

# Databases Autumn 2025

# Hand-In Exercise 1

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<b>Total Points</b>	
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## Task 1

- (a) Which instructor (LastName, FirstName) created the lesson with the LessonID 42?

$$\pi [LastName, FirstName] (\sigma [LessonID = '42'] (Lesson) \bowtie instructor) \quad (1)$$

- (b) In which semesters and for which courses was the sub-lesson with ID 21 used?

$$\begin{aligned} & \pi [Semester, Title, No, CourseID] \\ & (((\pi [MainLessonID] (\sigma [SubLessonID = '21'] (is\_part\_of))) \bowtie \\ & [MainLessonID = LessonID] (includes)) \bowtie (course)) \end{aligned} \quad (2)$$

- (c) What lessons (LessonID, Description) consist of sub-lessons?

$$\begin{aligned} & \pi [LessonID, Description] (is\_part\_of \bowtie \\ & [MainLessonID = LessonID] (Lesson)) \end{aligned} \quad (3)$$

- (d) Which courses were taught exclusively by Jon Snow?

$$\begin{aligned} T &= ((includes \bowtie \\ & [includes.LessonID = Lesson.LessonID] Lesson) \bowtie \\ & [Lesson.InstructorID = Instructor.InstructorID] Instructor) \\ Bad &= \pi [CourseID] (\sigma [\neg (LastName = 'Snow' \wedge FirstName = 'Jon')] (T)) \\ Good &= \pi [CourseID] (includes) - Bad \\ & \pi [Semester, Title, No, CourseID] (Course \bowtie \\ & [Course.CourseID = Good.CourseID] Good) \end{aligned} \quad (4)$$

- (e) What lessons (including the sub-lessons) are contained inside course 1 of the semester Spring 2024 and titled Database Systems?

$$\pi [Lesson.LessonID, Description] \left( Lesson \bowtie [Lesson.LessonID = A.LessonID] A \right) \quad (5)$$

- (f) How long (in minutes) is the lesson with the ID (LessonID) 21?

$$(l.Duration \mid l \in Lesson \wedge l.LessonID = 21) \quad (6)$$

- (g) Which lessons of the semester Autumn 2025 have a duration of less than 30 minutes?

$$\begin{aligned} & (l \mid l \in Lesson \wedge l.Duration < 30 \wedge \exists c \in Course (c.Semester = Autumn2025) \wedge \\ & \exists i \in Includes (i.CourseID = c.CourseID \wedge i.LessonID = l.LessonID)) \end{aligned} \quad (7)$$

- (h) For which semesters exist courses with main lessons where Jon Snow instructed at least one lesson?

$$\begin{aligned} & (c.Semester \mid c \in Course \wedge \exists i \in \\ & Includes(\exists l \in Lesson(l.LessonID = i.LessonID \wedge \\ & \exists j \in Instructor(l.InstructorID = j.InstructorID \wedge \\ & j.LastName = Snow \wedge j.FirstName = John)))) \end{aligned} \quad (8)$$

- (i) What lessons consist of sub-lessons that have been instructed by at least two different instructors?

$$\begin{aligned} & (l \mid l \in Lesson \wedge \exists i_1 \in is\_part\_of(i_1.MainLessonID = l.LessonID \wedge \\ & \exists l_1 \in Lesson(l_1.LessonID = i_1.SubLessonID)) \\ & \exists i_2 \in is\_part\_of(i_2.MainLessonID = i_1.MainLessonID \wedge \\ & \exists l_2 \in Lesson(l_2.LessonID = i_2.SubLessonID \wedge l_1.InstructorID \neq l_2.InstructorID))) \end{aligned} \quad (9)$$

- (j) Which courses contain only main lessons with a difficulty of at least 3?

$$\begin{aligned} & (c \mid c \in Course \wedge \forall i \in includes(c.CourseID = i.CourseID \wedge \\ & \forall l \in Lesson(l.LessonID = i.LessonID \wedge l.Difficulty \geq 3))) \end{aligned} \quad (10)$$

## Task 2

- (a) Person on Name:

$$\sigma[Name = 'ChristopherNolan'](Person) \quad (11)$$

Activity on SceneAuthor:

$$\sigma[Activity = 'director'](SceneAuthor) \quad (12)$$

Add join on both:

$$\begin{aligned} & \pi[MovieID, SceneID](\sigma[Name = 'ChristopherNolan' \wedge Activity = 'director'] \\ & (Person \bowtie SceneAuthor)) \end{aligned} \quad (13)$$

- (b) Movie on Title:

$$\sigma[MovieTitle = 'Inception'](Movie) \quad (14)$$

Hans Zimmer as composer (within that movie):

$$\begin{aligned} & \pi[MovieID, SceneID] \\ & (\sigma[MovieTitle = 'Inception' \wedge Name = 'HansZimmer' \wedge Activity = 'composer'] \\ & (Movie \bowtie SceneAuthor \bowtie Person)) \end{aligned} \quad (15)$$

Christopher Nolan as screenwriter (within that movie):

$$\begin{aligned} & \pi [MovieID, SceneID] \\ & (\sigma [MovieTitle = 'Inception' \wedge Name = 'ChristopherNolan' \wedge Activity = 'screenwriter'] \\ & \quad (Movie \bowtie SceneAuthor \bowtie Person)) \end{aligned} \quad (16)$$

Intersect on scene key then output SceneID:

$$\begin{aligned} & \pi [SceneID] \\ & \quad ((\pi [MovieID, SceneID] \\ & \quad (\sigma [MovieTitle = 'Inception' \wedge Name = 'HansZimmer' \wedge Activity = 'composer'] \\ & \quad \quad (Movie \bowtie SceneAuthor \bowtie Person)))) \cap \\ & \quad (\pi [MovieID, SceneID] \\ & \quad (\sigma [MovieTitle = 'Inception' \wedge Name = 'ChristopherNolan' \wedge Activity = 'screenwriter'] \\ & \quad \quad (Movie \bowtie SceneAuthor \bowtie Person)))) \end{aligned} \quad (17)$$

(c) Person on Name:

$$\sigma [Name = 'QuentinTarantino'] (Person) \quad (18)$$

Actor role on ScenePerformer:

$$\sigma [Role = 'actor'] (ScenePerformer) \quad (19)$$

Director activity on SceneAuthor:

$$\sigma [Activity = 'director'] (SceneAuthor) \quad (20)$$

Combine and output scene Titles:

$$\begin{aligned} & \pi [Title] (\sigma [Name = 'QuentinTarantino' \wedge Role = 'actor' \wedge Activity = 'director'] \\ & \quad (Scene \bowtie ScenePerformer \bowtie SceneAuthor \bowtie Person)) \end{aligned} \quad (21)$$

(d) Actor on ScenePerformer:

$$\sigma [Name = 'RobertDowneyJr.' \wedge Role = 'actor'] (ScenePerformer \bowtie Person) \quad (22)$$

Author on SceneAuthor:

$$\sigma [Name = 'RobertDowneyJr.'] (SceneAuthor \bowtie Person) \quad (23)$$

Union on MovieID, then output MovieTitle:

$$\begin{aligned} & \pi [MovieTitle] \\ & ((\pi [MovieID] (\sigma [Name = 'RobertDowneyJr.' \wedge Role = 'actor'] (ScenePerformer \bowtie Person)) \\ & \cup \pi [MovieID] (\sigma [Name = 'RobertDowneyJr.'] (SceneAuthor \bowtie Person))) \bowtie Movie) \end{aligned} \quad (24)$$

(e) Actor on ScenePerformer:

$$\sigma [Name = 'ScarlettJohansson' \wedge Role = 'actor'] (ScenePerformer \bowtie Person) \quad (25)$$

Stunt double on ScenePerformer:

$$\sigma [Name = 'ScarlettJohansson' \wedge Role = 'stuntdouble'] (ScenePerformer \bowtie Person) \quad (26)$$

Intersect on scene key, then output Titles:

$$\begin{aligned} \pi [Title] \\ ((\pi [MovieID, SceneID] (\sigma [Name = 'ScarlettJohansson' \wedge Role = 'actor'] \\ (ScenePerformer \bowtie Person))) \cap \pi [MovieID, SceneID] \\ (\sigma [Name = 'ScarlettJohansson' \wedge Role = 'stuntdouble'] \\ (ScenePerformer \bowtie Person))) \bowtie Scene) \end{aligned} \quad (27)$$

(f) Person on Name (subset of Person):

$$F_{1.1} = \{p | p \in Person \wedge p.Name = 'ChristopherNolan'\} \quad (28)$$

Activity on SceneAuthor (subset of SceneAuthor):

$$F_{1.2} = \{sa | sa \in SceneAuthor \wedge sa.Activity = 'director'\} \quad (29)$$

Join by PID, output (MovieID,SceneID) without Person:

$$\{\langle sa.MovieID, sa.SceneID \rangle | sa \in F_{1.2} \wedge \exists p (p \in F_{1.1} \wedge p.PID = sa.PID)\} \quad (30)$$

(g) Movie on Title:

$$G_{2.1} = \{m | m \in Movie \wedge m.MovieTitle = 'Inception'\} \quad (31)$$

Hans Zimmer as composer (within that movie):

$$\begin{aligned} G_{2.2} = \{sa | sa \in SceneAuthor \wedge sa.Activity = 'composer' \wedge \\ \exists p (p \in Person \wedge p.PID = sa.PID \wedge p.Name = 'HansZimmer') \wedge \\ \exists m (m \in G_{2.1} \wedge m.MovieID = sa.MovieID)\} \end{aligned} \quad (32)$$

Christopher Nolan as screenwriter (within that movie):

$$\begin{aligned} G_{2.3} = \{sa | sa \in SceneAuthor \wedge sa.Activity = 'screenwriter' \wedge \\ \exists p (p \in Person \wedge p.PID = sa.PID \wedge p.Name = 'ChristopherNolan') \wedge \\ \exists m (m \in G_{2.1} \wedge m.MovieID = sa.MovieID)\} \end{aligned} \quad (33)$$

Intersect on full scene key, then output SceneID:

$$\{\langle x.SceneID \rangle | x \in G_{2.2} \wedge \exists y (y \in G_{2.3} \wedge y.MovieID = x.MovieID \wedge y.SceneID = x.SceneID)\} \quad (34)$$

(h) Person on Name (subset of Person):

$$H_{3.1} = \{p | p \in Person \wedge p.Name = 'QuentinTarantino'\} \quad (35)$$

Actor role on ScenePerformer:

$$H_{3.2} = \{sp | sp \in ScenePerformer \wedge sp.Role = 'actor'\} \quad (36)$$

Director activity on SceneAuthor:

$$H_{3.3} = \{sa | sa \in SceneAuthor \wedge sa.Activity = 'director'\} \quad (37)$$

Join on person and scene, then output Title:

$$\begin{aligned} \{ \langle s.Title \rangle | s \in Scene \wedge \exists p \exists sp \exists sa (p \in H_{3.1} \wedge sp \in H_{3.2} \wedge sa \in H_{3.3} \wedge \\ sp.PID = p.PID \wedge sa.PID = p.PID \wedge \\ sp.MovieID = sa.MovieID \wedge sp.SceneID = sa.SceneID \wedge \\ s.MovieID = sp.MovieID \wedge s.SceneID = sp.SceneID) \} \end{aligned} \quad (38)$$

(i) Person on Name (subset of Person):

$$I_{4.1} = \{p | p \in Person \wedge p.Name = 'RobertDowneyJr.'\} \quad (39)$$

Actor role on ScenePerformer:

$$I_{4.2} = \{sp | sp \in ScenePerformer \wedge sp.Role = 'actor'\} \quad (40)$$

Any author activity on SceneAuthor:

$$I_{4.3} = \{sa | sa \in SceneAuthor\} \quad (41)$$

Actor or author in the same movie, then output MovieTitle:

$$\begin{aligned} \{ \langle m.MovieTitle \rangle | m \in Movie \wedge (\exists p \exists sp (p \in I_{4.1} \wedge sp \in I_{4.2} \wedge \\ sp.PID = p.PID \wedge sp.MovieID = m.MovieID) \vee \\ \exists q \exists sa (q \in I_{4.1} \wedge sa \in I_{4.3} \wedge sa.PID = q.PID \wedge sa.MovieID = m.MovieID)) \} \end{aligned} \quad (42)$$

(j) Person on Name (subset of Person):

$$J_{5.1} = \{p | p \in Person \wedge p.Name = 'ScarlettJohansson'\} \quad (43)$$

Actor role on ScenePerformer:

$$J_{5.2} = \{spA | spA \in ScenePerformer \wedge spA.Role = 'actor'\} \quad (44)$$

Stunt double role on ScenePerformer:

$$J_{5.3} = \{spS | spS \in ScenePerformer \wedge spS.Role = 'stuntdouble'\} \quad (45)$$

Same person, same scene, then output Title:

$$\begin{aligned} \{ \langle s.Title \rangle | s \in Scene \wedge \exists p \exists spA \exists spS (p \in J_{5.1} \wedge spA \in J_{5.2} \wedge spS \in J_{5.3} \wedge \\ spA.PID = p.PID \wedge spS.PID = p.PID \wedge \\ spA.MovieID = spS.MovieID \wedge spA.SceneID = spS.SceneID \wedge \\ s.MovieID = spA.MovieID \wedge s.SceneID = spA.SceneID) \} \end{aligned} \quad (46)$$