Databases Autumn 2025

Hand-In Exercise 1

October 15, 2025

Aiysha Frutiger
Jannick Seper
Luis Tritschler

Total Points	

Task	**Points**

Aiysha Frutiger
Jannick Seper
Luis Tritschler

Task 1

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Task 2

(a) Person on Name:

$$\sigma\left[Name =' ChristopherNolan'\right](Person) \tag{11}$$

Activity on SceneAuthor:

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

Add join on both:

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

(b) Movie on Title:

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

Hans Zimmer as composer (within that movie):

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

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:

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

(e) Actor on ScenePerformer:

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

Stunt double on ScenePerformer:

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

Intersect on scene key, then output Titles:

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

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

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

Activity on SceneAuthor (subset of SceneAuthor):

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

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

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

(g) Movie on Title:

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

Hans Zimmer as composer (within that movie):

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

Christopher Nolan as screenwriter (within that movie):

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

Intersect on full scene key, then output SceneID:

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

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

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

Actor role on ScenePerformer:

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

Director activity on SceneAuthor:

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

Join on person and scene, then output Title:

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

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

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

Actor role on ScenePerformer:

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

Any author activity on SceneAuthor:

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

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

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

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

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

Actor role on ScenePerformer:

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

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:

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