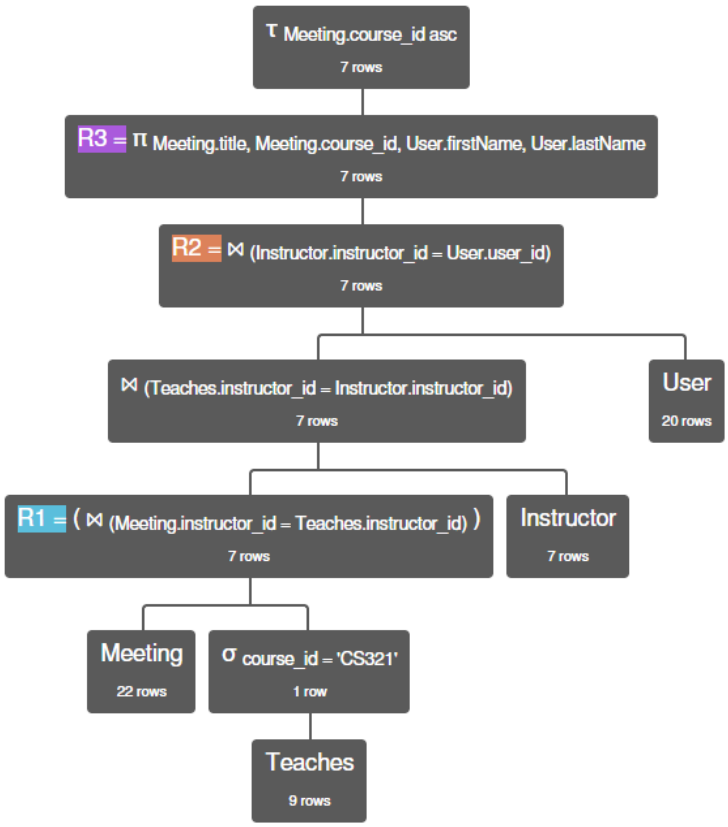
Q1:

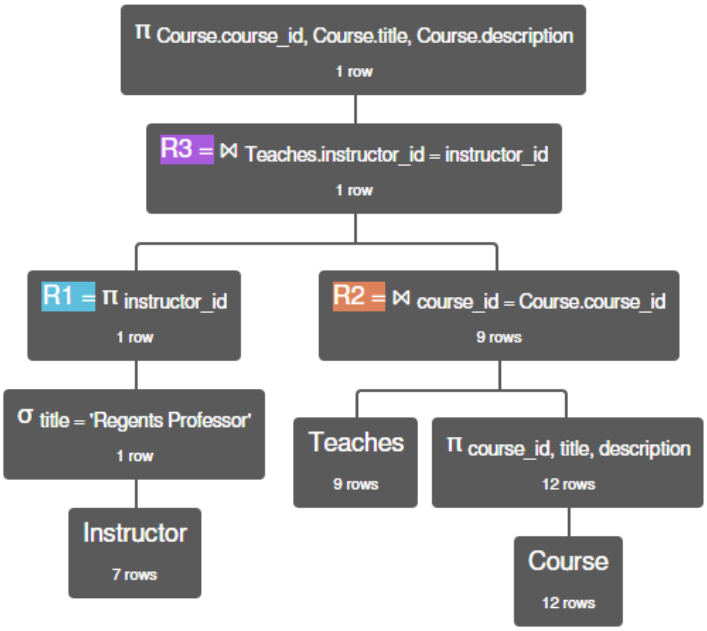


τ Meeting.course_id asc π Meeting.title, Meeting.course_id, User.firstName, User.lastName (((Meeting ⋈ (Meeting.instructor_id = Teaches.instructor_id) (σ course_id = 'CS321' (Teaches))) ⋈ (Teaches.instructor_id = Instructor.instructor_id) Instructor) ⋈ (Instructor.instructor_id = User.user_id) User)

Execution time: 2 ms

Meeting.title	Meeting.course_id	User.firstName	User.lastName
'Lecture1'	'CS321'	'Venera'	'Mason'
'Lecture2'	'CS321'	'Venera'	'Mason'
'Lecture3'	'CS321'	'Venera'	'Mason'
'Lecture4'	'CS321'	'Venera'	'Mason'
'Lecture1'	'CS437'	'Venera'	'Mason'
'Lecture5'	'CS451'	'Venera'	'Mason'
'Curriculum meeting'	*null*	'Venera'	'Mason'

Q2:

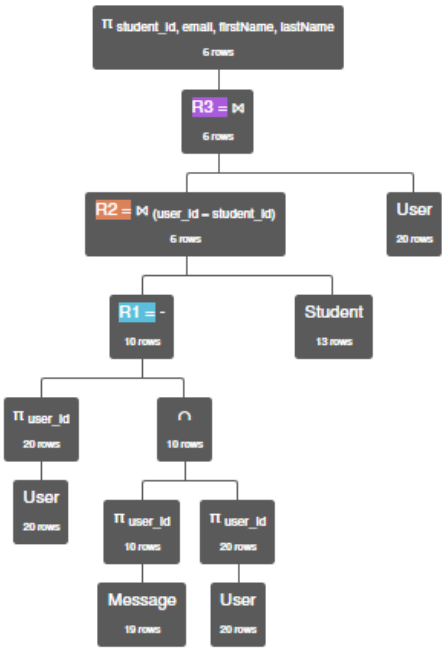


π Course.course_id, Course.title, Course.description (π instructor_id (σ title = 'Regents Professor' (Instructor)) ⋈ Teaches.instructor_id = instructor_id (Teaches ⋈ course_id = Course.course_id (π course_id, title, description (Course))))

Execution time: 2 ms

Course.course_id	Course.title	Course.description
'CS437'	'Introduction to Machine Learning'	'Undergraduate'

Q3:

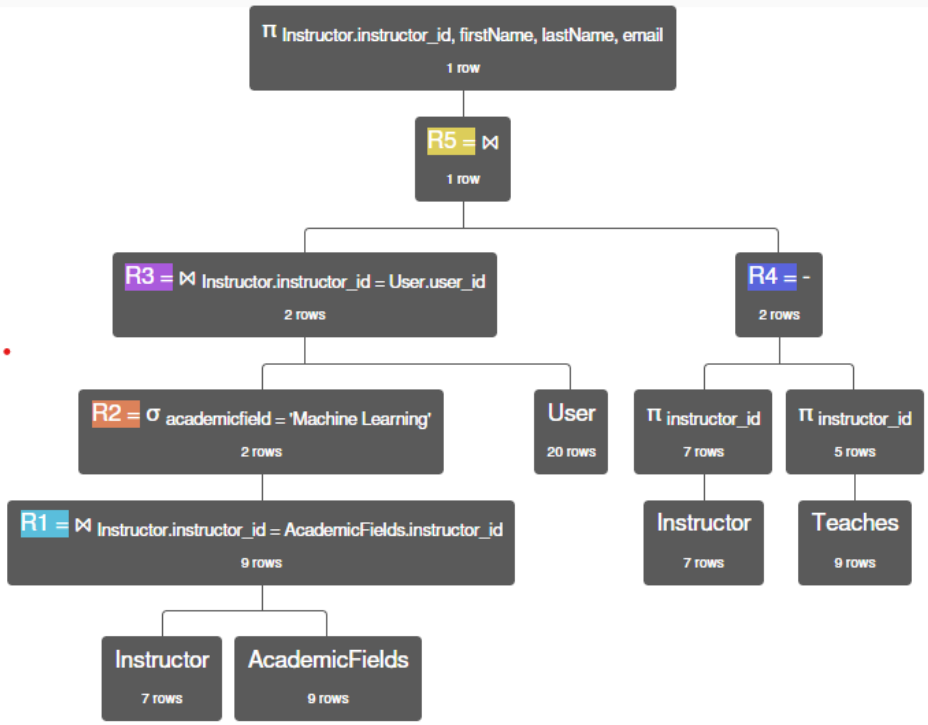


$$\pi_{\text{student\_id, email, firstName, lastName}} (((\pi_{\text{user\_id}} (\text{User}) - (\pi_{\text{user\_id}} (\text{Message}) \cap \pi_{\text{user\_id}} \text{User})) \bowtie_{(\text{user\_id} = \text{student\_id})} (\text{Student})) \bowtie \text{User})$$

Execution time: 2 ms

Student.student_id	User.email	User.firstName	User.lastName
15	'travis@wpi.edu'	'Travis'	'Person'
16	'min@wpi.edu'	'Min'	'Quin'
17	'kelly@wpi.edu'	'Kelly'	'Easton'
18	'amy@wpi.edu'	'Amy'	'Fan'
19	'ben@wpi.edu'	'Ben'	'Hill'
20	'connor@wpi.edu'	'Connor'	'Hall'

Q4:

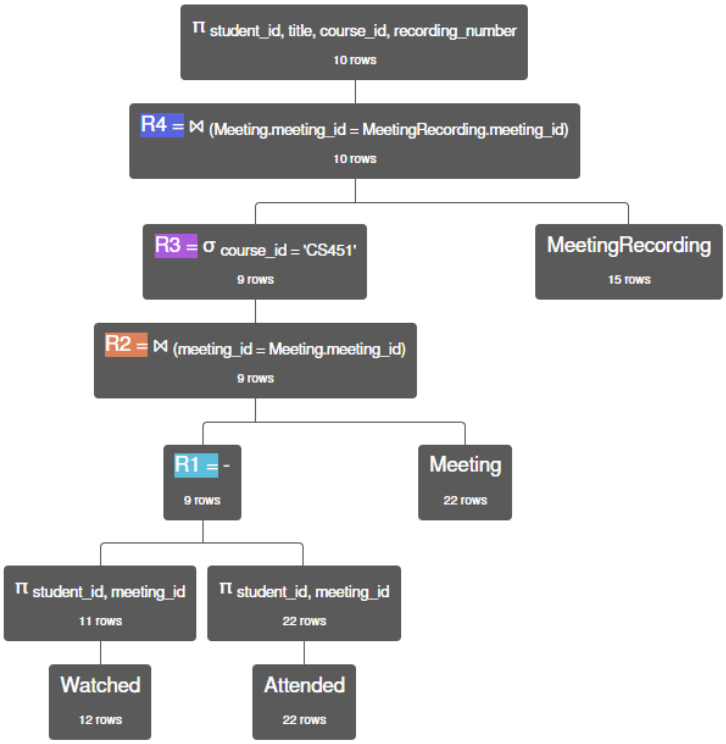


π Instructor.instructor_id, firstName, lastName, email ((σ academicfield = 'Machine Learning' (Instructor ⋈ Instructor.instructor_id = AcademicFields.instructor_id AcademicFields) ⋈ Instructor.instructor_id = User.user_id User) ⋈ ((π instructor_id Instructor) - (π instructor_id Teaches)))

Execution time: 2 ms

Instructor.instructor_id	User.firstName	User.lastName	User.email
3	'Carl'	'Hauser'	'hauser@wpi.edu'

Q5:

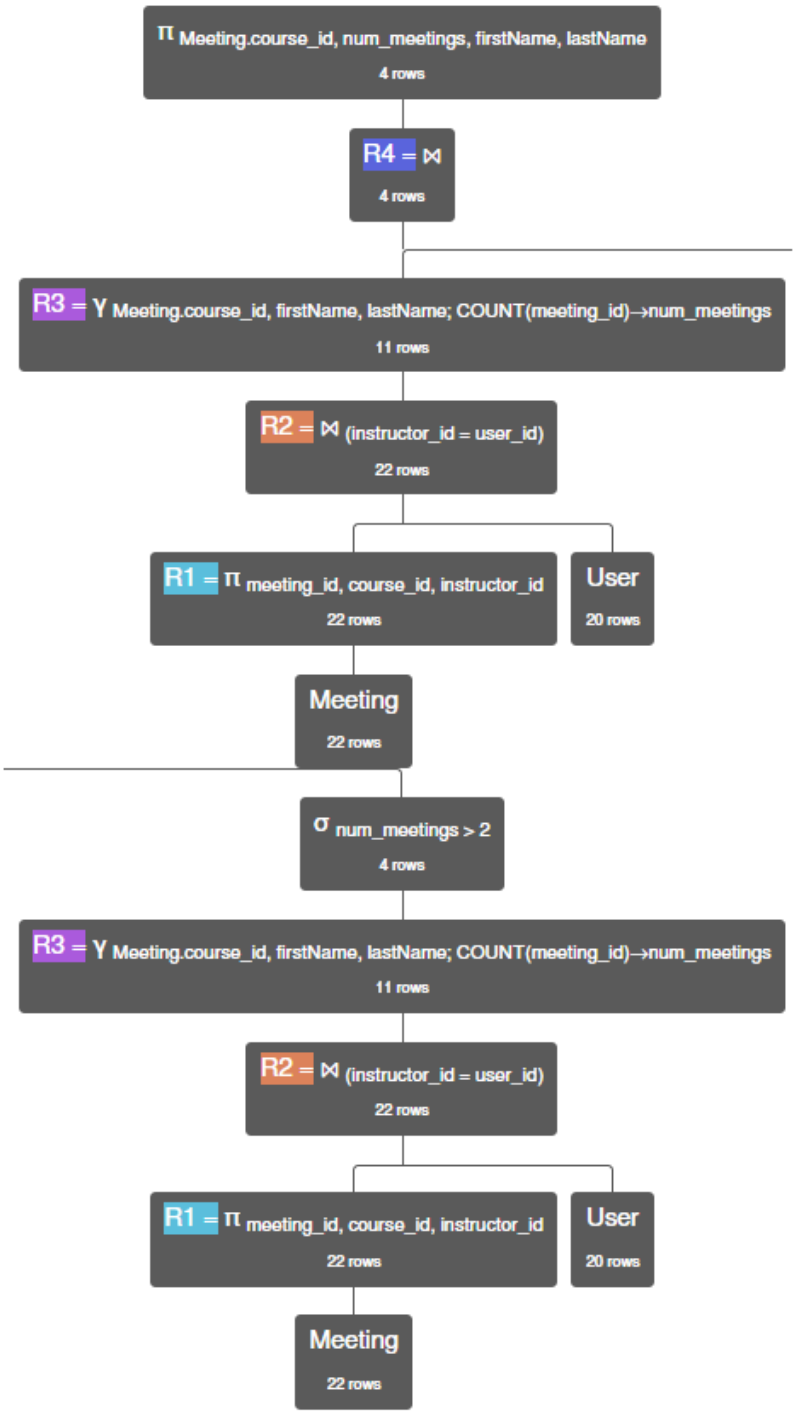


π student_id, title, course_id, recording_number (σ course_id = 'CS451' (((π student_id, meeting_id Watched) - (π student_id, meeting_id Attended)) ⋈ (meeting_id = Meeting.meeting_id) Meeting) ⋈ (Meeting.meeting_id = MeetingRecording.meeting_id) MeetingRecording)

Execution time: 2 ms

Watched.student_id	Meeting.title	Meeting.course_id	MeetingRecording.recording_number
9	'Lecture1'	'CS451'	1
10	'Lecture1'	'CS451'	1
12	'Lecture1'	'CS451'	1
13	'Lecture1'	'CS451'	1
18	'Lecture1'	'CS451'	1
13	'Lecture2'	'CS451'	1
14	'Lecture2'	'CS451'	1
16	'Lecture2'	'CS451'	1
15	'Lecture4'	'CS451'	1
15	'Lecture4'	'CS451'	2

Q6:

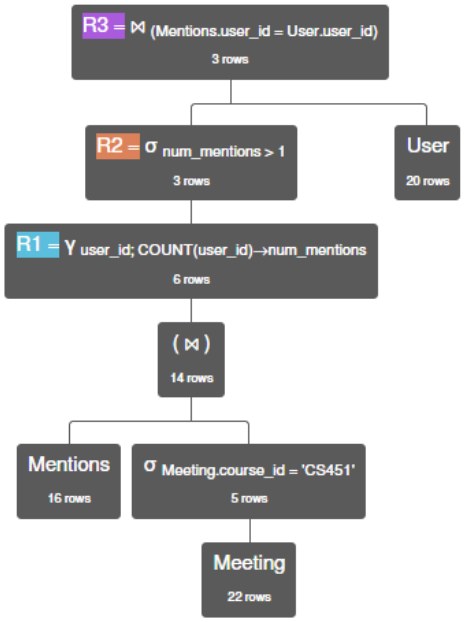

π Meeting.course_id, num_meetings, firstName, lastName
4 rows
R4 = ⋈
4 rows
R3 = γ Meeting.course_id, firstName, lastName; COUNT(meeting_id)→num_meetings
11 rows
R2 = ⋈ (instructor_id = user_id)
22 rows
R1 = π meeting_id, course_id, instructor_id
22 rows
User
20 rows
Meeting
22 rows
σ num_meetings > 2
4 rows
R3 = γ Meeting.course_id, firstName, lastName; COUNT(meeting_id)→num_meetings
11 rows
R2 = ⋈ (instructor_id = user_id)
22 rows
R1 = π meeting_id, course_id, instructor_id
22 rows
User
20 rows
Meeting
22 rows

$$\pi_{\text{Meeting.course\_id, num\_meetings, firstName, lastName}} \left(\gamma_{\text{Meeting.course\_id, firstName, lastName; COUNT(meeting\_id)} \rightarrow \text{num\_meetings}} \left(\pi_{\text{meeting\_id, course\_id, instructor\_id}} \left(\text{Meeting} \right) \bowtie_{\text{(instructor\_id = user\_id)}} \text{User} \right) \bowtie \left(\sigma_{\text{num\_meetings} > 2} \gamma_{\text{Meeting.course\_id, firstName, lastName; COUNT(meeting\_id)} \rightarrow \text{num\_meetings}} \left(\pi_{\text{meeting\_id, course\_id, instructor\_id}} \left(\text{Meeting} \right) \bowtie_{\text{(instructor\_id = user\_id)}} \text{User} \right) \right) \right)$$

Execution time: 3 ms

Meeting.course_id	num_meetings	User.firstName	User.lastName
'CS451'	4	'Sakire'	'ArslanAy'
'CS321'	4	'Venera'	'Mason'
'CS437'	3	'Diane'	'Cook'
'CS355'	3	'Sakire'	'ArslanAy'

Q7:

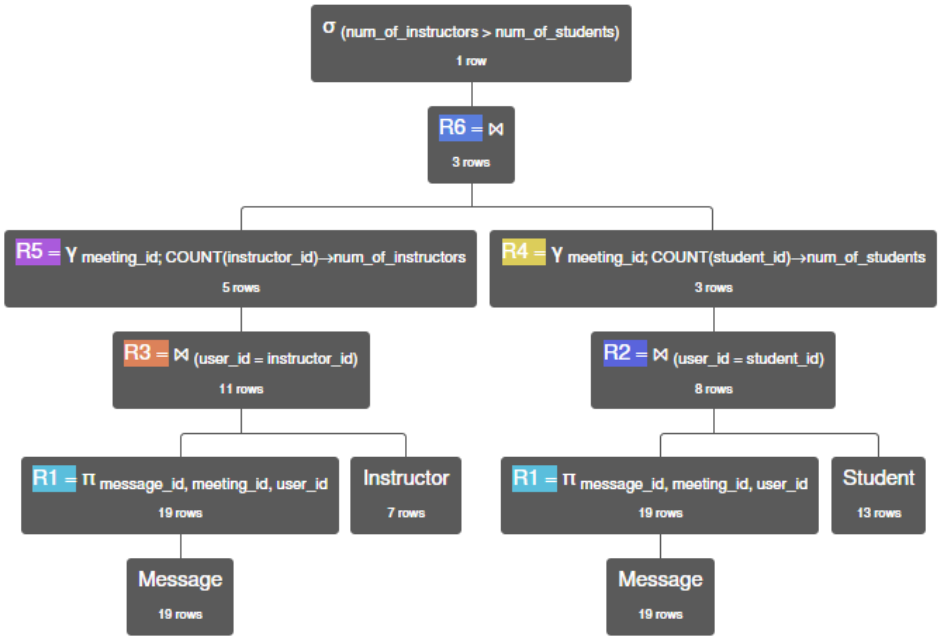


σ num_mentions > 1 γ user_id; COUNT(user_id)→num_mentions (Mentions ⋈ (σ Meeting.course_id = 'CS451' (Meeting))) ⋈ (Mentions.user_id = User.user_id) User

Execution time: 3 ms

Mentions.user_id	num_mentions	User.user_id	User.email	User.firstName	User.lastName
1	6	1	'arslanay@wpi.edu'	'Sakire'	'ArslanAy'
9	3	9	'noel@wpi.edu'	'Noel'	'Sam'
10	2	10	'andy@wpi.edu'	'Andy'	'White'

Q8:

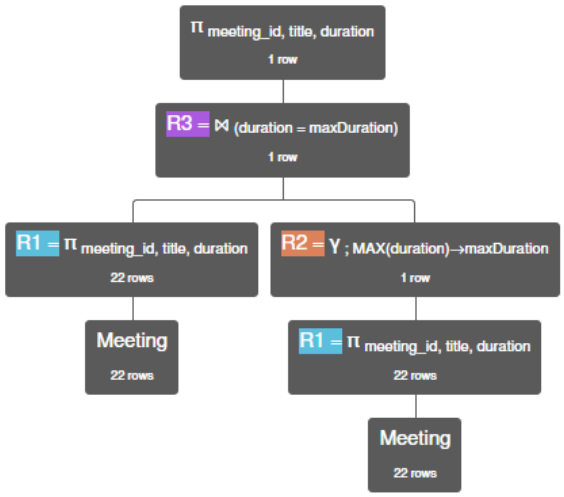


σ (num_of_instructors > num_of_students) (γ meeting_id; COUNT(instructor_id)→num_of_instructors (π message_id, meeting_id, user_id Message ⋈ (user_id = instructor_id) Instructor) ⋈ γ meeting_id; COUNT(student_id)→num_of_students (π message_id, meeting_id, user_id Message ⋈ (user_id = student_id) Student))

Execution time: 2 ms

Message.meeting_id	num_of_instructors	num_of_students
4	4	2

Q9:

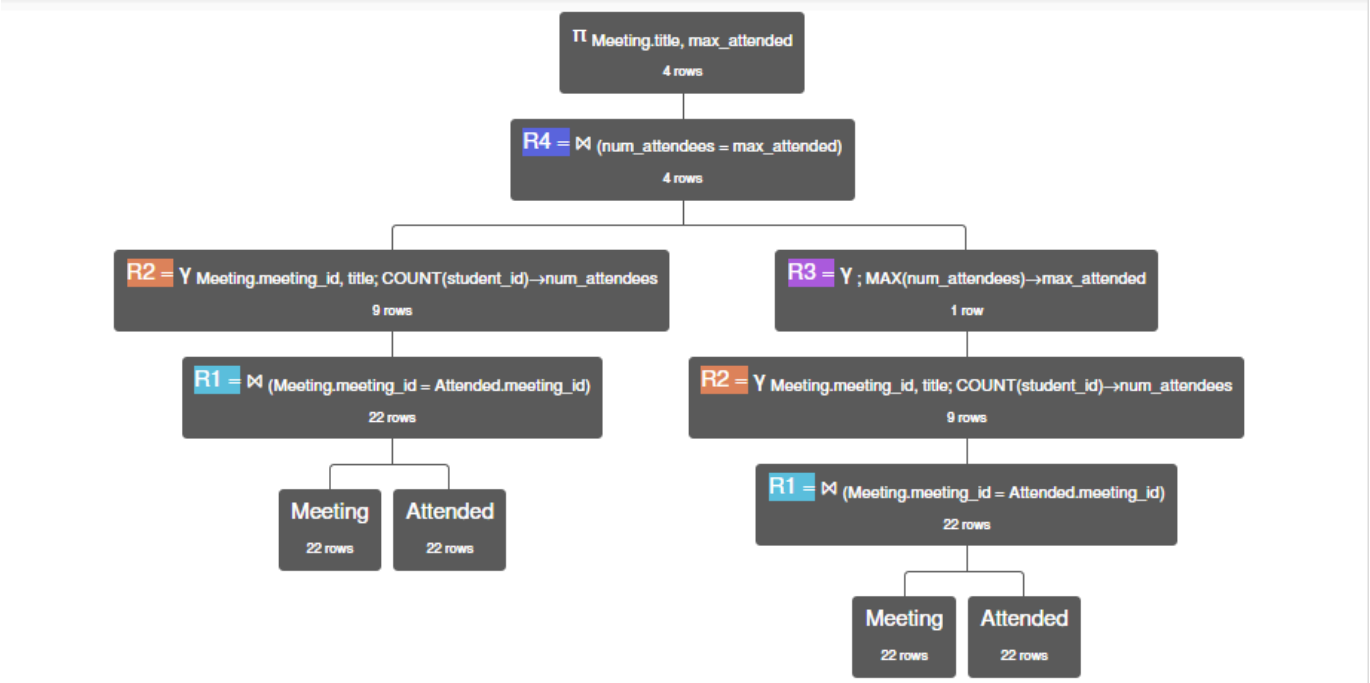


$$\pi_{\text{meeting\_id, title, duration}} (\pi_{\text{meeting\_id, title, duration}} (\text{Meeting}) \bowtie_{\text{(duration = maxDuration)}} \gamma_{\text{; MAX(duration)}\rightarrow\text{maxDuration}} \pi_{\text{meeting\_id, title, duration}} (\text{Meeting}))$$

Execution time: 4 ms

Meeting.meeting_id	Meeting.title	Meeting.duration
20	'Curriculum meeting'	115

Q10:



π Meeting.title, max_attended (γ Meeting.meeting_id, title; COUNT(student_id)→num_attendees (Meeting ⋈ (Meeting.meeting_id = Attended.meeting_id) Attended) ⋈ (num_attendees = max_attended) γ ; MAX(num_attendees)→max_attended γ Meeting.meeting_id, title; COUNT(student_id)→num_attendees (Meeting ⋈ (Meeting.meeting_id = Attended.meeting_id) Attended))

Execution time: 3 ms

Meeting.title	max_attended
'Lecture1'	3
'Lecture2'	3
'Lecture3'	3
'Lecture5'	3