STANFORD
COMPUTER SCIENCE

From 100 Students to 100,000

Jennifer Widom

Stanford University

"Introduction to Databases"

CS145 @ Stanford

140 (enrolled students)

DB-Class @ world

60,000 (enrolled students)

26,000 (of them submitted 1+ assignments)

6,500 (completed the entire course)

DB-Class cumulative [July '12]

115,000 (accounts)

480,000 (assignment submissions)

3,350,000 (video views)

History

1) "Flipped classroom"
2) Complete course materials online
3) Public course offering

"Flipped Classroom"

Lectures ➔ self-paced videos with embedded quizzes

Class time ➔ interactive activities

Sample Video (lecture)

Transactions

Isolation Level **Read Committed**

- A transaction may *not* perform dirty reads

  Still does not guarantee global serializability

T_1
```
Update Student Set GPA=(1.1)*GPA Where sizeHS>2500
```

concurrent with ...

T_2
```
Set Transaction Isolation Level Read Committed;
Select Avg(GPA) From Student;
Select Max(GPA) From Student;
```

$T_1 ; T_2$ $T_2 ; T_1$

09:22/17:40

Previous video | Next video | 1.0x | 1.2x | 1.5x

Sample Video (demo)

Execute All | Snippets | Total: 100%

```
select Student.sID, count(distinct cName)
from Student, Apply
where Student.sID = Apply.sID
group by Student.sID
union
select sID, 0
from Student
where sID not in (select sID from Apply);
```

Output

SQL: 1:select Student.sID, count(distinct cName) from Student, Apply where Student.sID = Appl... Rows:8

	sID	count(distinct cName)
1	123	3
2	234	1
3	345	2
4	543	1
5	678	1
6	765	2

(Number of colleges applied to by each student)

Log | Result(1)

20:17/25:17

Previous video | Next video | 1.0x | 1.2x | 1.5x

Sample In-Video Quiz

Consider a relation R(A,B,C) with multivalued dependency A ↠ B. Suppose there at least 3 different values for A, and each value of A is associated with at least 4 different B values and at least 5 different C values.

What is the minimum number of tuples in R?

- 60
- 15
- 12
- 27

Skip

Submit

06:23/23:41

Previous video | Next video | 1.0x | 1.2x | 1.5x

Sample In-Video Quiz

Consider a relation R(A,B,C) with multivalued dependency A →→ B. Suppose there at least 3 different values for A, and each value of A is associated with at least 4 different B values and at least 5 different

What is

Explanation

Multivalued dependency A ->> B says that for each value of A, we must have every combination of B and C values. So for each of the 3 values of A we must have at least 4*5=20 different tuples.

OK

- 6
- 1
- 12
- 27

Correct

Show Explanation

Continue

06:23/23:41

Previous video | Next video | 1.0x | 1.2x | 1.5x

Classroom Time

- Professor-led interactive problem-solving
- Lectures outside of core material
  - Guest lectures from industry
  - Guest lectures from Stanford
  - Research presentations
  - Advanced/exotic topics
- Help/review sessions

Step #2: Course Materials Publicly Available

Videos with embedded quizzes

+ Comprehensive exercises

+ Slides, scripts, readings, software guides

= Complete course

- Completed summer 2011
- 1000's of views

The Inflection Point

Online materials ➔ Structured course offering

+ Schedule with deadlines
+ A
+ C
+ "Statement of accomplishment"
✶ **Community**

(Still free of charge)

Transformed 1000's to 10,000's

Automated Exercises

- Quizzes using technology from Gradiance
  - "Root" question + bank of correct & incorrect answers
  - Explanations
  - Diffe

Students encouraged to repeat until perfect score

- Automa
  - Particularly well-suited for database class
  - Relational algebra, SQL, triggers, views, DTDs, XPath & XQuery, XSLT

Sample Quiz

Introduction to Databases

Feedback Preferences Logout

Jennifer Widom

- Home
- Video Lectures
- Assignments
- Exams
- Q&A Forum
- Course Materials
- Software Quick Guides
- FAQ
- Optional Exercises
- 2011 Course Schedule
- 2011 Weekly Videos
- About Us

Authorization Quiz

This quiz uses an approach pioneered and patented by the Gradiance Corporation. Each multiple-choice quiz problem is based on a "root question," from which the system generates different correct and incorrect choices each time you take the quiz. Thus, you can test yourself on the same material multiple times. We strongly urge you to continue testing on each topic until you complete the quiz with a perfect score at least once.

After submitting your selections the system will score your quiz, and for incorrect answers will provide an "explanation" (sometimes for correct ones too). These explanations should help you get the right answer the next time around. To prevent rapid-fire guessing, the system enforces a minimum of 10 minutes between each submission of solutions.

Question 1
Unanswered

Consider a set of users U, V, W, X, and Y. Suppose user U creates a table T and thus is the owner of T. Now suppose the following set of statements is executed in order:

```
1. User U: grant select on T to V,W with grant option
2. User V: grant select on T to W
3. User W: grant select on T to X,Y
4. User U: grant select on T to Y
5. User U: revoke select on T from V restrict
6. User U: revoke select on T from W cascade
```

Which of the following statements is true?

- Y does not have privilege SELECT ON T after statement 6
- W does not have privilege SELECT ON T after statement 5
- X does not have SELECT ON T privilege after statement 5
- X does not have privilege SELECT ON T after statement 6

Question 2
Unanswered

The following SQL statement over tables R(c,d), S(f,g), and T(a,b) requires certain privileges to execute:

```
UPDATE T
SET a=1, b=2
WHERE a <= ALL (SELECT d FROM R)
OR EXISTS (SELECT f FROM S WHERE f > T.a)
```

Which of the following privileges is **not** useful for execution of this SQL statement?

- SELECT ON T(b)
- SELECT ON R(d)

Sample Programming

Introduction to Databases

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XML Course-Catalog XPath and XQuery Exercises

In these exercises, you will be working with a small XML data set drawn from the Stanford course catalog. There are multiple departments, each with a department chair, some courses, and professors and/or lecturers who teach courses. The XML data is here.

Instructions: You are to write each of the following queries using either XPath or XQuery. Each question contains a link to a Query Workbench. The workbench will help you develop and debug your queries by running them using Saxon over the sample data set. Once you're satisfied with your solution, click the "Keep This Solution" button in the Query Workbench -- your query will be copied automatically to the box on this page for final submission.

You may perform these exercises as many times as you like, so we strongly encourage you to keep working with them until you complete the exercises with full credit.

NOTE: REMEMBER TO CLICK "Save and Submit" WHEN YOU ARE DONE!
Please be patient as it does take time to check all of the exercises.

Question 1
Unanswered

Return all Title elements (of both departments and courses).
Note: Your solution will need to reference ***doc("courses.xml")*** to access the data.
Query Workbench

Question 2
Unanswered

Return last names of all department chairs.
Note: Your solution will need to reference ***doc("courses.xml")*** to access the data.
Query Workbench

Personal Touch

Need for Perfection

Each order of magnitude more students

$\Rightarrow$ order of magnitude higher need to avoid ambiguities and errors

Meanwhile Back at Stanford

- Automated exercises and level of perfection well appreciated

Q: "Added v

Statistically-significant *increase* in evaluations

- In-class
- Hand-graded written exercises
- Programming project
- Real exams

The Public Students

Deeply appreciative

Q&A Forum - View

Type Here to Search | Search

Ask A New Question | Follow This Question

162

What is your background?

I'm 22 years old, high school drop out from the United States. I've been coding since I was 14, and have built a lot of applications, but I'm hoping to soak up anything I can from these courses (I enrolled for several others as well).

I think it's awesome Standford is offering these courses online for free, and has put so much effort into providing an excellent user experience (I'm really impressed so far).

How about the rest of you, where are you from, and what is your background?

Tags: greetings introductions websitequestions

Posted by Calvin Froedge (+175) [Edit] [Delete]
4 months 3 weeks ago [Feature?]

Sort By **Relevance** | Date (Newest First) | Date (Oldest First) Page 1 of 45 >>

487

Greetings all. I'm probably the old man of the class at the ripe old age of 71. (Just ran the Boston Marathon last April, so am still kicking) Started in this industry as a computer operator on the IBM 705 (used vacuum tubes - to startup, turn on filament current-let the hundreds of tubes warm up, then the plate current and air conditioning). Got BSEE from CalStateLA and did masters work in computer science at UCI. Worked for Digital Equip Corp (DEC) for many years primarily in there software support and consulting group then a few years of freelance consulting and now long since retired but still a lover of programming.Have done databases in Paradox and Access and some query stuff. Want to fill out my knowledge of databases with this course.

Posted by: Ronald Byrd (+487) [Edit] [Delete]
4 months 3 weeks ago [Feature?]

155

I'm a 13 year old high school freshman who's been involved with related endeavors since a young age ._. (Programming-ish since 9). I feel like the black sheep of this group, the rest of you are awesome.

I'd like to become a systems engineer or physicist, eventually.

Posted by: Unknown (+0) [Edit] [Delete]
4 months 3 weeks ago [Feature?]

150

Greetings all - It could be that I am the oldest person in the class because I am one month from my 72ed birthday (hello to Ronald Byrd down the list). I also worked on computers when the things had hundreds of tubes in them (6SN7►s as I remember) and was the first person that I know of to build a computer from scratch starting in 1971. I run the only operating SETI station in the US now (www.SETI.Net) and want to install a database for it to use. I have built several databases before and now use XML in the station but I have never been comfortable with what I

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With deepest feelings, thanks a lot, Professor Widom AND all the db-class team!! You've made wonderful things come true! Teaching could be not just a profession, but an Art - and that's what you did!

That's an honour for me, to be in this class. Whatever happens with me later on - but these times I will never forget :)

Happy New Year 2012 for everybody here!!

Posted by: Anastasia Klimchuk (+55) [Edit] [Delete]
3 months 4 weeks ago [Feature?]

25

Like others I am very grateful for the time and hard work that Professor Widom and her team creating the website have put into this course.

The assignment and quiz system motivated me to learn the materials and the screenside chats kept that momentum to continue.

The many helpful questions and answers on this forum have really assisted when I had problems.

Good luck with the final exam everyone.

~Marcus

Posted by: Marcus Bagshaw (+28) [Edit] [Delete]
4 months 12 hours ago [Feature?]

24

Hi Every one

Prof.Widom is great and I had very good time(Hope every one) listening to her Lectures and doing the assignments for the past few months. I could not really take the point that the course is getting over. Thanks Prof.Widom. I admire you.

Posted by: Anonymous User [Edit] [Delete]
4 months 16 hours ago [Feature?]

24

Thanks to Prof. Widom and all the db-class staff for this high-quality course. I have learnt a lot about databases and now I'm more confident to undertake this kind of tasks in a future. But most important, thanks for all the personal effort that you have put on this online course to humanize what could have been a cold weekly experience in front of a machine. You and the other students in the Q&A forum have made this experience more like a real class than many others to which I attended at the university. Finally, thanks for helping to democratice high-level learning about a topic that is so important in the information age.

I hope to meet again with all of you in future courses.

Posted by: Juan Luis Herrera Cortijo (+41) [Edit] [Delete]
3 months 4 weeks ago [Feature?]

21

Many thanks to you, Prof. Widom!

Posted by: Andrey Shapovalov (+10) [Edit] [Delete]
4 months 8 hours ago [Feature?]

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Thanks Professor Widom. You are now one of my teachers that I will remember for ever and admire. One of the best organized course I have ever taken. You rock!!!

Posted by: Smitha Saligrama (+21) [Edit] [Delete]

Q&A Forum - View

Ask A New Question

33

An ode to Stanford - Until next time

The students they came rushing in
From far and near and everywhere
To gaze upon this wondrous thing
A precious gift for all to share

Some saw the beauty right away
whilst others they did contemplate
Some knew there'd be a price to pay
Others rejoiced and couldn't wait

Young, old, 'tween - all came together
Timid, confident, wary and bold
United by the Stanford tether
Reaching a prize far better than gold

Teeth were gnashed, tears were shed
A cry of triumph would split the air
Some they never went to bed
night or day they didn't care

If any cried out from despair
Struggling hard to understand
Amy, Yong or Paul Walker
Stopped to lend a helping hand

'Twas a great sight to behold
The teamwork and camaraderie
All were embraced in the fold

A Top Student

- Posted 900 answers on Q&A Forum
- No discrimination against "dumb" questions
- Each answer correct, of perfect length, with examples when appropriate, perfect English

A Top Student

Q&A Forum - View

Type Here to Search | Search

Ask A New Question | Unfollow This Question

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Amy Cunningham

Now that the course is approaching its end, I would like to express my gratitude towards Amy Cunningham for her great contribution to this forum. Her clear and constructive answers helped us a lot in understanding the materials and exercises. Amy, thank you very much!

Tags: authorization

Posted by Anonymous User [Edit] [Delete]
4 months 10 hours ago [Feature?]

Sort By **Relevance** | Date (Newest First) | Date (Oldest First) Page 1 of 2 >>

54

> I'm waiting for someone to propose marriage to her. :)

<DownOnKnees>Amy, I have little to offer but a very large collection of dried, prepared and mounted plant and flower specimens on standard botanical specimen cards; it's quite an extensive collection, though. In addition to that I have several computers all with different operating systems and I also have access to some restricted databases. I have a house, car and stable job. I am also a very good cook. Other domestic attributes that I possess include keeping things tidy, and covering reference books I buy with removable plastic (not that self-adhesive stuff that is impossible to remove if it becomes damaged); I have over 200 books and it's possible I will let you read some of them. I get up early and go to bed early (well, most of the time). Based on this, I humbly ask: will you marry me?</DownOnKnees>

Edit: Oh I also like computer games, C, C++, SQL, Python, PHP, Modula-2, Lisp and occasionally ASM. I don't particularly like javascript or even HTML. COBOL I can deal with, but prefer not to.

Edit: Oh and also I probably should have given you a FLOWR.

Posted by: Craig Robbins (+348) [Edit] [Delete]
4 months 8 hours ago [Feature?]

36

I sometimes think Amy is Prof Widom in disguise !! An under-cover agent !

Posted by: Veena H Bhat (+104) [Edit] [Delete]
3 months 4 weeks ago [Feature?]

15

Amy you are brilliant.You always provide precise explanation of every question. Whenever I stuck I start looking for answers posted by Amy Cunningham.Thanks Amy

Posted by: Anonymous User [Edit] [Delete]
4 months 7 hours ago [Feature?]

14

@Amy, thanks for all the great answers.

@Craig, Congratulations--for either finding a fiancee or formulating the first query which Amy doesn't know how to answer!

Posted by: Robert Oreglia (+28) [Edit] [Delete]
3 months 4 weeks ago [Feature?]

Downsides

1) Complainers
2) Cheaters

What's Happened Since

- ~12 additional Stanford courses

  Mostly CS, but some others

- Very high interest across campus and beyond

- Many blossoming efforts
  - Universities and companies
  - Platforms and content
  - Non-profit and for-profit

Big Questions for University
(selected subset!)

- Course-content ownership — university or professor?
- Teaching credit for putting courses online? Money?
- Who's responsible for course production? Hosting?
- Is it a university's mission to educate the world?
- If everything is online, what's the $50K/year buying?
- What's the future of higher education?

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