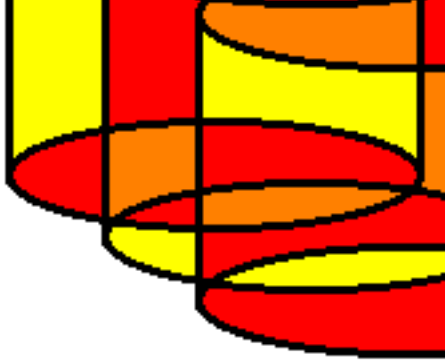
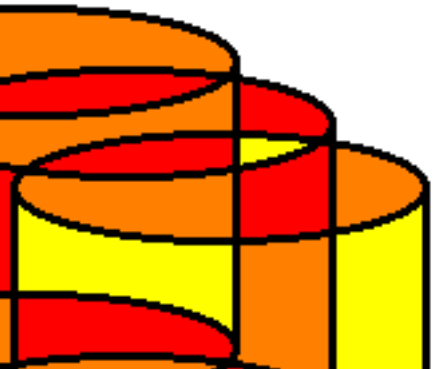
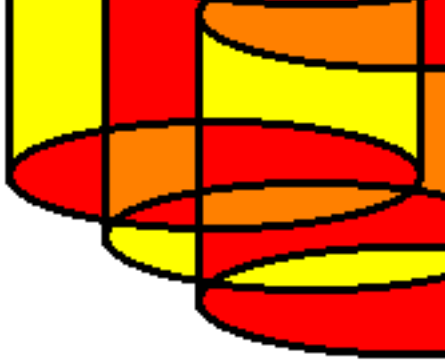
Temporalne baze podataka



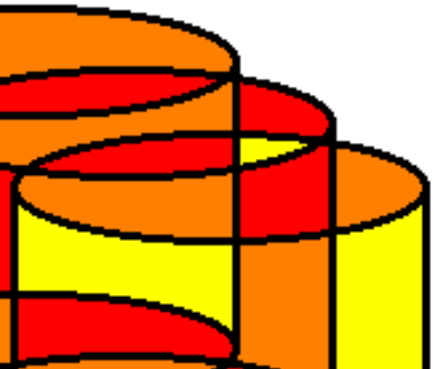
- baze podataka koje imaju ugrađene vremenske aspekte podataka te omogućavaju rad s takvim podacima putem prilagođenog jezika (temporal SQL)



Temporalne baze podataka

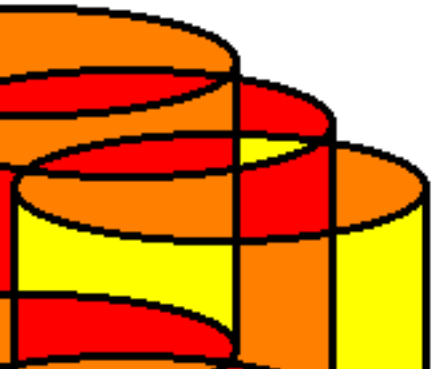


- Najčešće uključuju vrijednosti:
  - **vrijedećeg vremena** (valid time) – vrijeme tijekom kojeg je neka činjenica istinita obzirom na aplikacijsku domenu
  - **transakcijskog vremena** (transaction time) – vrijeme tijekom kojeg je neka činjenica pohranjena u bazi podataka
  - **bitemporalnog vremena** (bitemporal time) – kombinacija vrijedećeg i transakcijskog vremena

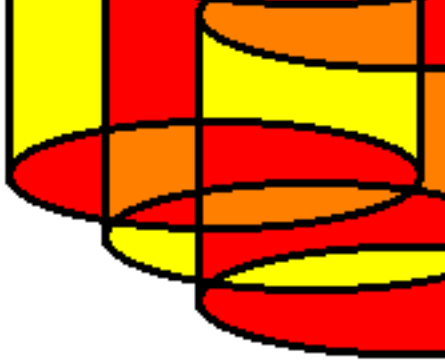


Temporalni podaci i PostgreSQL

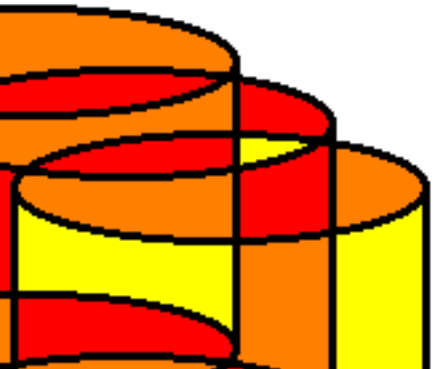
- PostgreSQL podržava neke aspekte temporalnih baza podataka najviše putem vremenskih tipova podataka kao i operacija za rad nad njima.



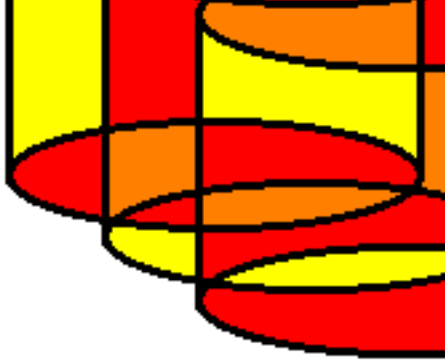
Vremenski podaci u PostgreSQL-u



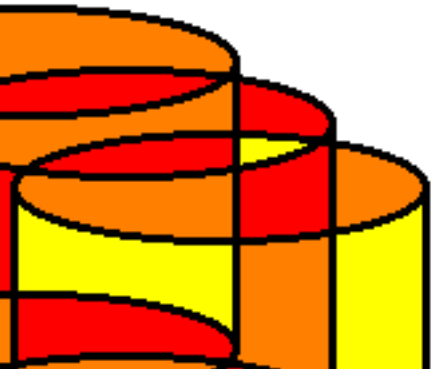
- **`timestamp`**, **`timestamptz`** – trenutak u vremenu (s vremenskom zonom)
- **`interval`** – vremenski neodređeni interval
- **`date`** - datum
- **`time`**, **`timetz`** – vrijeme u danu (s vremenskom zonom)



Vremenski intervali u PostgreSQL-u



- **`tsrange`**, **`tstzrange`** – vremenski određeni interval između dva trenutka u vremenu (s vremenskom zonom)
- **`daterange`** – vremenski određeni interval između dva datuma



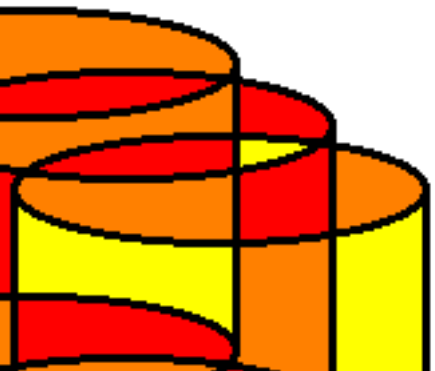
Unos podataka - timestamp

- Bez vremenske zone:

```
'2008-01-08 04:05:06'
```

- s vremenskom zonom:

```
'2008-01-08 04:05:06 -8:00'
```



Unos podataka - timestamp

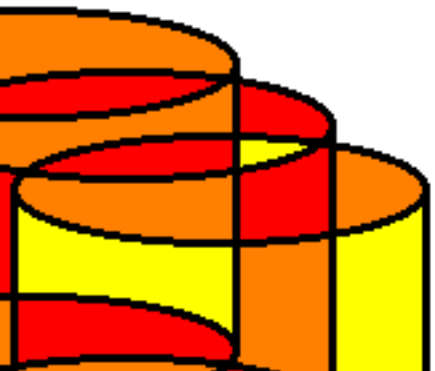
- S tim da su mogući kraći zapisi poput

```
'2008-01-08' = '2008-01-08 0:00:00'
```

```
'2008-01-08 -3' = '2008-01-08 0:00:00 -3:00'
```

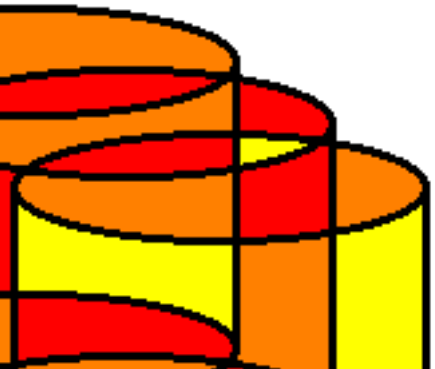
Unos podataka - interval

```
'1 year 2 days 3 hours 4 min 5 sec'

'1 year 2 days 3 hours 5 sec'

'1 hour 4 min 5 sec'
```



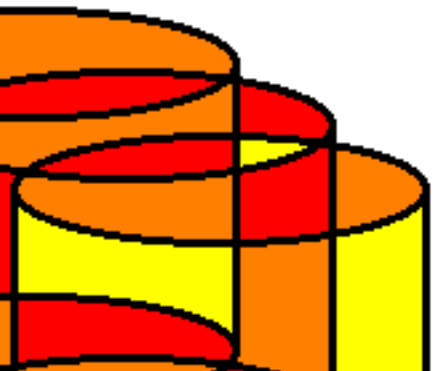
Unos podataka - date

```
'2008-01-24'
```

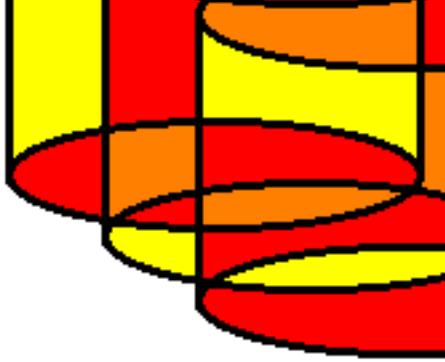


Unos podataka - time

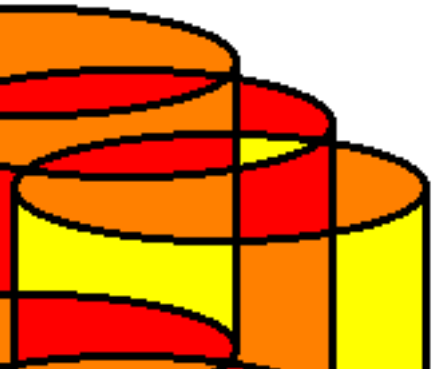
```
'18:30:21.23'

'18:30 +1'

'18:30'
```



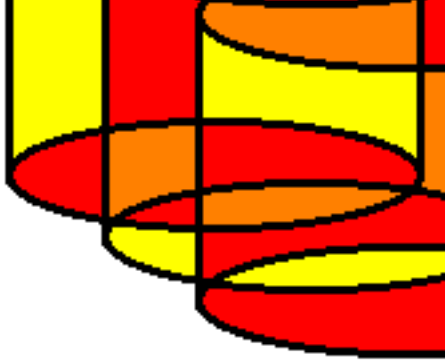
Unosi određenih intervala



```
tsrange
'[2016-01-01 14:30, 2016-01-01 15:30)'

tstzrange
'(2016-01-08 04:05:06 -8:00, 2016-01-09 12:22:55-8:00]'

daterange
'[2016-08-16, 2016-08-18]'
```

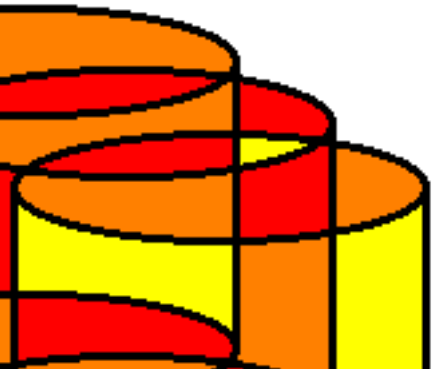


Unosi određenih intervala



Otvoreni i zatvoreni intervali, prazni interval

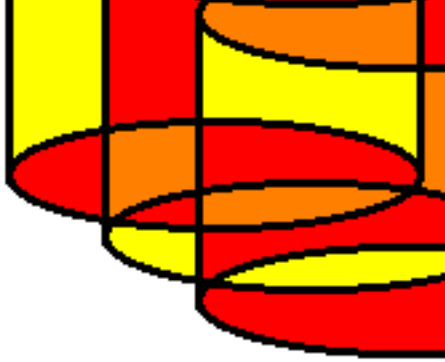
```
(donja-granica, gornja-granica)
[donja-granica, gornja-granica)
(donja-granica, gornja-granica]
[donja-granica, gornja-granica]
empty
```



Posebne vrijednosti

'epoch' – **date, timestamp** – 1970-01-01 00:00:00+00
'infinity' – **timestamp** – poslije svih drugih
'-infinity' – **timestamp** – prije svih drugih
'now' – **date**, **time**, **timestamp** – trenutno vrijeme
'today' – **date**, **timestamp** – danas, 0:00
'tomorrow' – **date**, **timestamp** – sutra, 0:00
'yesterday' – **date**, **timestamp** – jučer, 0:00
'allballs' – **time** – 00:00:00.00 UTC

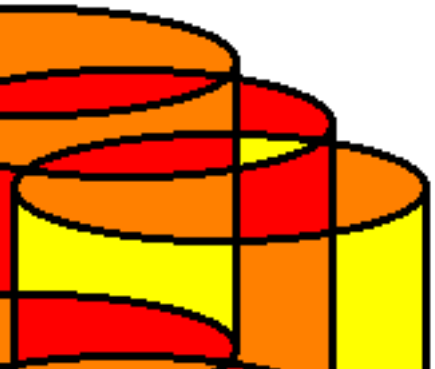
Kompatibilnost



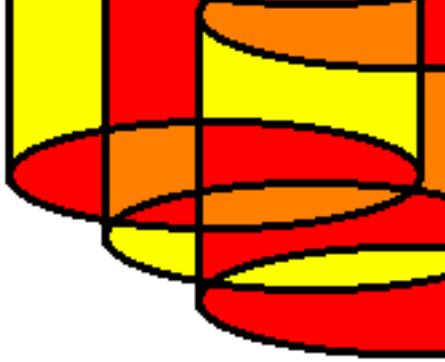
- Radi kompatibilnosti s SQL standardom moguće je koristiti i

```
CURRENT_DATE
CURRENT_TIME
CURRENT_TIMESTAMP
LOCALTIME
LOCALTIMESTAMP
```

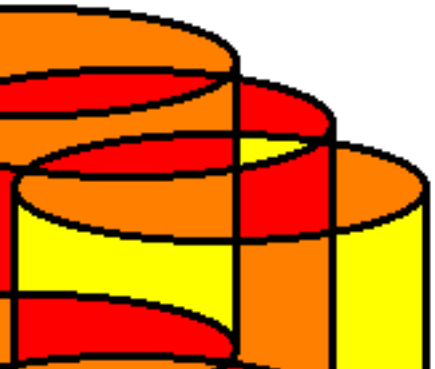
Bez navodnika!



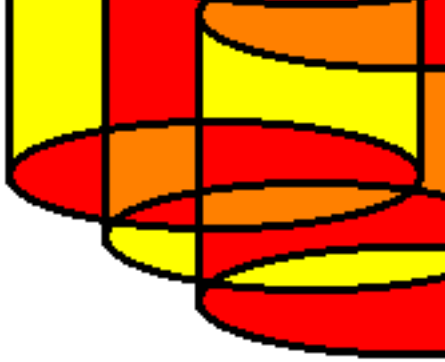
Operatori – zbrajanje



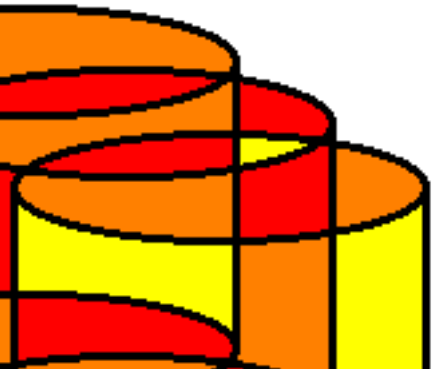
```
SELECT date '2001-09-28' + integer '7' AS t;
```



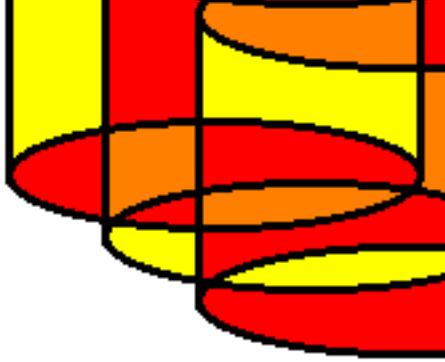
Operatori – zbrajanje



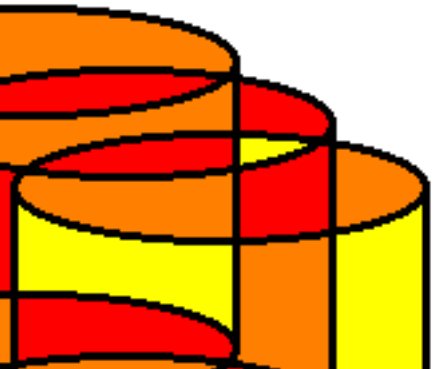
```
SELECT date '2001-09-28' + integer '7' AS t;

SELECT date '2001-09-28' + interval '1 hour'
  AS t;
```



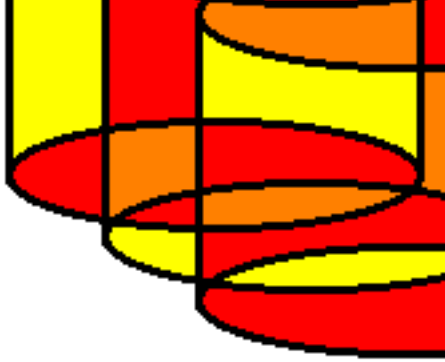
Operatori – zbrajanje



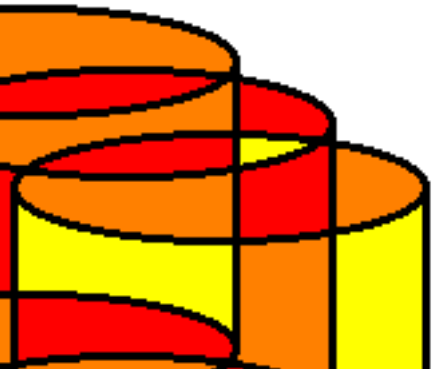
```
SELECT date '2001-09-28' + integer '7' AS t;

SELECT date '2001-09-28' + interval '1 hour'
  AS t;

SELECT date '2001-09-28' + time '03:00' AS t;
```



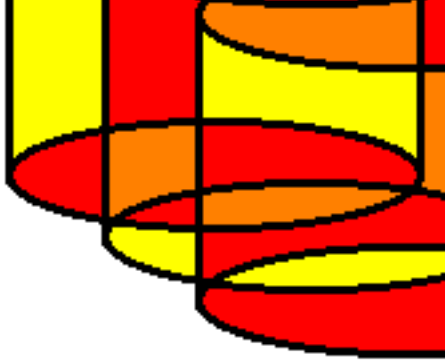
Operatori – zbrajanje



```
SELECT interval '1 day' + interval '1 hour' AS t;
```

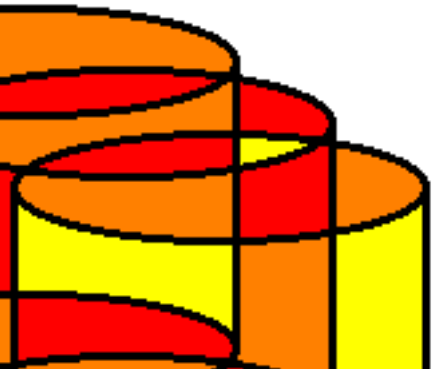


Operatori – zbrajanje



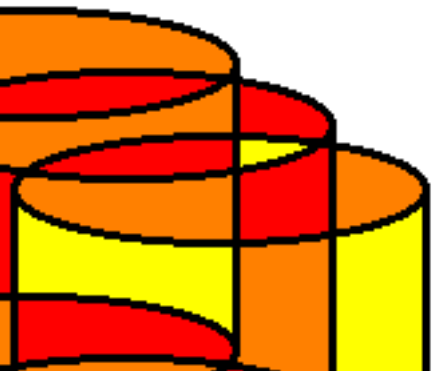
```
SELECT interval '1 day' + interval '1 hour' AS t;
```

```
SELECT timestamp '2001-09-28 01:00' + interval '23
  hours' AS t;
```



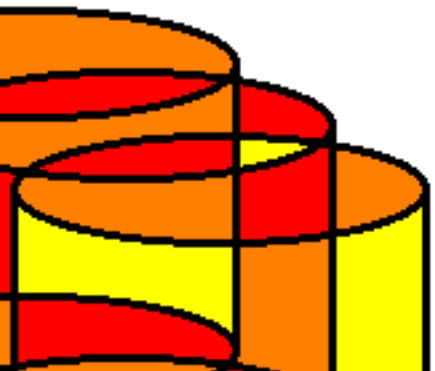
Operatori – zbrajanje

```
SELECT interval '1 day' + interval '1 hour' AS t;

SELECT timestamp '2001-09-28 01:00' + interval '23
  hours' AS t;

SELECT time '01:00' + interval '3 hours' AS t;
```



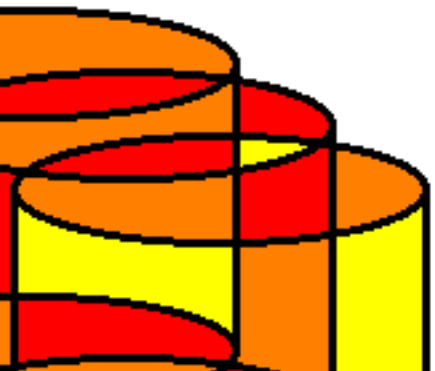
Operatori - oduzimanje

```
SELECT - interval '23 hours' AS t;
```



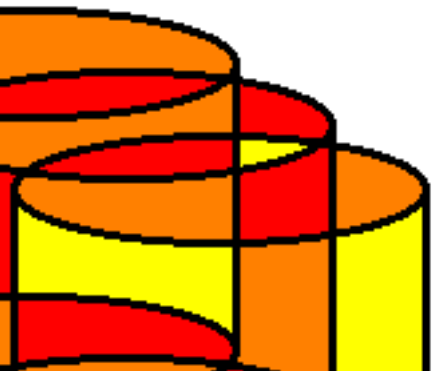
Operatori - oduzimanje

```
SELECT - interval '23 hours' AS t;

SELECT date '2001-10-01' - date '2001-09-28'
  AS t;
```



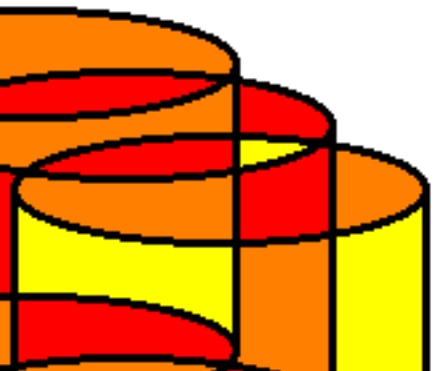
Operatori - oduzimanje

```
SELECT - interval '23 hours' AS t;

SELECT date '2001-10-01' - date '2001-09-28'
  AS t;

SELECT date '2001-10-01' - integer '7' AS t;
```



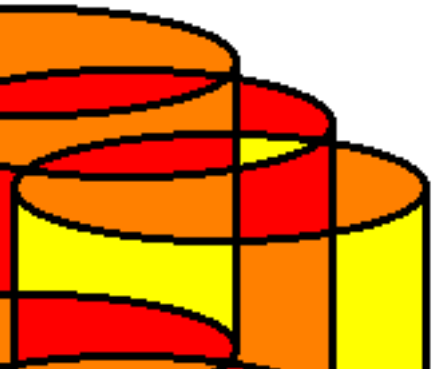
Operatori - oduzimanje

```
SELECT - interval '23 hours' AS t;

SELECT date '2001-10-01' - date '2001-09-28'
  AS t;

SELECT date '2001-10-01' - integer '7' AS t;

SELECT date '2001-09-28' - interval '1 hour'
  AS t;
```



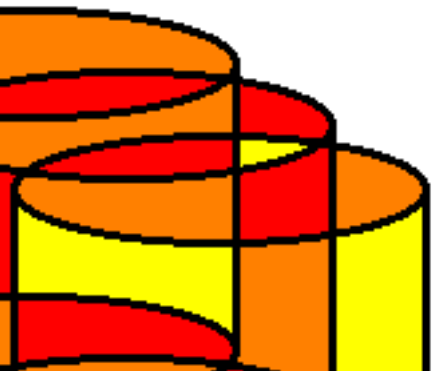
Operatori - oduzimanje

```
SELECT - interval '23 hours' AS t;

SELECT date '2001-10-01' - date '2001-09-28'
  AS t;

SELECT date '2001-10-01' - integer '7' AS t;

SELECT date '2001-09-28' - interval '1 hour'
  AS t;

SELECT time '05:00' - time '03:00' AS t;
```



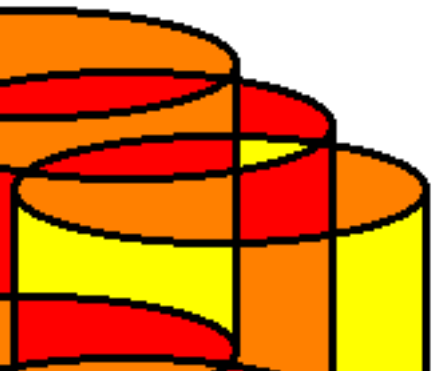
Operatori - oduzimanje

```
SELECT time '05:00' - interval '2 hours' AS t;
```



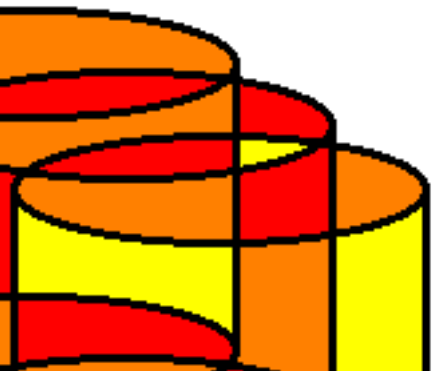
Operatori - oduzimanje

```
SELECT time '05:00' - interval '2 hours' AS t;

SELECT timestamp '2001-09-28 23:00' -
  interval '23 hours' AS t;
```



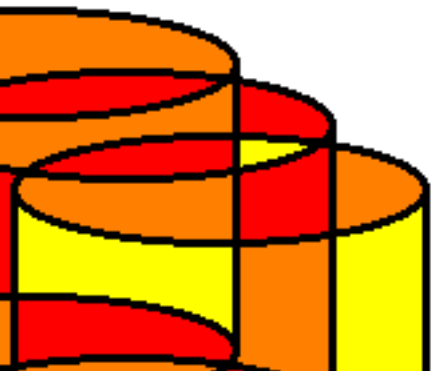
Operatori - oduzimanje

```
SELECT time '05:00' - interval '2 hours' AS t;

SELECT timestamp '2001-09-28 23:00' -
  interval '23 hours' AS t;

SELECT interval '1 day' - interval '1 hour' AS
  t;
```



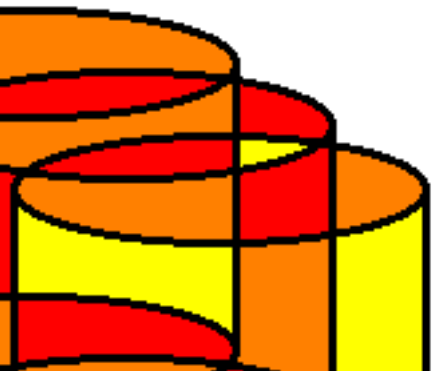
Operatori - oduzimanje

```
SELECT time '05:00' - interval '2 hours' AS t;

SELECT timestamp '2001-09-28 23:00' -
  interval '23 hours' AS t;

SELECT interval '1 day' - interval '1 hour' AS
  t;

SELECT timestamp '2001-09-29 03:00' -
  timestamp '2001-09-27 12:00' AS t;
```

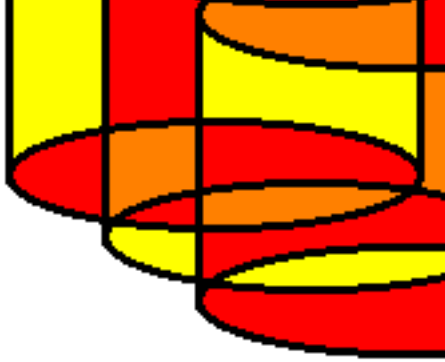


Operatori - množenje

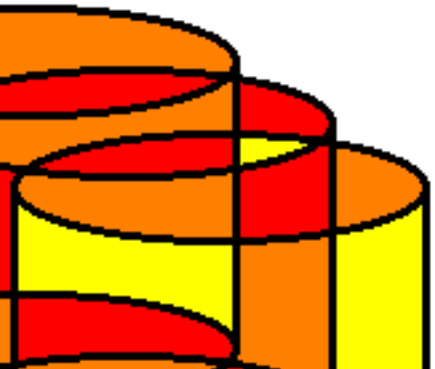
```
SELECT 900 * interval '1 second' AS
  t;
```



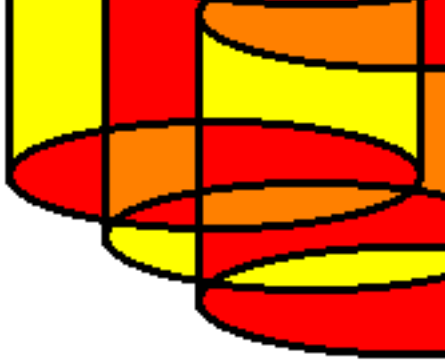
Operatori - množenje



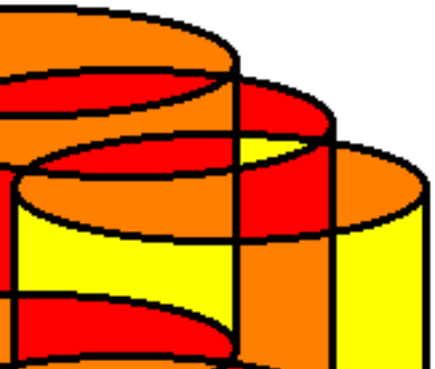
```
SELECT 900 * interval '1 second' AS
  t;

SELECT 21 * interval '1 day' AS t;
```



Operatori - množenje

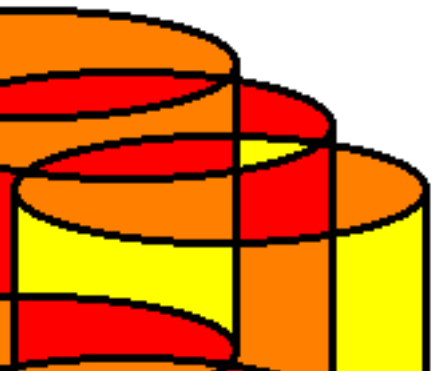


```
SELECT 900 * interval '1 second' AS
  t;

SELECT 21 * interval '1 day' AS t;

SELECT double precision '3.5' *
  interval '1 hour' AS t;
```

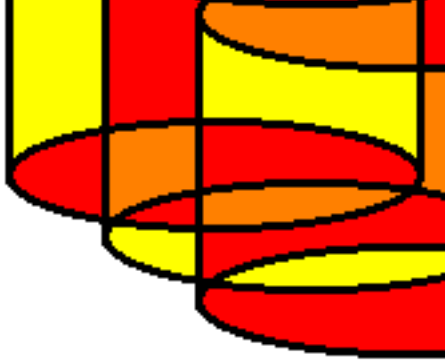


Operatori - djeljenje

```
SELECT interval '1 hour' / double
  precision '1.5' AS t;
```

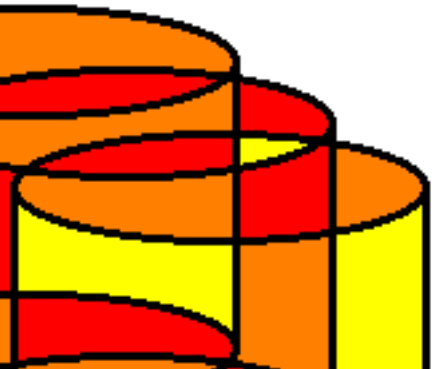


Operatori - OVERLAPS



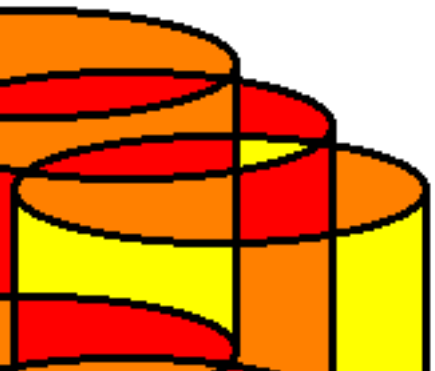
- Sintaksa

```
(start1, end1) OVERLAPS (start2, end2)

(start1, length1) OVERLAPS (start2, length2)
```

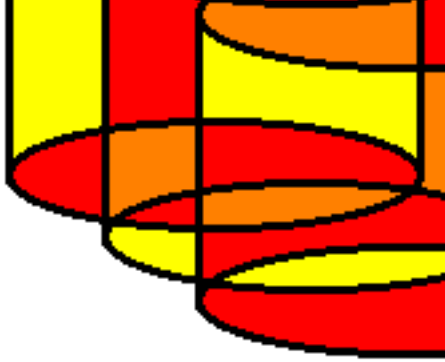


Operatori - OVERLAPS

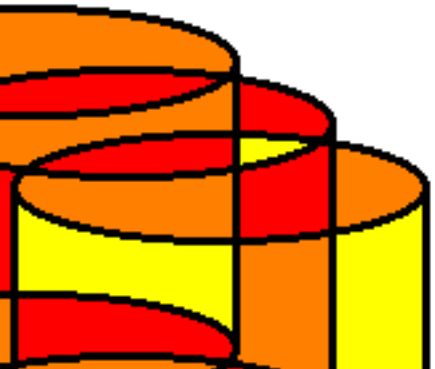
```
SELECT (DATE '2001-02-16', DATE '2001-12-21')
  OVERLAPS (DATE '2001-10-30', DATE '2002-10-
  30');
```



Operatori - OVERLAPS



```
SELECT (DATE '2001-02-16', DATE '2001-12-21')
  OVERLAPS (DATE '2001-10-30', DATE '2002-10-
  30');


SELECT (DATE '2001-09-16', INTERVAL '100
  days') OVERLAPS (DATE '2001-10-30', DATE
  '2002-10-30');
```

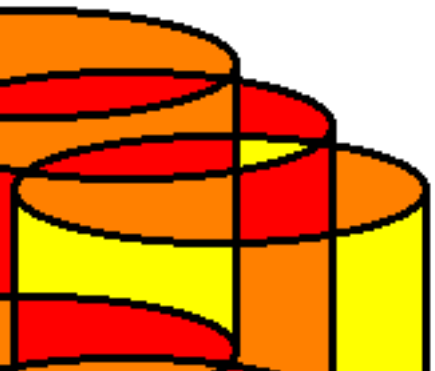


Operatori – određeni intervali

Operator	*Opis*
=	jednakost
<>	nejednakost
<	manji
>	veći
<=	manji ili jednak
>=	veći ili jednak
@>	sadrži interval
@>	sadrži element
<@	interval je sadržan u
<@	element je sadržan u
&&	preklapaju se (imaju zajedničkih točaka)
<<	strogo lijevo od
>>	strogo desno od
&<	ne prelazi desnu stranu
&>	ne prelazi lijevu stranu
-|-	slijedi
+	unija
*	presjek
-	razlika

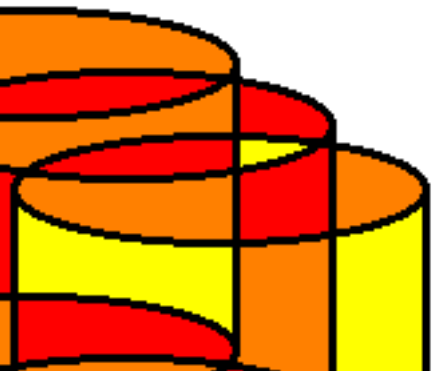
Funkcije za rad s temporalnim podacima

```
SELECT age(timestamp '2012-11-19',
  timestamp '1988-06-13');
```



Funkcije za rad s temporalnim podacima

```
SELECT age(timestamp '2012-11-19',
  timestamp '1988-06-13');


SELECT age(timestamp '1988-06-13');
```

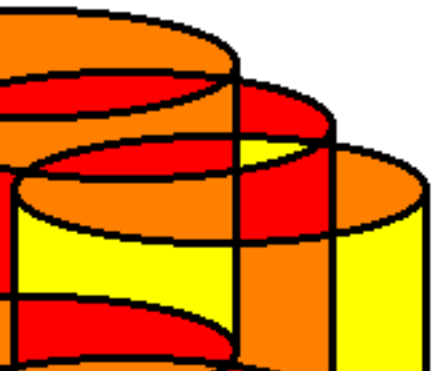


Funkcije za rad s temporalnim podacima

```
SELECT age(timestamp '2012-11-19',
  timestamp '1988-06-13');
```

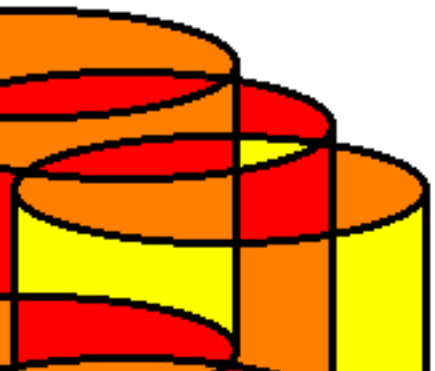
```
SELECT age(timestamp '1988-06-13');
```

- oduzima od trenutnog vremena



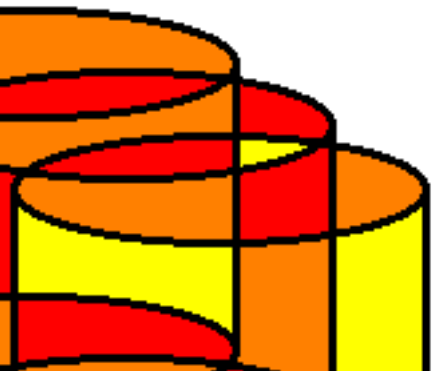
Funkcije za rad s temporalnim podacima

```
SELECT date_part('hour', timestamp
  '2001-02-16 20:38:40');
```



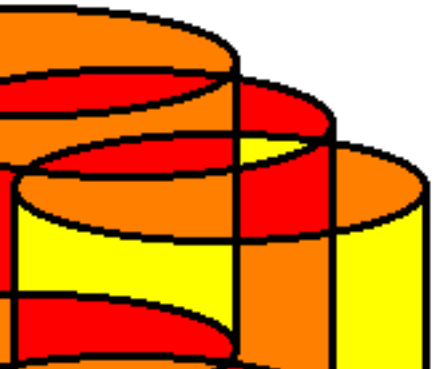
Funkcije za rad s temporalnim podacima

```
SELECT date_part('hour', timestamp
  '2001-02-16 20:38:40');


SELECT date_part('month', interval
  '2 years 3 months');
```



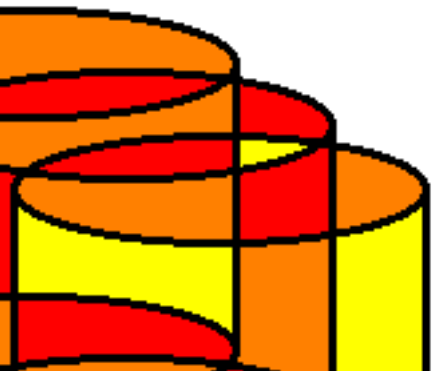
Funkcije za rad s temporalnim podacima

```
SELECT date_trunc('hour', timestamp
  '2001-02-16 20:38:40');
```



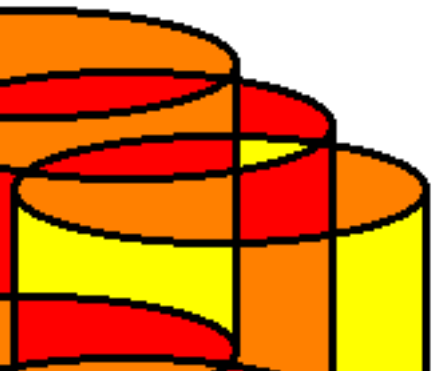
Funkcije za rad s temporalnim podacima

```
SELECT extract(hour from timestamp '2001-
  02-16 20:38:40');
```



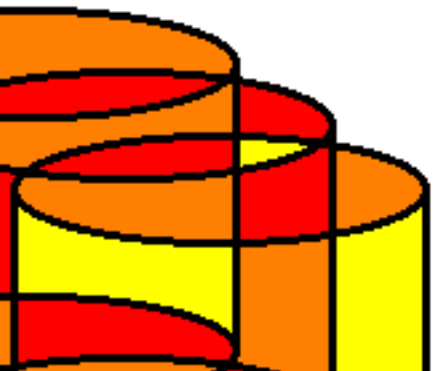
Funkcije za rad s temporalnim podacima

```
SELECT extract(hour from timestamp '2001-
  02-16 20:38:40');

SELECT extract(month from interval '2
  years 3 months');
```

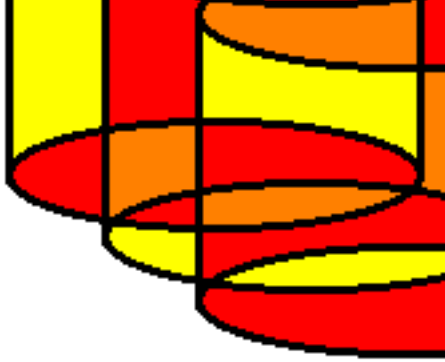


Funkcije za rad s temporalnim podacima

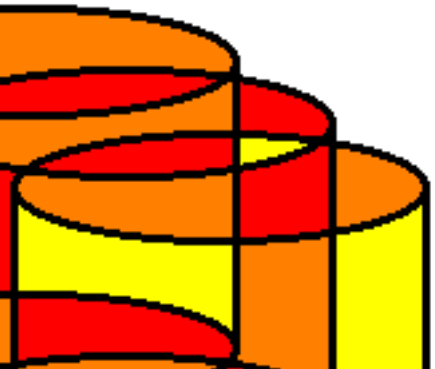
```
SELECT extract(hour from timestamp '2001-
  02-16 20:38:40');

SELECT extract(month from interval '2
  years 3 months');

SELECT extract(century from timestamp
  '2000-12-16 12:21:13');
```



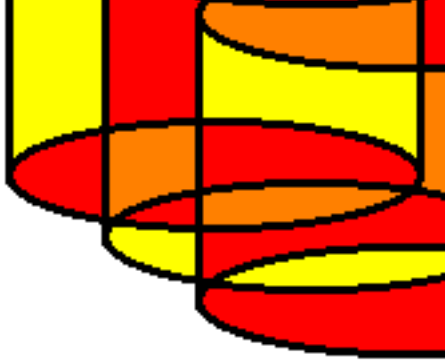
Implementacija temporalne baze podataka u PostgreSQL-u



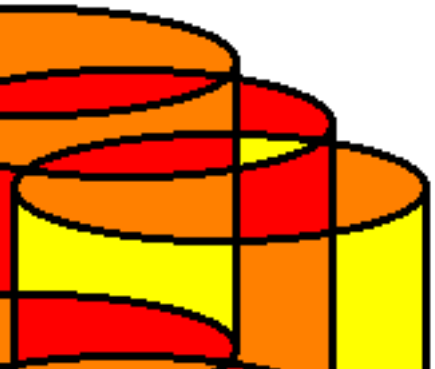
- PostgreSQL nije izravno sustav za upravljanje temporalnom bazom podataka, ali je u njemu moguće implementirati temporalnu bazu podataka kroz prilagodbu (korištenjem dodatnih temporalnih atributa i odgovarajućih okidača).



Prilagodba baze podataka



```
ALTER TABLE clanstvo
ADD COLUMN vrijedece_vrijeme TSRANGE
  DEFAULT tsrange( NOW()::TIMESTAMP, 'infinity'::TIMESTAMP );

ALTER TABLE clanstvo
DROP CONSTRAINT clanstvo_pkey;

ALTER TABLE clanstvo
ADD CONSTRAINT clanstvo_pkey
  PRIMARY KEY( clan, grupa, vrijedece_vrijeme );
```

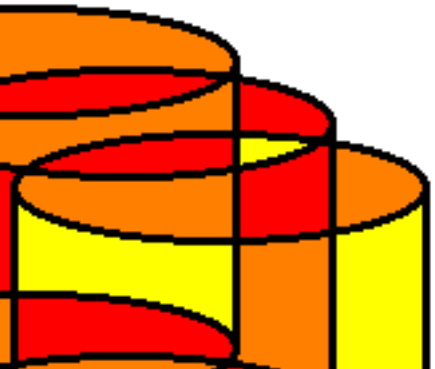


Prilagodba baze podataka

```
CREATE OR REPLACE FUNCTION promjena_clanstva()
 RETURNS TRIGGER
 AS $$
  BEGIN
   UPDATE clanstvo
   SET vrijedece_vrijeme = tsrange(
                 LOWER( vrijedece_vrijeme )::TIMESTAMP,
                 NOW()::TIMESTAMP )
      WHERE OLD.clan = clan
      AND OLD.grupa = grupa
      AND UPPER( vrijedece_vrijeme ) = 'infinity'::TIMESTAMP;
      RETURN NULL;
    END;
  $$
  LANGUAGE plpgsql;
```

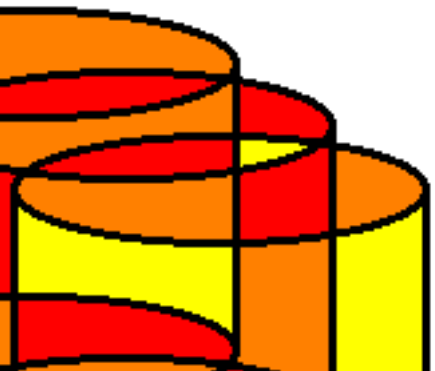
Prilagodba baze podataka

```
CREATE TRIGGER temp_clanstvo
BEFORE DELETE
ON clanstvo
FOR EACH ROW
EXECUTE PROCEDURE promjena_clanstva();
```

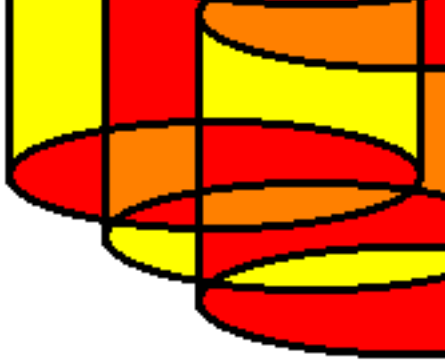


Isprobavanje

```
DELETE FROM clanstvo WHERE clan =
  'markus.schatten@foi.hr';
```



Isprobavanje



```
DELETE FROM clanstvo WHERE clan =
  'markus.schatten@foi.hr';


INSERT INTO clanstvo
  VALUES( 'markus.schatten@foi.hr', 1 );
```