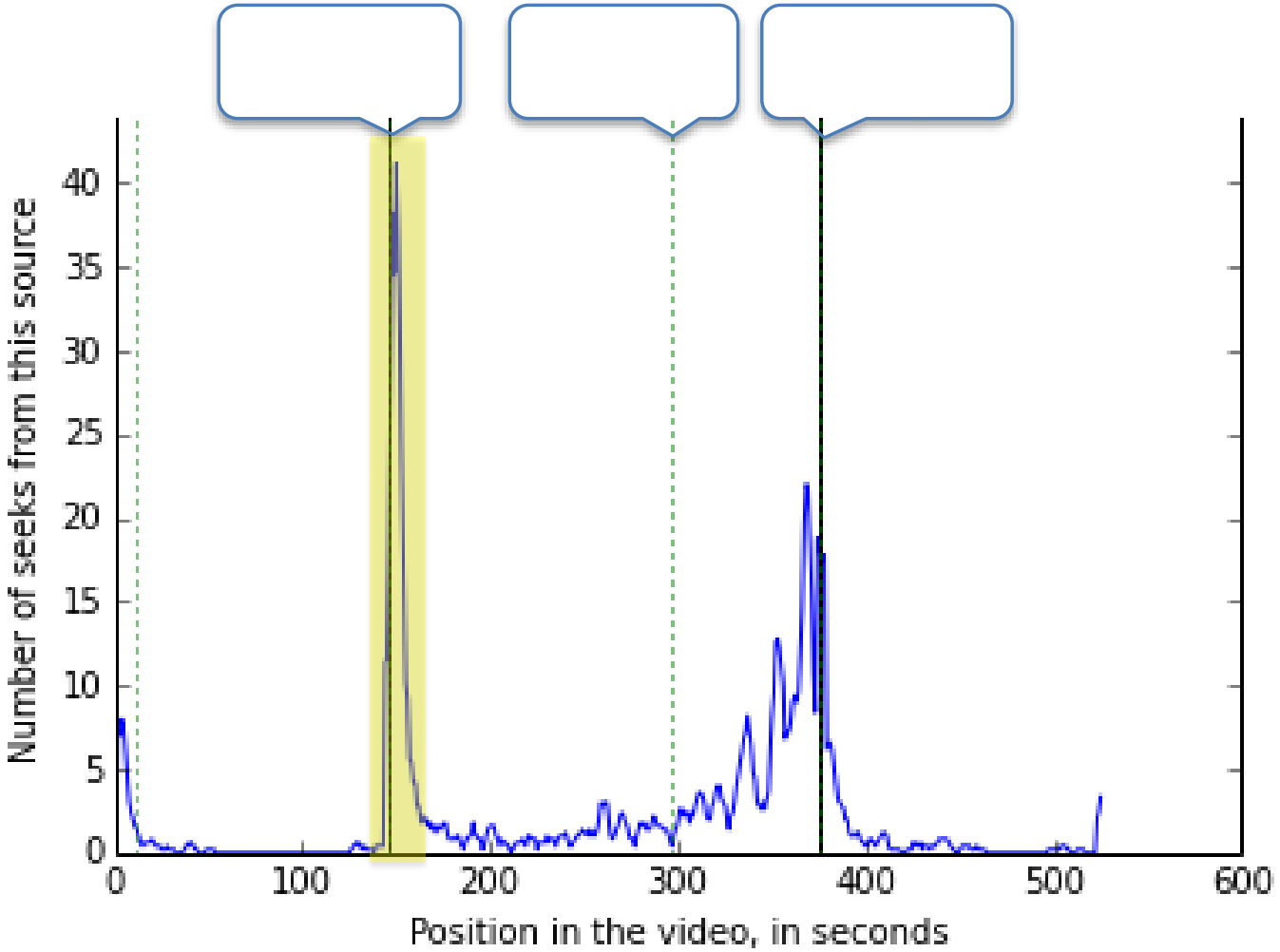
Users sometimes skip from one in-video quiz to the next

Sources of seeks to In-Video Quiz 2 in ML4 Lecture 13



Users sometimes skip from one in-video quiz to the next

Sources of seeks to In-Video Quiz 2 in ML4 Lecture 13



Conclusion

- In-video quizzes have high engagement
  - 74% of users who start watching a video will attempt the quiz, and 94% of those will answer correctly within 30 minutes
- A larger percentage of the video is watched for videos that have an in-video quiz
- Users often seek to in-video quizzes from the preceding section, and from in-video quizzes to the preceding section
  - May reflect quiz-driven navigation strategies, or looking for information to help answer the quiz

Are videos with more quizzes watched more?

Type of data	Lectures with no in-video quizzes	Lectures with 1 in-video quiz	Lectures with 2 in-video quizzes
Number of lecture videos	13	92	7
Average lecture video length (in seconds)	534.8	628.7	704.9
Average number of seconds of video watched per viewing session	333.8	492.4	528.7
Average percent of video watched per viewing session	59.3%	79.1%	75.6%
Percentage of viewers who start watching the video that reach the end	61.9%	67.5%	62.8%
Average number of seek chains per viewing session	1.16	1.43	1.78
Percentage of viewers who seeked at least once while viewing the video	36.2%	42.7%	47.5%

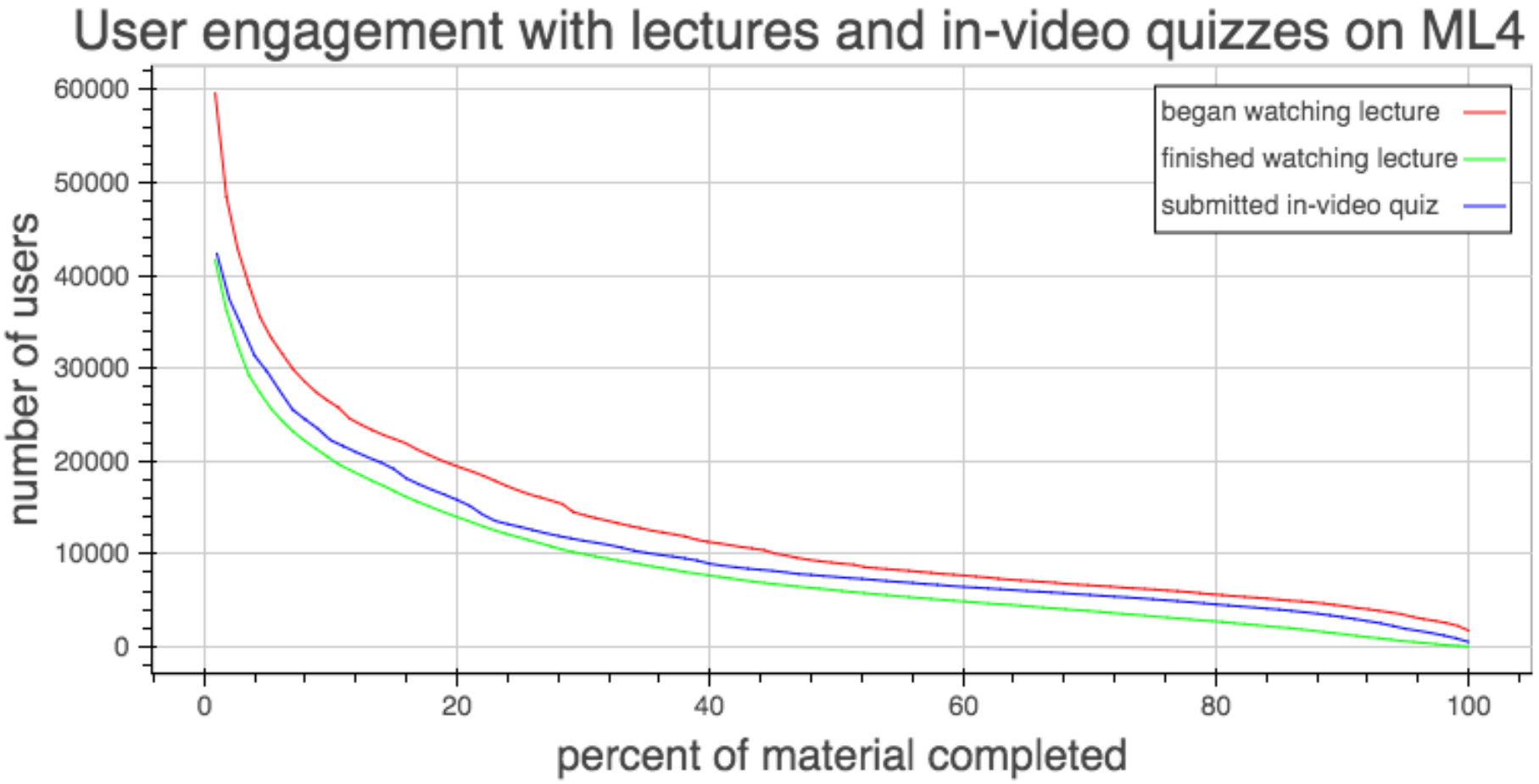
Are videos with more quizzes watched more?

Type of data	Lectures with no in-video quizzes	Lectures with 1 in-video quiz	Lectures with 2 in-video quizzes
Number of lecture videos	13	92	7
Average lecture video length (in seconds)	534.8	628.7	704.9
Average number of seconds of video watched per viewing session	333.8	492.4	528.7
Average percent of video watched per viewing session	59.3%	79.1%	75.6%
Percentage of viewers who start watching the video that reach the end	61.9%	67.5%	62.8%
Average number of seek chains per viewing session	1.16	1.43	1.78
Percentage of viewers who seeked at least once while viewing the video	36.2%	42.7%	47.5%

Are videos with more quizzes watched more?

Type of data	Lectures with no in-video quizzes	Lectures with 1 in-video quiz	Lectures with 2 in-video quizzes
Number of lecture videos	13	92	7
Average lecture video length (in seconds)	534.8	628.7	704.9
Average number of seconds of video watched per viewing session	333.8	492.4	528.7
Average percent of video watched per viewing session	59.3%	79.1%	75.6%
Percentage of viewers who start watching the video that reach the end	61.9%	67.5%	62.8%
Average number of seek chains per viewing session	1.16	1.43	1.78
Percentage of viewers who seeked at least once while viewing the video	36.2%	42.7%	47.5%

How much do people interact with in-video quizzes?

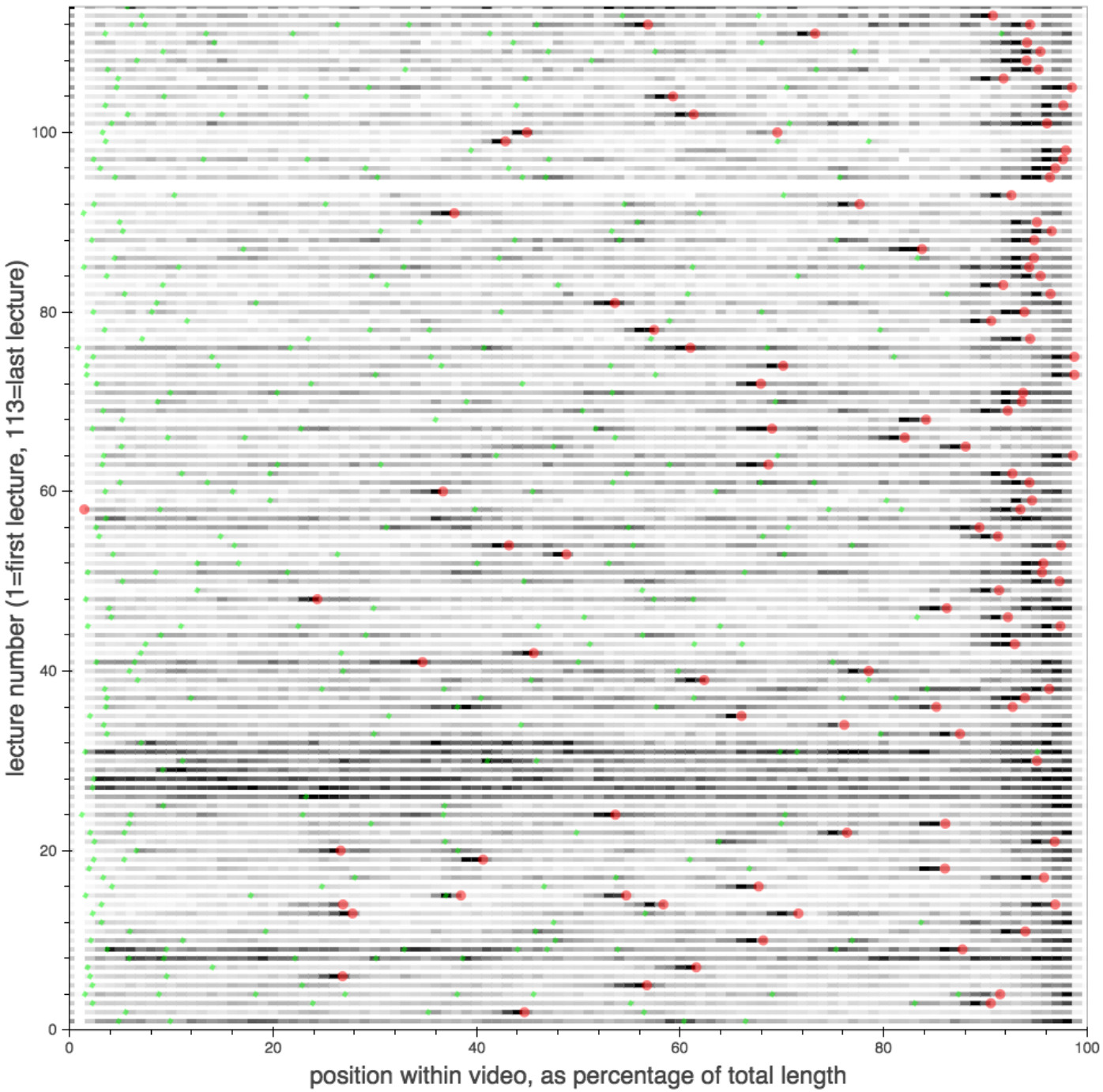


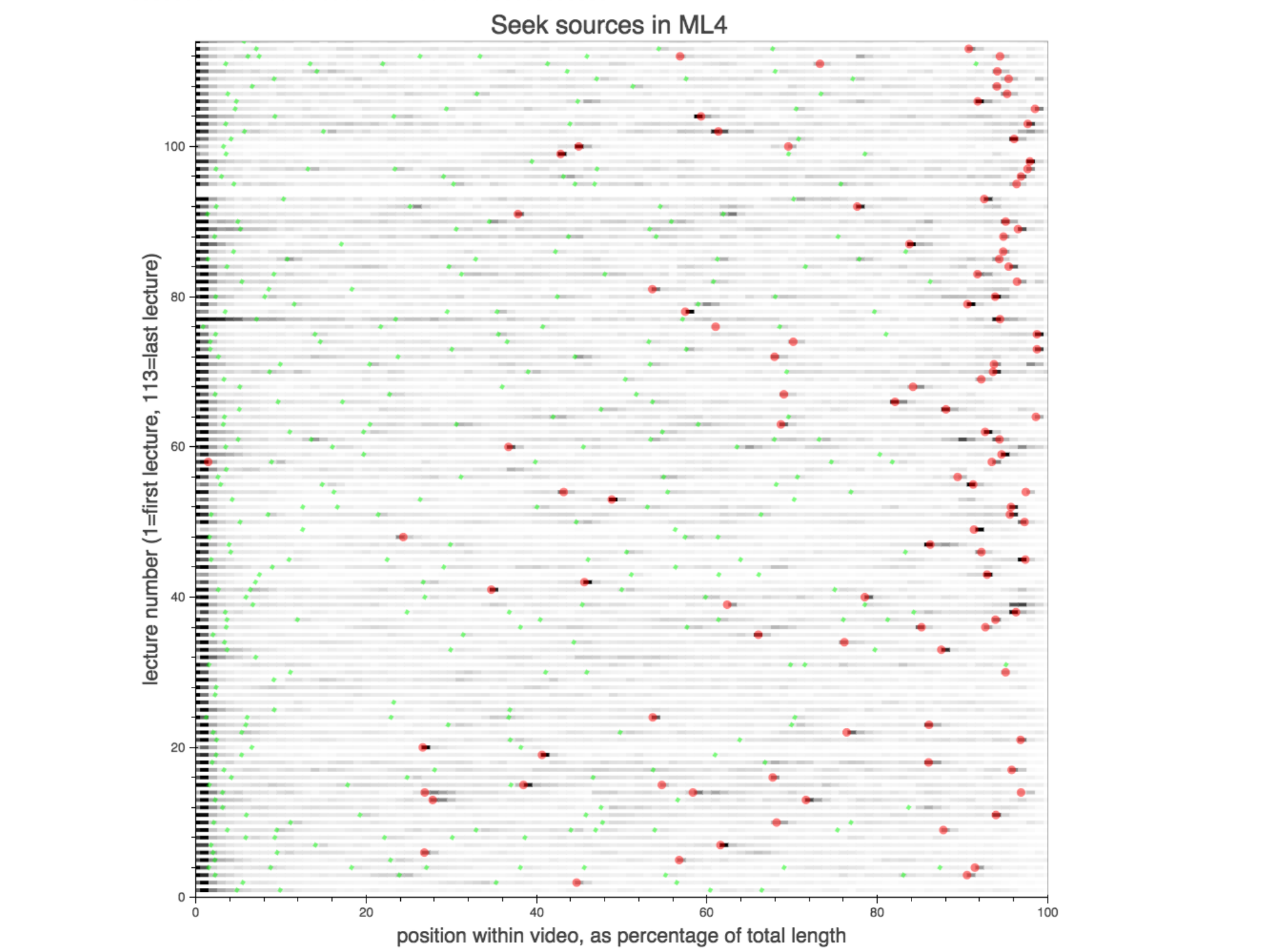
Seek chains do not tend to skip over in-video quizzes

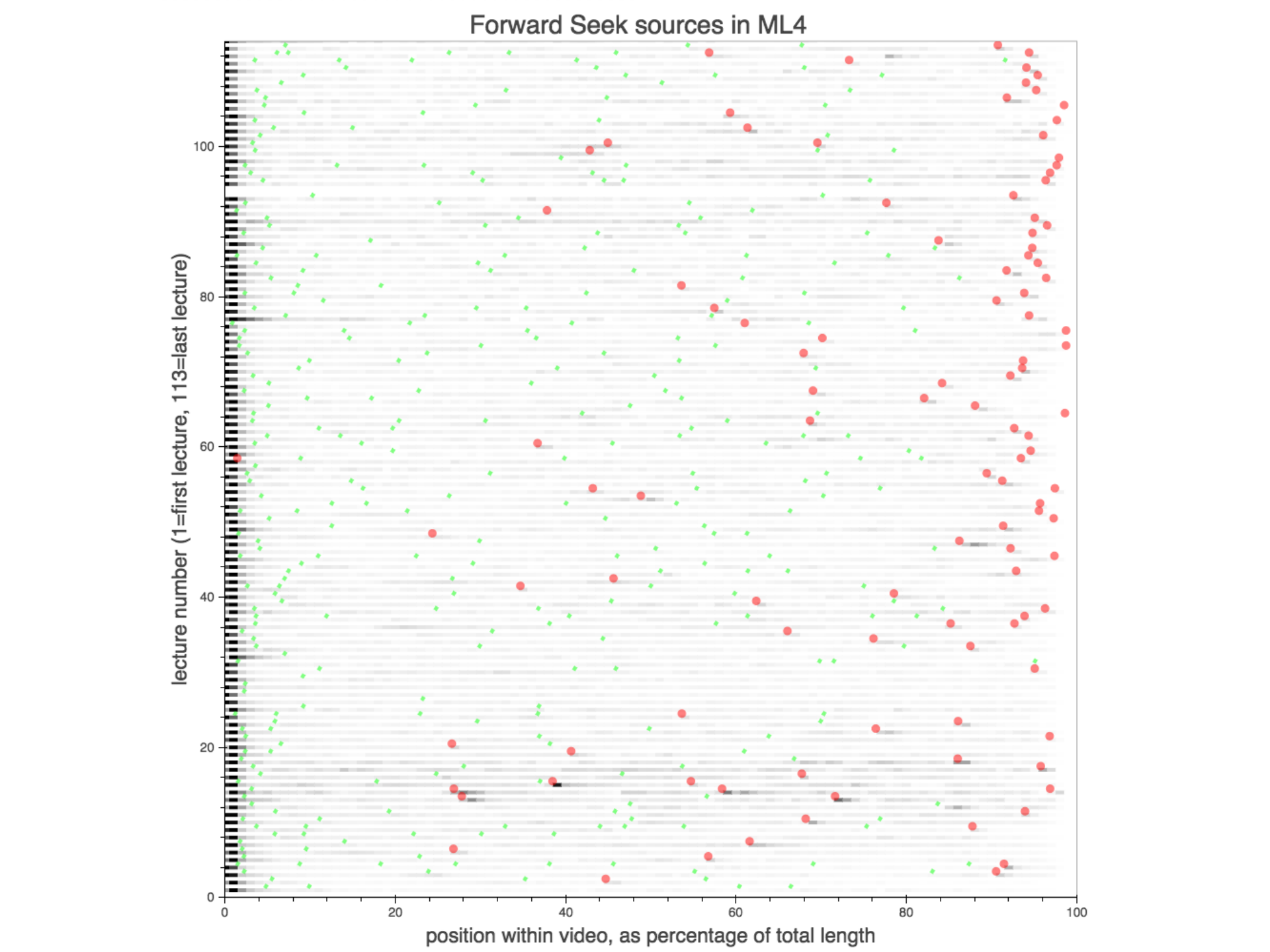
Event type	value
Forward seek chains	
Total # of forward seek chains	1169873 (55.6% of seeks)
Average length of a forward seek chain, in seconds	129 seconds
Average # of times each second of video was seeked forward over	2153 (baseline forward seek rate)
# forward seek chains crossing slide transitions (339 slide transitions total)	909675 (43.2% of seeks)
# forward seek chains crossing each slide transition	2683 (1.25x baseline)
# forward seek chains crossing quizzes (109 quizzes total)	98613 (4.69% of seeks)
# forward seek chains crossing each quiz	905 **(0.42x baseline)**
Backward seek chains	
Total # of backward seek chains	933463 (44.4% of seeks)
Average length of a backward seek chain, in seconds	54 seconds
Average # of times each second of video was seeked backward over	719 (baseline backward seek rate)
# backward seek chains crossing slide transitions (339 slide transitions total)	301129 (14.3% of seeks)
# backward seek chains crossing each slide transition	888 (1.24x baseline)
# backward seek chains crossing quizzes (109 quizzes total)	47184 (2.24% of seeks)
# backward seek chains crossing each quiz	432 **(0.60x baseline)**

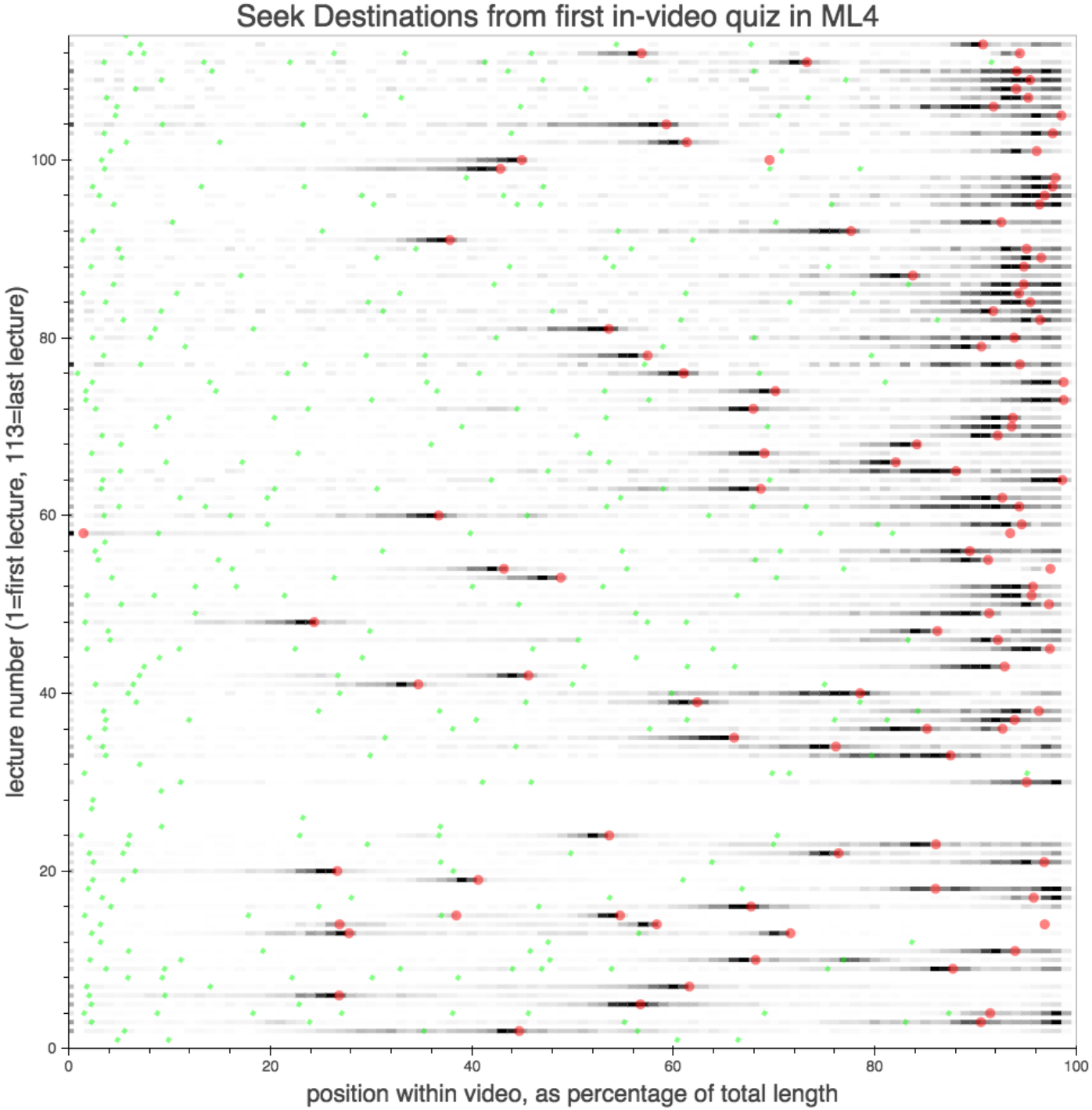
Seek sources and destinations

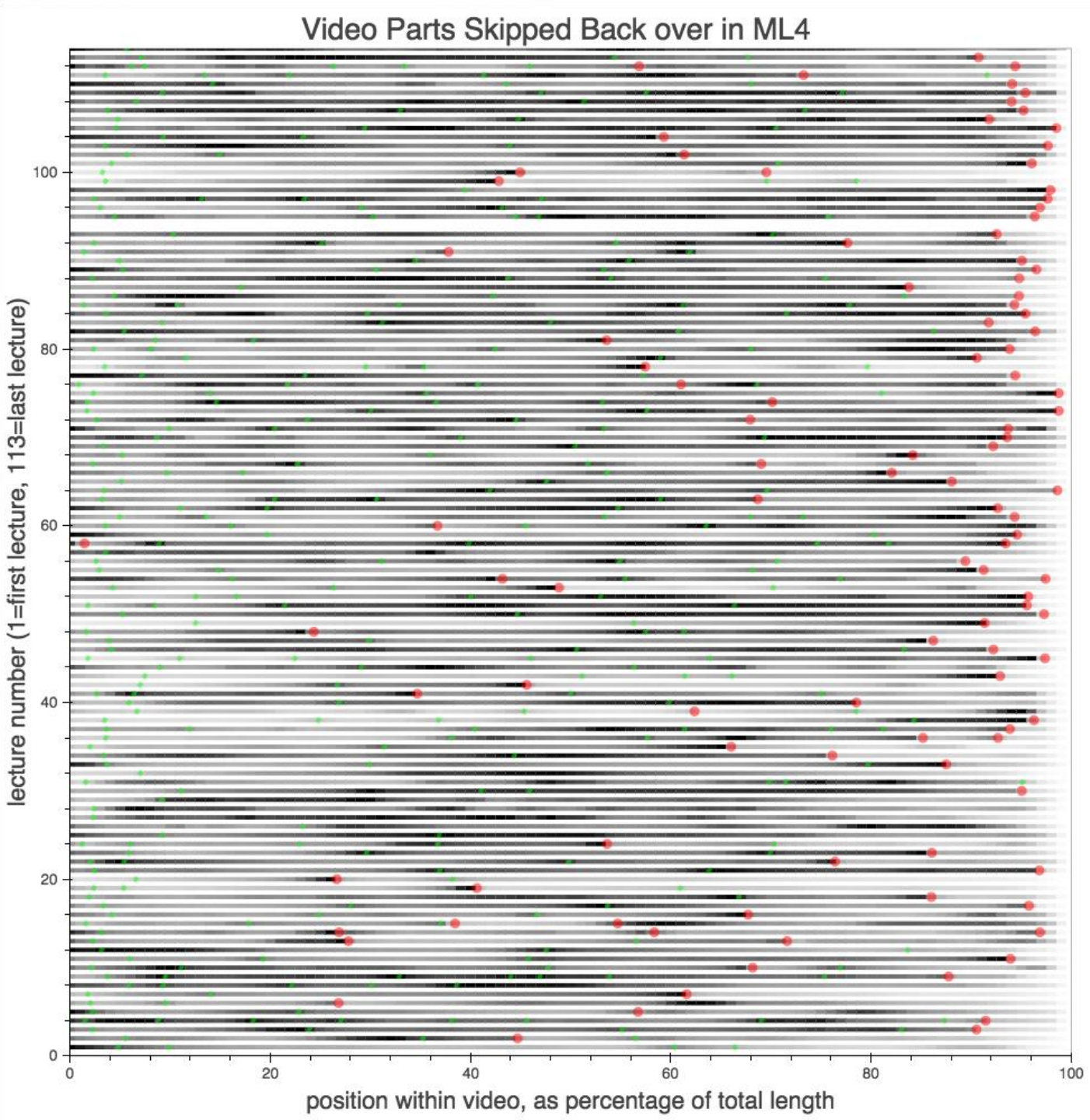
Event type	Seek chains going forward		Seek chains going backward	
	% of all seek chains	# seek chains, normalized by the length of the seek target (seconds). Ratio to baseline in parentheses	% of all seek chains	# seek chains, normalized by the length of the seek target (seconds). Ratio to baseline in parentheses
All seek chains	56%	16.40 (baseline)	44%	12.86 (baseline)
Seek chains going to in-video quizzes (and their surroundings)				
Seeks to quiz (+/- 0.5 sec)	0.35%	**67.43 (4.1x)**	0.20%	38.21 (3.0x)
Seeks to 10 seconds preceding quiz	3.35%	**62.17 (3.8x)**	1.82%	34.58 (2.7x)
Seeks to 10 seconds following quiz	1.15%	21.89 (1.3x)	0.70%	13.33 (1.0x)
Seek chains going to slide transitions (and their surroundings)				
Seeks to slide transition (+/- 0.5 sec)	0.22%	13.60 (0.8x)	0.35%	20.89 (1.6x)
Seeks to 10 seconds preceding slide transition	2.49%	15.04 (0.9x)	3.41%	20.63 (1.6x)
Seeks to 10 seconds following slide transition	3.54%	21.42 (1.3x)	2.33%	14.11 (1.1x)
Seek chains coming from in-video quizzes (and their surroundings)				
Seeks from quiz (+/- 0.5 sec)	0.36%	**67.17 (4.1x)**	3.79%	**713.4 (55x)**
Seeks from 10 seconds preceding quiz	0.65%	12.30 (0.8x)	0.96%	17.99 (1.4x)
Seeks from 10 seconds following quiz	1.89%	35.95 (2.2x)	1.63%	30.76 (2.4x)
Seek chains coming from slide transitions (and their surroundings)				
Seeks from slide transition (+/- 0.5 sec)	0.30%	18.22 (1.1x)	0.27%	16.22 (1.3x)
Seeks from 10 seconds preceding slide transition	6.72%	40.68 (2.5x)	2.27%	13.73 (1.1x)
Seeks from 10 seconds following slide transition	2.78%	16.81 (1.0x)	3.98%	24.10 (1.9x)

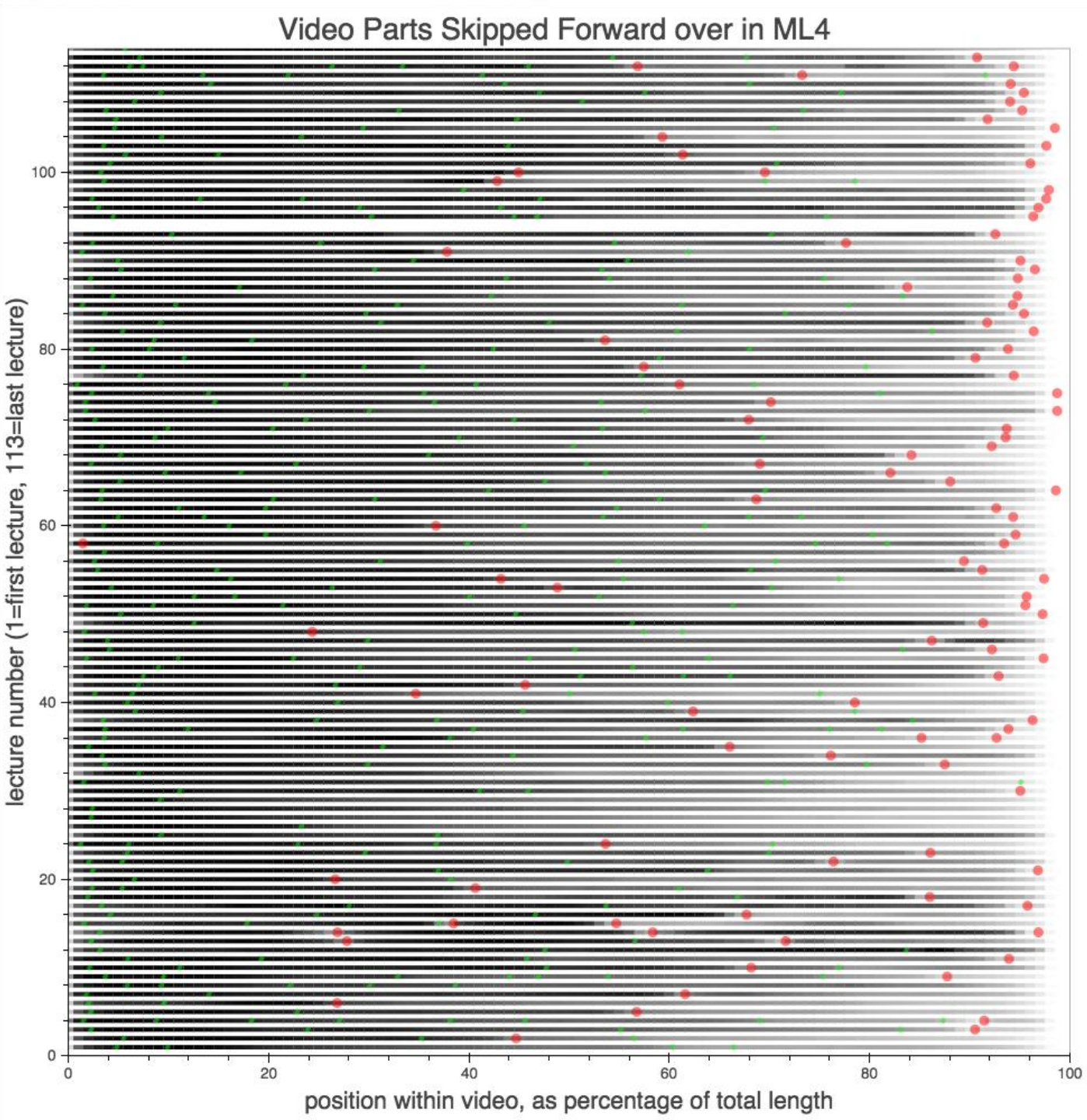

Forward Seek Destinations in ML4
lecture number (1=first lecture, 113=last lecture)
0
20
40
60
80
100
0
20
40
60
80
100
position within video, as percentage of total length


Seek sources in ML4
lecture number (1=first lecture, 113=last lecture)
0
20
40
60
80
100
position within video, as percentage of total length
0
20
40
60
80
100


Forward Seek sources in ML4
lecture number (1=first lecture, 113=last lecture)
position within video, as percentage of total length
0
20
40
60
80
100


Seek Destinations from first in-video quiz in ML4
lecture number (1=first lecture, 113=last lecture)
0
20
40
60
80
100
0
20
40
60
80
100
position within video, as percentage of total length


Video Parts Skipped Back over in ML4
lecture number (1=first lecture, 113=last lecture)
0
20
40
60
80
100
0
20
40
60
80
100
position within video, as percentage of total length


Video Parts Skipped Forward over in ML4
lecture number (1=first lecture, 113=last lecture)
0
20
40
60
80
100
0
20
40
60
80
100
position within video, as percentage of total length

Seek sources and destinations

- Seeks tend to remain within sections delimited by the in-video quizzes