Databases Autumn 2025

Hand-In Exercise 1

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Total Points	

Task	Points

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Task 1

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

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

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

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

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

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

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

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

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

$$(l.Duration \mid l \in Lesson \wedge l.LessonID = 21) \tag{4}$$

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

$$(l \mid l \in Lesson \wedge l.Duration < 30 \wedge \exists c \in Course(c.Semester = Autumn2025)\wedge$$
$$\exists \in Includes(i.CourseID = c.CourseID \wedge i.LessonID = l.LessonID)) \tag{5}$$

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

$$(c.Semester \mid c \in Course \wedge \exists i \in$$
$$Includes(\exists l \in Lesson(l.LessonID = i.LessonID\wedge$$
$$\exists j \in Instructor(l.InstructorID = j.InstructorID\wedge$$
$$j.LastName = Snow \wedge j.FirstName = John)))) \tag{6}$$

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

$$(l \mid l \in Lesson \wedge \exists i_1 \in is\_part\_of(i_1.MainLessonID = l.LessonID\wedge$$
$$\exists l_1 \in Lesson(l_1.LessonID = i_1.SubLessonID))$$
$$\exists i_2 \in is\_part\_of(i_2.MainLessonID = i_1.MainLessonID\wedge$$
$$\exists l_2 \in Lesson(l_2.LessonID = i_2.SubLessonID \wedge l_1.InstructorID \neq l_2.InstructorID))) \tag{7}$$

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

$$(c \mid c \in Course \wedge \forall i \in includes(c.CourseID = i.CourseID\wedge$$
$$\forall l \in Lesson(l.LessonID = i.LessonID \wedge l.Difficulty \geq 3))) \tag{8}$$

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Task 2

(a) Person on Name:
$$\sigma\left[Name ='ChristopherNolan'\right](Person) \tag{9}$$

Activity on SceneAuthor:

$$\sigma\left[Activity ='director'\right](SceneAuthor) \tag{10}$$

Add join on both:

$$\pi\left[MovieID, SceneID\right]\left(\sigma\left[Name ='ChristopherNolan' \wedge Activity ='director'\right]\right.$$
$$\left.(Person \bowtie SceneAuthor)\right) \tag{11}$$

(b) Movie on Title:
$$\sigma[MovieTitle ='Inception'](Movie) \tag{12}$$

Hans Zimmer as composer (within that movie):

$$\pi\left[MovieID, SceneID\right]$$
$$\left(\sigma\left[MovieTitle ='Inception' \wedge Name ='HansZimmer' \wedge Activity ='composer'\right]\right.$$
$$\left.(Movie \bowtie SceneAuthor \bowtie Person)\right) \tag{13}$$

Christopher Nolan as screenwriter (within that movie):

$$\pi\left[MovieID, SceneID\right]$$
$$\left(\sigma\left[MovieTitle ='Inception' \wedge Name ='ChristopherNolan' \wedge Activity ='screenwriter'\right]\right.$$
$$\left.(Movie \bowtie SceneAuthor \bowtie Person)\right) \tag{14}$$

Intersect on scene key then output SceneID:

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

(c) Person on Name:
$$\sigma\left[Name ='QuentinTarantino'\right](Person) \tag{16}$$

Actor role on ScenePerformer:

$$\sigma\left[Role ='actor'\right](ScenePerformer) \tag{17}$$

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Director activity on SceneAuthor:

$$\sigma\left[Activity ='director'\right](SceneAuthor) \tag{18}$$

Combine and output scene Titles:

$$\pi\left[Title\right](\sigma\left[Name ='QuentinTarantino' \wedge Role ='actor' \wedge Activity ='director'\right]$$
$$(Scene \bowtie ScenePerformer \bowtie SceneAuthor \bowtie Person)) \tag{19}$$

(d) Actor on ScenePerformer:

$$\sigma\left[Name ='RobertDowneyJr.' \wedge Role ='actor'\right](ScenePerformer \bowtie Person) \tag{20}$$

Author on SceneAuthor:

$$\sigma\left[Name ='RobertDowneyJr.'\right](SceneAuthor \bowtie Person) \tag{21}$$

Union on MovieID, then output MovieTitle:

$$\pi\left[MovieTitle\right]$$
$$((\pi\left[MovieID\right](\sigma\left[Name ='RobertDowneyJr.' \wedge Role ='actor'\right](ScenePerformer \bowtie Person))$$
$$\cup \pi\left[MovieID\right](\sigma\left[Name ='RobertDowneyJr.'\right](SceneAuthor \bowtie Person))) \bowtie Movie) \tag{22}$$

(e) Actor on ScenePerformer:

$$\sigma\left[Name ='ScarlettJohansson' \wedge Role ='actor'\right](ScenePerformer \bowtie Person) \tag{23}$$

Stunt double on ScenePerformer:

$$\sigma\left[Name ='ScarlettJohansson' \wedge Role ='stuntdouble'\right](ScenePerformer \bowtie Person) \tag{24}$$

Intersect on scene key, then output Titles:

$$\pi\left[Title\right]$$
$$((\pi\left[MovieID, SceneID\right](\sigma\left[Name ='ScarlettJohansson' \wedge Role ='actor'\right]$$
$$(ScenePerformer \bowtie Person)) \cap \pi\left[MovieID, SceneID\right]$$
$$(\sigma\left[Name ='ScarlettJohansson' \wedge Role ='stuntdouble'\right]$$
$$(ScenePerformer \bowtie Person))) \bowtie Scene) \tag{25}$$

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

$$F_{1.1} = \{p|p \in Person \wedge p.Name ='ChristopherNolan'\} \tag{26}$$

Activity on SceneAuthor (subset of SceneAuthor):

$$F_{1.2} = \{sa|sa \in SceneAuthor \wedge sa.Activity ='director'\} \tag{27}$$

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

$$\{\langle sa.MovieID, sa.SceneID\rangle|sa \in F_{1.2} \wedge \exists p(p \in F_{1.1} \wedge p.PID = sa.PID)\} \tag{28}$$

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(g) Movie on Title:

$$G_{2.1} = \{m|m \in Movie \wedge m.MovieTitle =' Inception'\} \tag{29}$$

Hans Zimmer as composer (within that movie):

$$G_{2.2} = \{sa|sa \in SceneAuthor \wedge sa.Activity =' composer' \wedge$$
$$\exists p(p \in Person \wedge p.PID = sa.PID \wedge p.Name =' HansZimmer') \wedge$$
$$\exists m(m \in G_{2.1} \wedge m.MovieID = sa.MovieID)\} \tag{30}$$

Christopher Nolan as screenwriter (within that movie):

$$G_{2.3} = \{sa|sa \in SceneAuthor \wedge sa.Activity =' screenwriter' \wedge$$
$$\exists p(p \in Person \wedge p.PID = sa.PID \wedge p.Name =' ChristopherNolan') \wedge$$
$$\exists m(m \in G_{2.1} \wedge m.MovieID = sa.MovieID)\} \tag{31}$$

Intersect on full scene key, then output SceneID:

$$\{\langle x.SceneID\rangle|x \in G_{2.2} \wedge \exists y(y \in G_{2.3} \wedge y.MovieID = x.MovieID \wedge y.SceneID = x.SceneID)\} \tag{32}$$

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

$$H_{3.1} = \{p|p \in Person \wedge p.Name =' QuentinTarantino'\} \tag{33}$$

Actor role on ScenePerformer:

$$H_{3.2} = \{sp|sp \in ScenePerformer \wedge sp.Role =' actor'\} \tag{34}$$

Director activity on SceneAuthor:

$$H_{3.3} = \{sa|sa \in SceneAuthor \wedge sa.Activity =' director'\} \tag{35}$$

Join on person and scene, then output Title:

$$\{\langle s.Title\rangle|s \in Scene \wedge \exists p\exists sp\exists sa(p \in H_{3.1} \wedge sp \in H_{3.2} \wedge sa \in H_{3.3} \wedge$$
$$sp.PID = p.PID \wedge sa.PID = p.PID \wedge$$
$$sp.MovieID = sa.MovieID \wedge sp.SceneID = sa.SceneID \wedge$$
$$s.MovieID = sp.MovieID \wedge s.SceneID = sp.SceneID)\} \tag{36}$$

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

$$I_{4.1} = \{p|p \in Person \wedge p.Name =' RobertDowneyJr.'\} \tag{37}$$

Actor role on ScenePerformer:

$$I_{4.2} = \{sp|sp \in ScenePerformer \wedge sp.Role =' actor'\} \tag{38}$$

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Any author activity on SceneAuthor:

$$I_{4.3} = \{sa|sa \in SceneAuthor\} \tag{39}$$

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

$$\{\langle m.MovieTitle\rangle|m \in Movie \wedge (\exists p \exists sp(p \in I_{4.1} \wedge sp \in I_{4.2} \wedge$$
$$sp.PID = p.PID \wedge sp.MovieID = m.MovieID) \vee$$
$$\exists q \exists sa(q \in I_{4.1} \wedge sa \in I_{4.3} \wedge sa.PID = q.PID \wedge sa.MovieID = m.MovieID))\} \tag{40}$$

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

$$J_{5.1} = \{p|p \in Person \wedge p.Name =' ScarlettJohansson'\} \tag{41}$$

Actor role on ScenePerformer:

$$J_{5.2} = \{spA|spA \in ScenePerformer \wedge spA.Role =' actor'\} \tag{42}$$

Stunt double role on ScenePerformer:

$$J_{5.3} = \{spS|spS \in ScenePerformer \wedge spS.Role =' stuntdouble'\} \tag{43}$$

Same person, same scene, then output Title:

$$\{\langle s.Title\rangle|s \in Scene \wedge \exists p \exists spA \exists spS(p \in J_{5.1} \wedge spA \in J_{5.2} \wedge spS \in J_{5.3} \wedge$$
$$spA.PID = p.PID \wedge spS.PID = p.PID \wedge$$
$$spA.MovieID = spS.MovieID \wedge spA.SceneID = spS.SceneID \wedge$$
$$s.MovieID = spA.MovieID \wedge s.SceneID = spA.SceneID)\} \tag{44}$$