Databases Autumn 2025

Hand-In Exercise 1

October 12, 2025

Aiysha Frutiger
Jannick Seper
Luis Tritschler

Total Points	

Task	Points

Databases
Autumn 2025
Exercise 1

Aiysha Frutiger
Jannick Seper
Luis Tritschler
Page 1 of 6

Task 1

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

$$\pi \left[LastName, FirstName\right] \left(\sigma \left[LessonID =' 42'\right] (Lesson) \bowtie instructor\right) \tag{1}$$

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

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

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

$$\begin{aligned} \pi \left[LessonID, Description\right] \left(\left(\sigma \left[SublessonID \neq' null'\right] (is\_part\_of)\right) \bowtie \right. \\ \left.\left[MainLessonID = LessonID\right] (Lesson)\right) \end{aligned} \tag{3}$$

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

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

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

$$\pi \left[\text{Lesson.LessonID, Description}\right] \left(\text{ Lesson } \bowtie [\text{Lesson.LessonID} = \text{A.LessonID}] \ A \right) \tag{5}$$

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

$$(l.Duration \mid l \in Lesson \wedge l.LessonID = 21) \tag{6}$$

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

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

Databases
Autumn 2025
Exercise 1

Aiysha Frutiger
Jannick Seper
Luis Tritschler
Page 2 of 6

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

$$
(c.Semester \mid c \in Course \land \exists i \in \\
Includes(\exists l \in Lesson(l.LessonID = i.LessonID \land \\
\exists j \in Instructor(l.InstructorID = j.InstructorID \land \\
j.LastName = Snow \land j.FirstName = John)))) \tag{8}
$$

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

$$
(l \mid l \in Lesson \land \exists i_1 \in is\_part\_of(i_1.MainLessonID = l.LessonID \land \\
\exists l_1 \in Lesson(l_1.LessonID = i_1.SubLessonID)) \\
\exists i_2 \in is\_part\_of(i_2.MainLessonID = i_1.MainLessonID \land \\
\exists l_2 \in Lesson(l_2.LessonID = i_2.SubLessonID \land l_1.InstructorID \neq l_2.InstructorID))) \tag{9}
$$

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

$$
(c \mid c \in Course \land \forall i \in includes(c.CourseID = i.CourseID \land \\
\forall l \in Lesson(l.LessonID = i.LessonID \land l.Difficulty \geq 3))) \tag{10}
$$

Task 2

(a) Person on Name:
$$
\sigma\,[Name =' ChristopherNolan']\,(Person) \tag{11}
$$

Activity on SceneAuthor:

$$
\sigma\,[Activity =' director']\,(SceneAuthor) \tag{12}
$$

Add join on both:

$$
\pi\,[MovieID, SceneID]\,(\sigma\,[Name =' ChristopherNolan' \land Activity =' director'] \\
(Person \bowtie SceneAuthor)) \tag{13}
$$

(b) Movie on Title:
$$
\sigma[MovieTitle =' Inception'](Movie) \tag{14}
$$

Hans Zimmer as composer (within that movie):

$$
\pi\,[MovieID, SceneID] \\
(\sigma\,[MovieTitle =' Inception' \land Name =' HansZimmer' \land Activity =' composer'] \\
(Movie \bowtie SceneAuthor \bowtie Person)) \tag{15}
$$

Databases
Autumn 2025
Exercise 1

Aiysha Frutiger
Jannick Seper
Luis Tritschler
Page 3 of 6

Christopher Nolan as screenwriter (within that movie):

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

Intersect on scene key then output SceneID:

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

(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:

$$\pi\,[Title]\,(\sigma\,[Name =' QuentinTarantino' \wedge Role =' actor' \wedge Activity =' director']$$
$$(Scene \bowtie ScenePerformer \bowtie SceneAuthor \bowtie Person)) \quad (21)$$

(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:

$$\pi\,[MovieTitle]$$
$$((\pi\,[MovieID]\,(\sigma\,[Name =' RobertDowneyJr.' \wedge Role =' actor']\,(ScenePerformer \bowtie Person))$$
$$\cup \pi\,[MovieID]\,(\sigma\,[Name =' RobertDowneyJr.']\,(SceneAuthor \bowtie Person))) \bowtie Movie) \quad (24)$$

Databases
Autumn 2025
Exercise 1

Aiysha Frutiger
Jannick Seper
Luis Tritschler
Page 4 of 6

(e) Actor on ScenePerformer:

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

Stunt double on ScenePerformer:

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

Intersect on scene key, then output Titles:

$$\pi\left[Title\right]$$
$$((\pi\left[MovieID, SceneID\right](\sigma\left[Name =' ScarlettJohansson' \wedge Role =' actor'\right]$$
$$(ScenePerformer \bowtie Person)) \cap \pi\left[MovieID, SceneID\right]$$
$$(\sigma\left[Name =' ScarlettJohansson' \wedge Role =' stuntdouble'\right]$$
$$(ScenePerformer \bowtie Person))) \bowtie Scene) \quad (27)$$

(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):

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

Christopher Nolan as screenwriter (within that movie):

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

Intersect on full scene key, then output SceneID:

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

Databases
Autumn 2025
Exercise 1

Aiysha Frutiger
Jannick Seper
Luis Tritschler
Page 5 of 6

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

$$H_{3.1} = \{p | p \in Person \land p.Name =' QuentinTarantino'\} \tag{35}$$

Actor role on ScenePerformer:

$$H_{3.2} = \{sp | sp \in ScenePerformer \land sp.Role =' actor'\} \tag{36}$$

Director activity on SceneAuthor:

$$H_{3.3} = \{sa | sa \in SceneAuthor \land sa.Activity =' director'\} \tag{37}$$

Join on person and scene, then output Title:

$$\{\langle s.Title \rangle | s \in Scene \land \exists p \exists sp \exists sa (p \in H_{3.1} \land sp \in H_{3.2} \land sa \in H_{3.3} \land$$
$$sp.PID = p.PID \land sa.PID = p.PID \land$$
$$sp.MovieID = sa.MovieID \land sp.SceneID = sa.SceneID \land$$
$$s.MovieID = sp.MovieID \land s.SceneID = sp.SceneID)\} \tag{38}$$

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

$$I_{4.1} = \{p | p \in Person \land p.Name =' RobertDowneyJr.'\} \tag{39}$$

Actor role on ScenePerformer:

$$I_{4.2} = \{sp | sp \in ScenePerformer \land sp.Role =' actor'\} \tag{40}$$

Any author activity on SceneAuthor:

$$I_{4.3} = \{sa | sa \in SceneAuthor\} \tag{41}$$

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

$$\{\langle m.MovieTitle \rangle | m \in Movie \land (\exists p \exists sp (p \in I_{4.1} \land sp \in I_{4.2} \land$$
$$sp.PID = p.PID \land sp.MovieID = m.MovieID) \lor$$
$$\exists q \exists sa (q \in I_{4.1} \land sa \in I_{4.3} \land sa.PID = q.PID \land sa.MovieID = m.MovieID))\} \tag{42}$$

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

$$J_{5.1} = \{p | p \in Person \land p.Name =' ScarlettJohansson'\} \tag{43}$$

Actor role on ScenePerformer:

$$J_{5.2} = \{spA | spA \in ScenePerformer \land spA.Role =' actor'\} \tag{44}$$

Databases
Autumn 2025
Exercise 1

Aiysha Frutiger
Jannick Seper
Luis Tritschler
Page 6 of 6

Stunt double role on ScenePerformer:

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

Same person, same scene, then output Title:

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