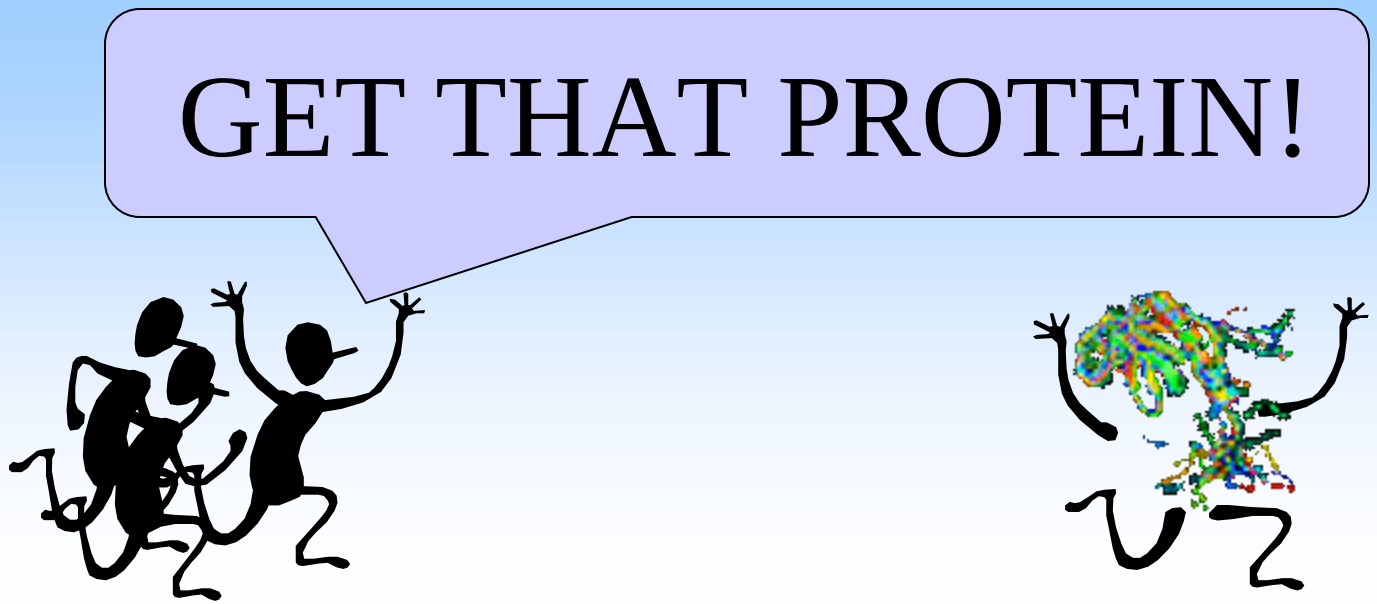



Eller

# TDDE49

## Databaser och informationssäkerhet för bioinformatik

http://www.ida.liu.se/~TDDE49

# Lärare

- Examinator: Olaf Hartig
- FÖ: Olaf Hartig, Matus Nemec, Patrick Lambrix
- LA: Sijin Cheng, Matus Nemec
- projekt: Patrick Lambrix, Sijin Cheng
- databasadministration: Sijin Cheng

- studierektor: Patrick Lambrix

- Olaf/Matus/Sijin på engelska

# Kurslitteratur

- Elmasri, R. and Navathe, S. B. Fundamentals of Database Systems, Addison Wesley.
- (Padron-McCarthy, webbkurs på Svenska)
- Anderson R, Security Engineering.
  - 2nd ed. online
- Adam Shostack: Threat Modeling.
  - online via LiU (biblioteket)
- Lab + projekt: på hemsidan

# Databaser

- Ett (av flera) sätt att lagra data i elektronisk format
- Används i det vardagliga livet: bank, bokning av hotell eller resa, sökning i biblioteket, handla
- nyare tillämpningar: multimediadatabaser, geografiska informationssystem, realtiddatabaser

# Databaser

- databashanteringssystem (DBMS): en uppsättning program som tillåter en användare att skapa och underhålla en databas
- databassystem = databas + databashanteringssystem

# Bioinformatik

- Kända sekvenser samlas i en stor databas. Insamlande och studier av sekvenser och jämförelser av sekvensernas uppbyggnad i olika organismer kallas bioinformatik. Forskningen inom bioinformatik är beroende av avancerad datalogi och matematik. (forksningsrådens strategidokument 2000)

# Bioinformatik

- Bioinformatics: research, development, or application of computational tools and approaches for expanding the use of biological, medical, behavioral or health data, including those to acquire, store, organize, archive, analyze or visualize data. (National Institutes of Health)

# Bioinformatik

Ämnen på ISMB:

- protein structure and modeling
- sequence motifs, alignments and families
- networks and modeling
- gene structure, regulation and modeling
- sequence and phylogeny
- databases, information and knowledge management

# TDDE49 Databaser och informationssäkerhet för Bioinformatik

- Denna kurs: fokus på biologiska databanker

# Relation med andra kurser inom TB-programmet:

- förkunskaper: molekylärbiologi, programmering
- bioinformatik - översikt och tillämpningar

# Årets ändringar i kursen

Ändringar:

- Online (covid19)
- Namnbyte
- Informationssäkerhet tillkommer (nya föreläsningar och nya labbar)
- Information retrieval, semi-strukturerad data, teoretiska delar av relationsdatabaser utgår.
- Nya labbar för databasdelen.
- Flipped classroom för databasföreläsningarna.

# Årets ändringar i kursen

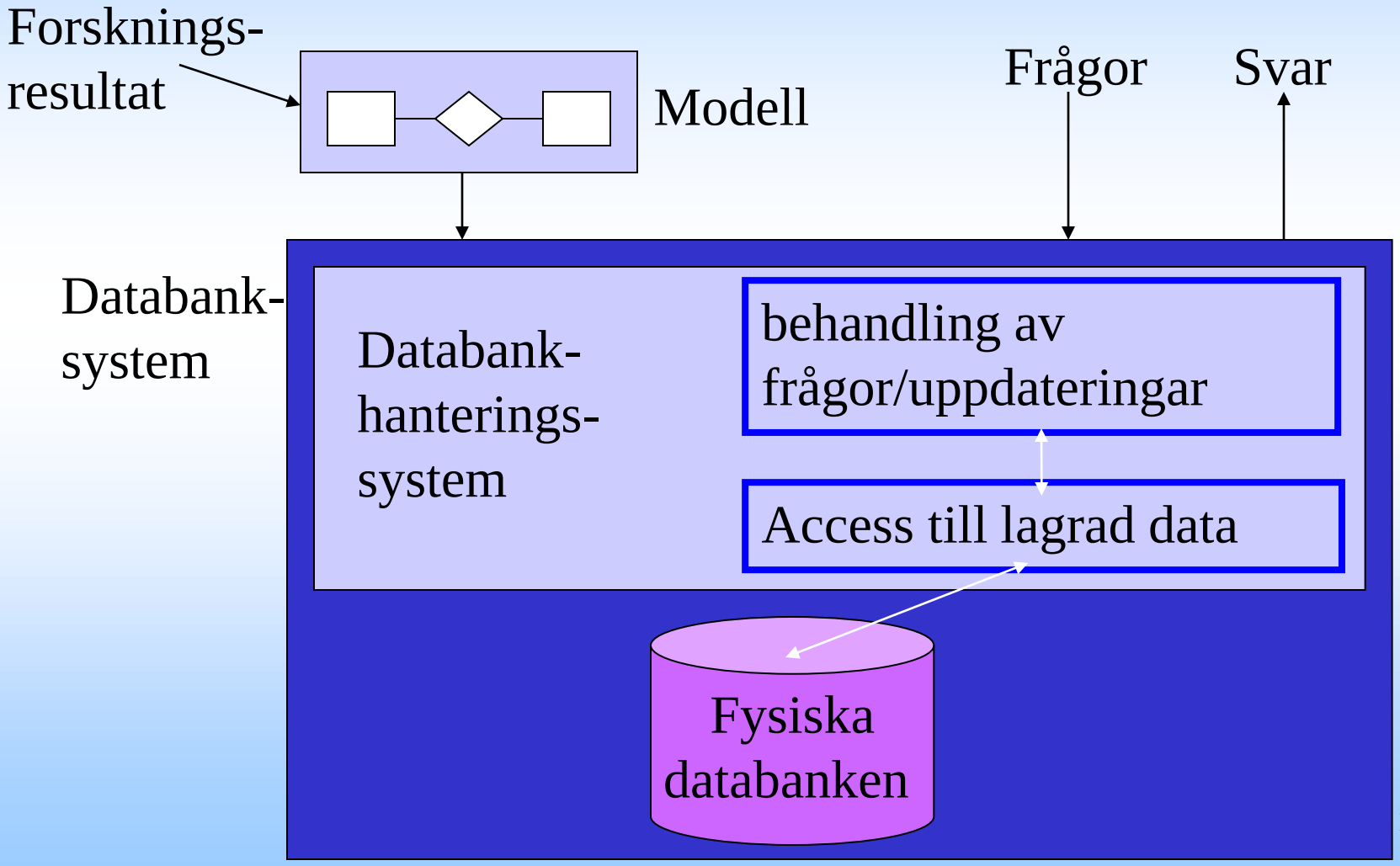
Tidigare ändringar:

- Separat inledning
- Genomgång projektbeskrivning
- Ändring inledning labbarna

# Biologiska databanker

- biologisk data i elektronisk format
- exempel: SWISS-PROT/UniProt, EMBL, DDBJ, PDB, GENBANK, KEGG, ACEDB
- används dagligen i forskningen

# Biologiska databanker



# Frågeställningar

- Vilken information lagrar man?
- Hur lagras informationen? (hög och låg nivå)
- Hur accessar man informationen?
  (användarnivå, systemnivå)
- Hur återställer man en databank efter crash?
- Hur kan flera användare accessa och uppdatera informationen samtidigt?

# Personer

- databankadministratör
- databankdesigner
- användare (’end user’)
- programmerare av tillämpningar

- DBMS designer
- utvecklare av verktyg
- operator, underhåll

1 tgctacccgc gcccgggctt ctggggtgtt ccccaaccac ggcccagccc tgccacaccc
61 cccgccccccg gcctccgcag ctcggcatgg gcgcgggggt gctcgtcctg ggcgcctccg
121 agcccggtaa cctgtcgtcg gccgcaccgc tccccgacgg cgcggccacc gcggcgcggc
181 tgctggtgcc cgcgtcgccg cccgcctcgt tgctgcctcc cgccagcgaa agccccgagc
241 cgctgtctca gcagtggaca gcgggcatgg gtctgctgat ggcgctcatc gtgctgctca
301 tcgtggcggg caatgtgctg gtgatcgtgg ccatcgccaa gacgccgcgg ctgcagacgc
361 tcaccaacct cttcatcatg tccctggcca gcgccgacct ggtcatgggg ctgctggtgg
421 tgccgttcgg ggccaccatc gtggtgtggg gccgctggga gtacggctcc ttcttctgcg
481 agctgtggac ctcagtggac gtgctgtgcg tgacggccag catcgagacc ctgtgtgtca
541 ttgccctgga ccgctacctc gccatcacct cgcccttccg ctaccagagc ctgctgacgc
601 gcgcgcgggc gcggggcctc gtgtgcaccg tgtgggccat ctcggccctg gtgtccttcc
661 tgcccatcct catgcactgg tggcgggcgg agagcgacga ggcgcgccgc tgctacaacg
721 accccaagtg ctgcgacttc gtcaccaacc gggcctacgc catcgcctcg tccgtagtct
781 ccttctacgt gcccctgtgc atcatggcct tcgtgtacct gcgggtgttc cgcgaggccc
841 agaagcaggt gaagaagatc gacagctgcg agcgccgttt cctcggcggc ccagcgcggc
901 cgccctcgcc ctcgccctcg cccgtccccg cgcccgcgcc gccgcccgga cccccgcgcc
961 ccgccgccgc cgccgccacc gccccgctgg ccaacgggcg tgcgggtaag cggcggccct
1021 cgcgcctcgt ggccctacgc gagcagaagg cgctcaagac gctgggcatc atcatgggcg
1081 tcttcacgct ctgctggctg cccttcttcc tggccaacgt ggtgaaggcc ttccaccgcg
1141 agctggtgcc cgaccgcctc ttcgtcttct tcaactggct gggctacgcc aactcggcct
1201 tcaaccccat catctactgc cgcagccccg acttccgcaa ggccttccag ggactgctct
1261 gctgcgcgcg cagggctgcc cgccggcgcc acgcgaccca cggagaccgg ccgcgcgcct
1321 cgggctgtct ggcccggccc ggacccccgc catcgcccgg ggccgcctcg gacgacgacg
1381 acgacgatgt cgtcggggcc acgccgcccg cgcgcctgct ggagccctgg gccggctgca
1441 acggcggggc ggcggcggac agcgactcga gcctggacga gccgtgccgc cccggcttcg
1501 cctcggaatc caaggtgtag ggcccggcgc ggggcgcgga ctccgggcac ggcttcccag
1561 gggaacgagg agatctgtgt ttacttaaga ccgatagcag gtgaactcga agcccacaat
1621 cctcgtctga atcatccgag gcaaagagaa aagccacgga ccgttgcaca aaaaggaaag
1681 tttgggaagg gatgggagag tggcttgctg atgttccttg ttg

| | |
|---|---|
| DEFINITION | Homo sapiens adrenergic, beta-1-, receptor |
| ACCESSION | NM_000684 |
| SOURCE ORGANISM | human |
| REFERENCE | 1 |
| AUTHORS | Frielle, Collins, Daniel, Caron, Lefkowitz, Kobilka |
| TITLE | Cloning of the cDNA for the human beta 1-adrenergic receptor |
| REFERENCE | 2 |
| AUTHORS | Frielle, Kobilka, Lefkowitz, Caron |
| TITLE | Human beta 1- and beta 2-adrenergic receptors: structurally and functionally related receptors derived from distinct genes |

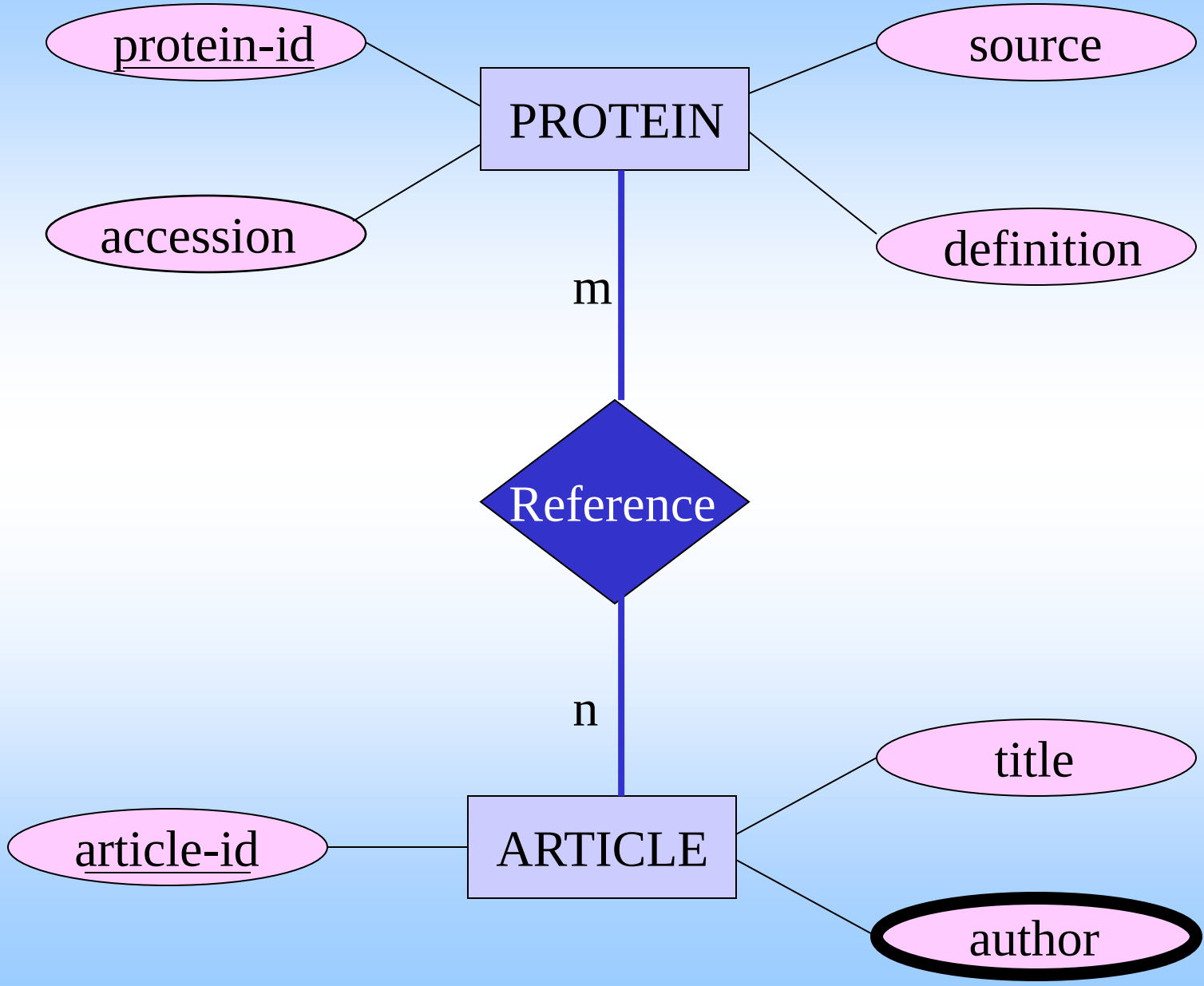
# Vilken information lagrar man?

- Modell av verkligheten
  - Entity-Relationship modell (ER)
  - Unified Modeling Language (UML)

# Entity-Relationship

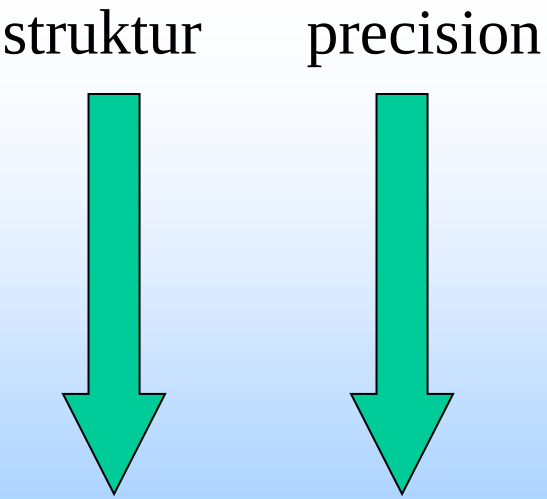
- entiteter och attribut
- entitetstyper
- nyckelattribut
- relationer
- kardinalitetsvillkor

# Entity-relationship



# Hur lagras informationen? (hög nivå) Hur accessar man informationen? (användarnivå)

- Text (IR)
- Semistrukturerad data
- Datamodeller (DB)
- Regler + Fakta (KB)



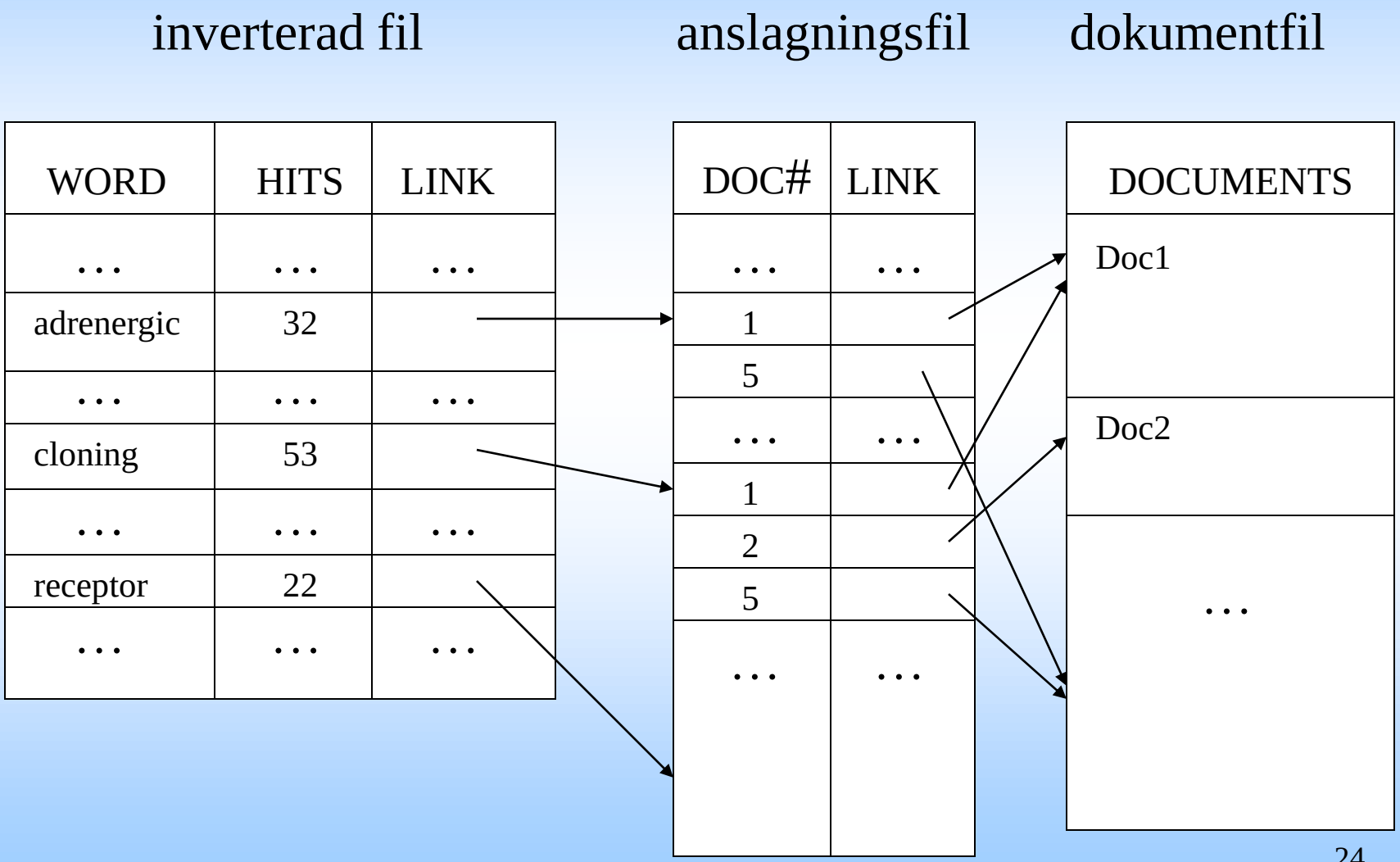
# Text - Information Retrieval

- sökning baseras på ord
- konceptuella modeller:

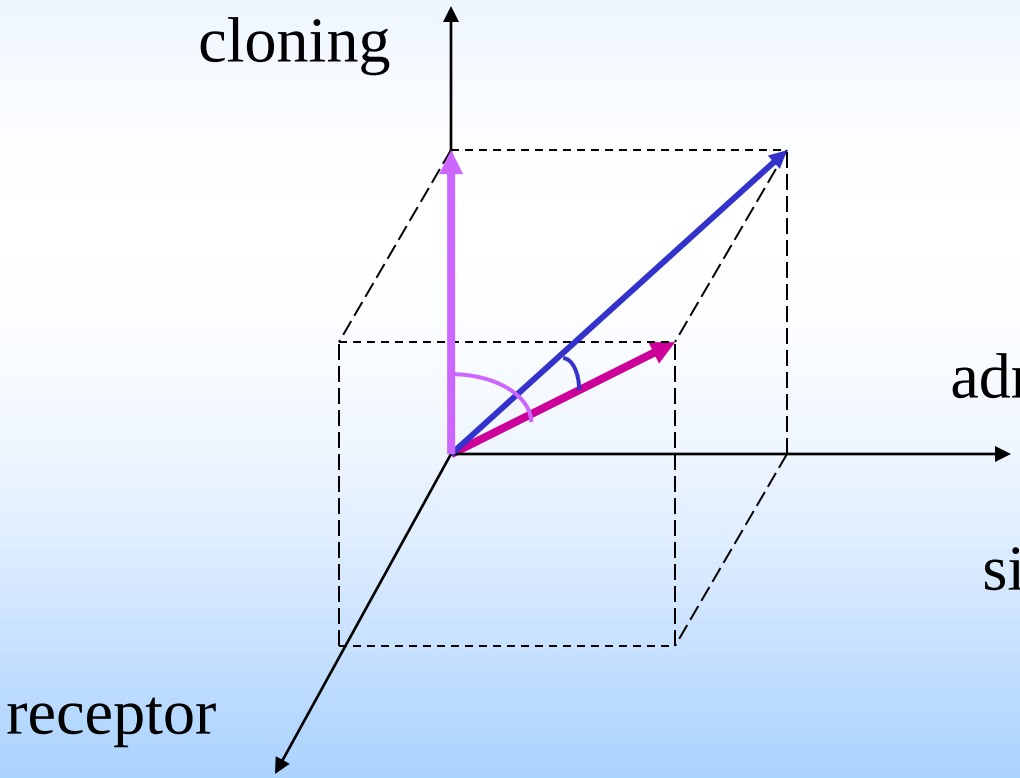
  boolesk, vektor, probabilistisk, …
- filmodell:

  flat fil, inverterad fil, ...

# IR - Filmodell: inverterad fil



# Vektormodellen (förenklad)




Doc1 (1,1,0)

Doc2 (0,1,0)

Q (1,1,1)

$$sim(d,q) = \frac{d \cdot q}{|d| \times |q|}$$

# Databaser

- Relationsdatabaser:
  - modell: tabeller + relationsalgebran
  - frågespråk (SQL)
- Objektorienterade databaser:
  - modell: fortlevande objekt, meddelande, inkapsling, ärvning
  - frågespråk (t.ex. OQL)
- System: GDB (R), ACEDB (OO)

# Relationsdatabaser

PROTEIN

| PROTEIN-ID | ACCESSION | DEFINITION | SOURCE |
|---|---|---|---|
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human |

REFERENCE

| PROTEIN-ID | ARTICLE-ID |
|---|---|
| 1 | 1 |
| 1 | 2 |

ARTICLE

| ARTICLE-ID | AUTHOR | TITLE |
|---|---|---|
| 1 | Frielle | Cloning of the cDNA for the human …. |
| 1 | Collins | Cloning of the cDNA for the human …. |
| 1 | Daniel | Cloning of the cDNA for the human …. |
| 1 | Caron | Cloning of the cDNA for the human …. |
| 1 | Lefkowitz | Cloning of the cDNA for the human …. |
| 1 | Kobilka | Cloning of the cDNA for the human …. |
| 2 | Frielle | Human beta 1- and beta 2-adrenergic receptors |
| 2 | Kobilka | Human beta 1- and beta 2-adrenergic receptors |
| 2 | Lefkowitz | Human beta 1- and beta 2-adrenergic receptors |
| 2 | Caron | Human beta 1- and beta 2-adrenergic receptors |

# Relationsdatabaser

PROTEIN

| PROTEIN-ID | ACCESSION | DEFINITION | SOURCE |
|---|---|---|---|
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human |

REFERENCE

| PROTEIN-ID | ARTICLE-ID |
|---|---|
| 1 | 1 |
| 1 | 2 |

ARTICLE-AUTHOR

| ARTICLE-ID | AUTHOR |
|---|---|
| 1 | Frielle |
| 1 | Collins |
| 1 | Daniel |
| 1 | Caron |
| 1 | Lefkowitz |
| 1 | Kobilka |
| 2 | Frielle |
| 2 | Kobilka |
| 2 | Lefkowitz |
| 2 | Caron |

ARTICLE-TITLE

| ARTICLE-ID | TITLE |
|---|---|
| 1 | Cloning of the cDNA for the human beta 1-adrenergic receptor |
| 2 | Human beta 1- and beta 2-adrenergic receptors: structurally and functionally related receptors derived from distinct genes |

# SQL

**select** source
**from** protein
**where** accession = NM_000684;

Vilka kolumner?
Vilka tabeller?
Vilka rader?

PROTEIN

| PROTEIN-ID | ACCESSION | DEFINITION | SOURCE |
|---|---|---|---|
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human |

# SQL

```
select title
from protein, article-title, reference
where protein.accession = NM_000684
  and protein.protein-id
                = reference.protein-id
  and reference.article-id
                = article-title.article-id;
```

REFERENCE

| PROTEIN-ID | ARTICLE-ID |
|---|---|
| 1 | 1 |
| 1 | 2 |

PROTEIN

| PROTEIN-ID | ACCESSION | DEFINITION | SOURCE |
|---|---|---|---|
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human |

ARTICLE-TITLE

| ARTICLE-ID | TITLE |
|---|---|
| 1 | Cloning of the … |
| 2 | Human beta 1- … |

# SQL

```
select title
from protein, article-title, reference
where protein.accession = NM_000684
  and protein.protein-id
                = reference.protein-id
  and reference.article-id
                = article-title.article-id;
```

REFERENCE

| PROTEIN-ID | ARTICLE-ID |
|---|---|
| 1 | 1 |
| 1 | 2 |

PROTEIN

| PROTEIN-ID | ACCESSION | DEFINITION | SOURCE |
|---|---|---|---|
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human |

ARTICLE-TITLE

| ARTICLE-ID | TITLE |
|---|---|
| 1 | Cloning of the … |
| 2 | Human beta 1- … |

| PROTEIN-ID | ACCESSION | DEFINITION | SOURCE |
|---|---|---|---|
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human |

# SQL

```
select title
from protein, article-title, reference
where protein.accession = NM_000684
  and protein.protein-id
            = reference.protein-id
  and reference.article-id
            = article-title.article-id;
```

REFERENCE

| PROTEIN-ID | ARTICLE-ID |
|---|---|
| 1 | 1 |
| 1 | 2 |

PROTEIN

| PROTEIN-ID | ACCESSION | DEFINITION | SOURCE |
|---|---|---|---|
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human |

ARTICLE-TITLE

| ARTICLE-ID | TITLE |
|---|---|
| 1 | Cloning of the … |
| 2 | Human beta 1- … |

PROTEIN

| PROTEIN-ID | ACCESSION | DEFINITION | SOURCE_ |
|---|---|---|---|
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human |
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human |

REFERENCE

| PROTEIN-ID | ARTICLE-ID |
|---|---|
| 1 | 1 |
| 1 | 2 |

# SQL

```
select title
from protein, article-title, reference
where protein.accession = NM_000684
  and protein.protein-id
                = reference.protein-id
  and reference.article-id
                = article-title.article-id;
```

REFERENCE

| PROTEIN-ID | ARTICLE-ID |
|---|---|
| 1 | 1 |
| 1 | 2 |

PROTEIN

| PROTEIN-ID | ACCESSION | DEFINITION | SOURCE |
|---|---|---|---|
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human |

ARTICLE-TITLE

| ARTICLE-ID | TITLE |
|---|---|
| 1 | Cloning of the … |
| 2 | Human beta 1- … |

| | | | | | REFERENCE | ARTICLE-TITLE | |
|---|---|---|---|---|---|---|---|
| PROTEIN-ID | ACCESSION | DEFINITION | SOURCE | PROTEIN-ID | ARTICLE-ID | ARTICLE-ID | TITLE |
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human | 1 | 1 | 1 | Cloning of the … |
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human | 1 | 2 | 2 | Human beta 1- … |

# SQL

```
select title
from protein, article-title, reference
where protein.accession = NM_000684
  and protein.protein-id
                = reference.protein-id
  and reference.article-id
                = article-title.article-id;
```

REFERENCE

| PROTEIN-ID | ARTICLE-ID |
|---|---|
| 1 | 1 |
| 1 | 2 |

PROTEIN

| PROTEIN-ID | ACCESSION | DEFINITION | SOURCE |
|---|---|---|---|
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human |

ARTICLE-TITLE

| ARTICLE-ID | TITLE |
|---|---|
| 1 | Cloning of the … |
| 2 | Human beta 1- … |

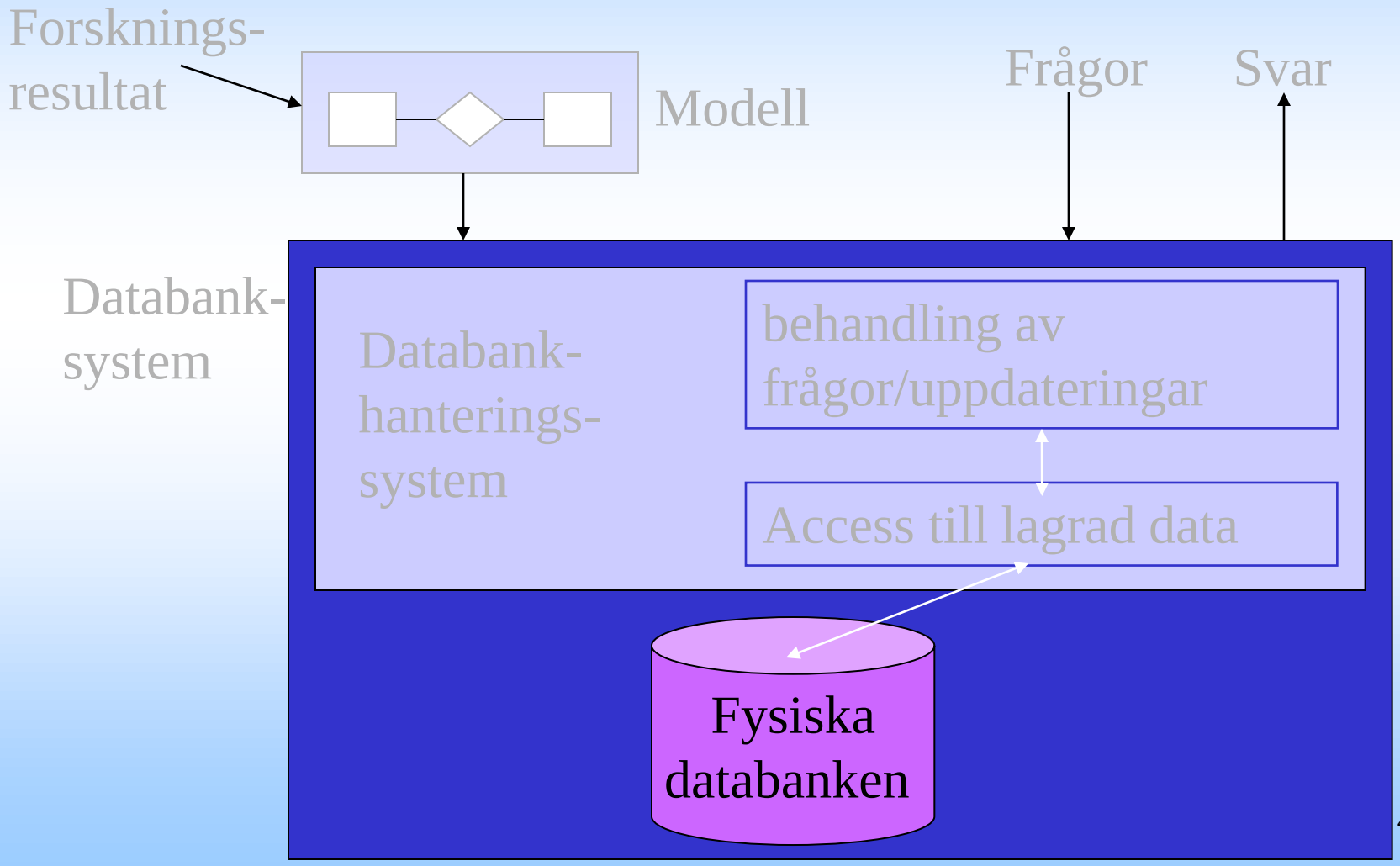
| | | | | | REFERENCE | ARTICLE-TITLE | |
|---|---|---|---|---|---|---|---|
| PROTEIN-ID | ACCESSION | DEFINITION | SOURCE | PROTEIN-ID | ARTICLE-ID | ARTICLE-ID | TITLE |
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human | 1 | 1 | 1 | Cloning of the … |
| 1 | NM_000684 | Homo sapiens adrenergic, beta-1-, receptor | human | 1 | 2 | 2 | Human beta 1- … |

TITLE

Cloning of the …

Human beta 1- …

# Hur lagras informationen? (låg nivå)



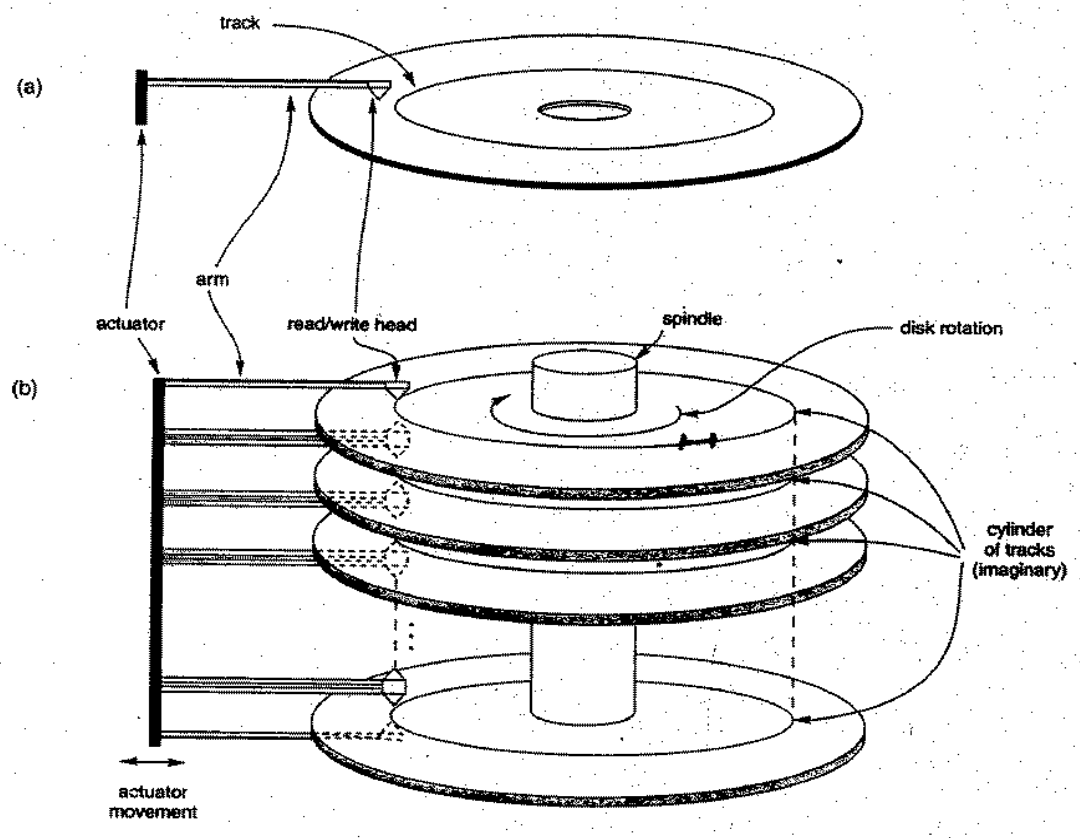
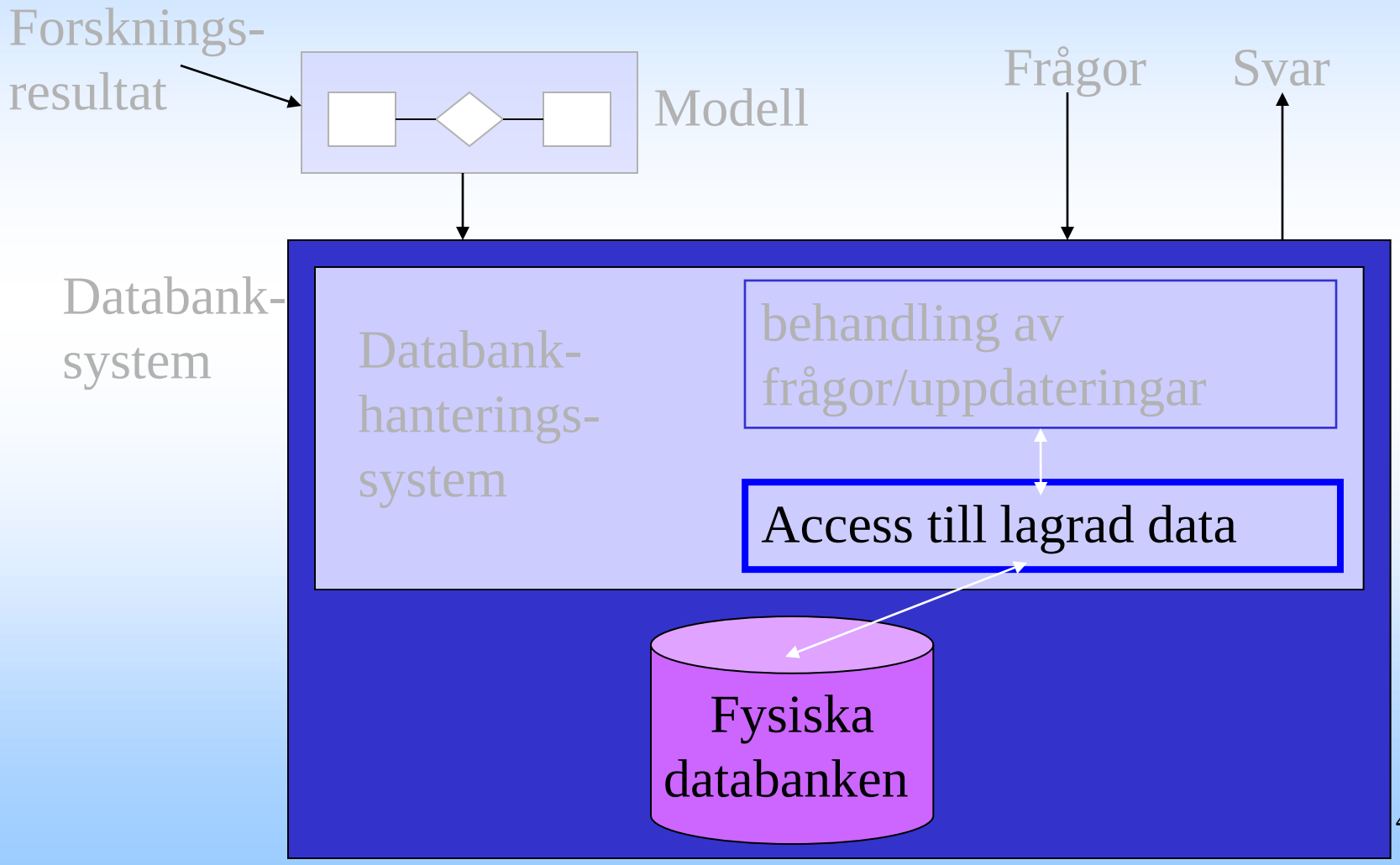



**Figure 5.1** (a) A single-sided disk with read/write hardware. (b) A disk pack with read/write hardware.

# Hur accessar man informationen? (systemnivå)

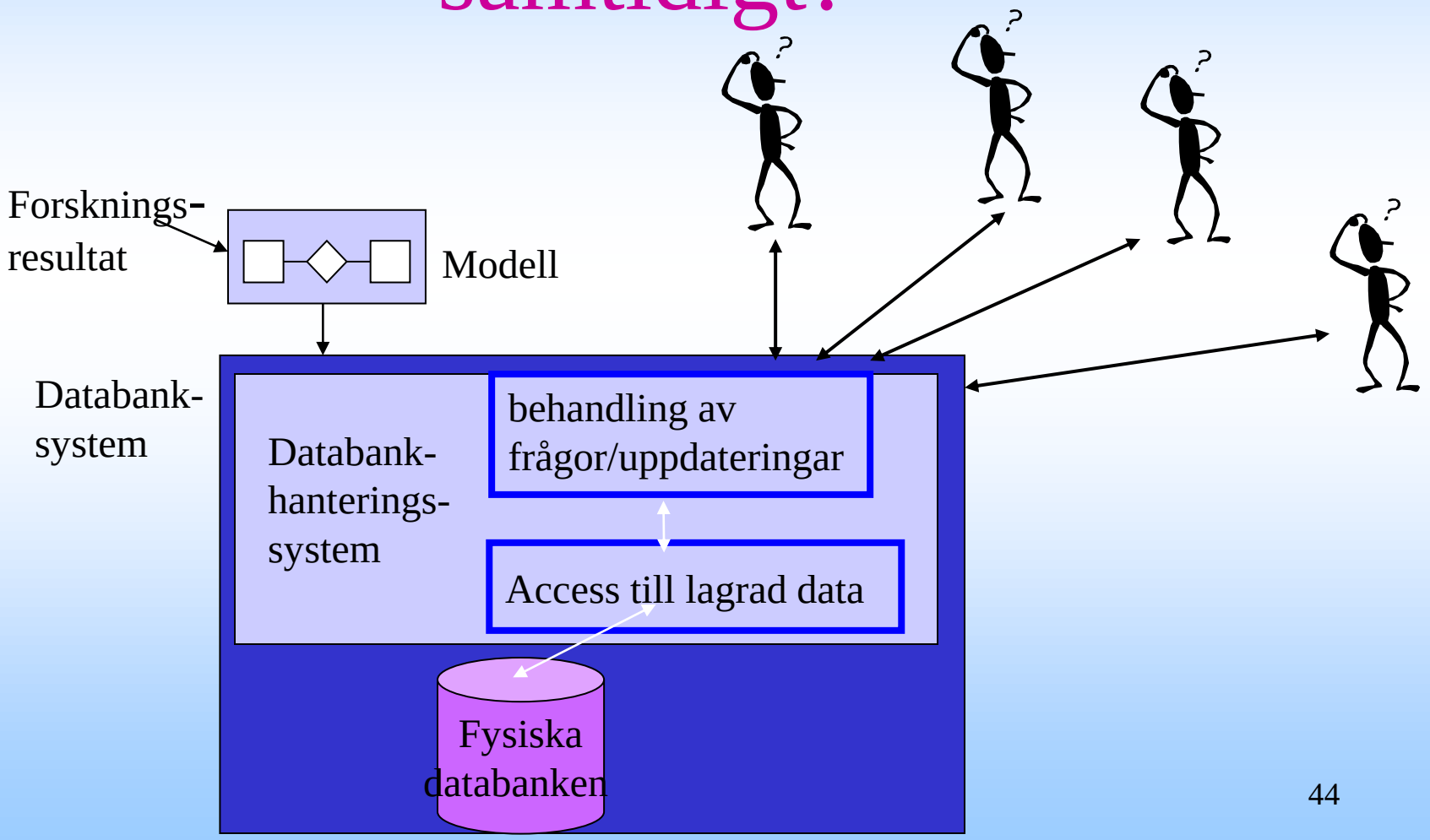


# Hur återställer man en databank efter crash?

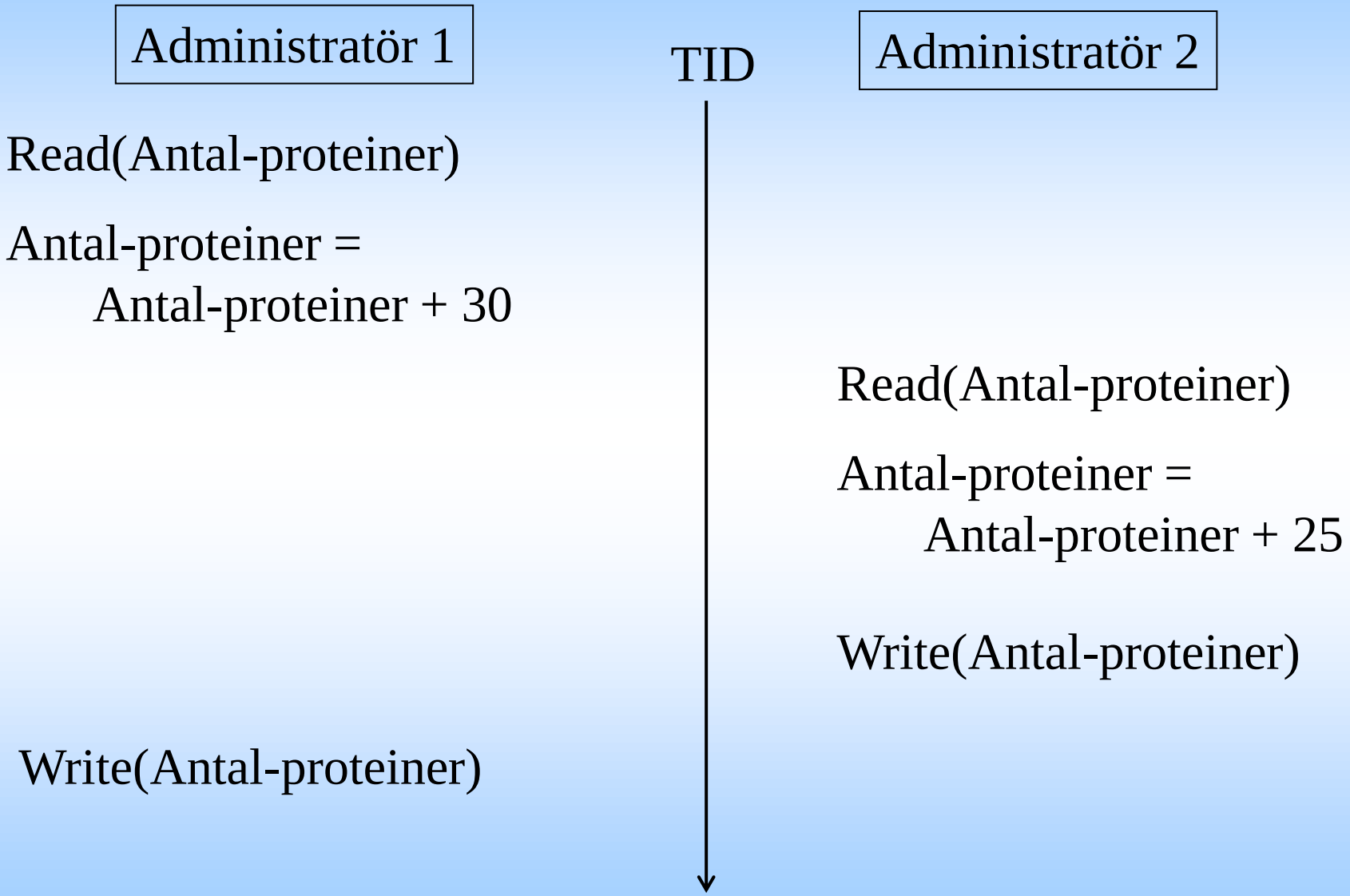
Återställning vid

- datorstop (system crash)
- systemfel
- samtidighetsfel (flera användare)
- skivfel
- katastrofer

# Hur kan flera användare accessa och uppdatera informationen samtidigt?

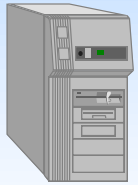


# Flera användare



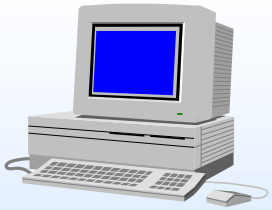
# Flera användare

DB

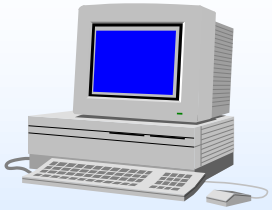


Antal-proteiner: 150

A1



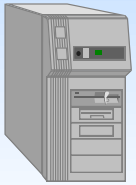
A2



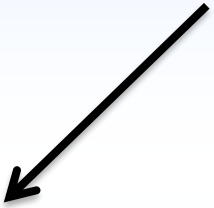
# Flera användare

DB

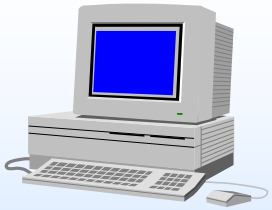
A1: Read(Antal-proteiner)



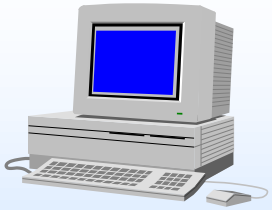
Antal-proteiner: 150



A1



A2



Antal-proteiner: 150

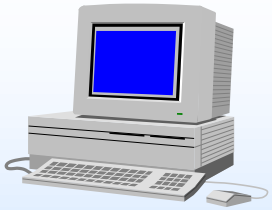
# Flera användare

DB

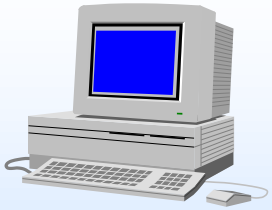
A1: Antal-proteiner =
Antal-proteiner + 30

Antal-proteiner: 150

A1



A2



Antal-proteiner: 150 + 30

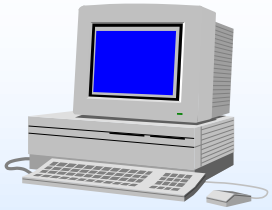
# Flera användare

DB

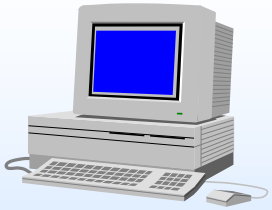
A1: Antal-proteiner =
Antal-proteiner + 30

Antal-proteiner: 150

A1



A2

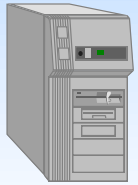


Antal-proteiner: 180

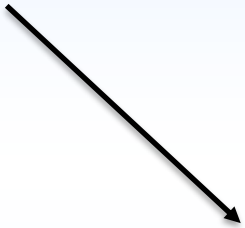
# Flera användare

DB

A2: Read(Antal-proteiner)

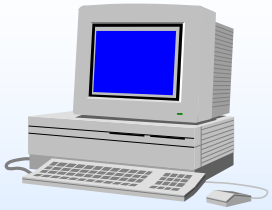


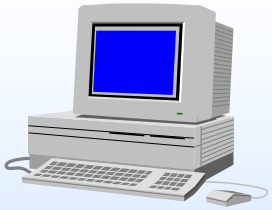
Antal-proteiner: 150



A1

A2





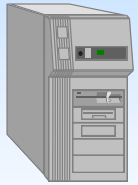
Antal-proteiner: 180

Antal-proteiner: 150

# Flera användare

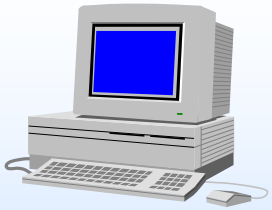
DB

A2: Antal-proteiner =
Antal-proteiner + 25

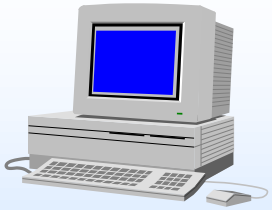


Antal-proteiner: 150

A1



A2



Antal-proteiner: 180

Antal-proteiner: 150 +25

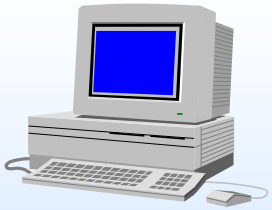
# Flera användare

DB

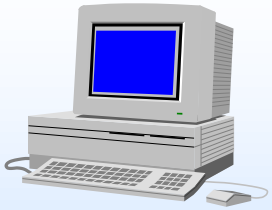
A2: Antal-proteiner =
Antal-proteiner + 25

Antal-proteiner: 150

A1



A2



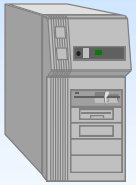
Antal-proteiner: 180

Antal-proteiner: 175

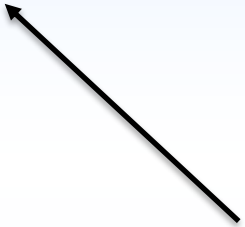
# Flera användare

DB

A2: Write(Antal-proteiner)

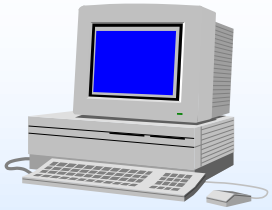


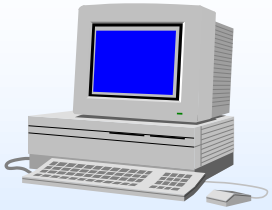
Antal-proteiner: ~~150~~



A1

A2





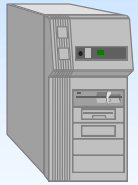
Antal-proteiner: 180

Antal-proteiner: 175

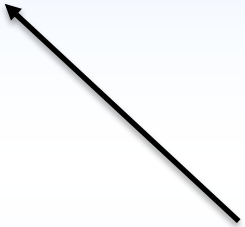
# Flera användare

DB

A2: Write(Antal-proteiner)

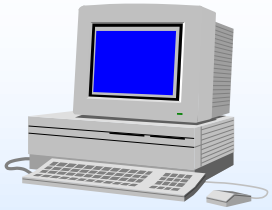


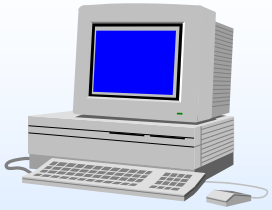
Antal-proteiner: 175



A1

A2





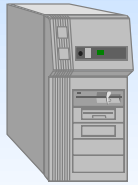
Antal-proteiner: 180

Antal-proteiner: 175

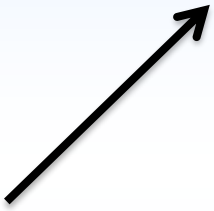
# Flera användare

DB

A1: Write(Antal-proteiner)

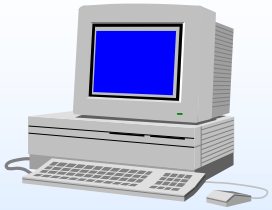


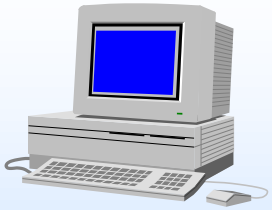
Antal-proteiner: ~~175~~



A1

A2





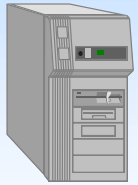
Antal-proteiner: 180

Antal-proteiner: 175

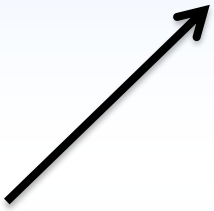
# Flera användare

DB

A1: Write(Antal-proteiner)

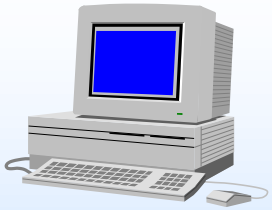


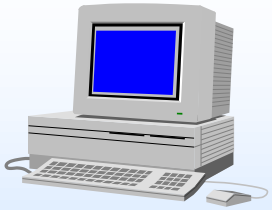
Antal-proteiner: 180



A1

A2



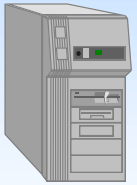


Antal-proteiner: 180

Antal-proteiner: 175

# Flera användare

DB



Antal-proteiner: 180

Antal-proteiner: 150 + 30 + 25 = 205

# Informationssäkerhet

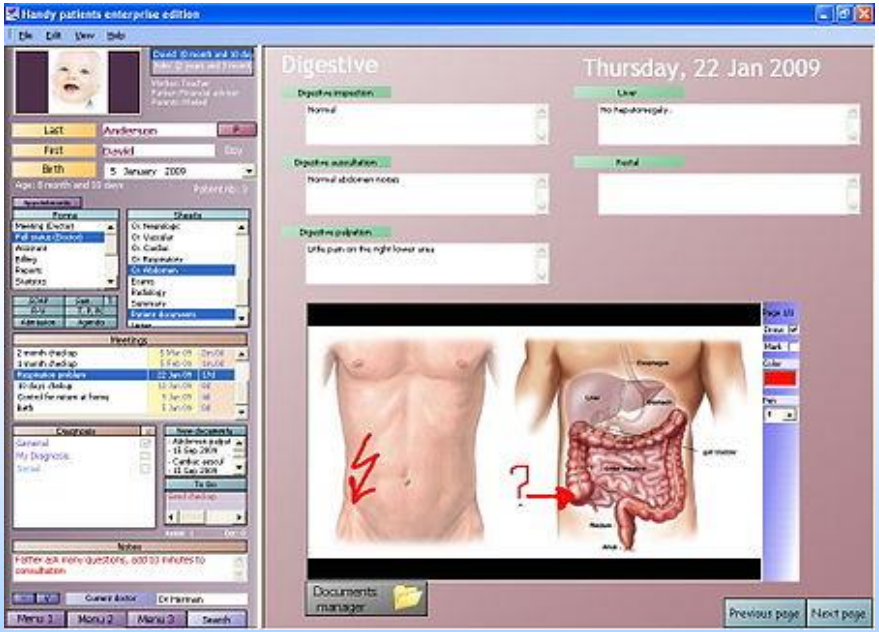
**Sekretess**

Enbart behöriga användare får ta del av informationen

**Integritet**

Korrekt och fullständig information

Tillgänglighet




https://en.wikipedia.org/wiki/Electronic_health_record

# Kursöversikt - FÖ

- Introduktion
- Relationsdatabaser och SQL
- Datamodellering, ER/EER diagram
- Att gå från EER diagram till relationsscheman

# Kursöversikt - FÖ

- Informationssäkerhet
- Databassäkerhet

# Kursöversikt - LA+projekt

- Lab1: Grundläggande SQL
- Lab2: Databasdesign och EER modellering
- Lab3: Avancerad SQL
- Lab4: Informationssäkerhet

# Kursöversikt - LA+projekt

- ’Lab5’: Projekt i bioinformatik

  genomdatabas

  proteindatabas

  enzymdatabas

  databas för biologiska reglersystem

# Kursöversikt - LA+projekt

- Rapporteringsdeadline vid varje tentamenstillfälle
- behövs ett särskilt databaskonto

--> automatisk vid registrering på kursen

databaskontona tas bort efter 1 år

- anmälan till laborationer via kurshemsidan senast 7 april

# Examination

- tenta
- laborationsserie
- projekt

# En kurs för TB

- Användning i senare kurser + arbete
- Unik och eftertraktad kompetens
  - Bio
  - Data
  - Förståelse av modellering + konsekvenser (Hur modellera? Hur ställa frågor? Värför går det långsamt? Varför får man inget svar?...)

# Samläsning

- Samläsning med TDDD12
  (DI, I, Ii, IP, M, Mat, Y)
- Innehåll föreläsningar:

  enbart databasdelen samläses

  (resten:

  TDDD12 databasteori

  TDDE49 informationssäkerhet)

# Samläsning

- labbar:
  - Flera labbar för TDDD12
  - Mera tid för TDDE49
- Projekt:
  - Unikt projekt för TDDE49