PASS 24
Data Community Summit

Collation Surprises:
Did Postgres Lose My Data?

putting words in order
without losing your mind
or your data

Jeremy Schneider

Postgres Engineer

GEICO | tech

“My Opinions Are My Own”

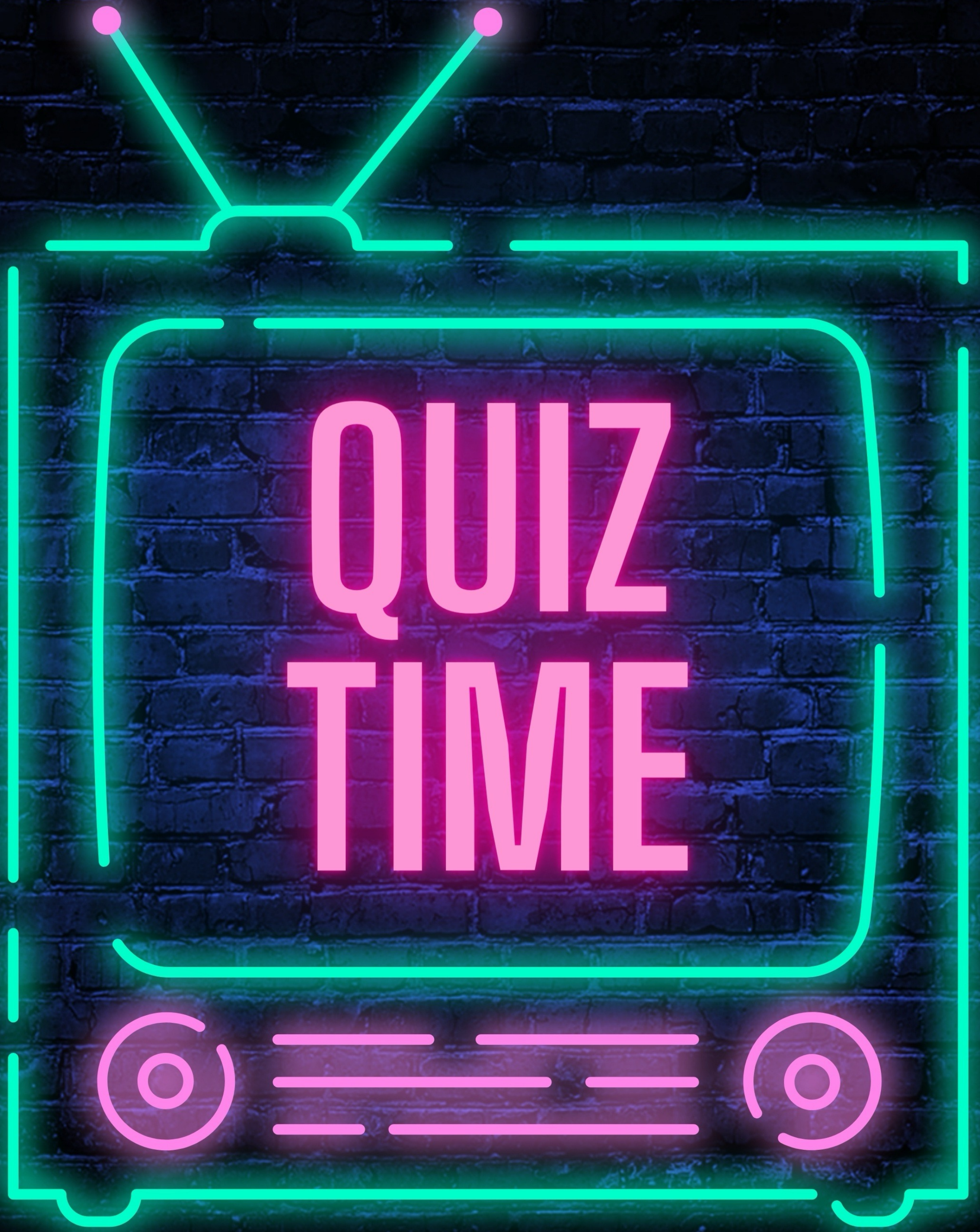


Image by Simon from Pixabay

Length of this Unicode string?

aनि亜𐂃

- 4
- 5
- 6
- 12
- 14
- 20

Jeremy Schneider

Postgres Engineer

GEICO | tech

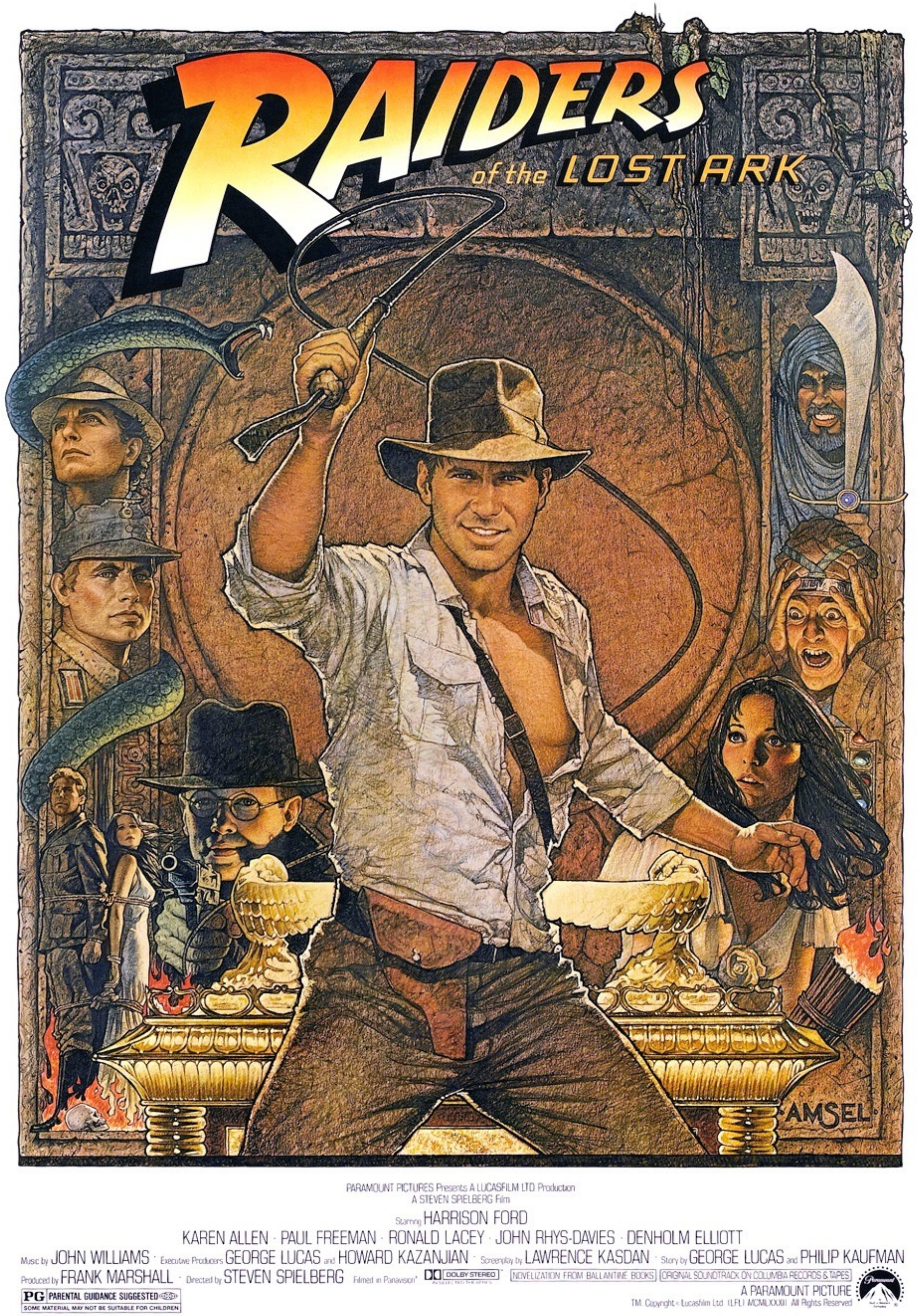
- Participant, speaker and/or organizer at Postgres user groups & conferences since 2017, Oracle & Linux user groups & conferences since the early 2000’s
- Currently helping build a next generation, hybrid-cloud database platform at GEICO
- Programming for 30 years and working with databases for 20 years, first focused on Oracle and later focused on Postgres
- Founder of "RAC Attack" Community Driven Oracle Cluster Database Workshop – almost 40 events across 15 countries between 2011 and 2016

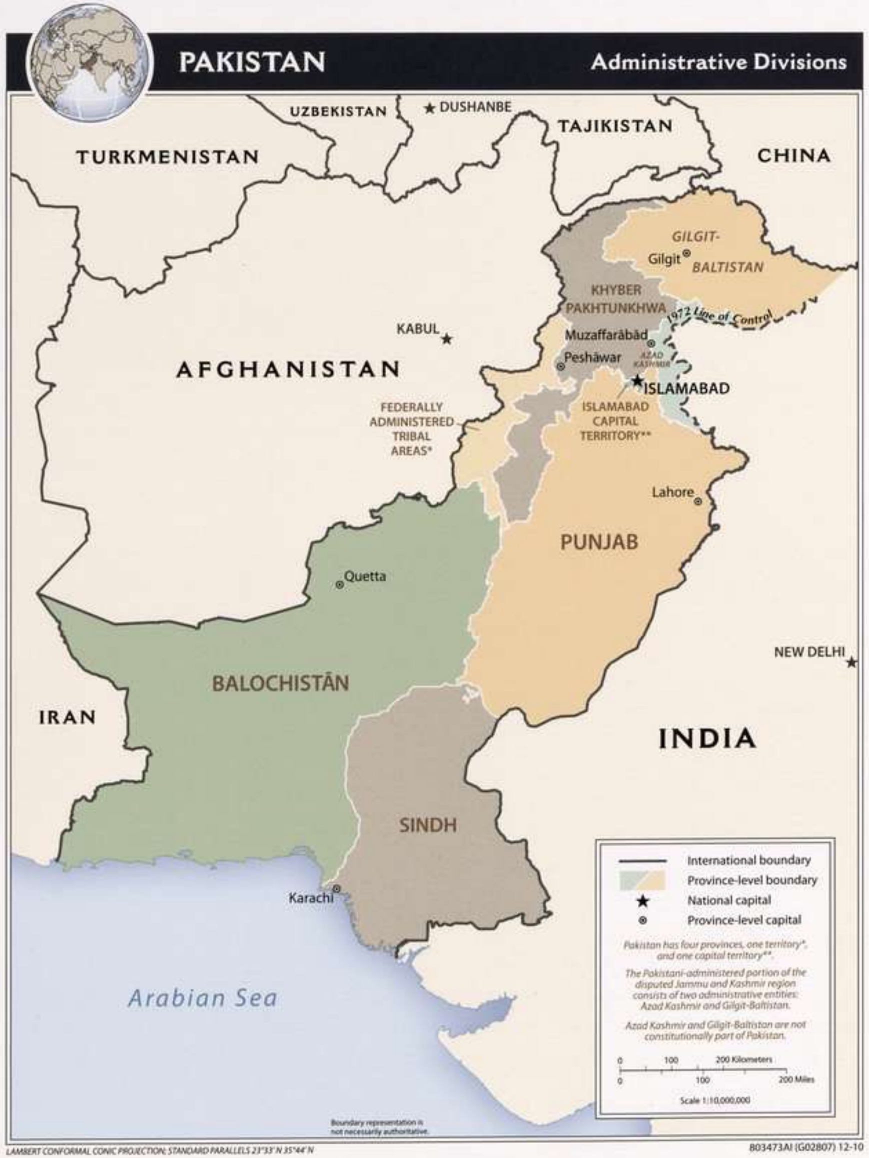
ardentperf.com

pgtreats.info/slack-invite

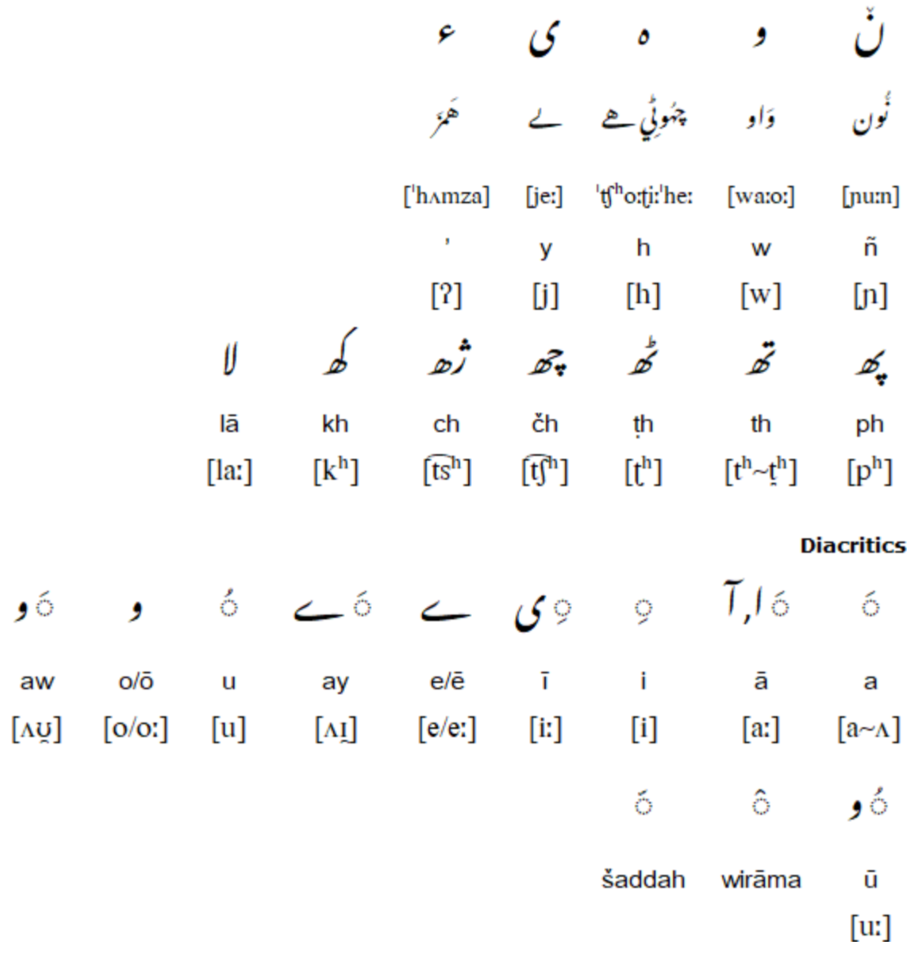
linkedin.com/in/ardentperf

@jer_s


RAIDERS
of the LOST ARK
AMSEL
PARAMOUNT PICTURES Presents A LUCASFILM LTD Production
A STEVEN SPIELBERG Film
Starring HARRISON FORD
KAREN ALLEN · PAUL FREEMAN · RONALD LACEY · JOHN RHYS-DAVIES · DENHOLM ELLIOTT
Music by JOHN WILLIAMS · Executive Producers GEORGE LUCAS and HOWARD KAZANJIAN · Screenplay by LAWRENCE KASDAN · Story by GEORGE LUCAS and PHILIP KAUFMAN
Produced by FRANK MARSHALL · Directed by STEVEN SPIELBERG Filmed in Panavision® DOLBY STEREO
NOVELIZATION FROM BALLANTINE BOOKS
ORIGINAL SOUNDTRACK ON COLUMBIA RECORDS & TAPES
PG PARENTAL GUIDANCE SUGGESTED
SOME MATERIAL MAY NOT BE SUITABLE FOR CHILDREN
A PARAMOUNT PICTURE
TM. Copyright © Lucasfilm Ltd. (LFL) MCMLXXXII All Rights Reserved


PAKISTAN
Administrative Divisions
UZBEKISTAN
DUSHANBE
TAJIKISTAN
TURKMENISTAN
CHINA
GILGIT-BALTISTAN
Gilgit
KHYBER PAKHTUNKHWA
1972 Line of Control
Muzaffarābād
AZAD KASHMIR
Peshāwar
ISLAMABAD
KABUL
AFGHANISTAN
FEDERALLY ADMINISTERED TRIBAL AREAS*
ISLAMABAD CAPITAL TERRITORY**
Lahore
PUNJAB
Quetta
NEW DELHI
BALOCHISTĀN
IRAN
INDIA
SINDH
Karachi
Arabian Sea
International boundary
Province-level boundary
National capital
Province-level capital
Pakistan has four provinces, one territory*, and one capital territory**.
The Pakistani-administered portion of the disputed Jammu and Kashmir region consists of two administrative entities: Azad Kashmir and Gilgit-Baltistan.
Azad Kashmir and Gilgit-Baltistan are not constitutionally part of Pakistan.
0
100
200 Kilometers
0
100
200 Miles
Scale 1:10,000,000
Boundary representation is not necessarily authoritative.
LAMBERT CONFORMAL CONIC PROJECTION; STANDARD PARALLELS 23°33' N 35°44' N
803473AI (G02807) 12-10

Ager, Simon. "Omniglot – writing systems and languages of the world".
Date accessed: 6th June 2023. www.omniglot.com



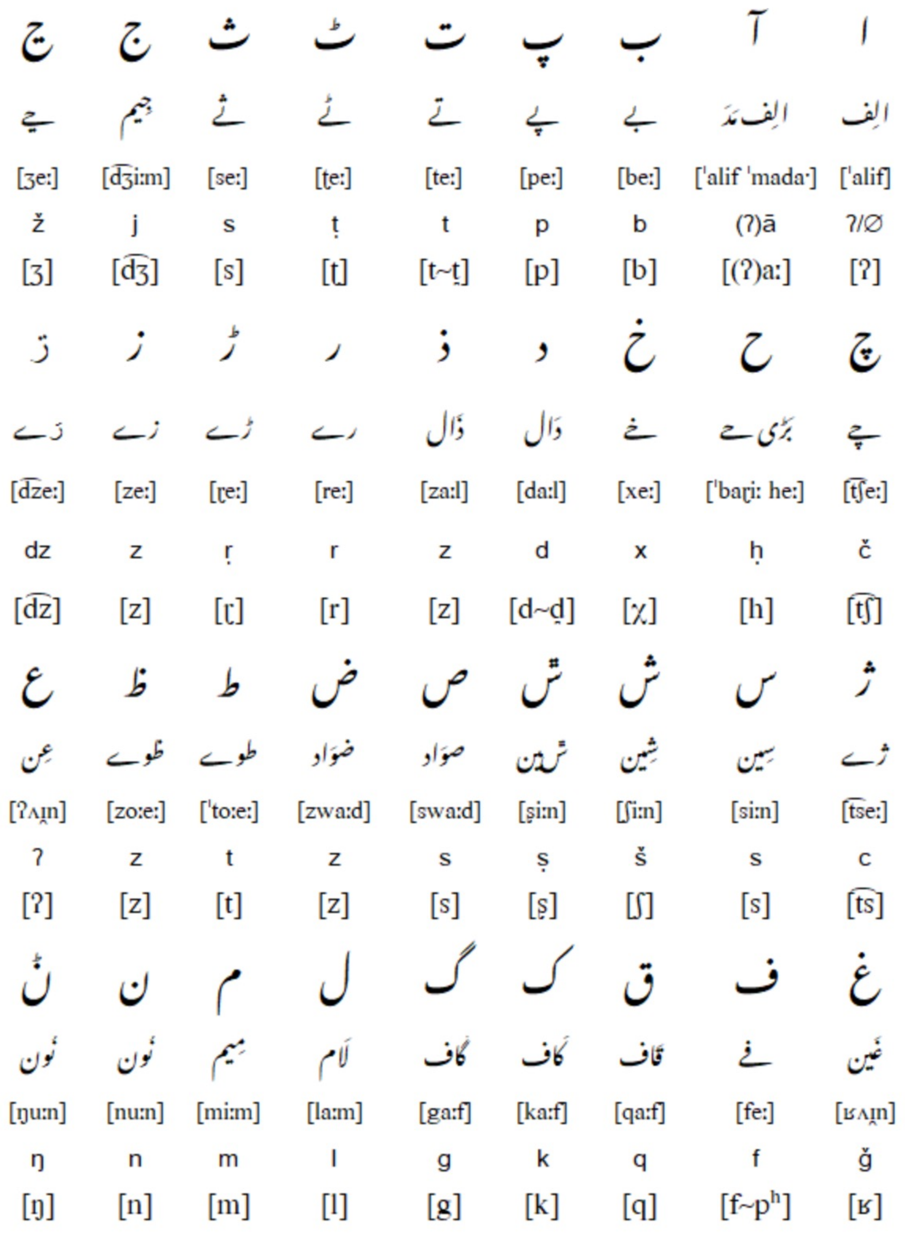
		ء	ی	ہ	و	ݩ
		ھمزہ	ے	چھوٹی ہے	واو	نون
		[ˈhʌmza]	[je:]	ˈt͡ʃʰo:ʈi:ˈhe:	[wa:o:]	[ɲu:n]
		'	y	h	w	ñ
		[ʔ]	[j]	[h]	[w]	[ɲ]
لا	کھ	ژھ	چھ	ٹھ	تھ	پھ
lā	kh	ch	čh	ṭh	th	ph
[la:]	[kʰ]	[t͡sʰ]	[t͡ʃʰ]	[ʈʰ]	[tʰ~t̪ʰ]	[pʰ]

Diacritics

◌َو	و	◌ُ	◌َے	ے	◌ِی	◌ِ	◌َ ا, آ	◌َ
aw	o/ō	u	ay	e/ē	ī	i	ā	a
[ʌʊ̯]	[o/o:]	[u]	[ʌɪ̯]	[e/e:]	[i:]	[i]	[a:]	[a~ʌ]
						◌ّ	◌̂	◌ُو
						šaddah	wirāma	ū
								[u:]

ث, ح, ذ, ص, ض, ط, ظ, ف, ء, ے and ق are only used in loanwords.

Persian alphabet for Balti

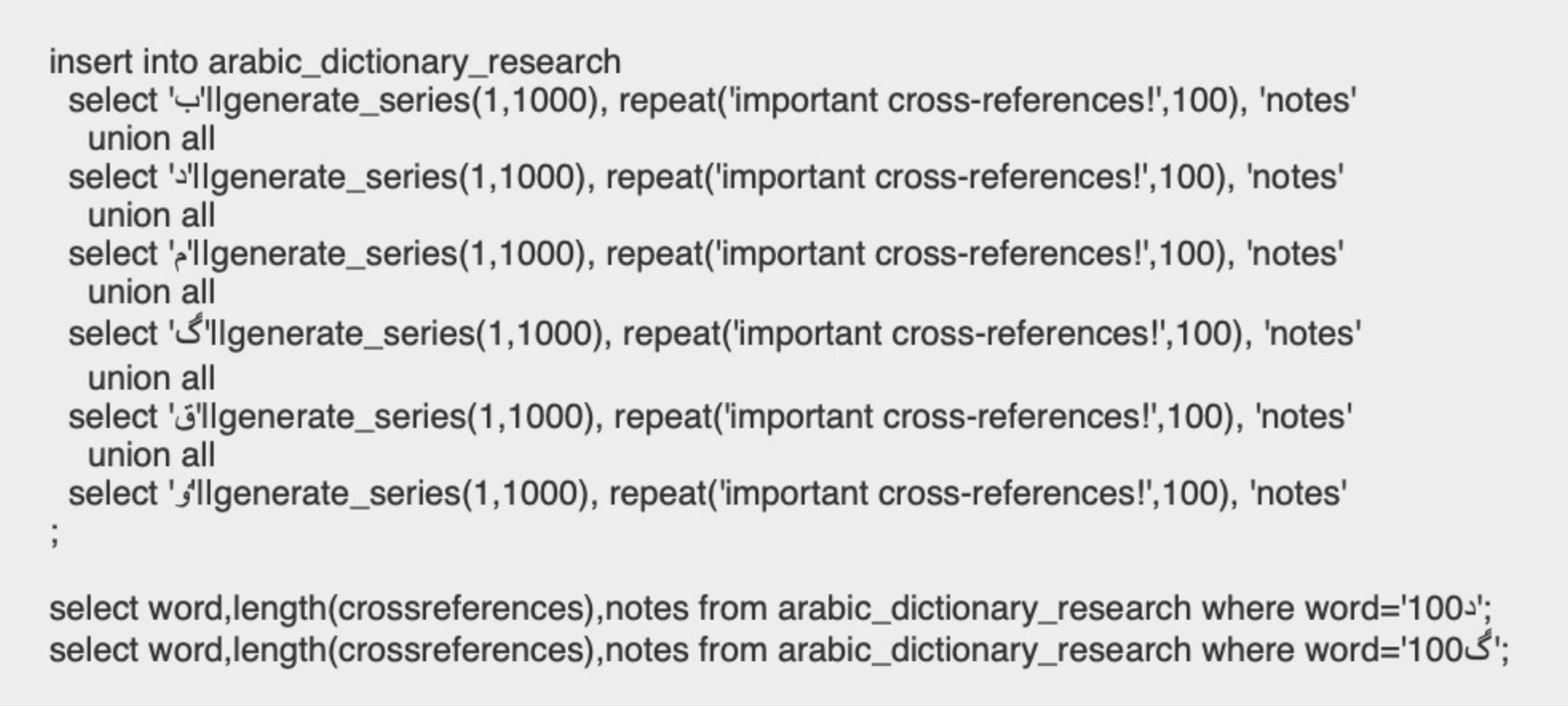


ڃ	ج	ث	ٹ	ت	پ	ب	آ	ا
ڃے	جیم	ثے	ٹے	تے	پے	بے	الِف مَد	الِف
[ʒe:]	[d͡ʒi:m]	[se:]	[ʈe:]	[te:]	[pe:]	[be:]	[ˈalif ˈmadaˑ]	[ˈalif]
ž	j	s	ṭ	t	p	b	(ʔ)ā	ʔ/∅
[ʒ]	[d͡ʒ]	[s]	[ʈ]	[t~t̪]	[p]	[b]	[(ʔ)a:]	[ʔ]
ڗ	ز	ڑ	ر	ذ	د	خ	ح	چ
ڗے	زے	ڑے	رے	ذال	دال	خے	بڑی حے	چے
[d͡ze:]	[ze:]	[ɽe:]	[re:]	[za:l]	[da:l]	[xe:]	[ˈbaɽi: he:]	[t͡ʃe:]
dz	z	ṛ	r	z	d	x	ḥ	č
[d͡z]	[z]	[ɽ]	[r]	[z]	[d~d̪]	[χ]	[h]	[t͡ʃ]
ع	ظ	ط	ض	ص	ڜ	ش	س	ژ
عین	ظوے	طوے	ضواد	صواد	ڜین	شین	سین	ژے
[ʔʌɪ̯n]	[zo:e:]	[ˈto:e:]	[zwa:d]	[swa:d]	[ʂi:n]	[ʃi:n]	[si:n]	[t͡se:]
ʔ	z	t	z	s	ṣ	š	s	c
[ʔ]	[z]	[t]	[z]	[s]	[ʂ]	[ʃ]	[s]	[t͡s]
ݨ	ن	م	ل	گ	ک	ق	ف	غ
ݨون	نون	میم	لام	گاف	کاف	قاف	فے	غین
[ŋu:n]	[nu:n]	[mi:m]	[la:m]	[ga:f]	[ka:f]	[qa:f]	[fe:]	[ʁʌɪ̯n]
ŋ	n	m	l	g	k	q	f	ğ
[ŋ]	[n]	[m]	[l]	[g]	[k]	[q]	[f~pʰ]	[ʁ]

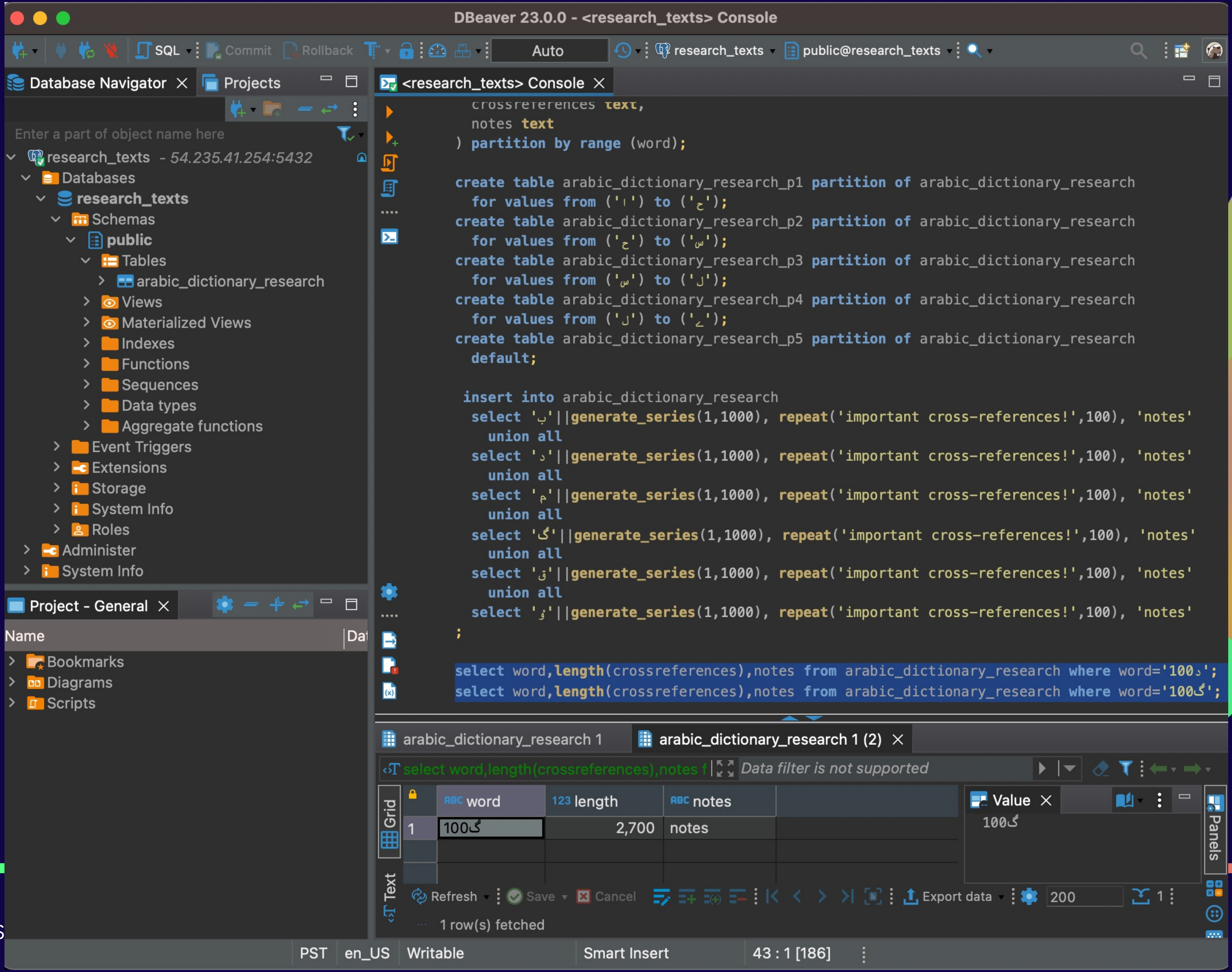
```
aws ec2 run-instances
  --instance-type t2.micro   --key-name mac   --tag-specifications
     'ResourceType=instance,Tags=[{Key=Name,Value=research-db}]'
  --image-id ami-0172070f66a8ebe63            --region us-east-1


sudo apt install postgresql-common
sudo sh /usr/share/postgresql-common/pgdg/apt.postgresql.org.sh
sudo apt install postgresql-15


create database research_texts template=template0
  locale_provider=icu icu_locale="en-US"
```

```
create table arabic_dictionary_research (
 word text,
 crossreferences text,
 notes text
) partition by range (word);

create table arabic_dictionary_research_p1 partition of arabic_dictionary_research
  for values from ('ا') to ('ح');
create table arabic_dictionary_research_p2 partition of arabic_dictionary_research
  for values from ('ح') to ('س');
create table arabic_dictionary_research_p3 partition of arabic_dictionary_research
  for values from ('س') to ('ل');
create table arabic_dictionary_research_p4 partition of arabic_dictionary_research
  for values from ('ل') to ('ے');
create table arabic_dictionary_research_p5 partition of arabic_dictionary_research
  default;
```

Photo by Daniel Chekalov on Unsplash



```
insert into arabic_dictionary_research
  select 'ب'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
    union all
  select 'د'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
    union all
  select 'م'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
    union all
  select 'گ'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
    union all
  select 'ق'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
    union all
  select 'ۇ'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
;

select word,length(crossreferences),notes from arabic_dictionary_research where word='د100';
select word,length(crossreferences),notes from arabic_dictionary_research where word='گ100';
```



```
    crossreferences text,
    notes text
  ) partition by range (word);

  create table arabic_dictionary_research_p1 partition of arabic_dictionary_research
    for values from ('ا') to ('ج');
  create table arabic_dictionary_research_p2 partition of arabic_dictionary_research
    for values from ('ج') to ('س');
  create table arabic_dictionary_research_p3 partition of arabic_dictionary_research
    for values from ('س') to ('ل');
  create table arabic_dictionary_research_p4 partition of arabic_dictionary_research
    for values from ('ل') to ('ے');
  create table arabic_dictionary_research_p5 partition of arabic_dictionary_research
    default;

   insert into arabic_dictionary_research
    select 'ب'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
      union all
    select 'د'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
      union all
    select 'م'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
      union all
    select 'گ'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
      union all
    select 'ق'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
      union all
    select 'ؤ'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
  ;

  select word,length(crossreferences),notes from arabic_dictionary_research where word='100د';
  select word,length(crossreferences),notes from arabic_dictionary_research where word='100گ';
```

select word,length(crossreferences),notes f

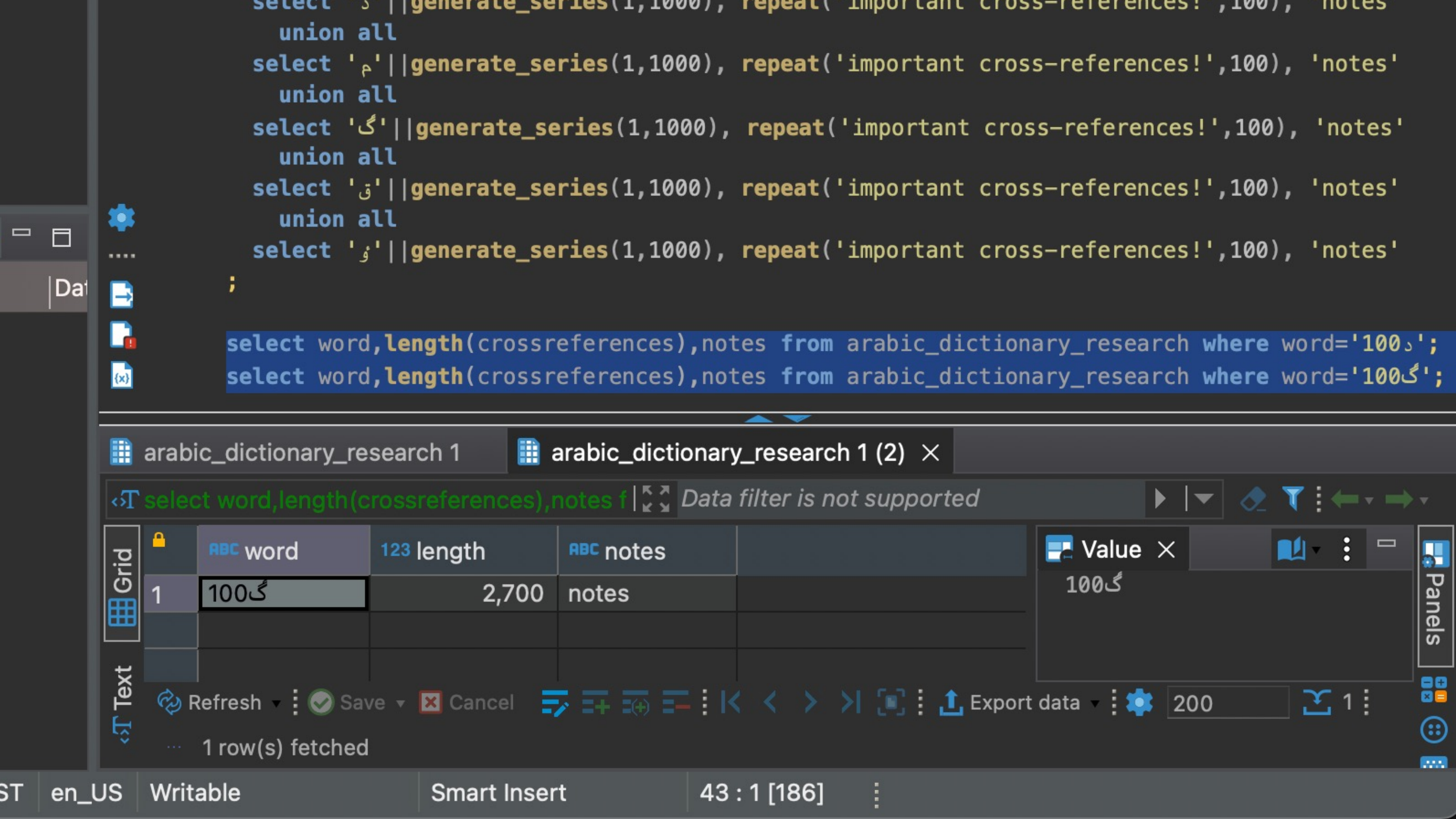
	word	length	notes
1	100گ	2,700	notes

Value: 100گ

1 row(s) fetched

#PASS

PASS24 Data Community Summit



```
    select 'د'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
      union all
    select 'م'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
      union all
    select 'گ'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
      union all
    select 'ق'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
      union all
    select 'ؤ'||generate_series(1,1000), repeat('important cross-references!',100), 'notes'
;

select word,length(crossreferences),notes from arabic_dictionary_research where word='100د';
select word,length(crossreferences),notes from arabic_dictionary_research where word='100گ';
```

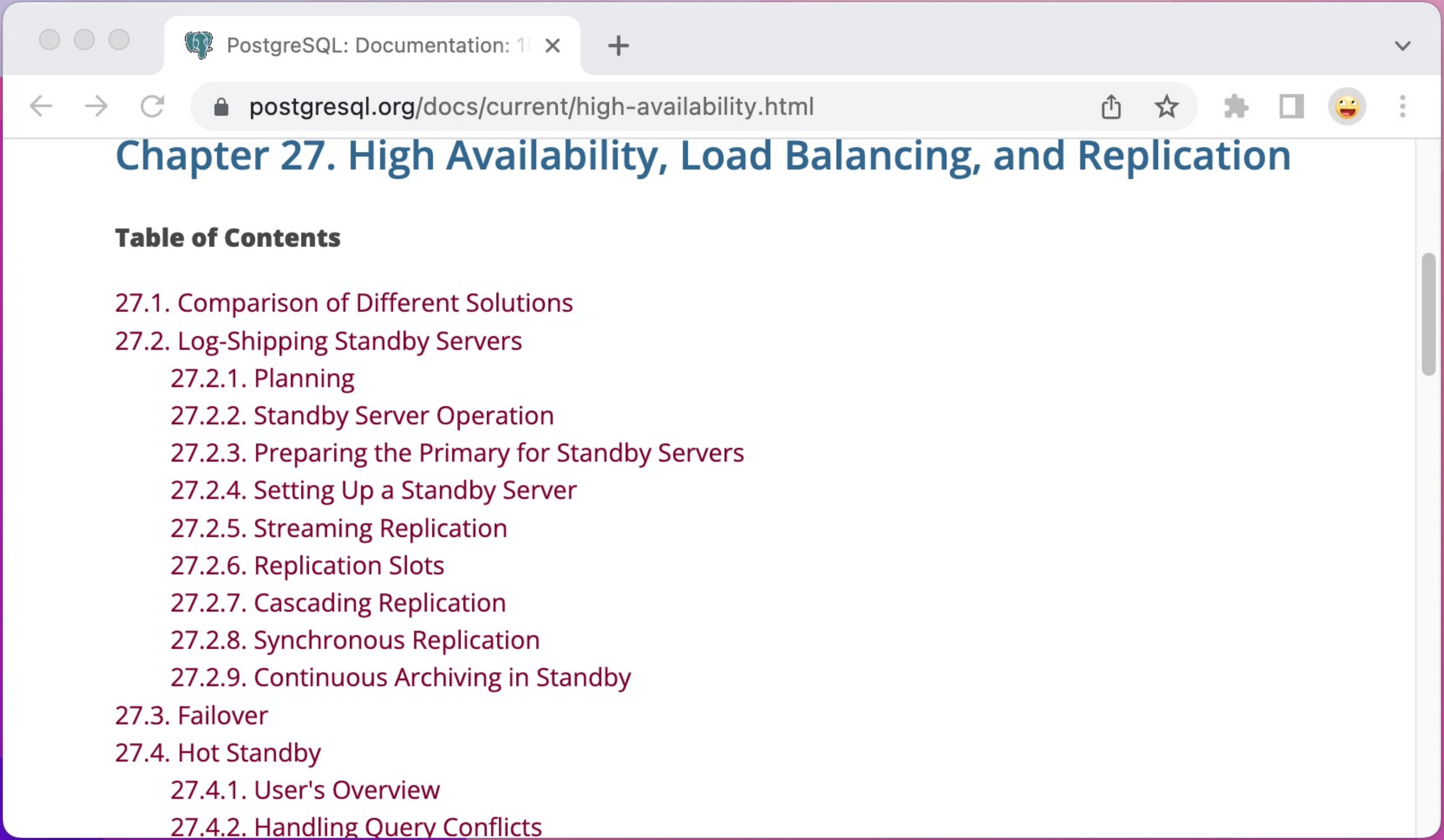
Dat
arabic_dictionary_research 1
arabic_dictionary_research 1 (2)
select word,length(crossreferences),notes f
Data filter is not supported
Grid
Text
Value
Panels
Refresh
Save
Cancel
Export data
200
1

	word	length	notes
1	100گ	2,700	notes

Value: 100گ

1 row(s) fetched

Photo by Kanashi on Unsplash

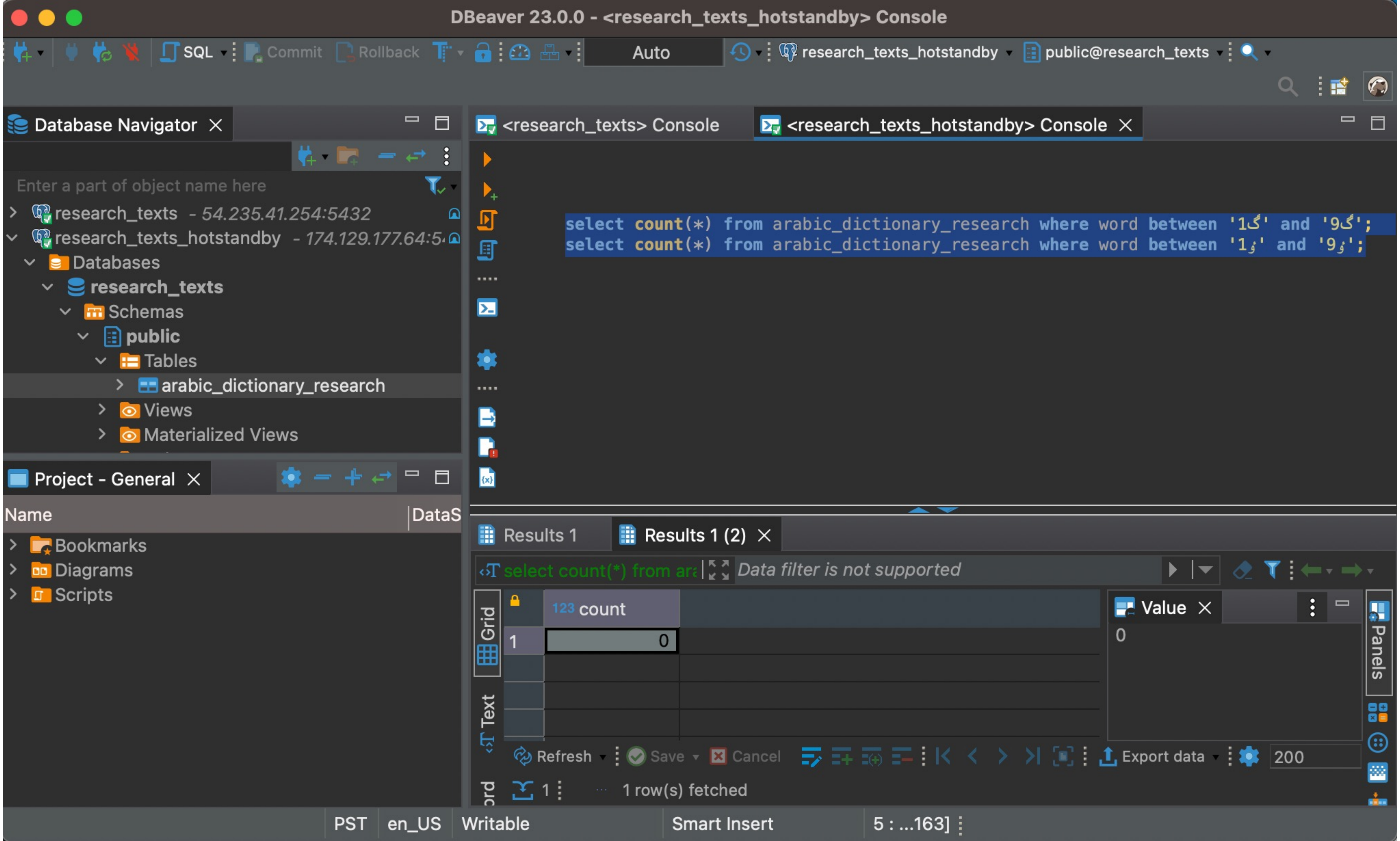

PostgreSQL: Documentation: 1
postgresql.org/docs/current/high-availability.html

Chapter 27. High Availability, Load Balancing, and Replication

Table of Contents

```
aws ec2 run-instances
  --instance-type t2.micro   --key-name mac   --tag-specifications
   'ResourceType=instance,Tags=[{Key=Name,Value=research-db-hotstandby}]'
  --image-id ami-0fd2c44049dd805b8            --region us-east-1


sudo apt install postgresql-common
sudo sh /usr/share/postgresql-common/pgdg/apt.postgresql.org.sh
sudo apt install postgresql-15

# cut and paste instructions from
#      https://ubuntu.com/server/docs/databases-postgresql
#                         to easily set up the hot standby database
```

Photo by Aditya



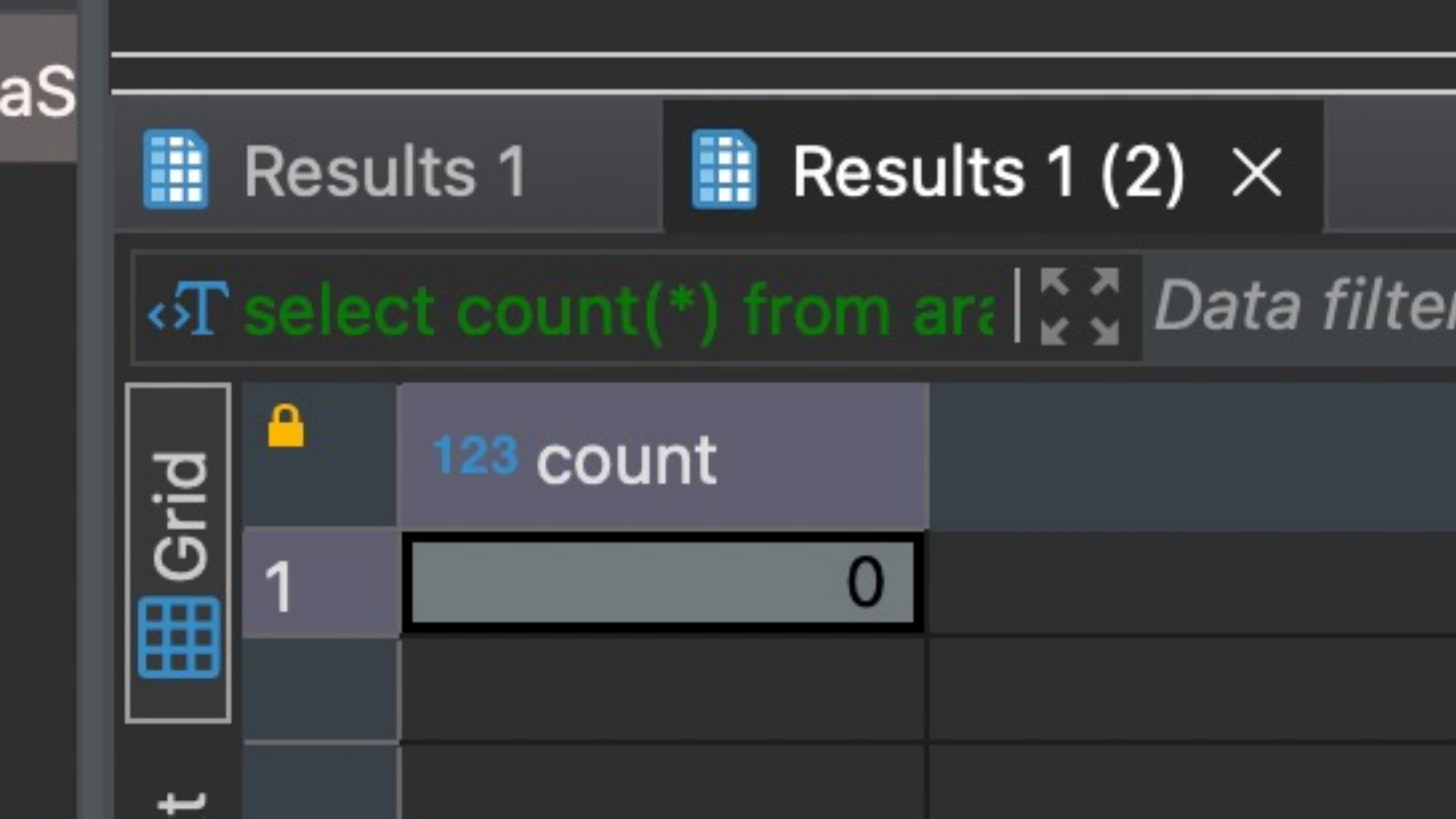
```
select count(*) from arabic_dictionary_research where word between '1گ' and '9گ';
select count(*) from arabic_dictionary_research where word between '1ۋ' and '9ۋ';
```

```
select count(*) from ar
```

	count
1	0

Value: 0

1 row(s) fetched



```
select count(*) from ara
```

	123 count
1	0

ORIGINAL MOTION PICTURE SOUNDTRACK
DREAMWORKS
PUSS IN BOOTS
THE LAST WISH
Score by Heitor Pereira

Checklist for Responding to Data Corruption

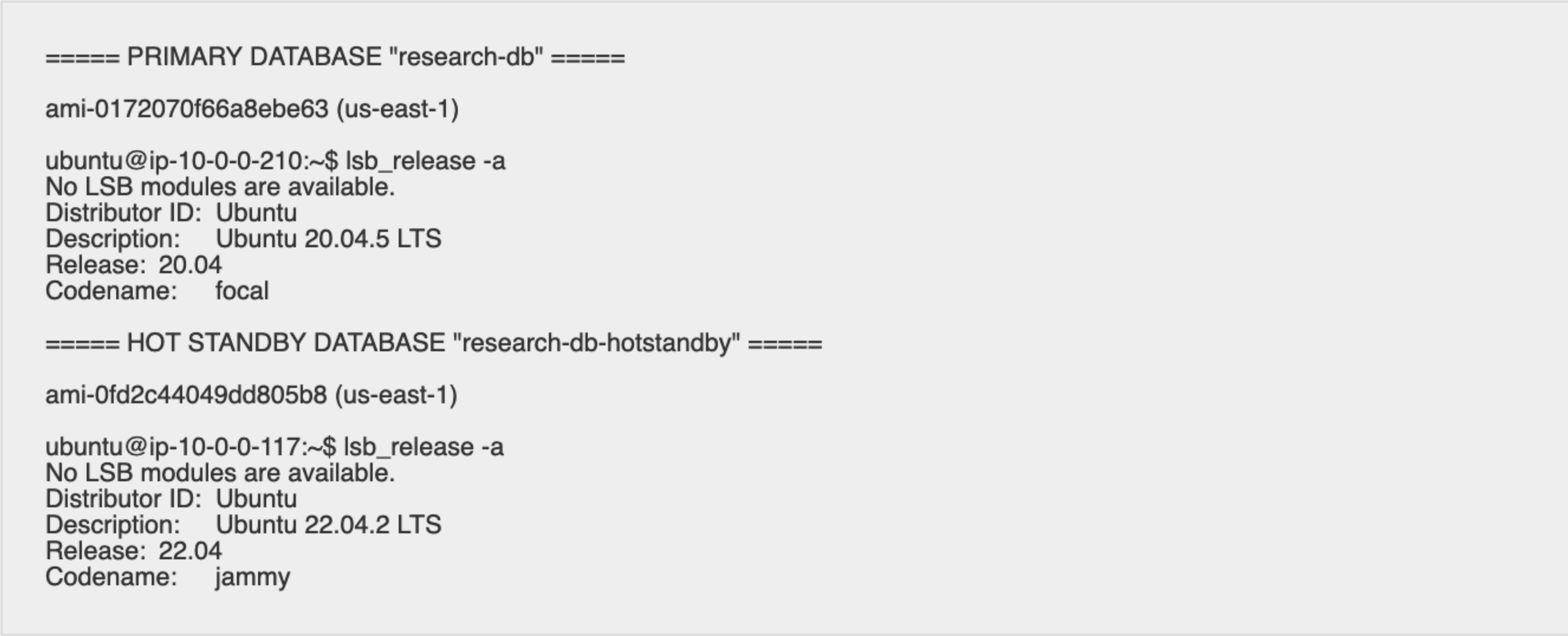
https://ardentperf.com/2019/11/08/postgresql-invalid-page-and-checksum-verification-failed/

- Verify Backup and Log File Retention (long enough for investigation)
- Articulate and Write the Business Impact at Present
- Freeze Ongoing Changes (any dev teams)
- Inventory Copies of Data
- Safely Scan to Determine If There's More Corruption
- Follow General Best Practices
  - Two-person rule, rename/move not delete, verify/compare healthy neighboring data, test remediations before applying on prod, document everything.

Did Postgres Lose My Data?

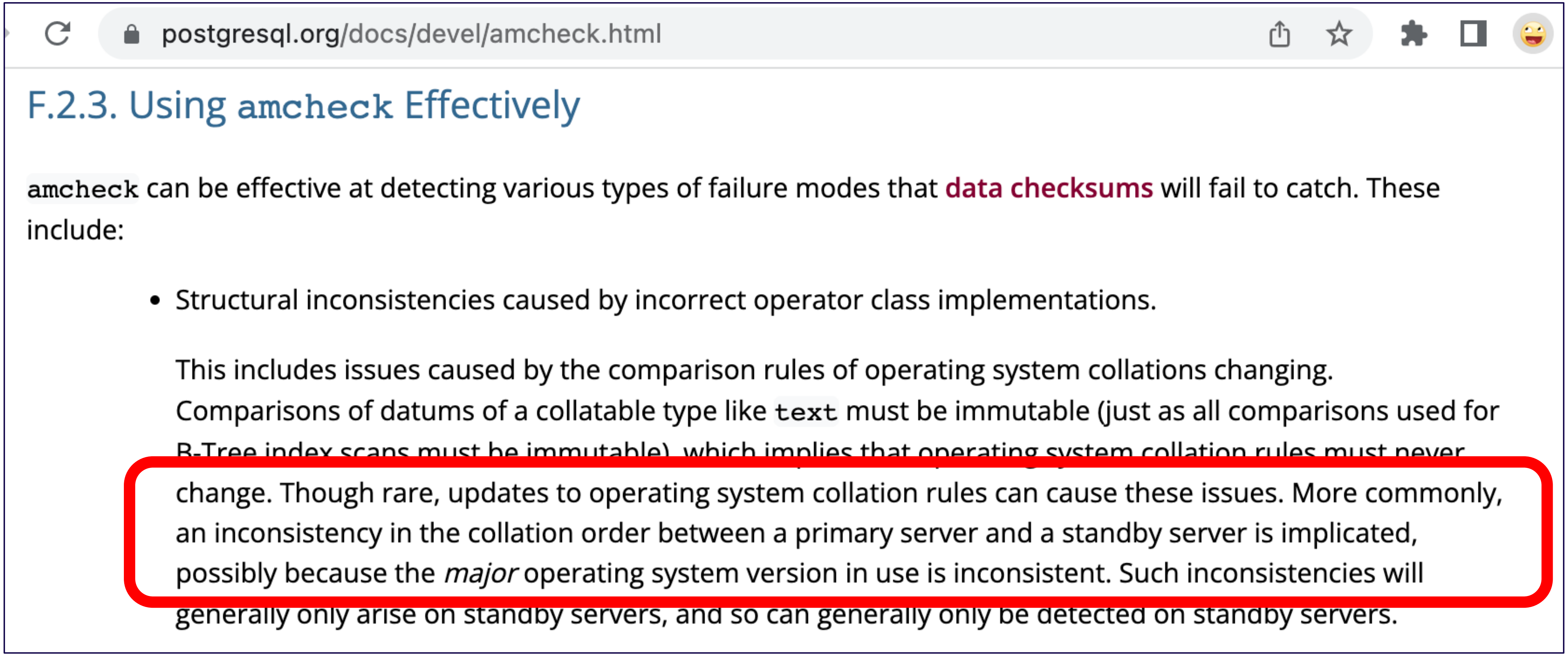
Diagnosis

So what happened? The root cause was the operating system we used for the hot standby.



```
===== PRIMARY DATABASE "research-db" =====

ami-0172070f66a8ebe63 (us-east-1)

ubuntu@ip-10-0-0-210:~$ lsb_release -a
No LSB modules are available.
Distributor ID:  Ubuntu
Description:     Ubuntu 20.04.5 LTS
Release:  20.04
Codename:     focal

===== HOT STANDBY DATABASE "research-db-hotstandby" =====

ami-0fd2c44049dd805b8 (us-east-1)

ubuntu@ip-10-0-0-117:~$ lsb_release -a
No LSB modules are available.
Distributor ID:  Ubuntu
Description:     Ubuntu 22.04.2 LTS
Release:  22.04
Codename:     jammy
```

Diagnosis



F.2.3. Using `amcheck` Effectively

`amcheck` can be effective at detecting various types of failure modes that **data checksums** will fail to catch. These include:

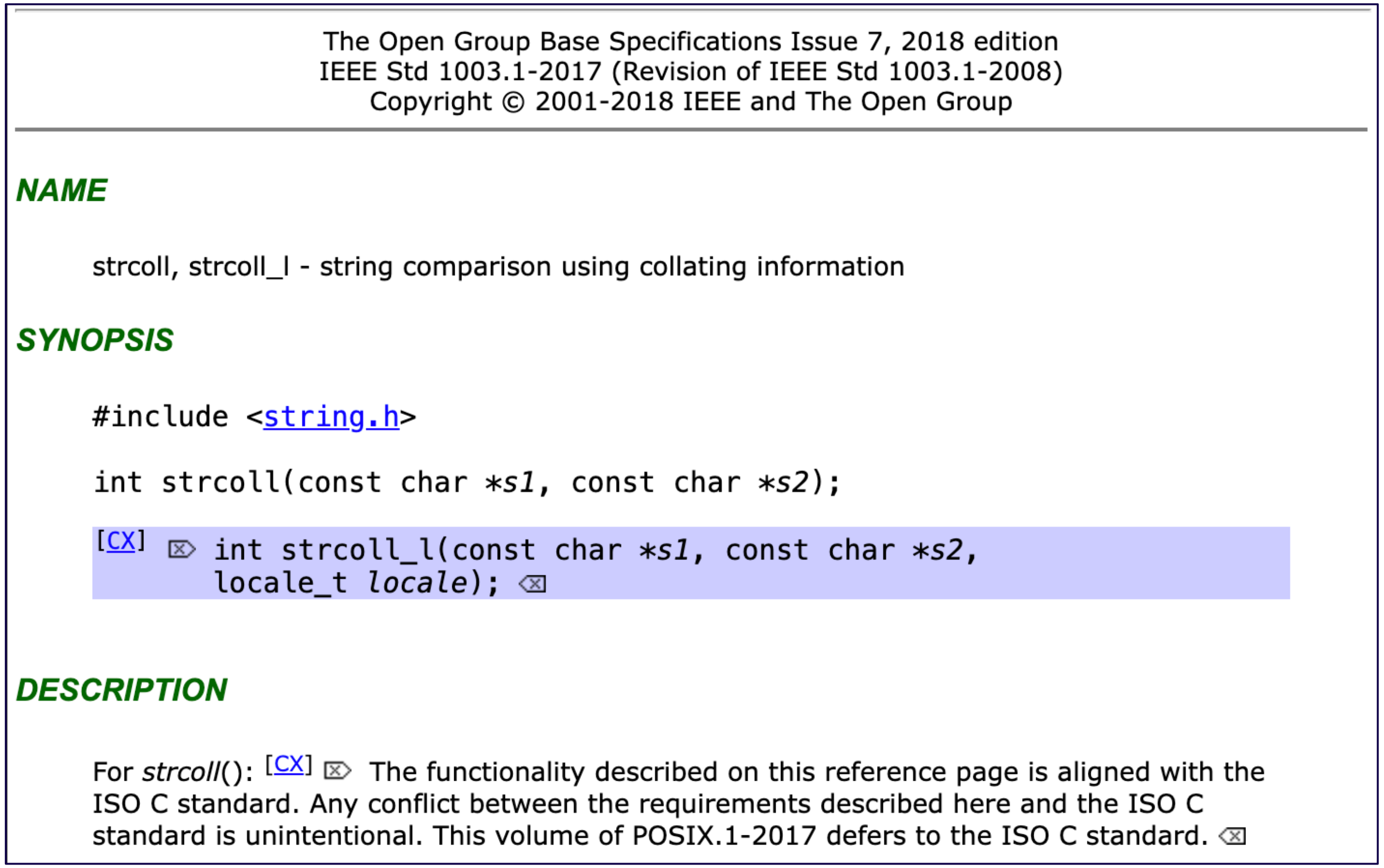
- Structural inconsistencies caused by incorrect operator class implementations.

  This includes issues caused by the comparison rules of operating system collations changing. Comparisons of datums of a collatable type like `text` must be immutable (just as all comparisons used for B-Tree index scans must be immutable), which implies that operating system collation rules must never change. Though rare, updates to operating system collation rules can cause these issues. More commonly, an inconsistency in the collation order between a primary server and a standby server is implicated, possibly because the *major* operating system version in use is inconsistent. Such inconsistencies will generally only arise on standby servers, and so can generally only be detected on standby servers.

“PostgreSQL does not include its own string comparison code. It calls external libraries, which were installed & managed separately.

- Operating System
- Unicode ICU Library

The Backstory, Part 1



The Open Group Base Specifications Issue 7, 2018 edition
IEEE Std 1003.1-2017 (Revision of IEEE Std 1003.1-2008)
Copyright © 2001-2018 IEEE and The Open Group

NAME

strcoll, strcoll_l - string comparison using collating information

SYNOPSIS

```
#include <string.h>

int strcoll(const char *s1, const char *s2);

[CX] ⌦ int strcoll_l(const char *s1, const char *s2,
       locale_t locale); ⌫
```

DESCRIPTION

For *strcoll*(): [CX] ⌦ The functionality described on this reference page is aligned with the ISO C standard. Any conflict between the requirements described here and the ISO C standard is unintentional. This volume of POSIX.1-2017 defers to the ISO C standard. ⌫

The Backstory, Part 2 – Six Years Ago

Widespread encounters:

- Queries giving incorrect results
  data appears to be lost
- Inserting records with duplicate primary keys
  unique constraints not enforced correctly
- Mysterious crashes
  in one case during WAL replay, preventing a DB from doing crash recovery

Caused by **changes in sort order**

23 Things I Completely Got Wrong

about putting words in order

during 7 years working with Postgres

INCORRECT

1. Putting words in order is simple

compare each character
from beginning to end (memcmp)

Image by Simon from Pixabay

Putting Words In Order

```
select *
from (values      ('Baptisto')
      ,           ('banqueta')
      ,           ('baño')
      ,           ('como')
      ,           ('chorizo')
      ) list(word)
order by word;
```

Putting Words In Order

baño
banqueta
Baptisto
chorizo
como

banqueta
baño
Baptisto
como
chorizo

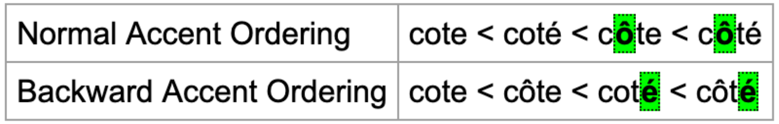
Baptisto
banqueta
baño
chorizo
como

```
select * from (values('Baptisto'),('banqueta'),('baño'),('como'),('chorizo’)) list(word) order by word;
```

Linguistic Collation is Complex

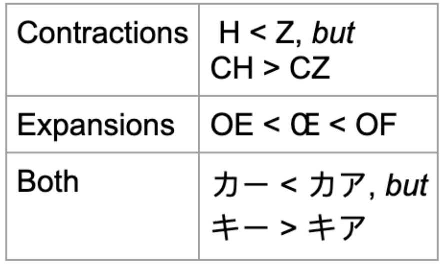
- **Contractions**: two (or more) characters sort as if they were a single base letter. In *Table 4*, *CH* acts like a single letter sorted after *C*.
- **Expansions**: a single character sorts as if it were a sequence of two (or more) characters. In *Table 4*, an *Œ* ligature sorts as if it were the sequence of *O* + *E*.
- **Backwards Accent**: In row 1 of *Table 5*, the first accent difference is on the *o*, so that is what determines the order. In some French dictionary ordering traditions, however, it is the *last* accent difference that determines the order, as shown in row 2.

Table 5. Backward Accent Ordering



Normal Accent Ordering	cote < coté < côte < côté
Backward Accent Ordering	cote < côte < coté < côté

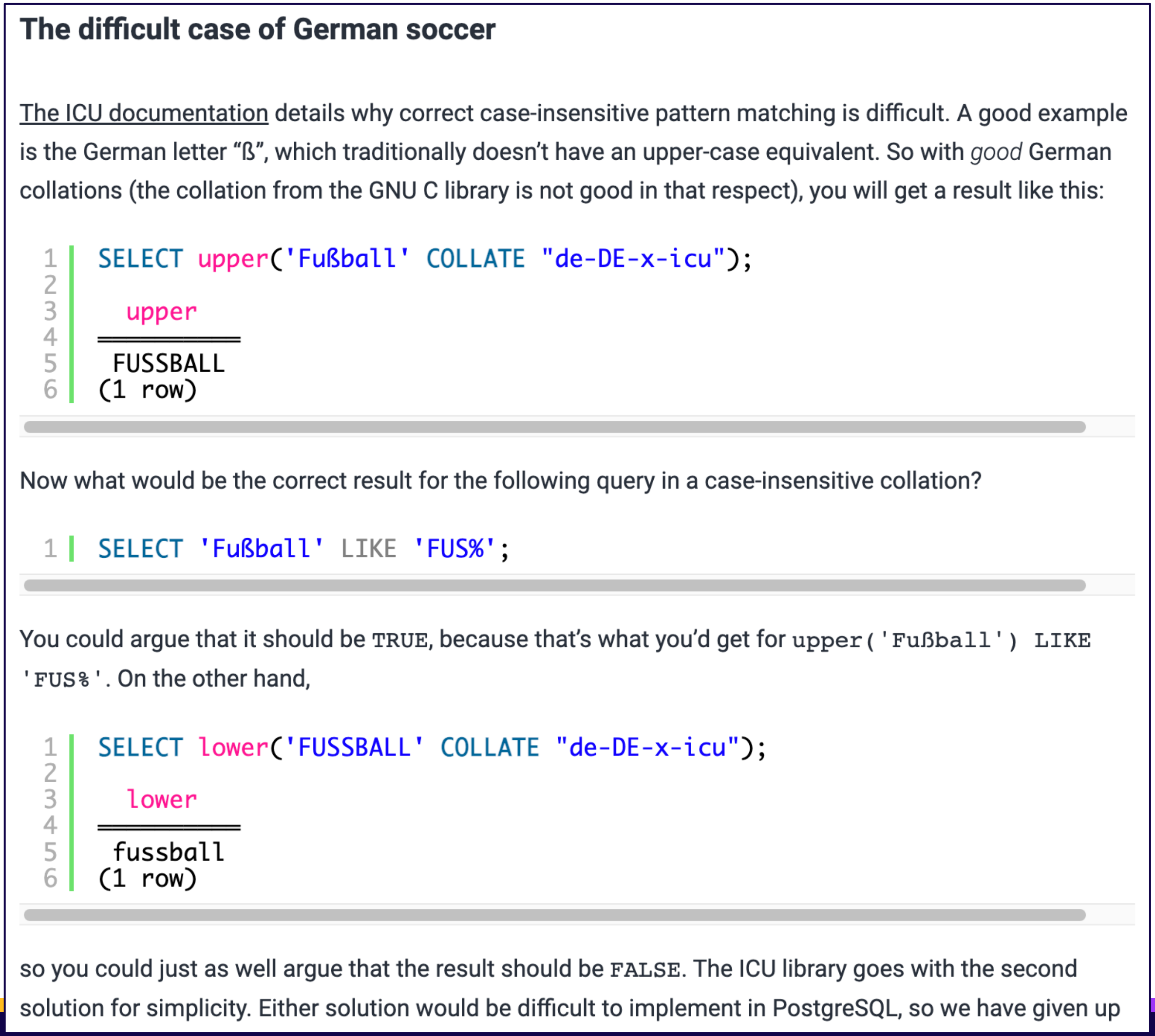
Table 4. Context Sensitivity



Contractions	H < Z, *but* CH > CZ
Expansions	OE < Œ < OF
Both	カー < カア, *but* キー > キア

https://www.unicode.org/reports/tr10/

https://www.cybertec-postgresql.com/en/case-insensitive-pattern-matching-in-postgresql/



The difficult case of German soccer

The ICU documentation details why correct case-insensitive pattern matching is difficult. A good example is the German letter "ß", which traditionally doesn't have an upper-case equivalent. So with *good* German collations (the collation from the GNU C library is not good in that respect), you will get a result like this:

```
SELECT upper('Fußball' COLLATE "de-DE-x-icu");

  upper
══════════
 FUSSBALL
(1 row)
```

Now what would be the correct result for the following query in a case-insensitive collation?

```
SELECT 'Fußball' LIKE 'FUS%';
```

You could argue that it should be `TRUE`, because that's what you'd get for `upper('Fußball') LIKE 'FUS%'`. On the other hand,

```
SELECT lower('FUSSBALL' COLLATE "de-DE-x-icu");

  lower
══════════
 fussball
(1 row)
```

so you could just as well argue that the result should be `FALSE`. The ICU library goes with the second solution for simplicity. Either solution would be difficult to implement in PostgreSQL, so we have given up

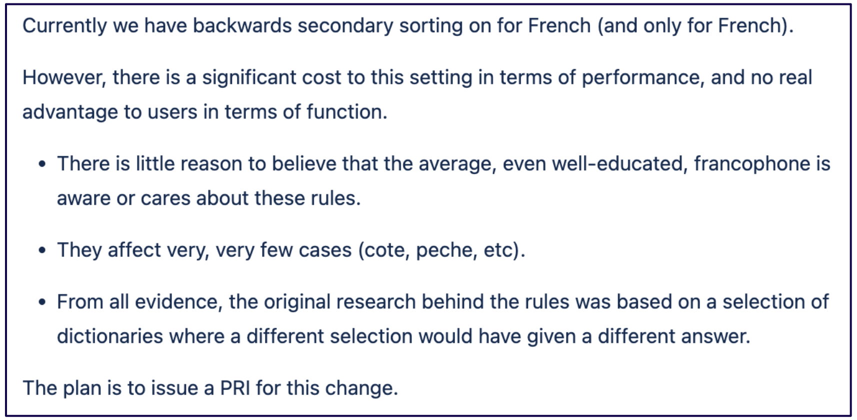
INCORRECT

2. The way computers and people put words in order doesn't change

Must be a mistake by maintainers of the external library?

“Correct” Ordering Does Change

French (2010)
https://unicode-org.atlassian.net/browse/CLDR-2905

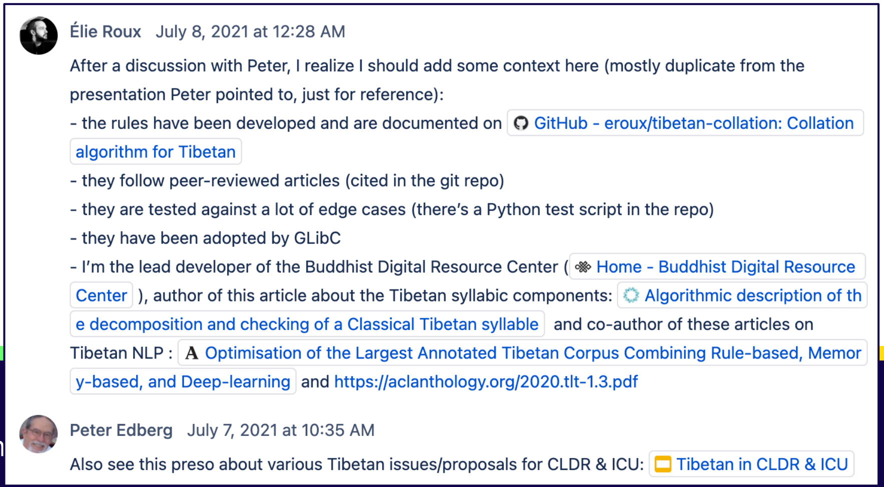

Currently we have backwards secondary sorting on for French (and only for French).

However, there is a significant cost to this setting in terms of performance, and no real advantage to users in terms of function.

- There is little reason to believe that the average, even well-educated, francophone is aware or cares about these rules.
- They affect very, very few cases (cote, peche, etc).
- From all evidence, the original research behind the rules was based on a selection of dictionaries where a different selection would have given a different answer.

The plan is to issue a PRI for this change.

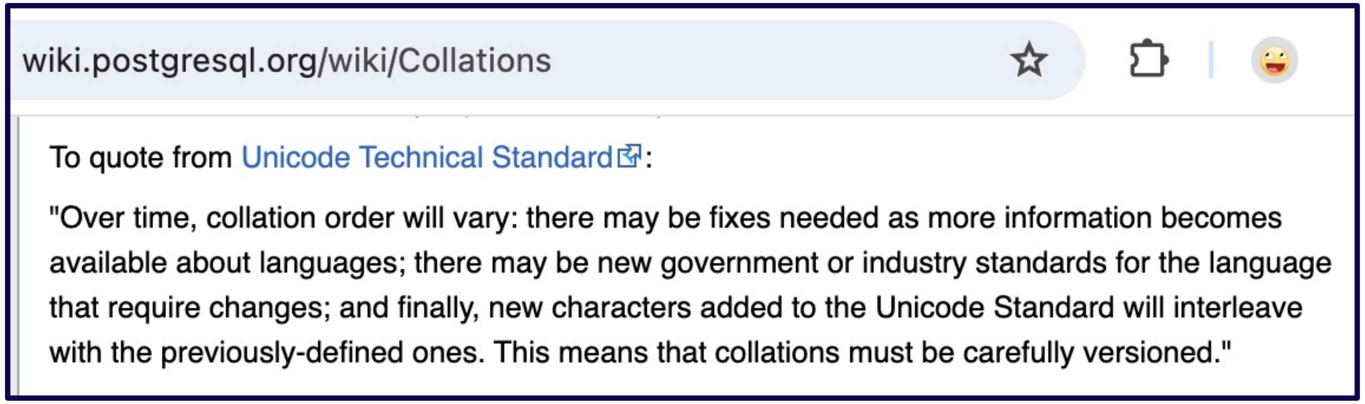
Tibetan (2021)
https://unicode-org.atlassian.net/browse/CLDR-9895


Élie Roux July 8, 2021 at 12:28 AM

After a discussion with Peter, I realize I should add some context here (mostly duplicate from the presentation Peter pointed to, just for reference):
- the rules have been developed and are documented on GitHub - eroux/tibetan-collation: Collation algorithm for Tibetan
- they follow peer-reviewed articles (cited in the git repo)
- they are tested against a lot of edge cases (there’s a Python test script in the repo)
- they have been adopted by GLibC
- I’m the lead developer of the Buddhist Digital Resource Center (Home - Buddhist Digital Resource Center), author of this article about the Tibetan syllabic components: Algorithmic description of the decomposition and checking of a Classical Tibetan syllable and co-author of these articles on Tibetan NLP : Optimisation of the Largest Annotated Tibetan Corpus Combining Rule-based, Memory-based, and Deep-learning and https://aclanthology.org/2020.tlt-1.3.pdf

Peter Edberg July 7, 2021 at 10:35 AM

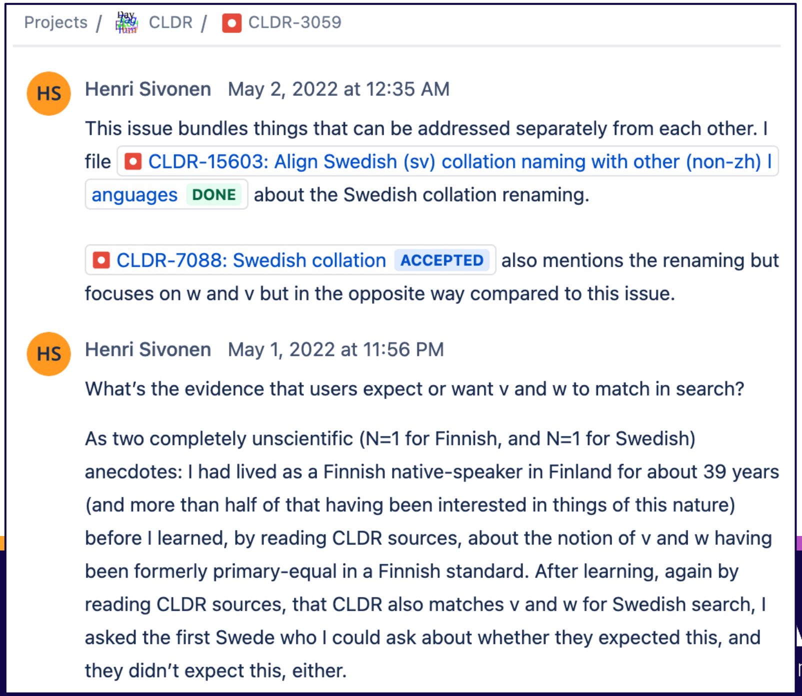
Also see this preso about various Tibetan issues/proposals for CLDR & ICU: Tibetan in CLDR & ICU



To quote from Unicode Technical Standard:

"Over time, collation order will vary: there may be fixes needed as more information becomes available about languages; there may be new government or industry standards for the language that require changes; and finally, new characters added to the Unicode Standard will interleave with the previously-defined ones. This means that collations must be carefully versioned."

Swedish (2022)
https://unicode-org.atlassian.net/browse/CLDR-3059



HS Henri Sivonen May 2, 2022 at 12:35 AM

This issue bundles things that can be addressed separately from each other. I file CLDR-15603: Align Swedish (sv) collation naming with other (non-zh) languages DONE about the Swedish collation renaming.

CLDR-7088: Swedish collation ACCEPTED also mentions the renaming but focuses on w and v but in the opposite way compared to this issue.

HS Henri Sivonen May 1, 2022 at 11:56 PM

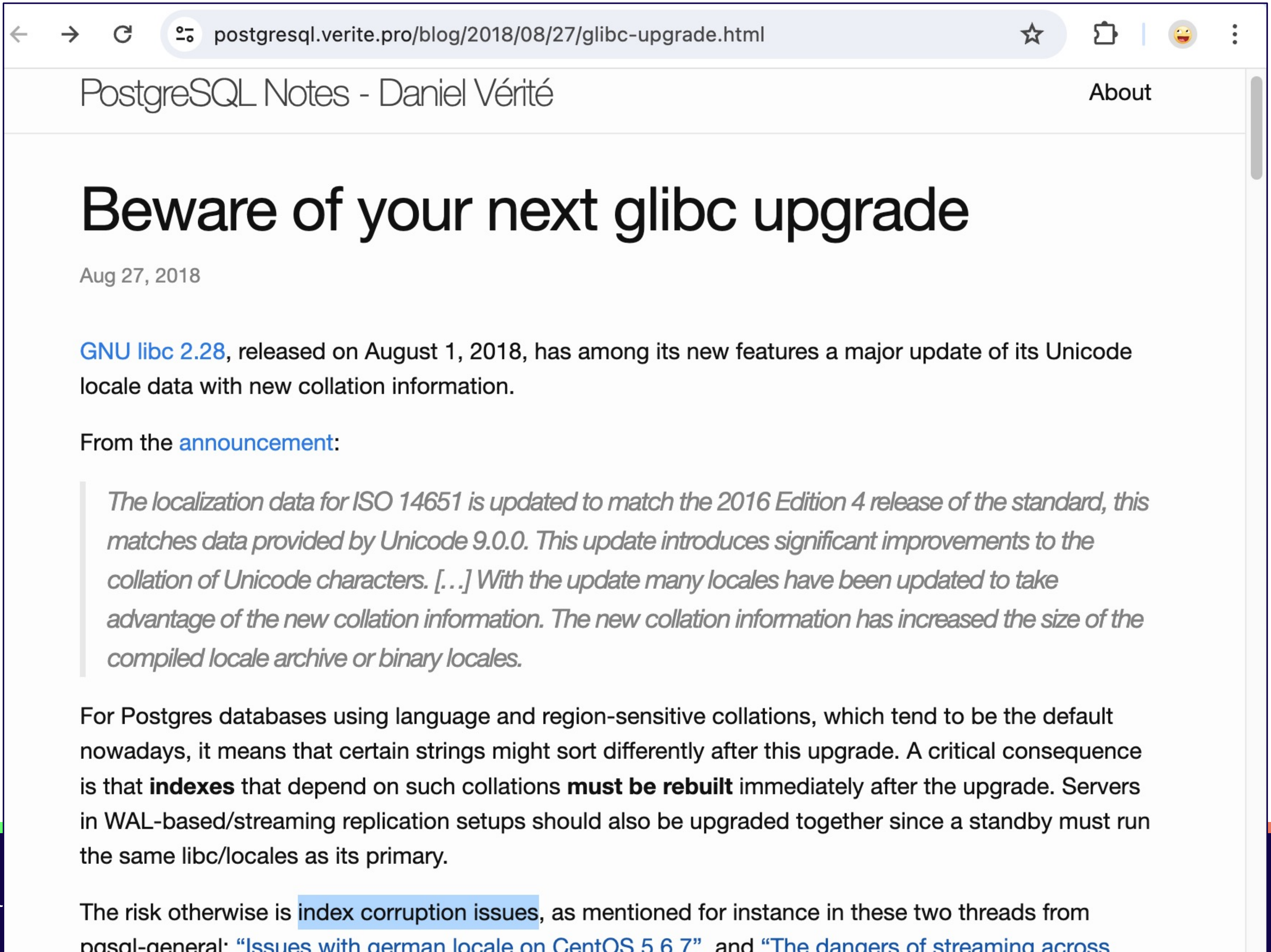
What’s the evidence that users expect or want v and w to match in search?

As two completely unscientific (N=1 for Finnish, and N=1 for Swedish) anecdotes: I had lived as a Finnish native-speaker in Finland for about 39 years (and more than half of that having been interested in things of this nature) before I learned, by reading CLDR sources, about the notion of v and w having been formerly primary-equal in a Finnish standard. After learning, again by reading CLDR sources, that CLDR also matches v and w for Swedish search, I asked the first Swede who I could ask about whether they expected this, and they didn’t expect this, either.

INCORRECT

3. Changing sort order is rare

Rare Large Change Got Everyone's Attention



PostgreSQL Notes - Daniel Vérité

About

Beware of your next glibc upgrade

Aug 27, 2018

GNU libc 2.28, released on August 1, 2018, has among its new features a major update of its Unicode locale data with new collation information.

From the announcement:

> *The localization data for ISO 14651 is updated to match the 2016 Edition 4 release of the standard, this matches data provided by Unicode 9.0.0. This update introduces significant improvements to the collation of Unicode characters. […] With the update many locales have been updated to take advantage of the new collation information. The new collation information has increased the size of the compiled locale archive or binary locales.*

For Postgres databases using language and region-sensitive collations, which tend to be the default nowadays, it means that certain strings might sort differently after this upgrade. A critical consequence is that **indexes** that depend on such collations **must be rebuilt** immediately after the upgrade. Servers in WAL-based/streaming replication setups should also be upgraded together since a standby must run the same libc/locales as its primary.

The risk otherwise is index corruption issues, as mentioned for instance in these two threads from pgsql-general: "Issues with german locale on CentOS 5,6,7", and "The dangers of streaming across

2018

Rare Large Change Got Everyone’s Attention

DANGER: glibc 2.28 has a scary and major collation change

Even pure ASCII strings change sort order!

- Debian 10 (buster)
- Ubuntu 18.04
- RHEL 8
- SLE15 Service Pack 3

https://wiki.postgresql.org/wiki/Locale_data_changes

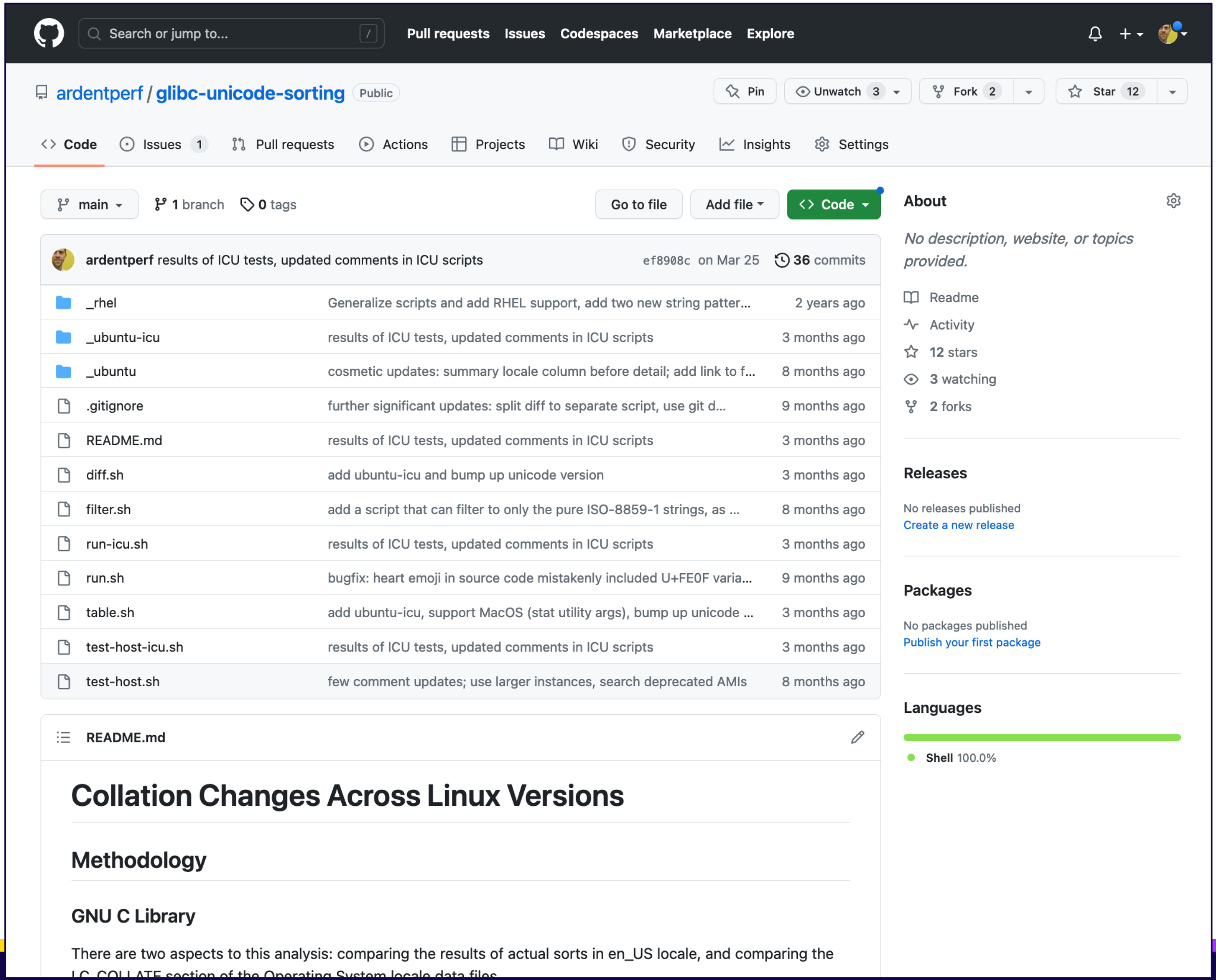
Collation Torture Test

Data to answer the questions:

Is this really a problem?

How common are sort order changes?

- 10 years of historical versions
- Ubuntu and RHEL
- All assigned code points



ardentperf results of ICU tests, updated comments in ICU scripts ef8908c on Mar 25 36 commits

_rhel	Generalize scripts and add RHEL support, add two new string patter...	2 years ago
_ubuntu-icu	results of ICU tests, updated comments in ICU scripts	3 months ago
_ubuntu	cosmetic updates: summary locale column before detail; add link to f...	8 months ago
.gitignore	further significant updates: split diff to separate script, use git d...	9 months ago
README.md	results of ICU tests, updated comments in ICU scripts	3 months ago
diff.sh	add ubuntu-icu and bump up unicode version	3 months ago
filter.sh	add a script that can filter to only the pure ISO-8859-1 strings, as ...	8 months ago
run-icu.sh	results of ICU tests, updated comments in ICU scripts	3 months ago
run.sh	bugfix: heart emoji in source code mistakenly included U+FE0F varia...	9 months ago
table.sh	add ubuntu-icu, support MacOS (stat utility args), bump up unicode ...	3 months ago
test-host-icu.sh	results of ICU tests, updated comments in ICU scripts	3 months ago
test-host.sh	few comment updates; use larger instances, search deprecated AMIs	8 months ago

No description, website, or topics provided.

No releases published

No packages published

README.md

Collation Changes Across Linux Versions

Methodology

GNU C Library

There are two aspects to this analysis: comparing the results of actual sorts in en_US locale, and comparing the LC_COLLATE section of the Operating System locale data files

286,654 × 91 = 26 million

286,654 unicode code points

×

91 string patterns

=

26 million strings

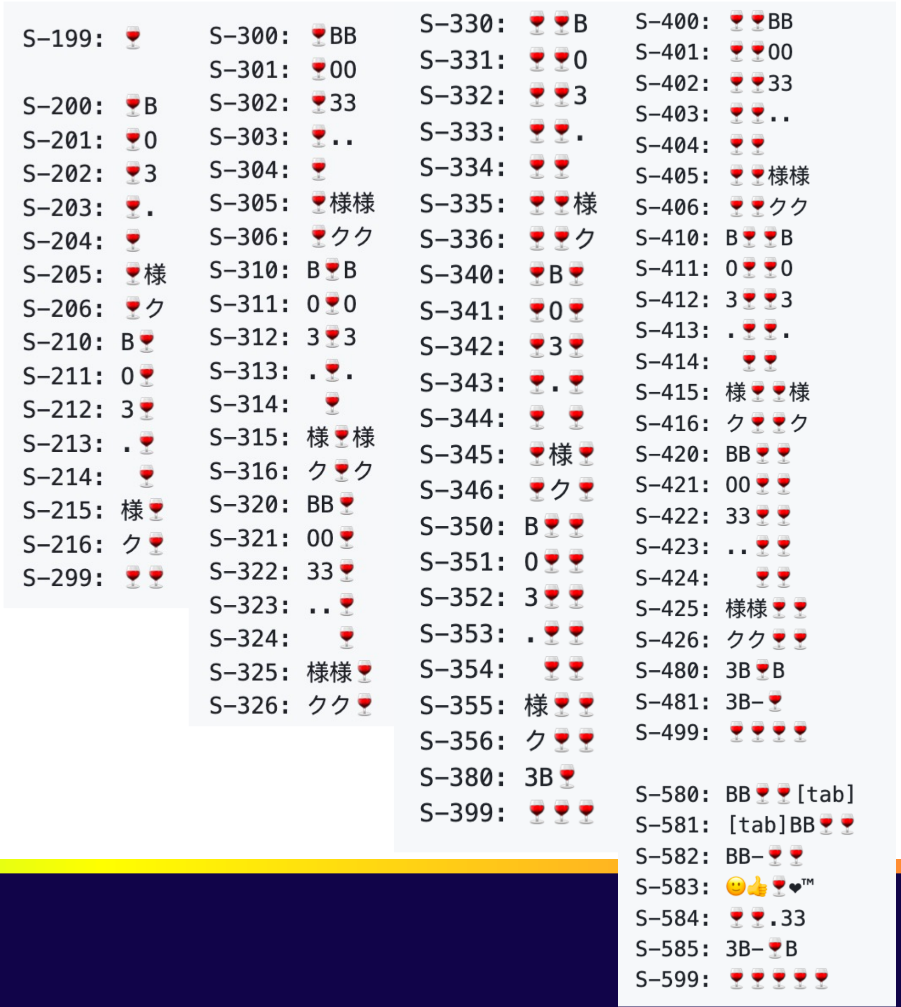
⬛ U+2B1B	😂 U+1F602	֊ U+058A	ב U+05D1	ﾟ U+FF9F	ঠ U+09A0
ڡ U+06A1	リ U+30EA	🍟 U+1F35F	｢ U+FF62	⬆ U+2B06	ό U+03CC

Everyone in the world should be able to use their own language on phones and computers.

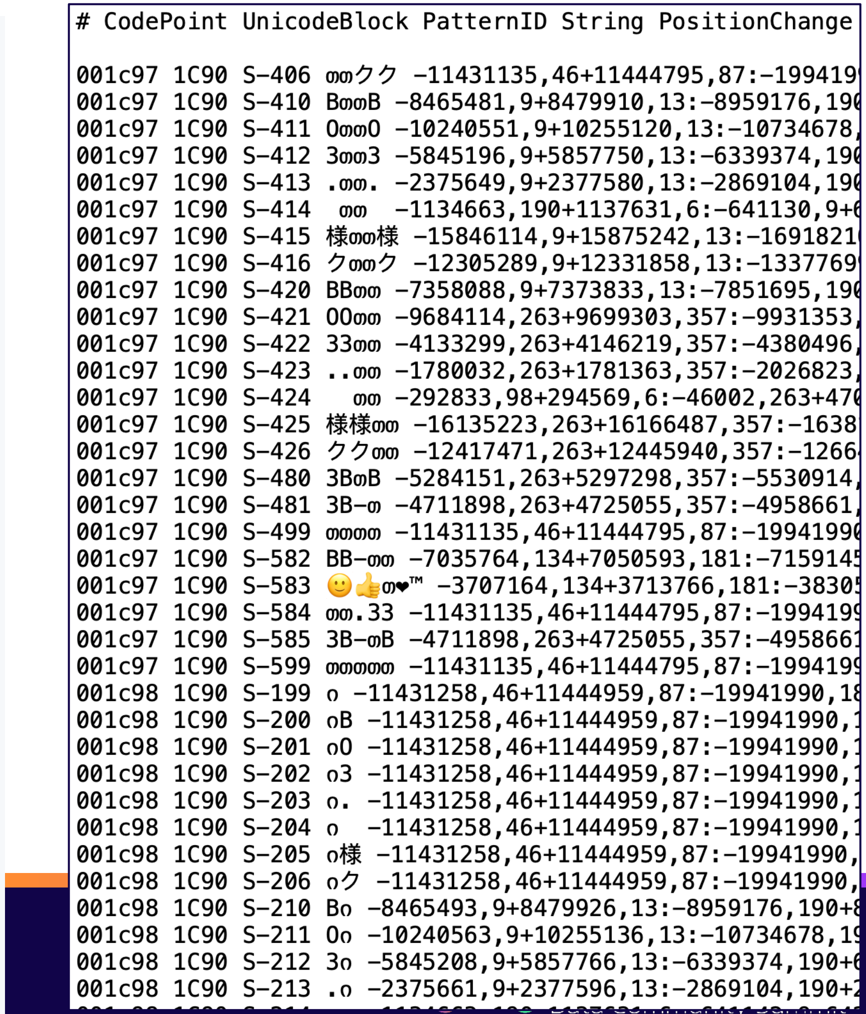
LEARN MORE ABOUT UNICODE

ADOPT A CHARACTER

ಥ U+0CA5	″ U+2033	ដ U+178A	ق U+0642	٩ U+0669	༏ U+0F0F
ҹ U+04B9	〜 U+301C	⁾ U+207E	Ｔ U+FF34	ᐛ U+141B	ツ U+30C4



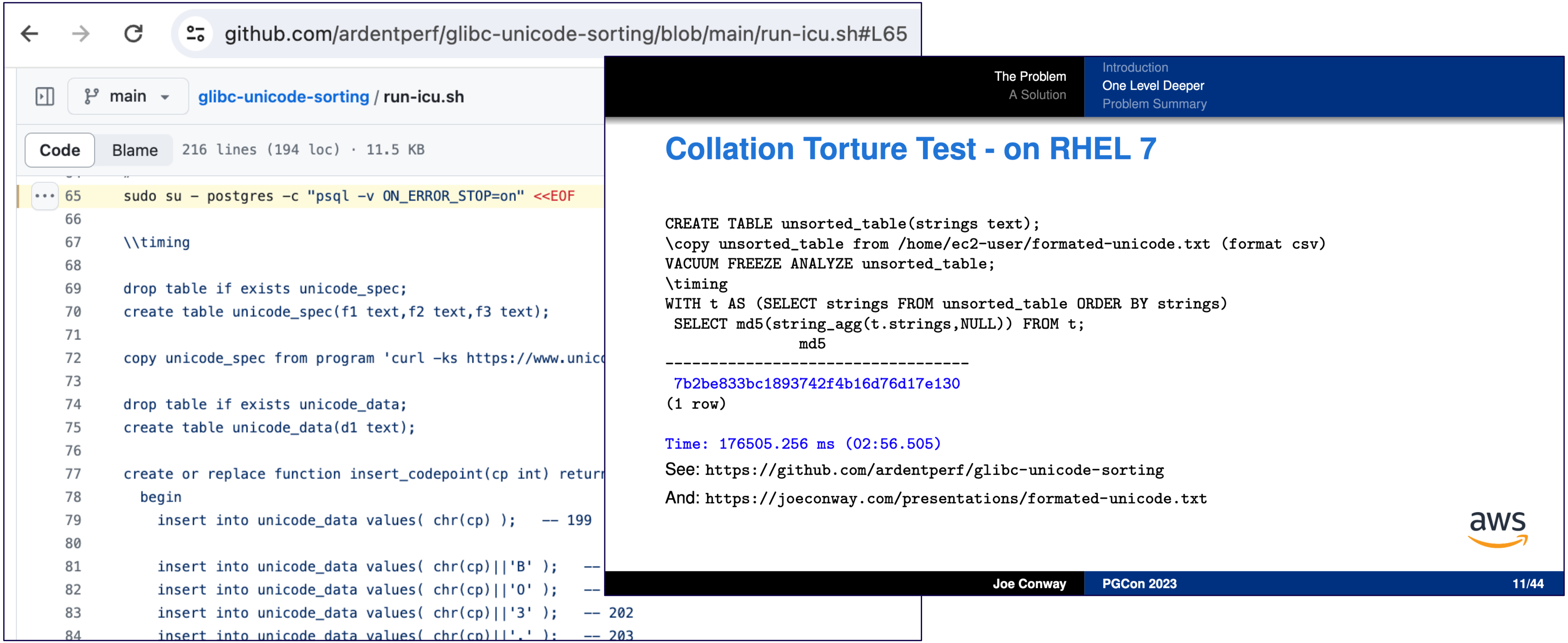
```
S-199: 🍷

S-200: 🍷B
S-201: 🍷0
S-202: 🍷3
S-203: 🍷.
S-204: 🍷
S-205: 🍷様
S-206: 🍷ク
S-210: B🍷
S-211: 0🍷
S-212: 3🍷
S-213: .🍷
S-214:  🍷
S-215: 様🍷
S-216: ク🍷
S-299: 🍷🍷

S-300: 🍷BB
S-301: 🍷00
S-302: 🍷33
S-303: 🍷..
S-304: 🍷
S-305: 🍷様様
S-306: 🍷クク
S-310: B🍷B
S-311: 0🍷0
S-312: 3🍷3
S-313: .🍷.
S-314:  🍷
S-315: 様🍷様
S-316: ク🍷ク
S-320: BB🍷
S-321: 00🍷
S-322: 33🍷
S-323: ..🍷
S-324:   🍷
S-325: 様様🍷
S-326: クク🍷

S-330: 🍷🍷B
S-331: 🍷🍷0
S-332: 🍷🍷3
S-333: 🍷🍷.
S-334: 🍷🍷
S-335: 🍷🍷様
S-336: 🍷🍷ク
S-340: 🍷B🍷
S-341: 🍷0🍷
S-342: 🍷3🍷
S-343: 🍷.🍷
S-344: 🍷 🍷
S-345: 🍷様🍷
S-346: 🍷ク🍷
S-350: B🍷🍷
S-351: 0🍷🍷
S-352: 3🍷🍷
S-353: .🍷🍷
S-354:  🍷🍷
S-355: 様🍷🍷
S-356: ク🍷🍷
S-380: 3B🍷
S-399: 🍷🍷🍷

S-400: 🍷🍷BB
S-401: 🍷🍷00
S-402: 🍷🍷33
S-403: 🍷🍷..
S-404: 🍷🍷
S-405: 🍷🍷様様
S-406: 🍷🍷クク
S-410: B🍷🍷B
S-411: 0🍷🍷0
S-412: 3🍷🍷3
S-413: .🍷🍷.
S-414:  🍷🍷
S-415: 様🍷🍷様
S-416: ク🍷🍷ク
S-420: BB🍷🍷
S-421: 00🍷🍷
S-422: 33🍷🍷
S-423: ..🍷🍷
S-424:   🍷🍷
S-425: 様様🍷🍷
S-426: クク🍷🍷
S-480: 3B🍷B
S-481: 3B-🍷
S-499: 🍷🍷🍷🍷

S-580: BB🍷🍷[tab]
S-581: [tab]BB🍷🍷
S-582: BB-🍷🍷
S-583: 🙂👍🍷❤™
S-584: 🍷🍷.33
S-585: 3B-🍷B
S-599: 🍷🍷🍷🍷🍷
```



```
# CodePoint UnicodeBlock PatternID String PositionChange

001c97 1C90 S-406 ᲗᲗクク -11431135,46+11444795,87:-199419
001c97 1C90 S-410 BᲗᲗB -8465481,9+8479910,13:-8959176,190
001c97 1C90 S-411 0ᲗᲗ0 -10240551,9+10255120,13:-10734678,
001c97 1C90 S-412 3ᲗᲗ3 -5845196,9+5857750,13:-6339374,190
001c97 1C90 S-413 .ᲗᲗ. -2375649,9+2377580,13:-2869104,190
001c97 1C90 S-414  ᲗᲗ  -1134663,190+1137631,6:-641130,9+6
001c97 1C90 S-415 様ᲗᲗ様 -15846114,9+15875242,13:-1691821
001c97 1C90 S-416 クᲗᲗク -12305289,9+12331858,13:-1337769
001c97 1C90 S-420 BBᲗᲗ -7358088,9+7373833,13:-7851695,190
001c97 1C90 S-421 00ᲗᲗ -9684114,263+9699303,357:-9931353,
001c97 1C90 S-422 33ᲗᲗ -4133299,263+4146219,357:-4380496,
001c97 1C90 S-423 ..ᲗᲗ -1780032,263+1781363,357:-2026823,
001c97 1C90 S-424   ᲗᲗ -292833,98+294569,6:-46002,263+47
001c97 1C90 S-425 様様ᲗᲗ -16135223,263+16166487,357:-1638
001c97 1C90 S-426 ククᲗᲗ -12417471,263+12445940,357:-1266
001c97 1C90 S-480 3BᲗB -5284151,263+5297298,357:-5530914,
001c97 1C90 S-481 3B-Თ -4711898,263+4725055,357:-4958661,
001c97 1C90 S-499 ᲗᲗᲗᲗ -11431135,46+11444795,87:-1994199
001c97 1C90 S-582 BB-ᲗᲗ -7035764,134+7050593,181:-7159145
001c97 1C90 S-583 🙂👍Თ❤™ -3707164,134+3713766,181:-38305
001c97 1C90 S-584 ᲗᲗ.33 -11431135,46+11444795,87:-1994199
001c97 1C90 S-585 3B-ᲗB -4711898,263+4725055,357:-4958661
001c97 1C90 S-599 ᲗᲗᲗᲗᲗ -11431135,46+11444795,87:-1994199
001c98 1C90 S-199 Ი -11431258,46+11444959,87:-19941990,18
001c98 1C90 S-200 ᲘB -11431258,46+11444959,87:-19941990,1
001c98 1C90 S-201 Ი0 -11431258,46+11444959,87:-19941990,1
001c98 1C90 S-202 Ი3 -11431258,46+11444959,87:-19941990,1
001c98 1C90 S-203 Ი. -11431258,46+11444959,87:-19941990,1
001c98 1C90 S-204 Ი  -11431258,46+11444959,87:-19941990,1
001c98 1C90 S-205 Ი様 -11431258,46+11444959,87:-19941990,
001c98 1C90 S-206 Იク -11431258,46+11444959,87:-19941990,
001c98 1C90 S-210 BᲘ -8465493,9+8479926,13:-8959176,190+8
001c98 1C90 S-211 0Ი -10240563,9+10255136,13:-10734678,19
001c98 1C90 S-212 3Ი -5845208,9+5857766,13:-6339374,190+6
001c98 1C90 S-213 .Ი -2375661,9+2377596,13:-2869104,190+2
```

Every single RHEL major and Ubuntu LTS in the last 10 years has sort order changes except for Ubuntu 14.04

Collation Torture Test


github.com/ardentperf/glibc-unicode-sorting/blob/main/run-icu.sh#L65
main
glibc-unicode-sorting / run-icu.sh
Code
Blame
216 lines (194 loc) · 11.5 KB

```
sudo su - postgres -c "psql -v ON_ERROR_STOP=on" <<EOF

\\timing

drop table if exists unicode_spec;
create table unicode_spec(f1 text,f2 text,f3 text);

copy unicode_spec from program 'curl -ks https://www.unicc

drop table if exists unicode_data;
create table unicode_data(d1 text);

create or replace function insert_codepoint(cp int) returr
  begin
    insert into unicode_data values( chr(cp) );    -- 199

    insert into unicode_data values( chr(cp)||'B' );    --
    insert into unicode_data values( chr(cp)||'O' );    --
    insert into unicode_data values( chr(cp)||'3' );    -- 202
    insert into unicode_data values( chr(cp)||'.' );    -- 203
```

Collation Torture Test - on RHEL 7

```
CREATE TABLE unsorted_table(strings text);
\copy unsorted_table from /home/ec2-user/formated-unicode.txt (format csv)
VACUUM FREEZE ANALYZE unsorted_table;
\timing
WITH t AS (SELECT strings FROM unsorted_table ORDER BY strings)
 SELECT md5(string_agg(t.strings,NULL)) FROM t;
               md5
----------------------------------
 7b2be833bc1893742f4b16d76d17e130
(1 row)

Time: 176505.256 ms (02:56.505)
```

See: `https://github.com/ardentperf/glibc-unicode-sorting`

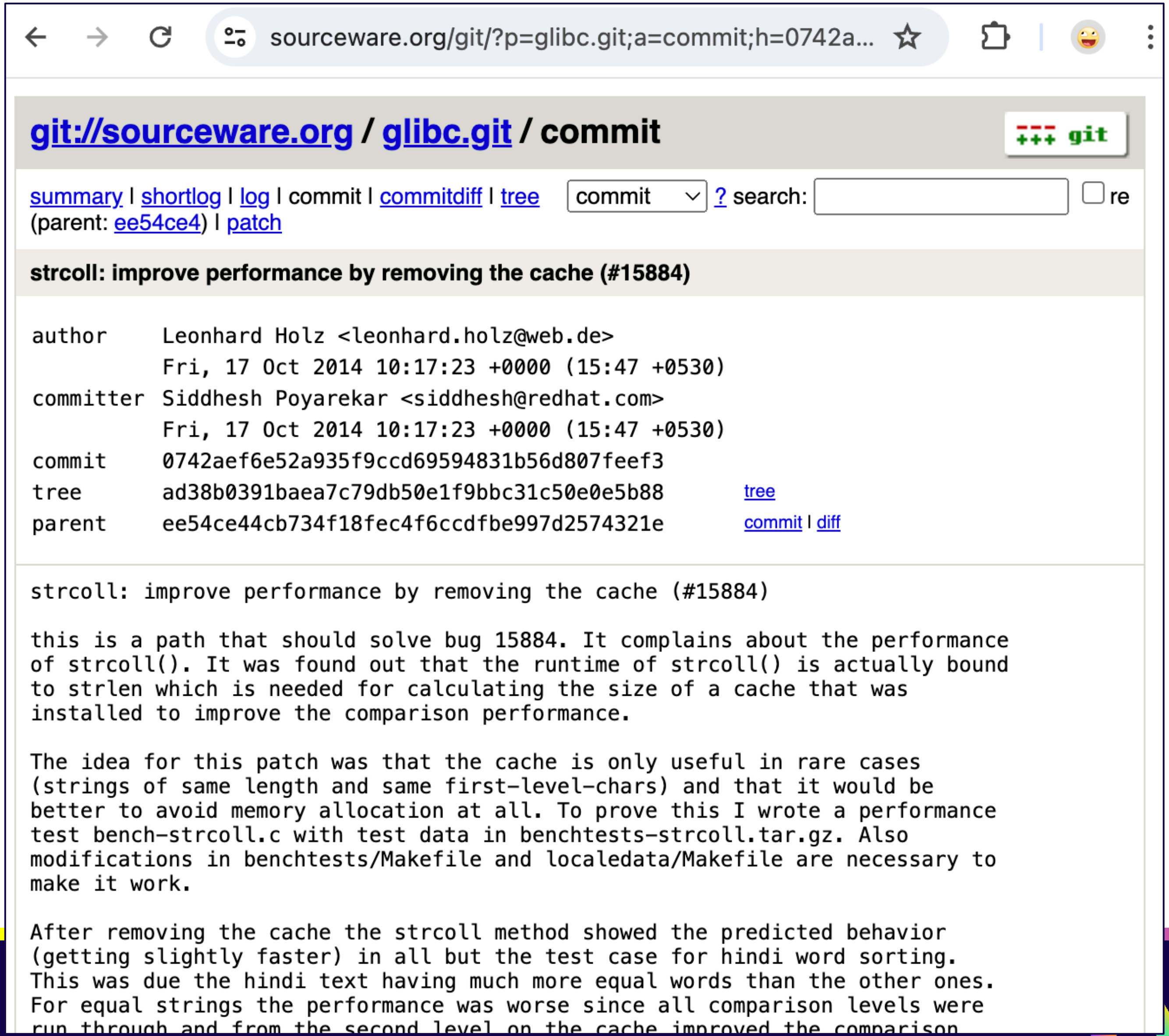
And: `https://joeconway.com/presentations/formated-unicode.txt`

INCORRECT

4. Changing sort order is intentional

Unintentional Changes

In 2014, a 300-line commit to refactor an internal cache for perf reasons changed sort order of 22,000 code points (mostly CJK) in the collation torture test between glibc versions 2.19 and 2.21


sourceware.org/git/?p=glibc.git;a=commit;h=0742a...
git://sourceware.org / glibc.git / commit
git
summary | shortlog | log | commit | commitdiff | tree
commit
? search:
re
(parent: ee54ce4) | patch
tree
commit | diff

strcoll: improve performance by removing the cache (#15884)

```
author     Leonhard Holz <leonhard.holz@web.de>
           Fri, 17 Oct 2014 10:17:23 +0000 (15:47 +0530)
committer  Siddhesh Poyarekar <siddhesh@redhat.com>
           Fri, 17 Oct 2014 10:17:23 +0000 (15:47 +0530)
commit     0742aef6e52a935f9ccd69594831b56d807feef3
tree       ad38b0391baea7c79db50e1f9bbc31c50e0e5b88
parent     ee54ce44cb734f18fec4f6ccdfbe997d2574321e
```

```
strcoll: improve performance by removing the cache (#15884)

this is a path that should solve bug 15884. It complains about the performance
of strcoll(). It was found out that the runtime of strcoll() is actually bound
to strlen which is needed for calculating the size of a cache that was
installed to improve the comparison performance.

The idea for this patch was that the cache is only useful in rare cases
(strings of same length and same first-level-chars) and that it would be
better to avoid memory allocation at all. To prove this I wrote a performance
test bench-strcoll.c with test data in benchtests-strcoll.tar.gz. Also
modifications in benchtests/Makefile and localedata/Makefile are necessary to
make it work.

After removing the cache the strcoll method showed the predicted behavior
(getting slightly faster) in all but the test case for hindi word sorting.
This was due the hindi text having much more equal words than the other ones.
For equal strings the performance was worse since all comparison levels were
run through and from the second level on the cache improved the comparison
```

INCORRECT

5. Indexes are the only thing corrupted

Users are safe if they rebuild indexes

Possible Corruption After Sort Order Change

https://ardentperf.com/2023/03/26/did-postgres-lose-my-data/

```
create table arabic_dictionary_research (
 word text,
 crossreferences text,
 notes text
) partition by range (word);

create table arabic_dictionary_research_p1 partition of arabic_dictionary_research
  for values from ('ا') to ('ح');
create table arabic_dictionary_research_p2 partition of arabic_dictionary_research
  for values from ('ح') to ('س');
create table arabic_dictionary_research_p3 partition of arabic_dictionary_research
  for values from ('س') to ('ل');
create table arabic_dictionary_research_p4 partition of arabic_dictionary_research
  for values from ('ل') to ('ے');
create table arabic_dictionary_research_p5 partition of arabic_dictionary_research
  default;
```

Possible Corruption After Sort Order Change

Updating an external collation library can cause corruption that isn't noticed until long afterwards.

Can trigger a sort order change:

- OS Upgrade
- Failover and Hot Standby
  - Patroni, Kubernetes, etc
- Distributed Systems

Can be corrupted by version change:

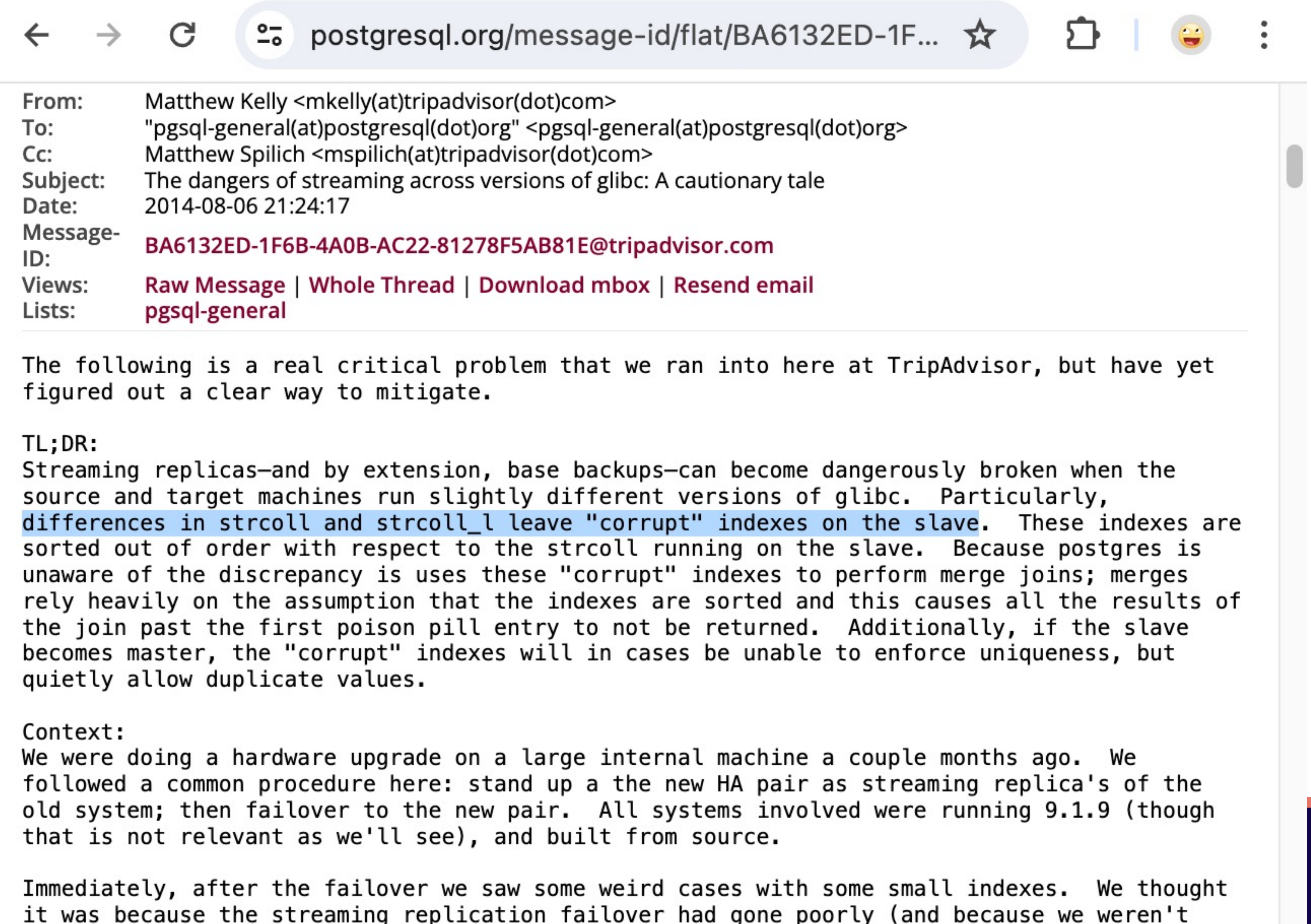
- Indexes
  - All types, not just btree
- Constraints
  - All types, not just unique/primary-key
- Partitions
- FDWs – eg. mergejoin depends on same local/remote ordering
- *Maybe: un-refreshed materialized views, triggers, generated columns? (I'm not sure)*

INCORRECT

6. Users can rebuild the impacted objects

It’s inconvenient but at least there is always a “fix”

Hot Standby to Scale Out Reads



From:	Matthew Kelly <mkelly(at)tripadvisor(dot)com>
To:	"pgsql-general(at)postgresql(dot)org" <pgsql-general(at)postgresql(dot)org>
Cc:	Matthew Spilich <mspilich(at)tripadvisor(dot)com>
Subject:	The dangers of streaming across versions of glibc: A cautionary tale
Date:	2014-08-06 21:24:17
Message-ID:	BA6132ED-1F6B-4A0B-AC22-81278F5AB81E@tripadvisor.com
Views:	Raw Message | Whole Thread | Download mbox | Resend email
Lists:	pgsql-general

The following is a real critical problem that we ran into here at TripAdvisor, but have yet figured out a clear way to mitigate.

TL;DR:
Streaming replicas—and by extension, base backups—can become dangerously broken when the source and target machines run slightly different versions of glibc. Particularly, differences in strcoll and strcoll_l leave "corrupt" indexes on the slave. These indexes are sorted out of order with respect to the strcoll running on the slave. Because postgres is unaware of the discrepancy is uses these "corrupt" indexes to perform merge joins; merges rely heavily on the assumption that the indexes are sorted and this causes all the results of the join past the first poison pill entry to not be returned. Additionally, if the slave becomes master, the "corrupt" indexes will in cases be unable to enforce uniqueness, but quietly allow duplicate values.

Context:
We were doing a hardware upgrade on a large internal machine a couple months ago. We followed a common procedure here: stand up a the new HA pair as streaming replica's of the old system; then failover to the new pair. All systems involved were running 9.1.9 (though that is not relevant as we'll see), and built from source.

Immediately, after the failover we saw some weird cases with some small indexes. We thought it was because the streaming replication failover had gone poorly (and because we weren't

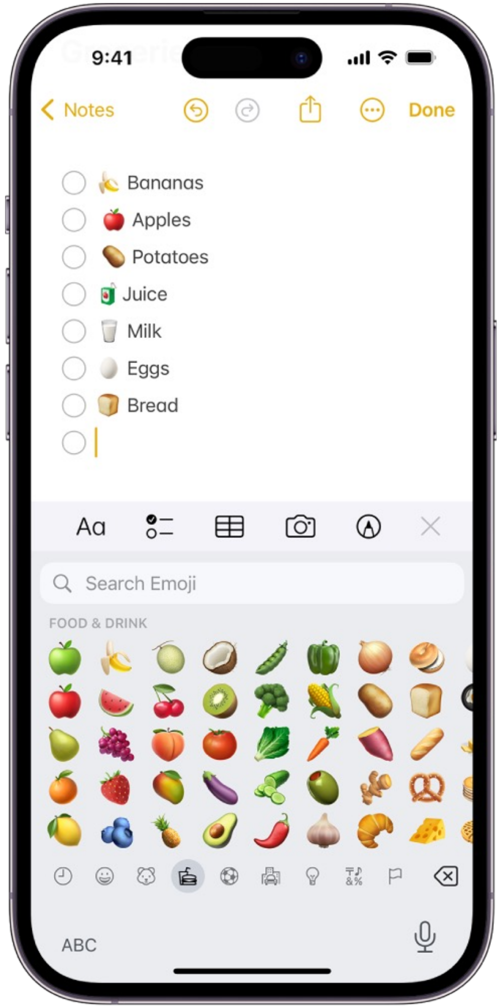
2014

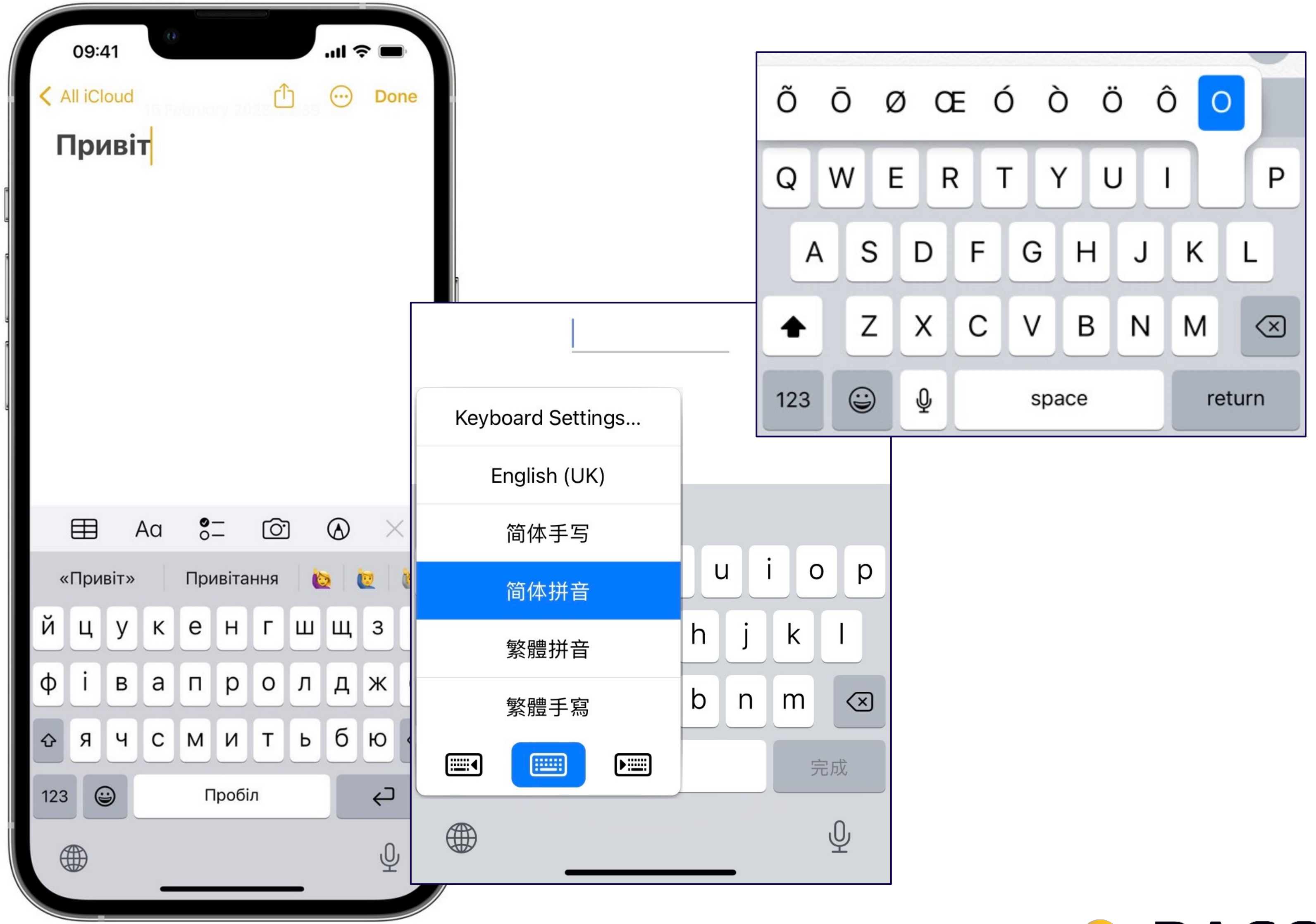
INCORRECT

7. My database doesn't have any characters from that uncommon language with a sort order change

I can safely update the collation library and ignore warnings about corruption

Assume Unexpected Characters



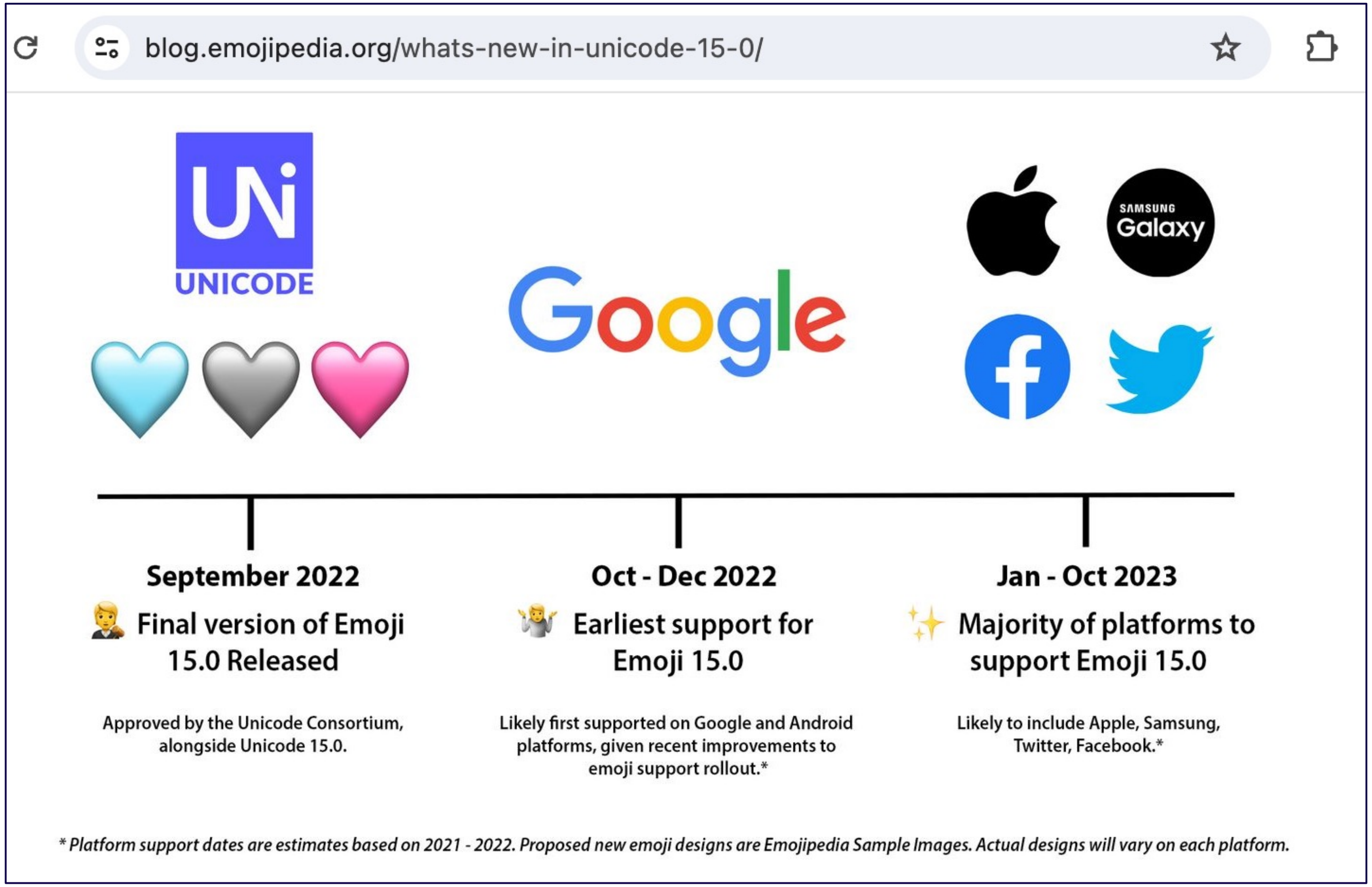


INCORRECT

8. My database understands all of the characters that are in it

Device and App Updates

- New versions of Unicode are deployed quickly to devices and end users
- *Generally less than a year*
- A database that rejects unknown code points will not store data entered on current phones & apps, if the data includes new characters
- Patches were under discussion on the mailing lists *(I'm not sure of outcome)*



blog.emojipedia.org/whats-new-in-unicode-15-0/

September 2022
Final version of Emoji 15.0 Released

Approved by the Unicode Consortium, alongside Unicode 15.0.

Oct - Dec 2022
Earliest support for Emoji 15.0

Likely first supported on Google and Android platforms, given recent improvements to emoji support rollout.*

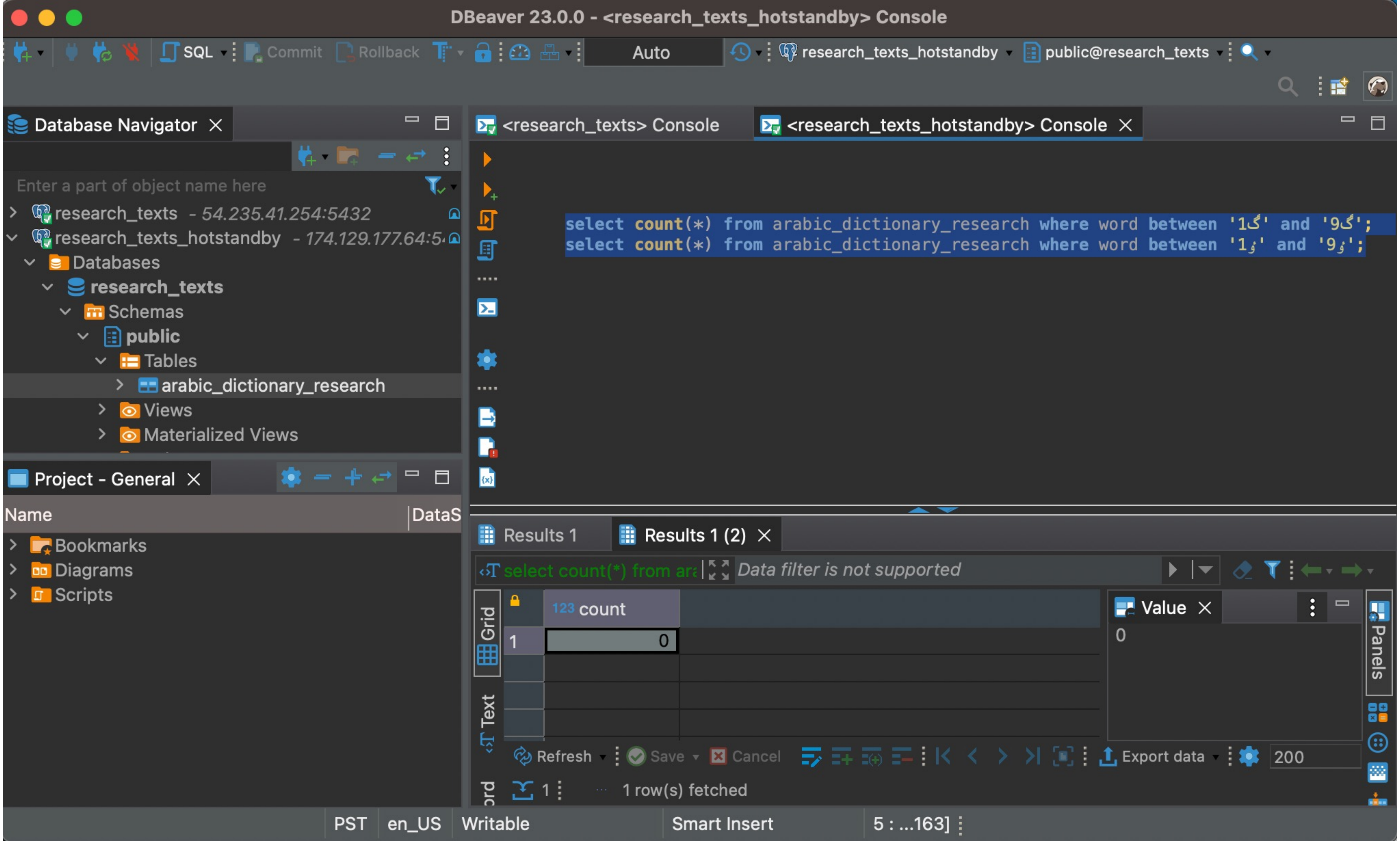
Jan - Oct 2023
Majority of platforms to support Emoji 15.0

Likely to include Apple, Samsung, Twitter, Facebook.*

** Platform support dates are estimates based on 2021 - 2022. Proposed new emoji designs are Emojipedia Sample Images. Actual designs will vary on each platform.*

INCORRECT

9. The Postgres warning message about “wrong collation library version” will be displayed to someone



DBeaver 23.0.0 - <research_texts_hotstandby> Console

research_texts - 54.235.41.254:5432
research_texts_hotstandby - 174.129.177.64:5
- Databases
  - research_texts
    - Schemas
      - public
        - Tables
          - arabic_dictionary_research
        - Views
        - Materialized Views

```
select count(*) from arabic_dictionary_research where word between '1گ' and '9گ';
select count(*) from arabic_dictionary_research where word between '1ۋ' and '9ۋ';
```

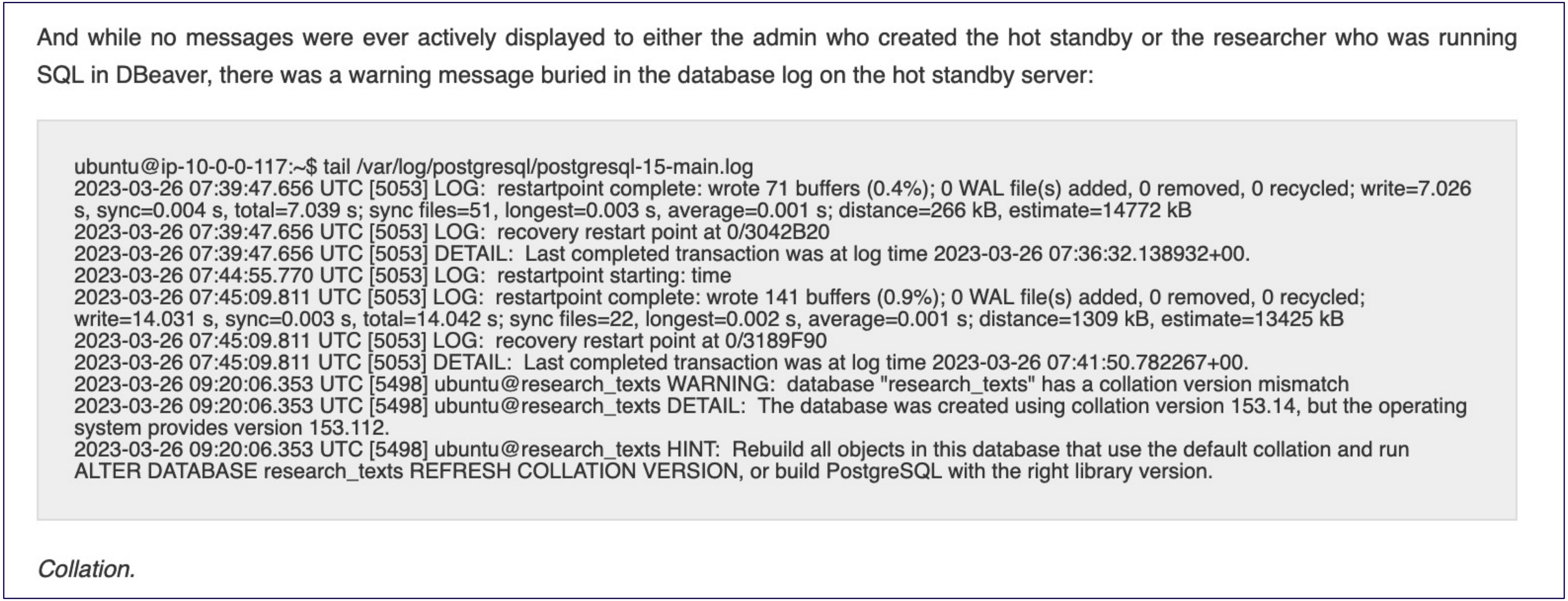
	123 count
1	0

Value: 0

1 row(s) fetched

“Warning” May Appear in Server Logs Only

https://ardentperf.com/2023/03/26/did-postgres-lose-my-data/



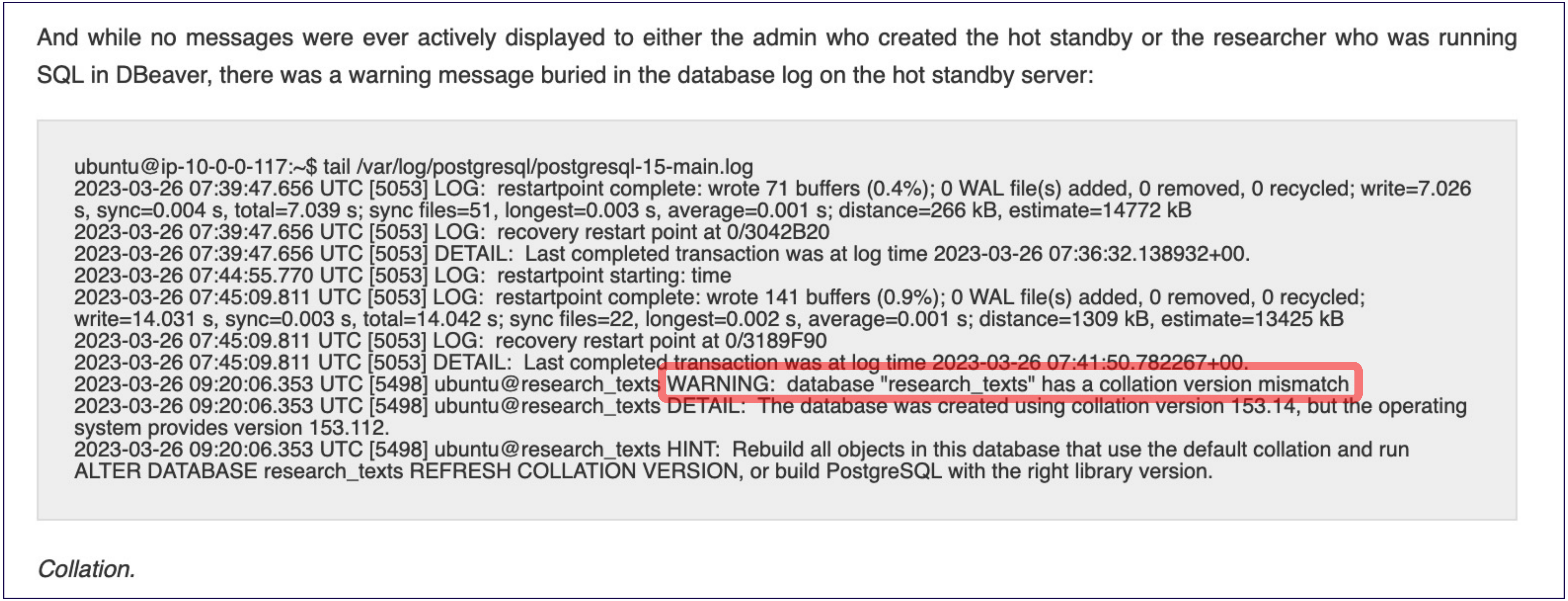
And while no messages were ever actively displayed to either the admin who created the hot standby or the researcher who was running SQL in DBeaver, there was a warning message buried in the database log on the hot standby server:

```
ubuntu@ip-10-0-0-117:~$ tail /var/log/postgresql/postgresql-15-main.log
2023-03-26 07:39:47.656 UTC [5053] LOG:  restartpoint complete: wrote 71 buffers (0.4%); 0 WAL file(s) added, 0 removed, 0 recycled; write=7.026
s, sync=0.004 s, total=7.039 s; sync files=51, longest=0.003 s, average=0.001 s; distance=266 kB, estimate=14772 kB
2023-03-26 07:39:47.656 UTC [5053] LOG:  recovery restart point at 0/3042B20
2023-03-26 07:39:47.656 UTC [5053] DETAIL:  Last completed transaction was at log time 2023-03-26 07:36:32.138932+00.
2023-03-26 07:44:55.770 UTC [5053] LOG:  restartpoint starting: time
2023-03-26 07:45:09.811 UTC [5053] LOG:  restartpoint complete: wrote 141 buffers (0.9%); 0 WAL file(s) added, 0 removed, 0 recycled;
write=14.031 s, sync=0.003 s, total=14.042 s; sync files=22, longest=0.002 s, average=0.001 s; distance=1309 kB, estimate=13425 kB
2023-03-26 07:45:09.811 UTC [5053] LOG:  recovery restart point at 0/3189F90
2023-03-26 07:45:09.811 UTC [5053] DETAIL:  Last completed transaction was at log time 2023-03-26 07:41:50.782267+00.
2023-03-26 09:20:06.353 UTC [5498] ubuntu@research_texts WARNING:  database "research_texts" has a collation version mismatch
2023-03-26 09:20:06.353 UTC [5498] ubuntu@research_texts DETAIL:  The database was created using collation version 153.14, but the operating
system provides version 153.112.
2023-03-26 09:20:06.353 UTC [5498] ubuntu@research_texts HINT:  Rebuild all objects in this database that use the default collation and run
ALTER DATABASE research_texts REFRESH COLLATION VERSION, or build PostgreSQL with the right library version.
```

Collation.

“Warning” May Appear in Server Logs Only

https://ardentperf.com/2023/03/26/did-postgres-lose-my-data/



And while no messages were ever actively displayed to either the admin who created the hot standby or the researcher who was running SQL in DBeaver, there was a warning message buried in the database log on the hot standby server:

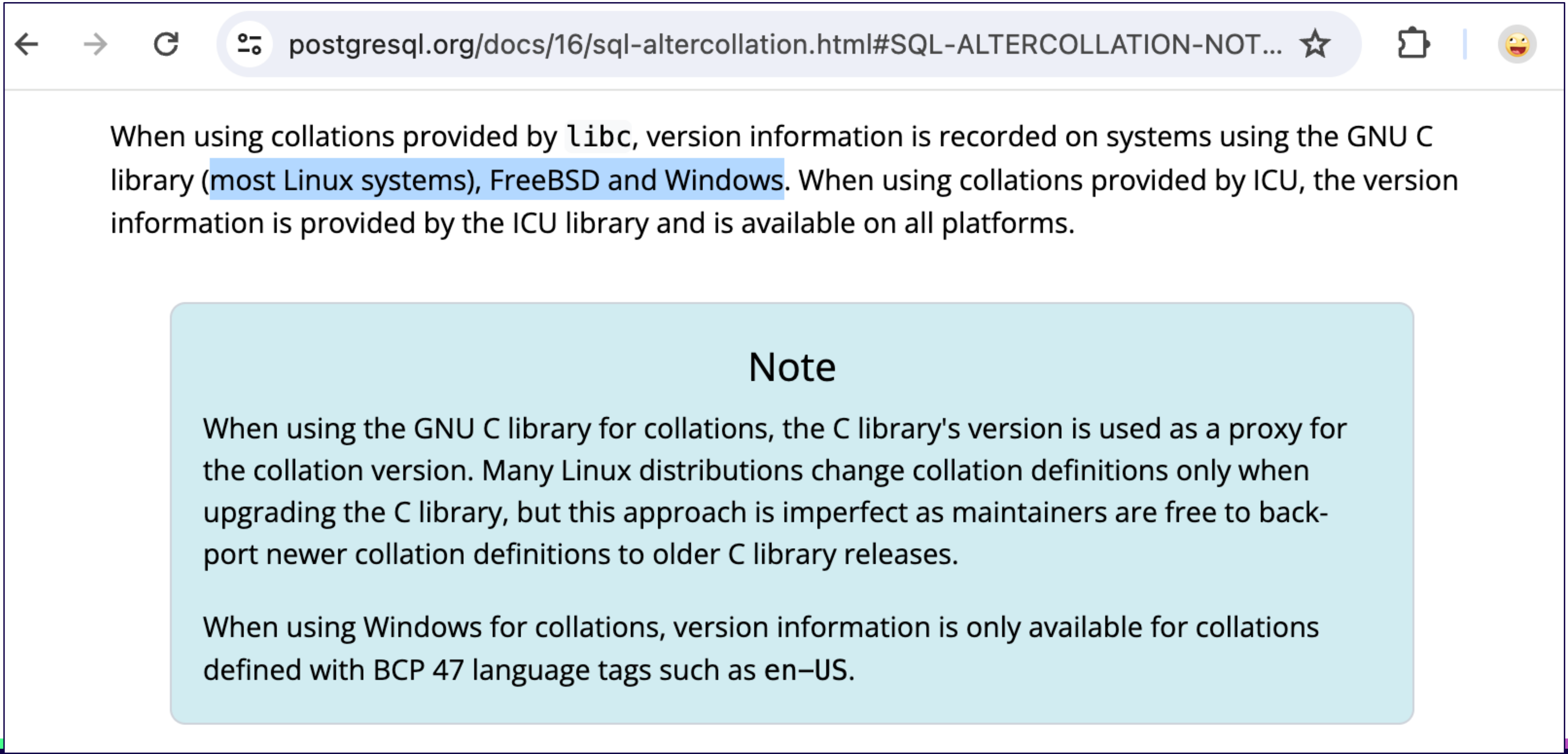
```
ubuntu@ip-10-0-0-117:~$ tail /var/log/postgresql/postgresql-15-main.log
2023-03-26 07:39:47.656 UTC [5053] LOG:  restartpoint complete: wrote 71 buffers (0.4%); 0 WAL file(s) added, 0 removed, 0 recycled; write=7.026
s, sync=0.004 s, total=7.039 s; sync files=51, longest=0.003 s, average=0.001 s; distance=266 kB, estimate=14772 kB
2023-03-26 07:39:47.656 UTC [5053] LOG:  recovery restart point at 0/3042B20
2023-03-26 07:39:47.656 UTC [5053] DETAIL:  Last completed transaction was at log time 2023-03-26 07:36:32.138932+00.
2023-03-26 07:44:55.770 UTC [5053] LOG:  restartpoint starting: time
2023-03-26 07:45:09.811 UTC [5053] LOG:  restartpoint complete: wrote 141 buffers (0.9%); 0 WAL file(s) added, 0 removed, 0 recycled;
write=14.031 s, sync=0.003 s, total=14.042 s; sync files=22, longest=0.002 s, average=0.001 s; distance=1309 kB, estimate=13425 kB
2023-03-26 07:45:09.811 UTC [5053] LOG:  recovery restart point at 0/3189F90
2023-03-26 07:45:09.811 UTC [5053] DETAIL:  Last completed transaction was at log time 2023-03-26 07:41:50.782267+00.
2023-03-26 09:20:06.353 UTC [5498] ubuntu@research_texts WARNING:  database "research_texts" has a collation version mismatch
2023-03-26 09:20:06.353 UTC [5498] ubuntu@research_texts DETAIL:  The database was created using collation version 153.14, but the operating
system provides version 153.112.
2023-03-26 09:20:06.353 UTC [5498] ubuntu@research_texts HINT:  Rebuild all objects in this database that use the default collation and run
ALTER DATABASE research_texts REFRESH COLLATION VERSION, or build PostgreSQL with the right library version.
```

Collation.

INCORRECT

10. Postgres can always know what version of C Libraries are installed on the OS

Postgres Detects Version On Common OS’s


postgresql.org/docs/16/sql-altercollation.html#SQL-ALTERCOLLATION-NOT…

When using collations provided by `libc`, version information is recorded on systems using the GNU C library (most Linux systems), FreeBSD and Windows. When using collations provided by ICU, the version information is provided by the ICU library and is available on all platforms.

Note

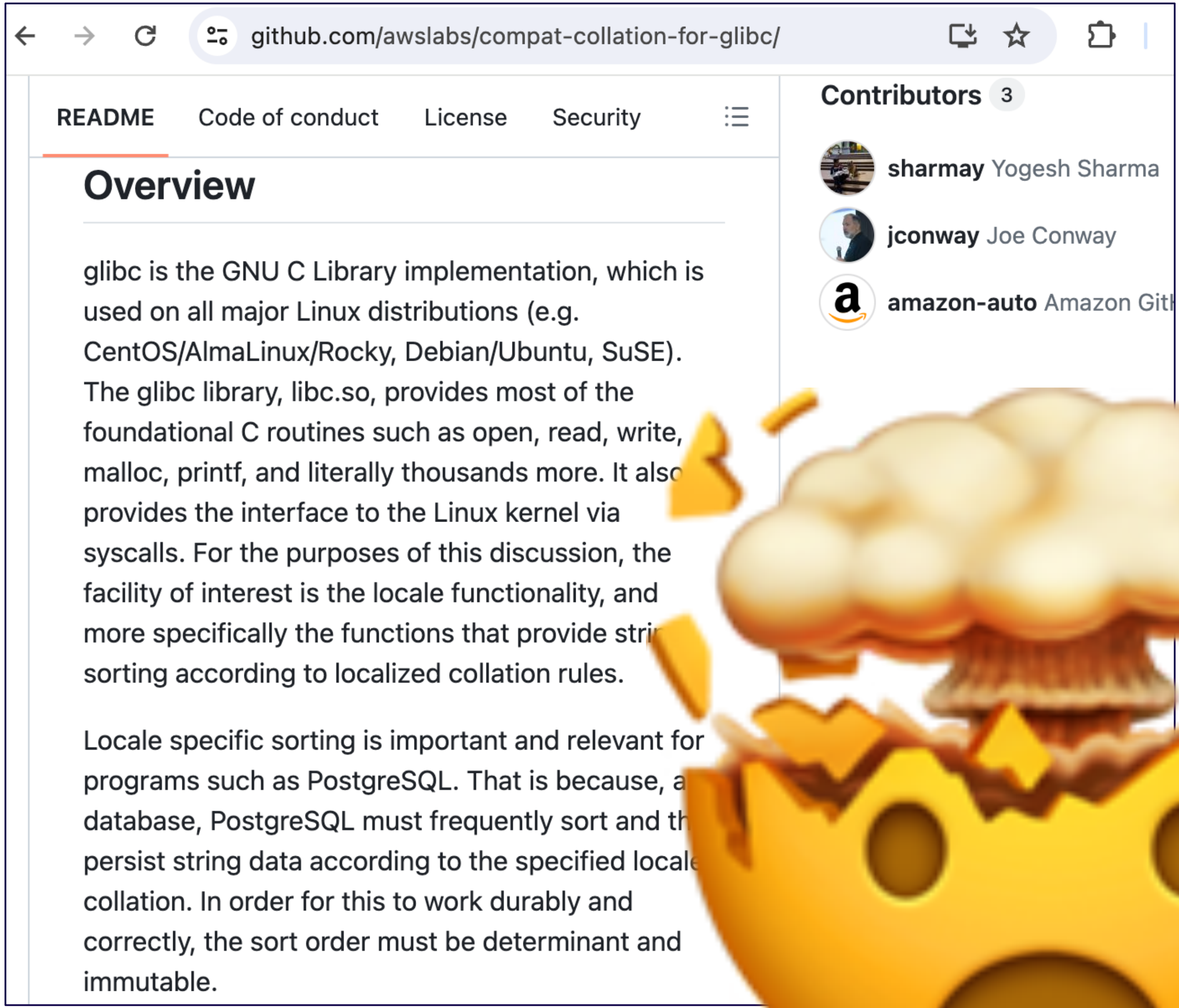
When using the GNU C library for collations, the C library's version is used as a proxy for the collation version. Many Linux distributions change collation definitions only when upgrading the C library, but this approach is imperfect as maintainers are free to back-port newer collation definitions to older C library releases.

When using Windows for collations, version information is only available for collations defined with BCP 47 language tags such as en–US.

INCORRECT

11. You can't just

"extract the collation code from an old glibc (GNU C Library) version,
build it as an independent library,
and install it on a new major OS release"



github.com/awslabs/compat-collation-for-glibc/

Overview

glibc is the GNU C Library implementation, which is used on all major Linux distributions (e.g. CentOS/AlmaLinux/Rocky, Debian/Ubuntu, SuSE). The glibc library, libc.so, provides most of the foundational C routines such as open, read, write, malloc, printf, and literally thousands more. It also provides the interface to the Linux kernel via syscalls. For the purposes of this discussion, the facility of interest is the locale functionality, and more specifically the functions that provide stri sorting according to localized collation rules.

Locale specific sorting is important and relevant for programs such as PostgreSQL. That is because, a database, PostgreSQL must frequently sort and th persist string data according to the specified locale collation. In order for this to work durably and correctly, the sort order must be determinant and immutable.

Contributors 3

- sharmay Yogesh Sharma
- jconway Joe Conway
- amazon-auto Amazon Git

#PASSDataSummit

PASS24 Data Community Summit

CONFERENCE SCHEDULE - PGCON 2023

Back

SORTING OUT GLIBC COLLATION CHALLENGES

Date: 2023-05-31
Time: 10:00–10:45
Room: DMS 1140
Level: Intermediate

Background: "libc" is commonly used as a shorthand for the "standard C library", a library of standard functions that can be used by all C programs. glibc is the GNU C Library implementation, which is used o
glibc library, libc.so, provides most of the foundational C routines suc
provides the interface to the Linux kernel via syscalls.

For the purposes of this talk, the facility of interest is the locale functi
according to localized collation rules. In order for PostgreSQL to work
Since glibc implements the sort order, if/when glibc changes the sort
PostgreSQL, and thereby causes data corruption. Indexes that have b
order according to the currently installed version of glibc.

Proposed Solution: A solution, outlined in this talk, demonstrates a m
specific glibc base-version. That may then be used on another Linux s
and/or OS upgrades.

Summary: If a PostgreSQL database resides on, for example, a RHEL 7
upgraded to RHEL 8 with glibc version 2.28, the majority of indexes bu
examples of the types of breakage that can occur, the proposed solut

SPEAKER

Joe Conway

aws

Collation Challenges

Sorting It Out

Joe Conway
conway@amazon.com
mail@joeconway.com

AWS
May 31, 2023

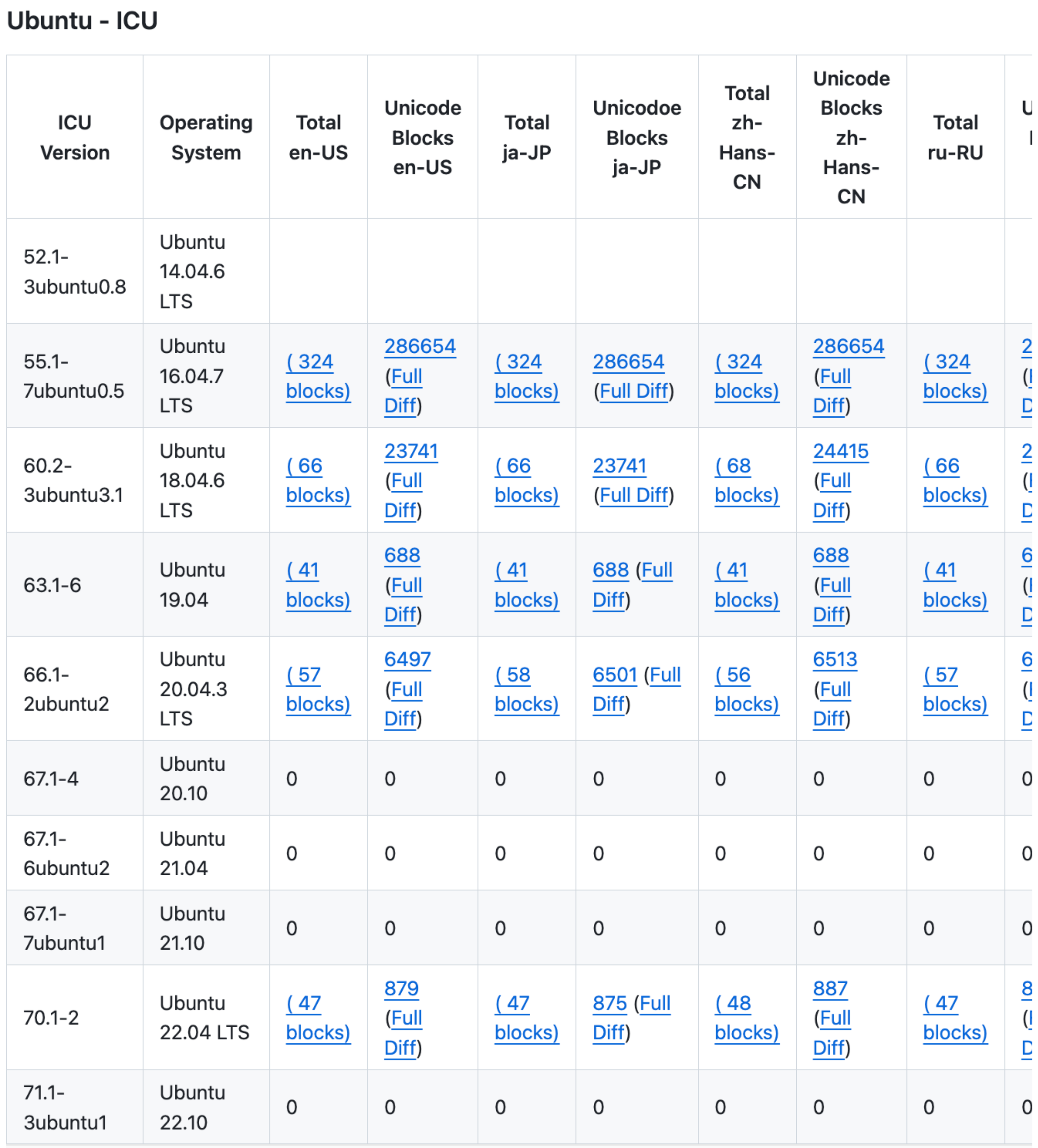
INCORRECT

12. ICU solves everything

ICU is a far better choice than the operating system C library

But it doesn't solve everything

Every single Ubuntu LTS in the last 8 years has ICU sort order changes

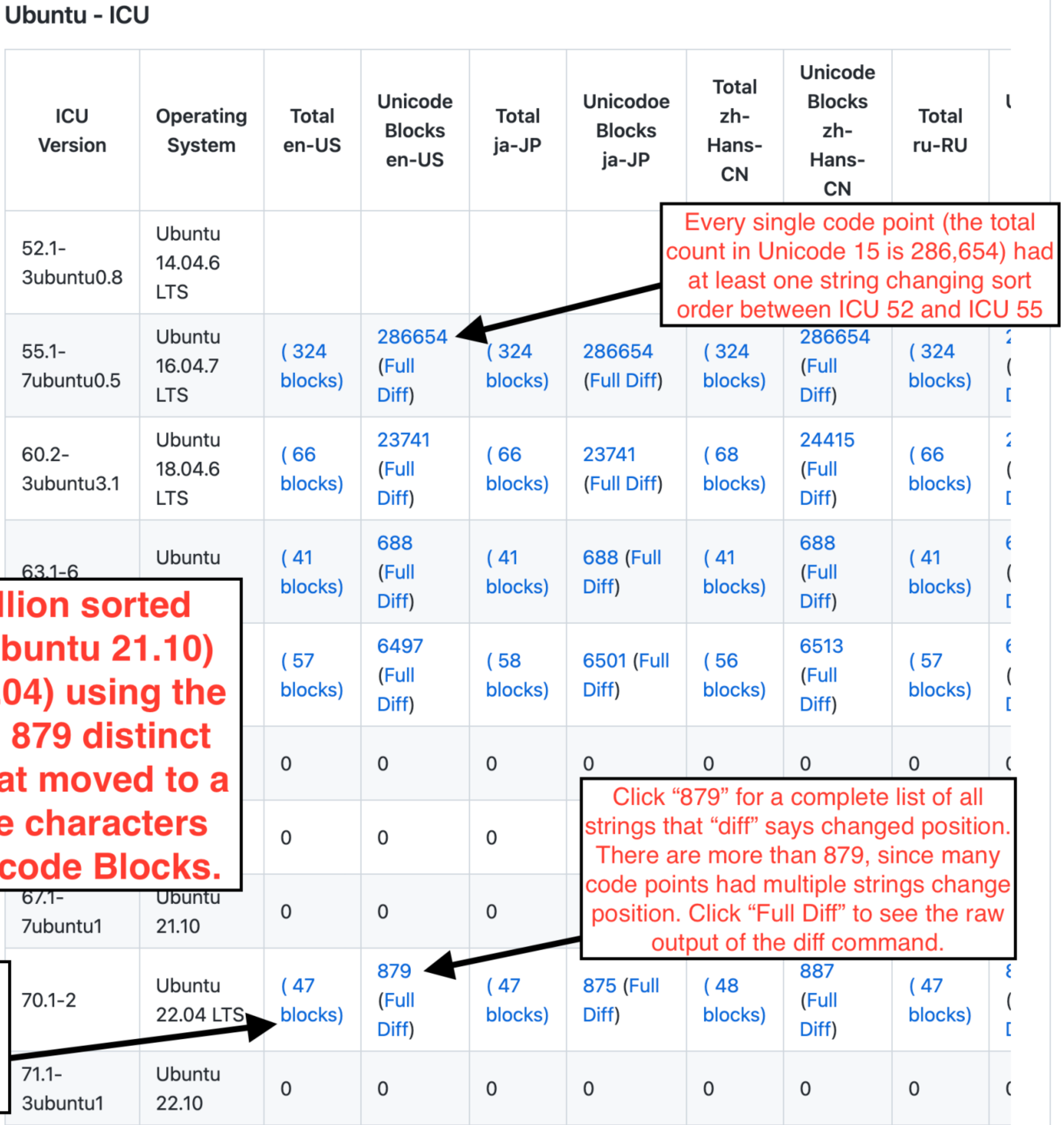


Ubuntu - ICU

ICU Version	Operating System	Total en-US	Unicode Blocks en-US	Total ja-JP	Unicodoe Blocks ja-JP	Total zh-Hans-CN	Unicode Blocks zh-Hans-CN	Total ru-RU	U I
52.1-3ubuntu0.8	Ubuntu 14.04.6 LTS								
55.1-7ubuntu0.5	Ubuntu 16.04.7 LTS	(324 blocks)	286654 (Full Diff)	(324 blocks)	286654 (Full Diff)	(324 blocks)	286654 (Full Diff)	(324 blocks)	2 (I D
60.2-3ubuntu3.1	Ubuntu 18.04.6 LTS	(66 blocks)	23741 (Full Diff)	(66 blocks)	23741 (Full Diff)	(68 blocks)	24415 (Full Diff)	(66 blocks)	2 (I D
63.1-6	Ubuntu 19.04	(41 blocks)	688 (Full Diff)	(41 blocks)	688 (Full Diff)	(41 blocks)	688 (Full Diff)	(41 blocks)	6 (I D
66.1-2ubuntu2	Ubuntu 20.04.3 LTS	(57 blocks)	6497 (Full Diff)	(58 blocks)	6501 (Full Diff)	(56 blocks)	6513 (Full Diff)	(57 blocks)	6 (I D
67.1-4	Ubuntu 20.10	0	0	0	0	0	0	0	0
67.1-6ubuntu2	Ubuntu 21.04	0	0	0	0	0	0	0	0
67.1-7ubuntu1	Ubuntu 21.10	0	0	0	0	0	0	0	0
70.1-2	Ubuntu 22.04 LTS	(47 blocks)	879 (Full Diff)	(47 blocks)	875 (Full Diff)	(48 blocks)	887 (Full Diff)	(47 blocks)	8 (I D
71.1-3ubuntu1	Ubuntu 22.10	0	0	0	0	0	0	0	0

INCORRECT

13. ICU never had a huge sort order change like the glibc 2.28 fiasco



Ubuntu - ICU

ICU Version	Operating System	Total en-US	Unicode Blocks en-US	Total ja-JP	Unicodoe Blocks ja-JP	Total zh-Hans-CN	Unicode Blocks zh-Hans-CN	Total ru-RU
52.1-3ubuntu0.8	Ubuntu 14.04.6 LTS							
55.1-7ubuntu0.5	Ubuntu 16.04.7 LTS	(324 blocks)	286654 (Full Diff)	(324 blocks)	286654 (Full Diff)	(324 blocks)	286654 (Full Diff)	(324 blocks)
60.2-3ubuntu3.1	Ubuntu 18.04.6 LTS	(66 blocks)	23741 (Full Diff)	(66 blocks)	23741 (Full Diff)	(68 blocks)	24415 (Full Diff)	(66 blocks)
63.1-6	Ubuntu	(41 blocks)	688 (Full Diff)	(41 blocks)	688 (Full Diff)	(41 blocks)	688 (Full Diff)	(41 blocks)
		(57 blocks)	6497 (Full Diff)	(58 blocks)	6501 (Full Diff)	(56 blocks)	6513 (Full Diff)	(57 blocks)
		0	0	0	0	0	0	0
		0	0	0				
67.1-7ubuntu1	Ubuntu 21.10	0	0	0				
70.1-2	Ubuntu 22.04 LTS	(47 blocks)	879 (Full Diff)	(47 blocks)	875 (Full Diff)	(48 blocks)	887 (Full Diff)	(47 blocks)
71.1-3ubuntu1	Ubuntu 22.10	0	0	0	0	0	0	0

Every single code point (the total count in Unicode 15 is 286,654) had at least one string changing sort order between ICU 52 and ICU 55

A "diff" between 26 million sorted strings from ICU 67.1 (Ubuntu 21.10) and ICU 70.1 (Ubuntu 22.04) using the locale "en-US" reported 879 distinct characters in patterns that moved to a different location. Those characters were spread over 47 Unicode Blocks.

Click "879" for a complete list of all strings that "diff" says changed position. There are more than 879, since many code points had multiple strings change position. Click "Full Diff" to see the raw output of the diff command.

Click here for a summary of which string patterns and how many distinct code points appear in each of the 47 impacted unicode blocks

Collation Torture Test Summary

- Both glibc and ICU have regular collation changes.
- Both had at least one release with very large numbers of changes.

- PL/pgSQL code is published on github to generate a table with the 26 million strings in the "collation torture test"
- Can checksum the sorted list to create a test and detect changes

https://github.com/ardentperf/glibc-unicode-sorting/blob/main/run-icu.sh#L65

INCORRECT

14. Assume Devrim and Christoph are happy to build old ICU versions for you

INCORRECT

14. Assume Devrim and Christoph are happy to build old ICU versions for you

Unclear if we want this?
Join the mailing lists and let’s discuss!

New contributors always welcome!

INCORRECT

15. Sort order doesn’t change in library updates with just patch version changes

INCORRECT

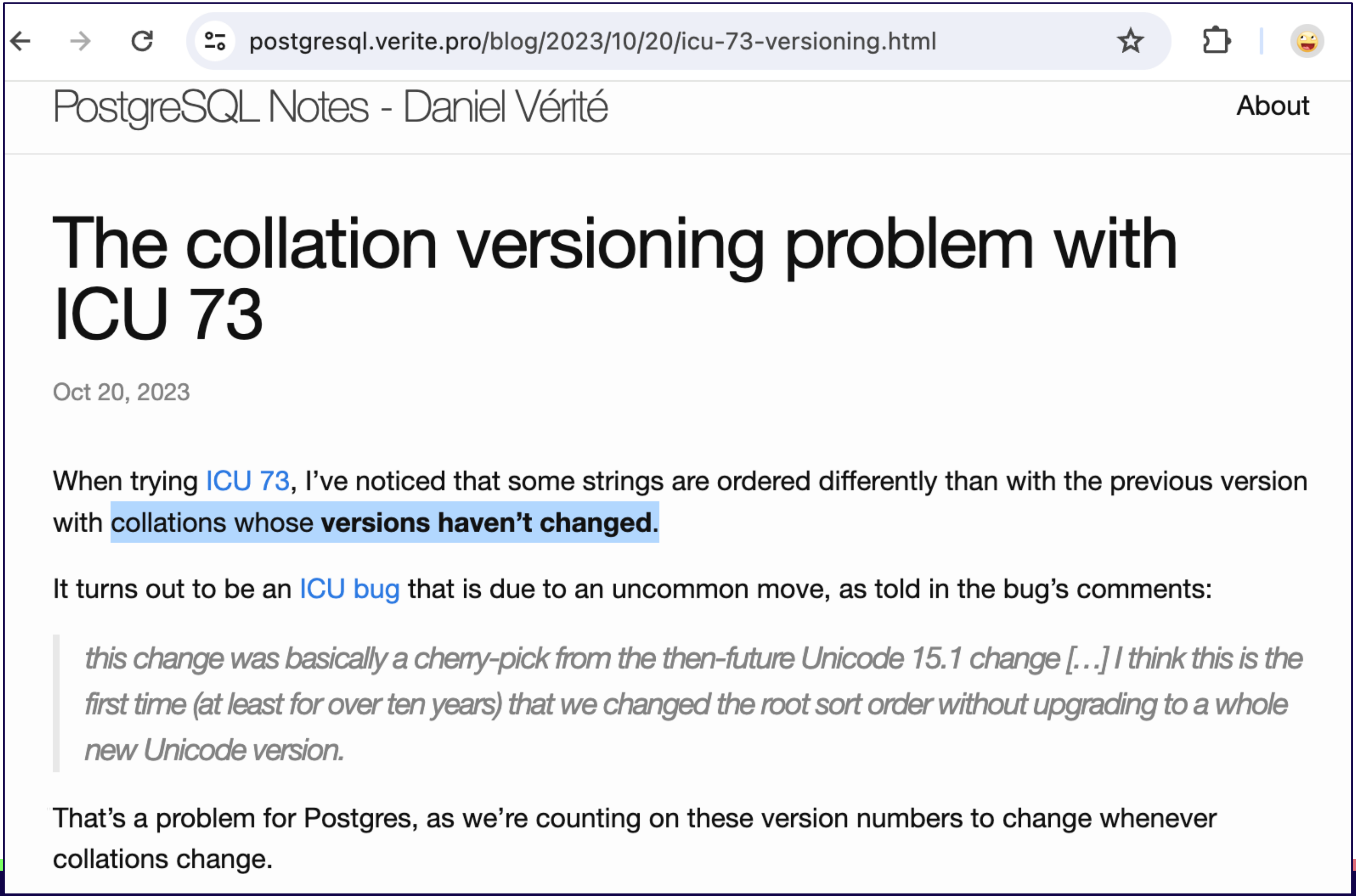
15. Sort order doesn’t change in library updates with just patch version changes

✅ glibc 2.26-59.amzn2

INCORRECT

16. Sort order doesn't change in library updates with NO version changes

When It Changed With No Version Bump



postgresql.verite.pro/blog/2023/10/20/icu-73-versioning.html

PostgreSQL Notes - Daniel Vérité

About

The collation versioning problem with ICU 73

Oct 20, 2023

When trying ICU 73, I've noticed that some strings are ordered differently than with the previous version with collations whose **versions haven't changed**.

It turns out to be an ICU bug that is due to an uncommon move, as told in the bug's comments:

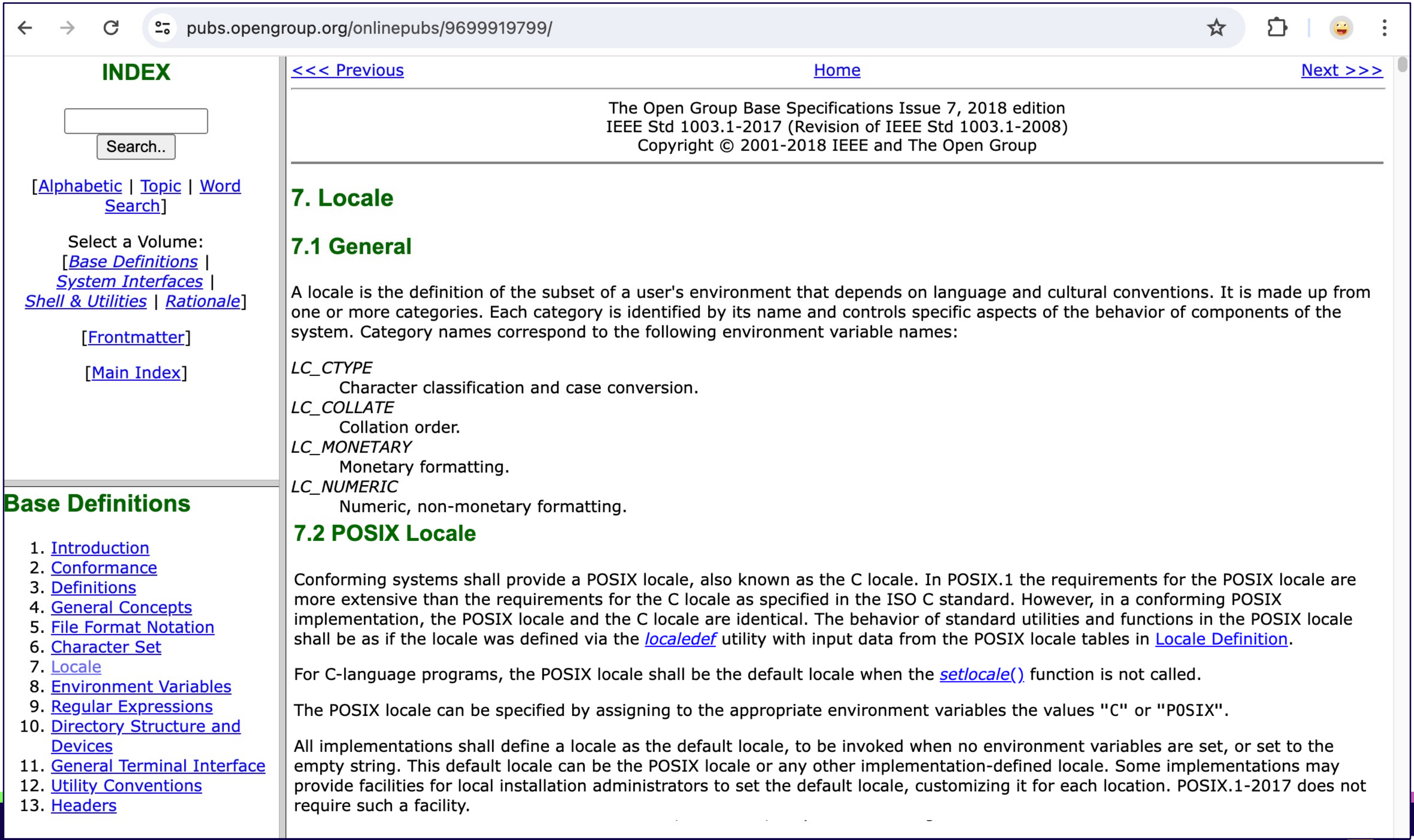
> *this change was basically a cherry-pick from the then-future Unicode 15.1 change […] I think this is the first time (at least for over ten years) that we changed the root sort order without upgrading to a whole new Unicode version.*

That's a problem for Postgres, as we're counting on these version numbers to change whenever collations change.

INCORRECT

17. Postgres doesn't yet have builtin collation that avoids all corruption risks

POSIX locale – also known as C locale



INDEX

Search..

[Alphabetic | Topic | Word Search]

Select a Volume:
[*Base Definitions* | *System Interfaces* | *Shell & Utilities* | *Rationale*]

[Frontmatter]

[Main Index]

Base Definitions

<<< Previous | Home | Next >>>

The Open Group Base Specifications Issue 7, 2018 edition
IEEE Std 1003.1-2017 (Revision of IEEE Std 1003.1-2008)
Copyright © 2001-2018 IEEE and The Open Group

7. Locale

7.1 General

A locale is the definition of the subset of a user's environment that depends on language and cultural conventions. It is made up from one or more categories. Each category is identified by its name and controls specific aspects of the behavior of components of the system. Category names correspond to the following environment variable names:

LC_CTYPE
Character classification and case conversion.
LC_COLLATE
Collation order.
LC_MONETARY
Monetary formatting.
LC_NUMERIC
Numeric, non-monetary formatting.

7.2 POSIX Locale

Conforming systems shall provide a POSIX locale, also known as the C locale. In POSIX.1 the requirements for the POSIX locale are more extensive than the requirements for the C locale as specified in the ISO C standard. However, in a conforming POSIX implementation, the POSIX locale and the C locale are identical. The behavior of standard utilities and functions in the POSIX locale shall be as if the locale was defined via the *localedef* utility with input data from the POSIX locale tables in Locale Definition.

For C-language programs, the POSIX locale shall be the default locale when the *setlocale*() function is not called.

The POSIX locale can be specified by assigning to the appropriate environment variables the values "C" or "POSIX".

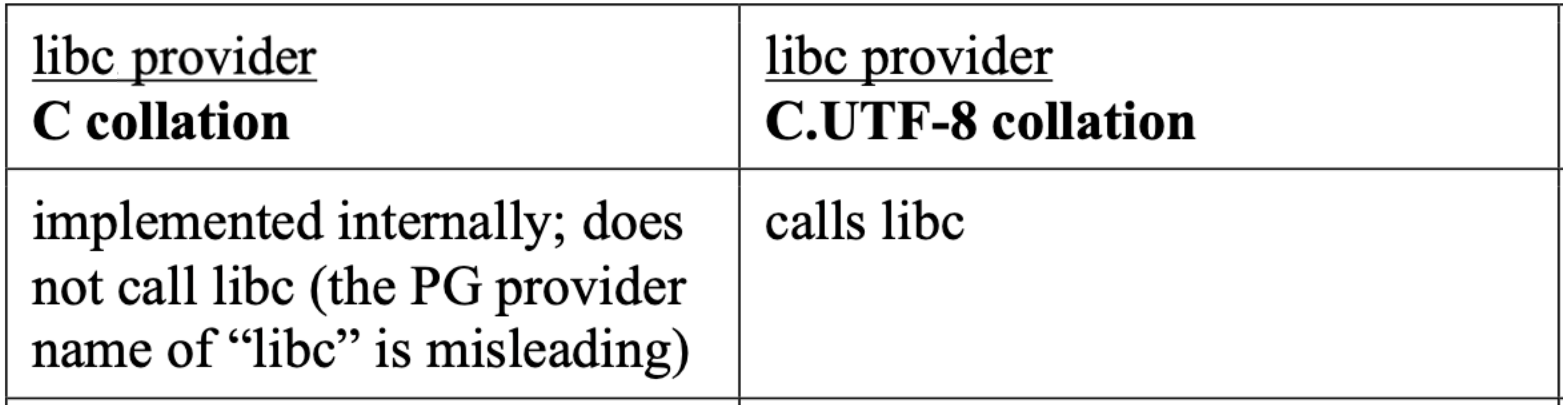
All implementations shall define a locale as the default locale, to be invoked when no environment variables are set, or set to the empty string. This default locale can be the POSIX locale or any other implementation-defined locale. Some implementations may provide facilities for local installation administrators to set the default locale, customizing it for each location. POSIX.1-2017 does not require such a facility.

INCORRECT

18. Postgres `C` and `C.UTF-8` are the same

INCORRECT

18. Postgres `C` and `C.UTF-8` are the same

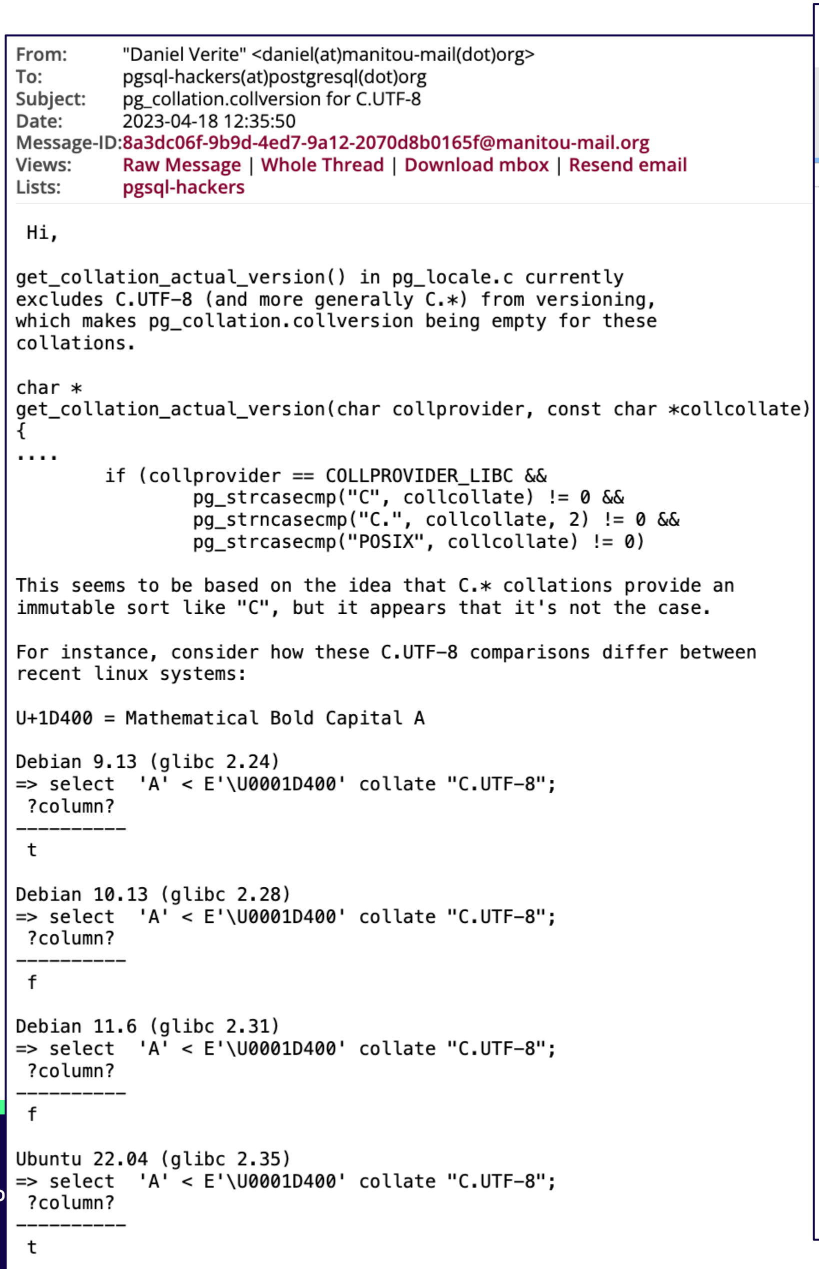


libc provider **C collation**	libc provider **C.UTF-8 collation**
implemented internally; does not call libc (the PG provider name of “libc” is misleading)	calls libc

INCORRECT

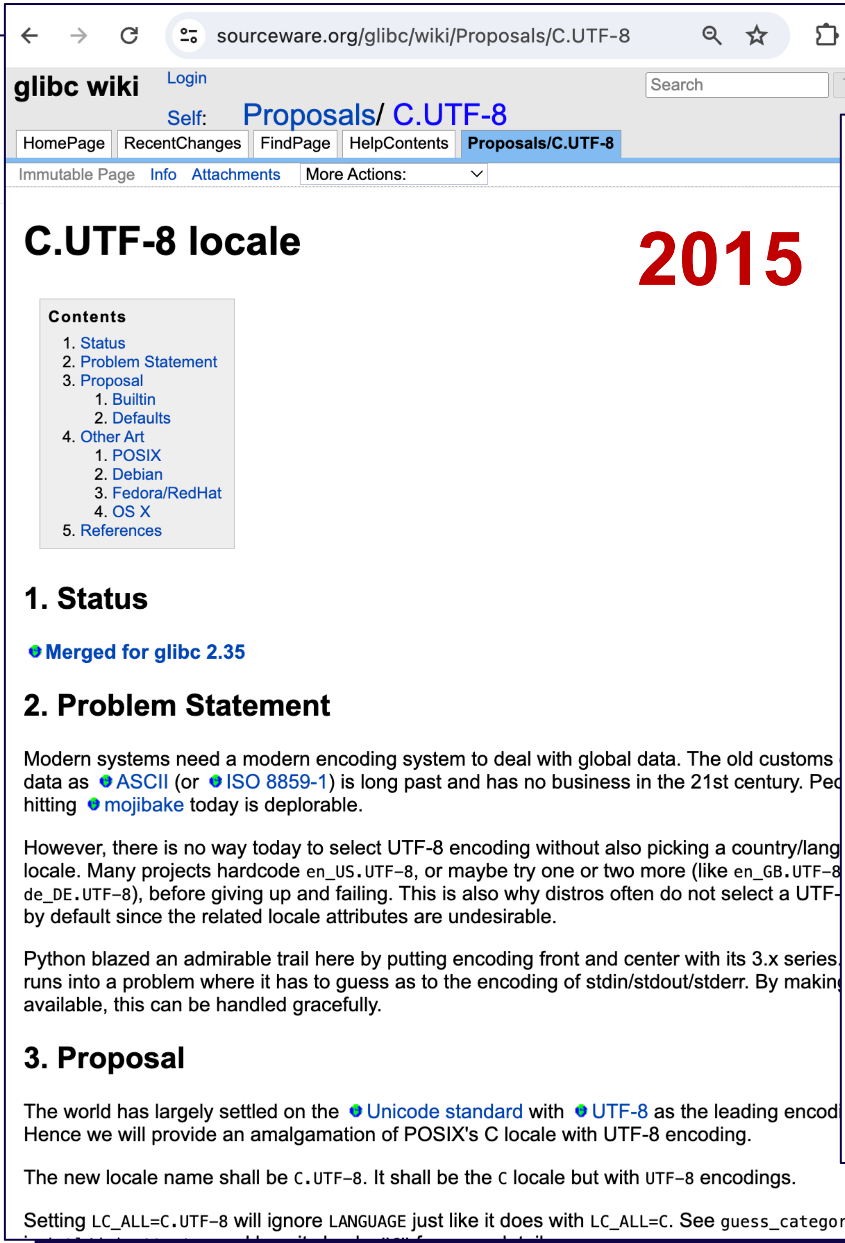
19. Sort order doesn't change in `C.UTF-8`

Sort Order Changed in glibc C.UTF-8



From: "Daniel Verite" <daniel(at)manitou-mail(dot)org>
To: pgsql-hackers(at)postgresql(dot)org
Subject: pg_collation.collversion for C.UTF-8
Date: 2023-04-18 12:35:50
Message-ID: 8a3dc06f-9b9d-4ed7-9a12-2070d8b0165f@manitou-mail.org
Views: Raw Message | Whole Thread | Download mbox | Resend email
Lists: pgsql-hackers

```
 Hi,

get_collation_actual_version() in pg_locale.c currently
excludes C.UTF-8 (and more generally C.*) from versioning,
which makes pg_collation.collversion being empty for these
collations.

char *
get_collation_actual_version(char collprovider, const char *collcollate)
{
....
	if (collprovider == COLLPROVIDER_LIBC &&
		pg_strcasecmp("C", collcollate) != 0 &&
		pg_strncasecmp("C.", collcollate, 2) != 0 &&
		pg_strcasecmp("POSIX", collcollate) != 0)

This seems to be based on the idea that C.* collations provide an
immutable sort like "C", but it appears that it's not the case.

For instance, consider how these C.UTF-8 comparisons differ between
recent linux systems:

U+1D400 = Mathematical Bold Capital A

Debian 9.13 (glibc 2.24)
=> select  'A' < E'\U0001D400' collate "C.UTF-8";
 ?column?
----------
 t

Debian 10.13 (glibc 2.28)
=> select  'A' < E'\U0001D400' collate "C.UTF-8";
 ?column?
----------
 f

Debian 11.6 (glibc 2.31)
=> select  'A' < E'\U0001D400' collate "C.UTF-8";
 ?column?
----------
 f

Ubuntu 22.04 (glibc 2.35)
=> select  'A' < E'\U0001D400' collate "C.UTF-8";
 ?column?
----------
 t
```



Proposals/ C.UTF-8

C.UTF-8 locale

2015

1. Status

- Merged for glibc 2.35

2. Problem Statement

Modern systems need a modern encoding system to deal with global data. The old customs data as ASCII (or ISO 8859-1) is long past and has no business in the 21st century. Pe hitting mojibake today is deplorable.

However, there is no way today to select UTF-8 encoding without also picking a country/lang locale. Many projects hardcode `en_US.UTF-8`, or maybe try one or two more (like `en_GB.UTF-8` `de_DE.UTF-8`), before giving up and failing. This is also why distros often do not select a UTF- by default since the related locale attributes are undesirable.

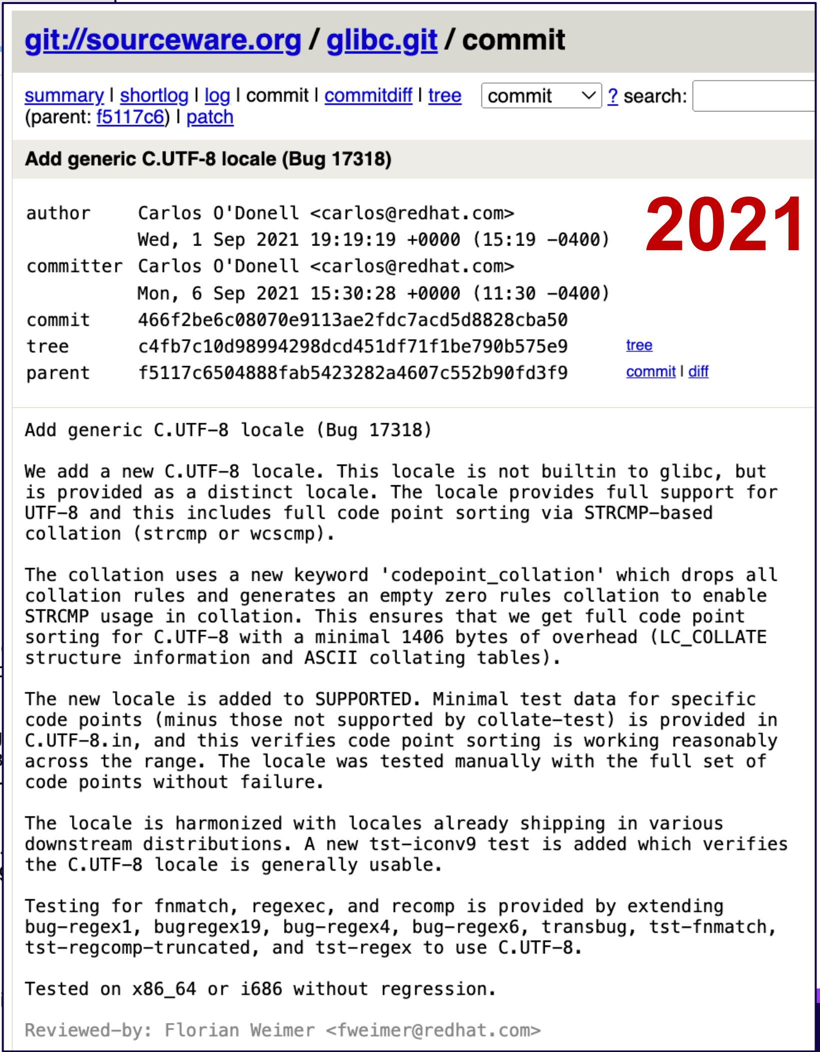
Python blazed an admirable trail here by putting encoding front and center with its 3.x series runs into a problem where it has to guess as to the encoding of stdin/stdout/stderr. By makin available, this can be handled gracefully.

3. Proposal

The world has largely settled on the Unicode standard with UTF-8 as the leading encod Hence we will provide an amalgamation of POSIX's C locale with UTF-8 encoding.

The new locale name shall be `C.UTF-8`. It shall be the `C` locale but with `UTF-8` encodings.

Setting `LC_ALL=C.UTF-8` will ignore `LANGUAGE` just like it does with `LC_ALL=C`. See `guess_category_value()`



git://sourceware.org / glibc.git / commit
summary | shortlog | log | commit | commitdiff | tree
commit
? search:
(parent: f5117c6) | patch

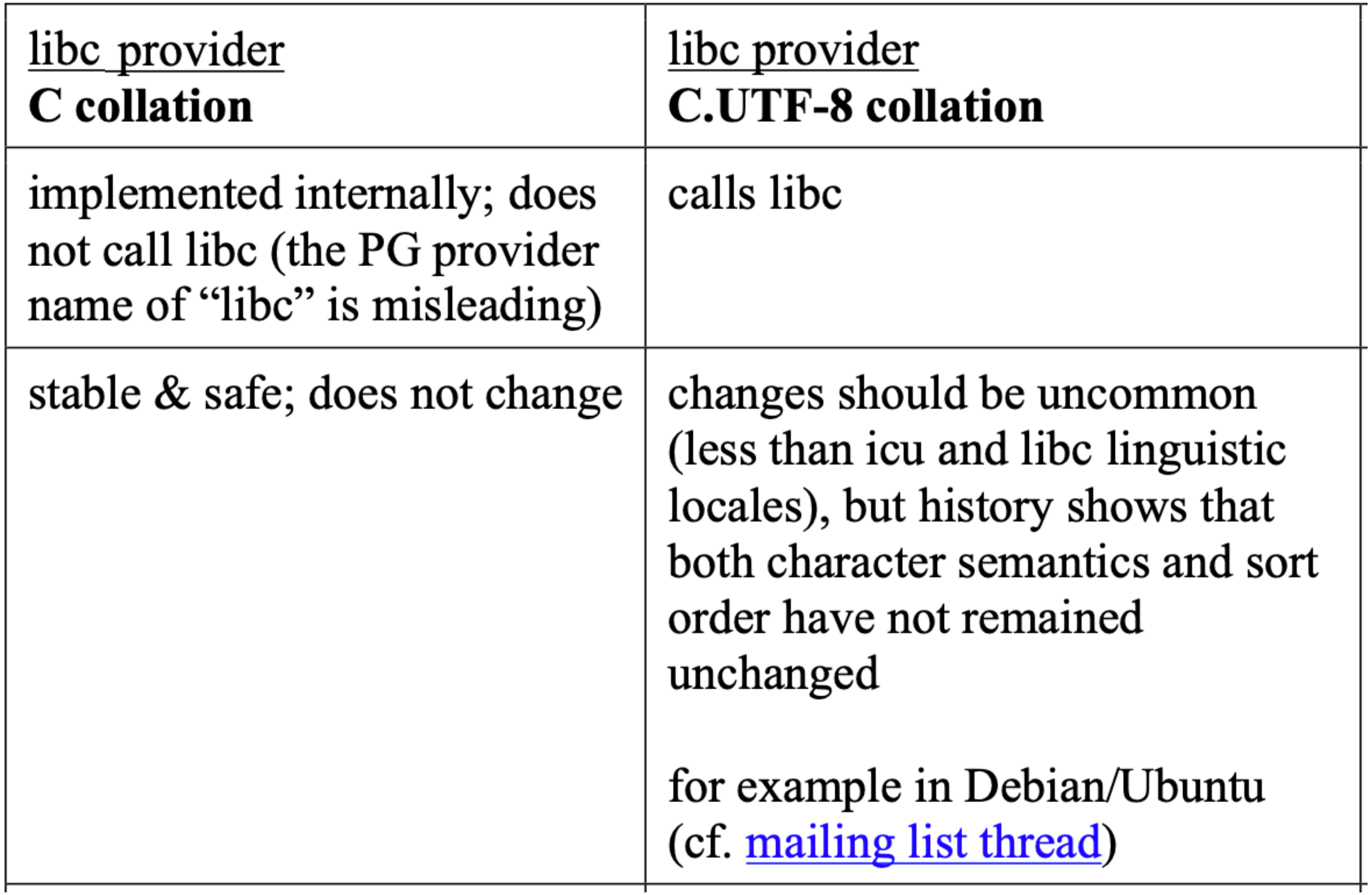
Add generic C.UTF-8 locale (Bug 17318)

2021

```
author     Carlos O'Donell <carlos@redhat.com>
           Wed, 1 Sep 2021 19:19:19 +0000 (15:19 -0400)
committer  Carlos O'Donell <carlos@redhat.com>
           Mon, 6 Sep 2021 15:30:28 +0000 (11:30 -0400)
commit     466f2be6c08070e9113ae2fdc7acd5d8828cba50
tree       c4fb7c10d98994298dcd451df71f1be790b575e9       tree
parent     f5117c6504888fab5423282a4607c552b90fd3f9       commit | diff
```

```
Add generic C.UTF-8 locale (Bug 17318)

We add a new C.UTF-8 locale. This locale is not builtin to glibc, but
is provided as a distinct locale. The locale provides full support for
UTF-8 and this includes full code point sorting via STRCMP-based
collation (strcmp or wcscmp).

The collation uses a new keyword 'codepoint_collation' which drops all
collation rules and generates an empty zero rules collation to enable
STRCMP usage in collation. This ensures that we get full code point
sorting for C.UTF-8 with a minimal 1406 bytes of overhead (LC_COLLATE
structure information and ASCII collating tables).

The new locale is added to SUPPORTED. Minimal test data for specific
code points (minus those not supported by collate-test) is provided in
C.UTF-8.in, and this verifies code point sorting is working reasonably
across the range. The locale was tested manually with the full set of
code points without failure.

The locale is harmonized with locales already shipping in various
downstream distributions. A new tst-iconv9 test is added which verifies
the C.UTF-8 locale is generally usable.

Testing for fnmatch, regexec, and recomp is provided by extending
bug-regex1, bugregex19, bug-regex4, bug-regex6, transbug, tst-fnmatch,
tst-regcomp-truncated, and tst-regex to use C.UTF-8.

Tested on x86_64 or i686 without regression.

Reviewed-by: Florian Weimer <fweimer@redhat.com>
```

Sort Order Changed in glibc C.UTF-8



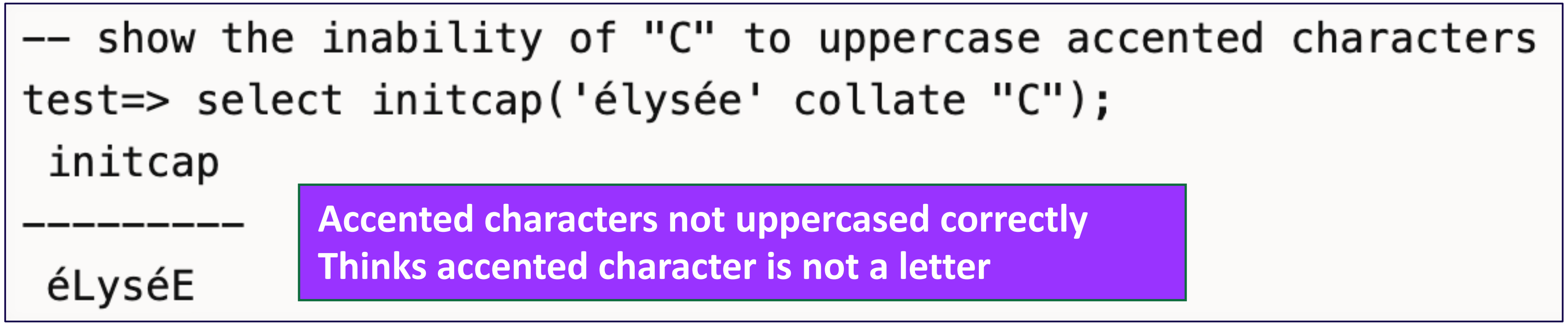
libc provider **C collation**	libc provider **C.UTF-8 collation**
implemented internally; does not call libc (the PG provider name of "libc" is misleading)	calls libc
stable & safe; does not change	changes should be uncommon (less than icu and libc linguistic locales), but history shows that both character semantics and sort order have not remained unchanged for example in Debian/Ubuntu (cf. mailing list thread)

INCORRECT

20. Collation provider is only for sort order

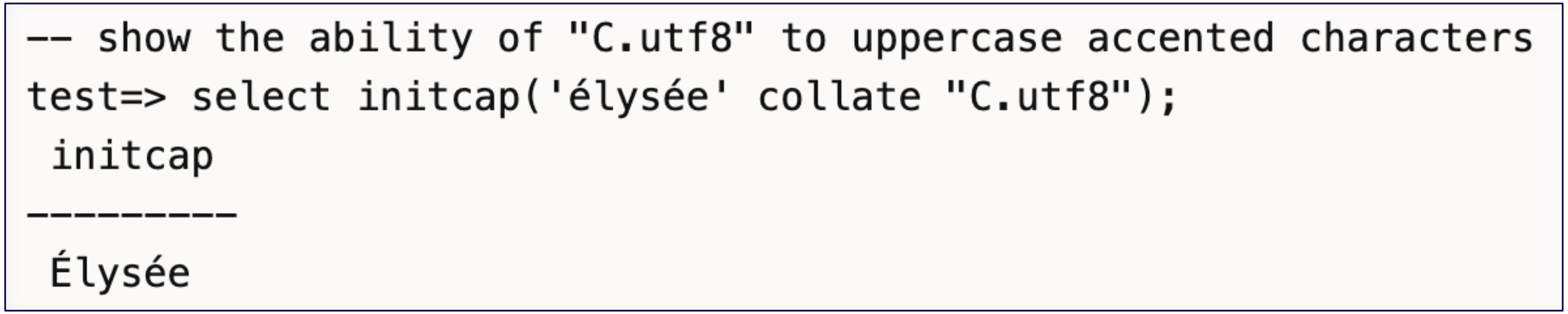
Postgres “C” Locale Only Understands ASCII

✅ CTYPE = upper, lower, initcap, regex character classes, etc



```
-- show the inability of "C" to uppercase accented characters
test=> select initcap('élysée' collate "C");
 initcap
---------
 éLyséE
```

Accented characters not uppercased correctly
Thinks accented character is not a letter



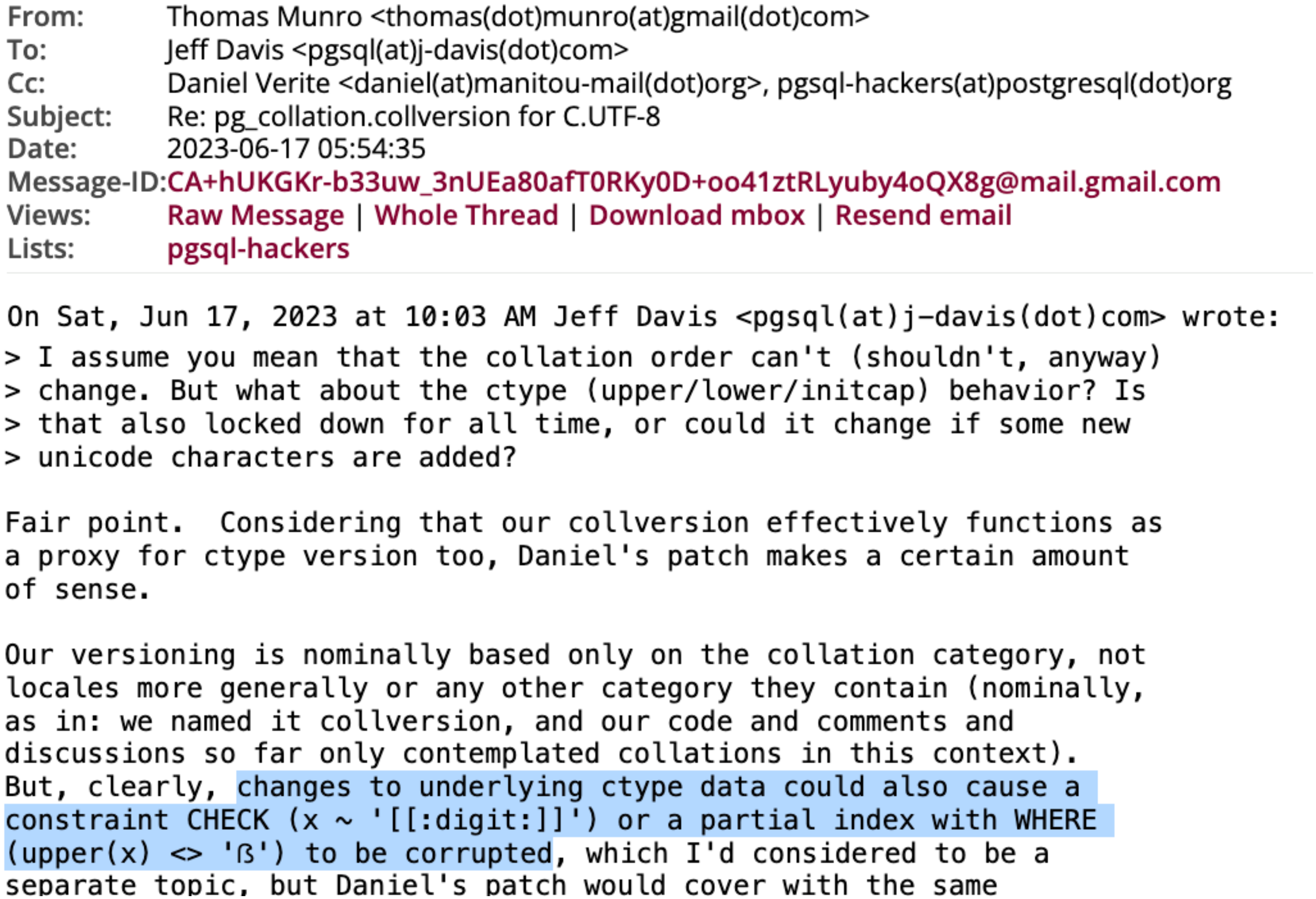
```
-- show the ability of "C.utf8" to uppercase accented characters
test=> select initcap('élysée' collate "C.utf8");
 initcap
---------
 Élysée
```

https://postgresql.verite.pro/blog/2024/03/13/binary-sorted-indexes.html

INCORRECT

21. CTYPE doesn’t change in `C.UTF-8`

Upper,etc might change too



From: Thomas Munro <thomas(dot)munro(at)gmail(dot)com>
To: Jeff Davis <pgsql(at)j-davis(dot)com>
Cc: Daniel Verite <daniel(at)manitou-mail(dot)org>, pgsql-hackers(at)postgresql(dot)org
Subject: Re: pg_collation.collversion for C.UTF-8
Date: 2023-06-17 05:54:35
Message-ID:CA+hUKGKr-b33uw_3nUEa80afT0RKy0D+oo41ztRLyuby4oQX8g@mail.gmail.com
Views: Raw Message | Whole Thread | Download mbox | Resend email
Lists: pgsql-hackers

On Sat, Jun 17, 2023 at 10:03 AM Jeff Davis <pgsql(at)j-davis(dot)com> wrote:

> I assume you mean that the collation order can't (shouldn't, anyway)
> change. But what about the ctype (upper/lower/initcap) behavior? Is
> that also locked down for all time, or could it change if some new
> unicode characters are added?

Fair point. Considering that our collversion effectively functions as a proxy for ctype version too, Daniel's patch makes a certain amount of sense.

Our versioning is nominally based only on the collation category, not locales more generally or any other category they contain (nominally, as in: we named it collversion, and our code and comments and discussions so far only contemplated collations in this context). But, clearly, changes to underlying ctype data could also cause a constraint CHECK (x ~ '[[:digit:]]') or a partial index with WHERE (upper(x) <> 'ß') to be corrupted, which I'd considered to be a separate topic, but Daniel's patch would cover with the same

INCORRECT

22. Users want DB-wide linguistic sort

No widely used major database today would default to code-point or binary sort order

Code Point Order as Database Default

https://ardentperf.com/2024/05/22/default-sort-order-in-db2-sql-server-oracle-postgres-17/

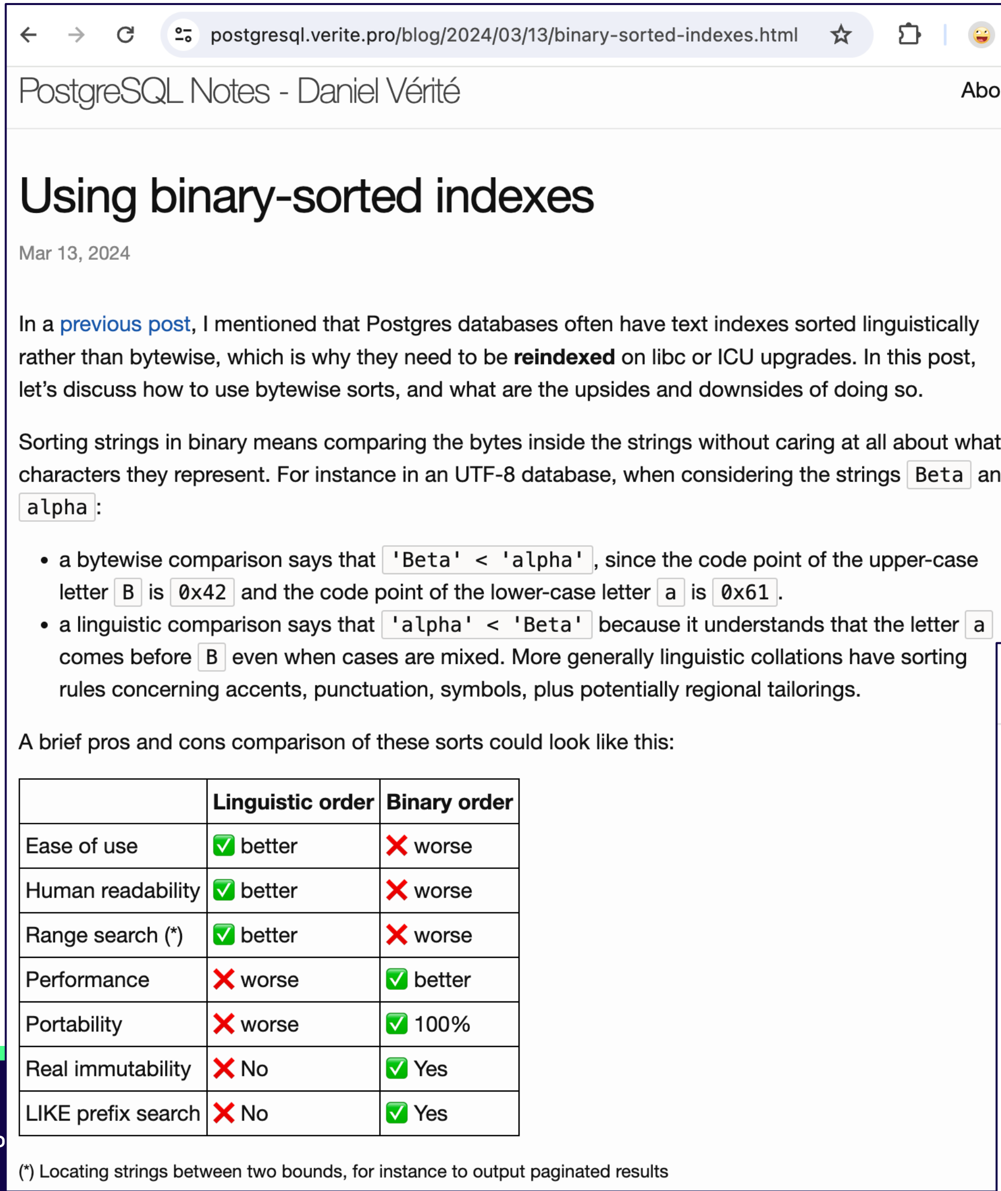
	Default Collation	Server/Client	System Catalogs	UCA Support
Oracle	Code Point Order ‡ (called BINARY)	Property of connection/client, can change	Always BINARY	Unicode Versions 6.1 / 6.2 / 7.0 / 12.1 builtin
Db2	Code Point Order (called IDENTITY)	Property of database/server, cannot change	Always IDENTITY for Unicode DBs	Unicode Versions 4.0 / 5.0 / 5.2 / 7.0 builtin
SQL Server	OS default locale with 8-bit encoding	Property of database/server, can change DB default for new objects, cannot server/catalogs	Server collation	Not supported (afaik?)
Postgres	OS default locale with Unicode	Property of database/server, cannot change	Database collation	Unicode Version 4.2+ installed separately

‡ If Oracle client locale is Europe, Middle East, Quebec, or a few other unlucky countries – then the default behavior is that ORDER BY and a few functions like regex sort with client locale, while operators like greater-than, less-than, group-by and indexes still use code-point/BINARY order.

Anecdotally, it seems common to run Oracle with default settings for database-wide collation.

Oracle third-party apps like eBusiness Suite require binary (code-point) collation.
Some SQL Server third-party apps also mandate a specific collation, for portability.

Code Point Order as Database Default



postgresql.verite.pro/blog/2024/03/13/binary-sorted-indexes.html

PostgreSQL Notes - Daniel Vérité

About

Using binary-sorted indexes

Mar 13, 2024

In a previous post, I mentioned that Postgres databases often have text indexes sorted linguistically rather than bytewise, which is why they need to be **reindexed** on libc or ICU upgrades. In this post, let's discuss how to use bytewise sorts, and what are the upsides and downsides of doing so.

Sorting strings in binary means comparing the bytes inside the strings without caring at all about what characters they represent. For instance in an UTF-8 database, when considering the strings `Beta` and `alpha`:

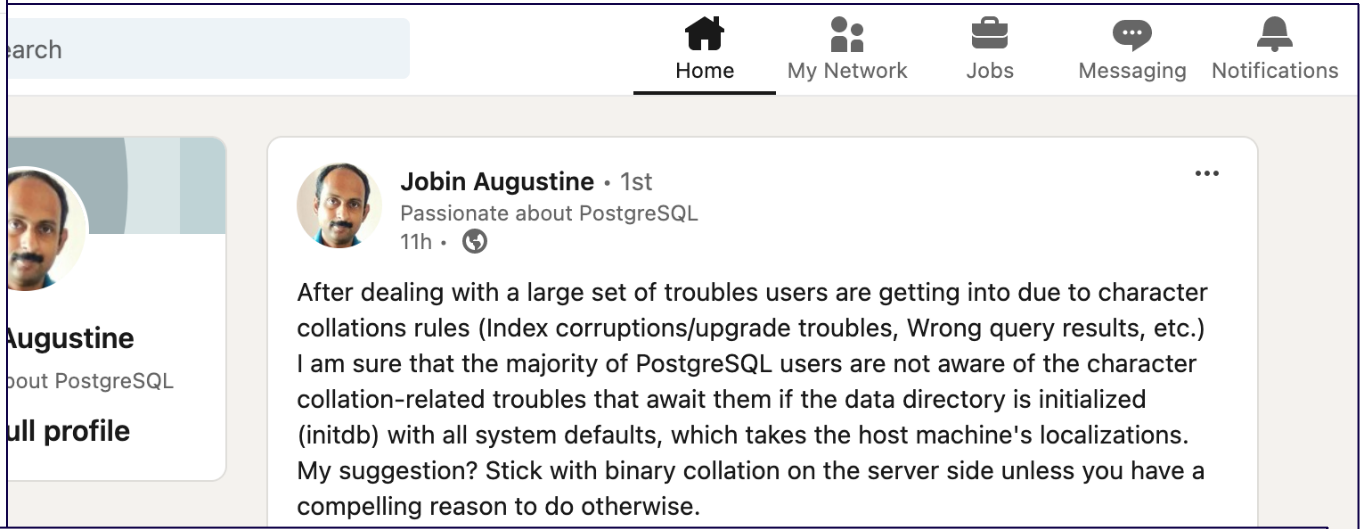
- a bytewise comparison says that `'Beta' < 'alpha'`, since the code point of the upper-case letter `B` is `0x42` and the code point of the lower-case letter `a` is `0x61`.
- a linguistic comparison says that `'alpha' < 'Beta'` because it understands that the letter `a` comes before `B` even when cases are mixed. More generally linguistic collations have sorting rules concerning accents, punctuation, symbols, plus potentially regional tailorings.

A brief pros and cons comparison of these sorts could look like this:

	Linguistic order	Binary order
Ease of use	✅ better	❌ worse
Human readability	✅ better	❌ worse
Range search (*)	✅ better	❌ worse
Performance	❌ worse	✅ better
Portability	❌ worse	✅ 100%
Real immutability	❌ No	✅ Yes
LIKE prefix search	❌ No	✅ Yes

(*) Locating strings between two bounds, for instance to output paginated results

Ongoing discussion: making a case for binary at DB level?

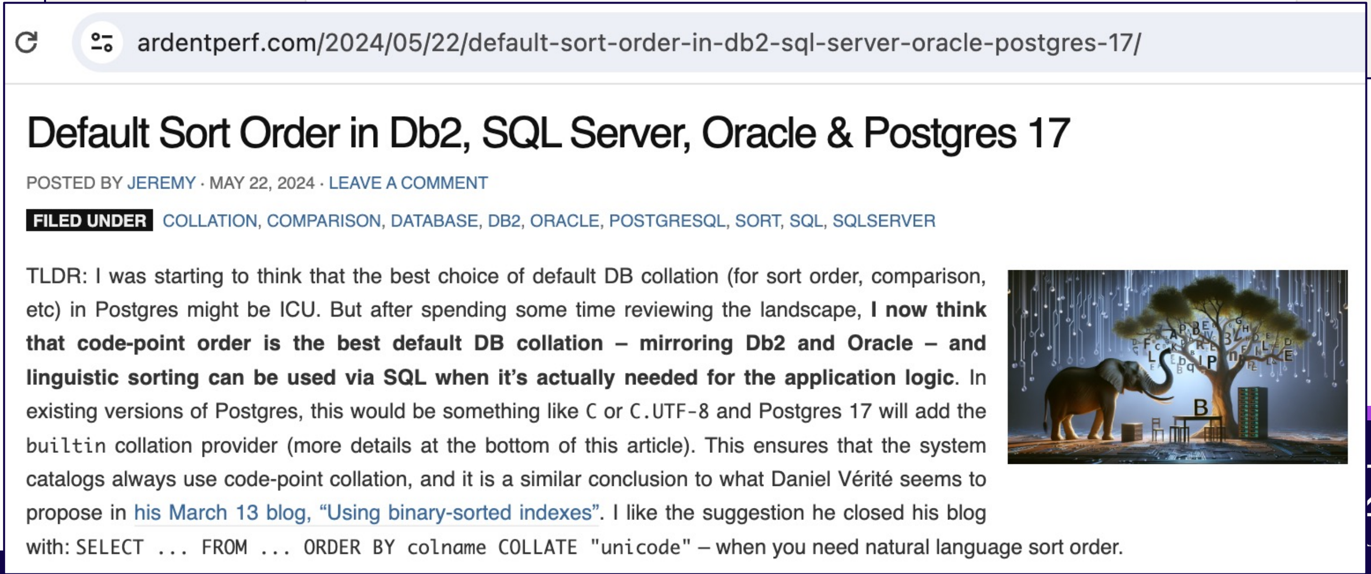


Jobin Augustine • 1st

Passionate about PostgreSQL

11h •

After dealing with a large set of troubles users are getting into due to character collations rules (Index corruptions/upgrade troubles, Wrong query results, etc.)
I am sure that the majority of PostgreSQL users are not aware of the character collation-related troubles that await them if the data directory is initialized (initdb) with all system defaults, which takes the host machine's localizations.
My suggestion? Stick with binary collation on the server side unless you have a compelling reason to do otherwise.



ardentperf.com/2024/05/22/default-sort-order-in-db2-sql-server-oracle-postgres-17/

Default Sort Order in Db2, SQL Server, Oracle & Postgres 17

POSTED BY JEREMY · MAY 22, 2024 · LEAVE A COMMENT

FILED UNDER COLLATION, COMPARISON, DATABASE, DB2, ORACLE, POSTGRESQL, SORT, SQL, SQLSERVER

TLDR: I was starting to think that the best choice of default DB collation (for sort order, comparison, etc) in Postgres might be ICU. But after spending some time reviewing the landscape, **I now think that code-point order is the best default DB collation – mirroring Db2 and Oracle – and linguistic sorting can be used via SQL when it's actually needed for the application logic.** In existing versions of Postgres, this would be something like `C` or `C.UTF-8` and Postgres 17 will add the `builtin` collation provider (more details at the bottom of this article). This ensures that the system catalogs always use code-point collation, and it is a similar conclusion to what Daniel Vérité seems to propose in his March 13 blog, "Using binary-sorted indexes". I like the suggestion he closed his blog with: `SELECT ... FROM ... ORDER BY colname COLLATE "unicode"` – when you need natural language sort order.

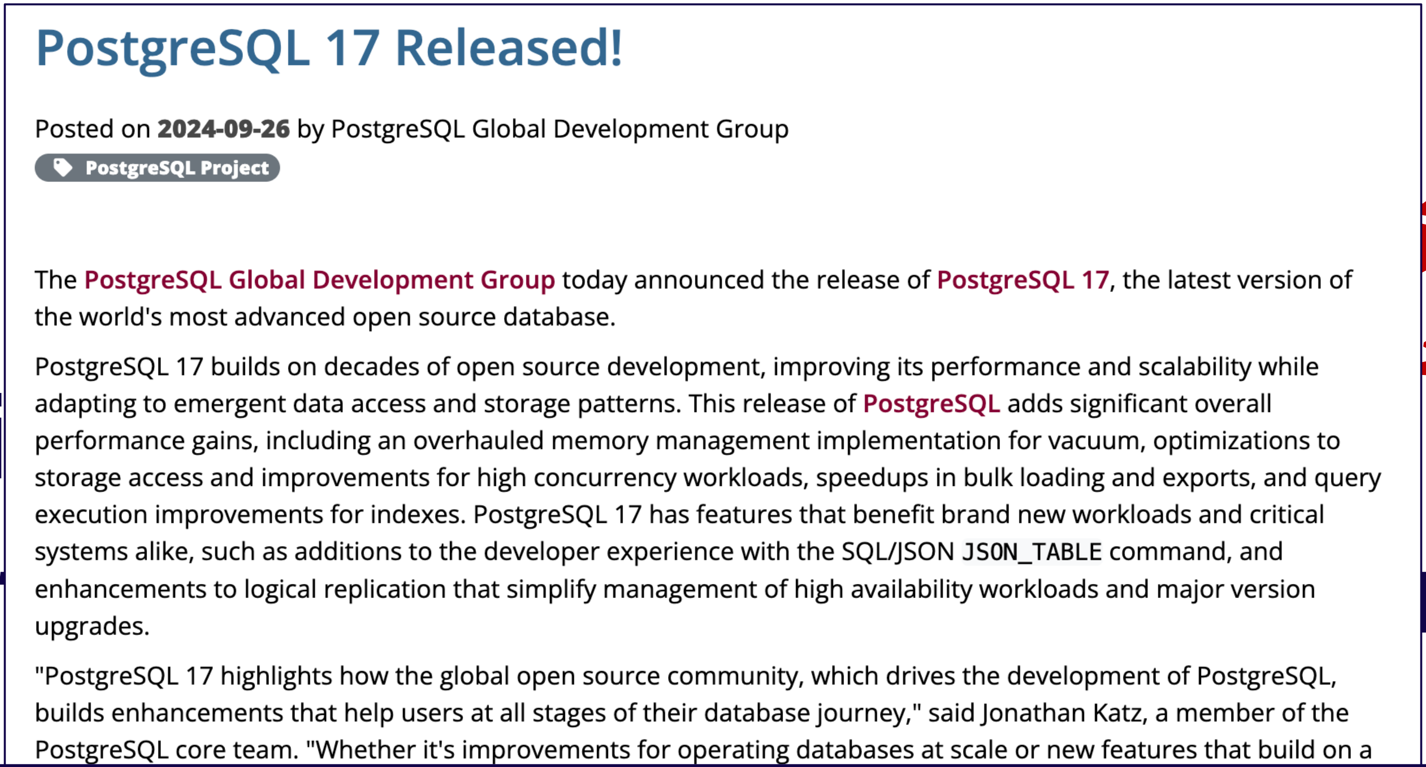
INCORRECT

23. Postgres isn’t likely to get a new builtin collation solving these problems

Usable character semantics and no corruption risks

23. Postgres i

builtin collat ms



PostgreSQL 17 Released!

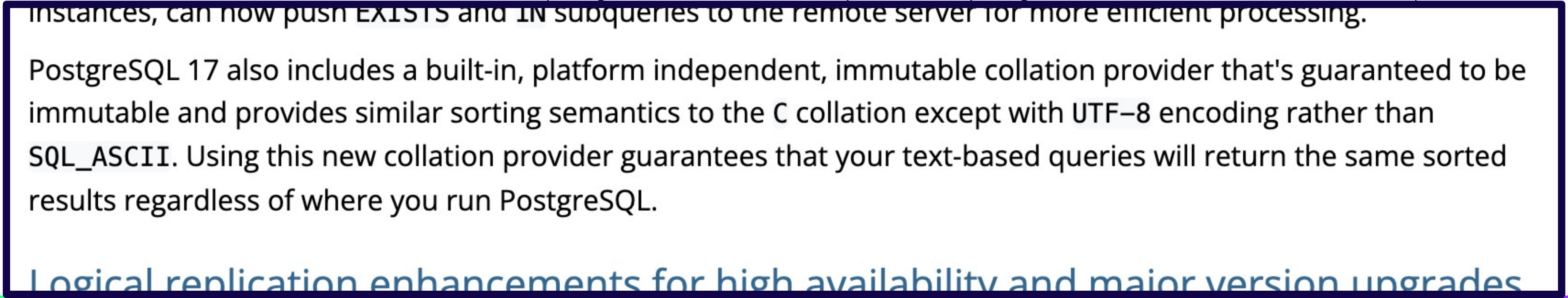
Posted on **2024-09-26** by PostgreSQL Global Development Group

PostgreSQL Project

The PostgreSQL Global Development Group today announced the release of PostgreSQL 17, the latest version of the world's most advanced open source database.

PostgreSQL 17 builds on decades of open source development, improving its performance and scalability while adapting to emergent data access and storage patterns. This release of PostgreSQL adds significant overall performance gains, including an overhauled memory management implementation for vacuum, optimizations to storage access and improvements for high concurrency workloads, speedups in bulk loading and exports, and query execution improvements for indexes. PostgreSQL 17 has features that benefit brand new workloads and critical systems alike, such as additions to the developer experience with the SQL/JSON `JSON_TABLE` command, and enhancements to logical replication that simplify management of high availability workloads and major version upgrades.

"PostgreSQL 17 highlights how the global open source community, which drives the development of PostgreSQL, builds enhancements that help users at all stages of their database journey," said Jonathan Katz, a member of the PostgreSQL core team. "Whether it's improvements for operating databases at scale or new features that build on a



instances, can now push `EXISTS` and `IN` subqueries to the remote server for more efficient processing.

PostgreSQL 17 also includes a built-in, platform independent, immutable collation provider that's guaranteed to be immutable and provides similar sorting semantics to the `C` collation except with `UTF-8` encoding rather than `SQL_ASCII`. Using this new collation provider guarantees that your text-based queries will return the same sorted results regardless of where you run PostgreSQL.

Logical replication enhancements for high availability and major version upgrades

Advanced Collation Features

Collation Precedence in PostgreSQL

Levels of Defaults:

- OS Environment (for initdb)
- Template0/1 (for database)
- Database
- Table/Column
- Data Type (for constants)
- Explicit in SQL statement

Conflict Resolution Rules:

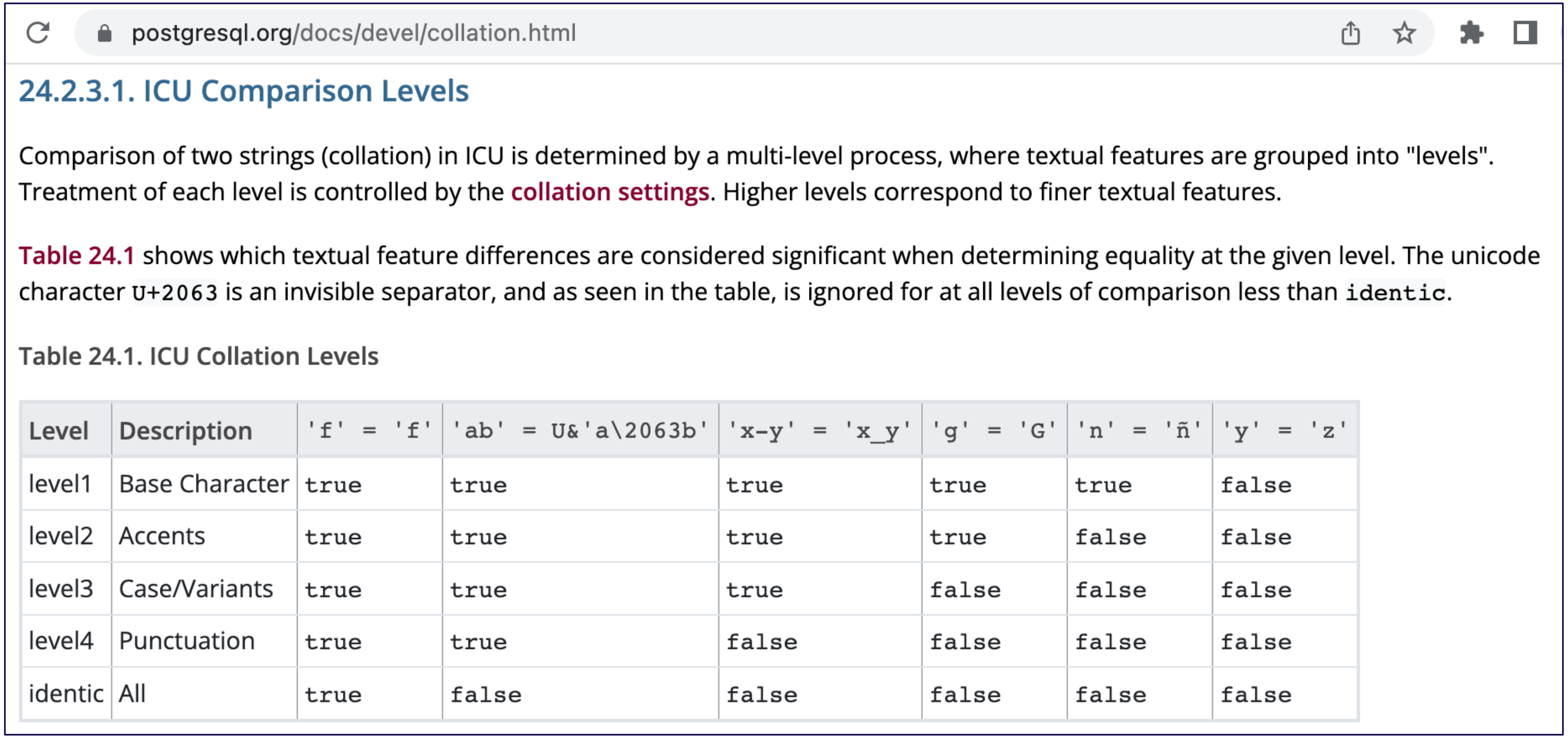
1. Explicit > Implicit
2. Non-default > Default
3. Indeterminate collation only raises error if collation is needed at runtime

Docs: Part III (Server Admin)
Chapter 24 (Localization)
Part 24.2 (Collation Support)

Advanced Collation Support with ICU

- Case insensitive comparison
- Comparison of base characters, ignoring accents
  - Example: count rows where user input was Mexico, México, mexico, or méxico
- Compare digits by numeric value
  - Example: id-45 < id-123
- Ignore whitespace, so that similar strings are kept close together
  - By default, glibc keeps similar strings close but with ICU whitespace can cause similar strings to sort far apart from each other.
  - Example: “full time” and “full-time” and “fulltime”
- May get extra performance by comparing without normalizing
  - Safe for strings that are system-generated and guaranteed to be consistent, or that are pre-normalized

Advanced Collation Support with ICU



24.2.3.1. ICU Comparison Levels

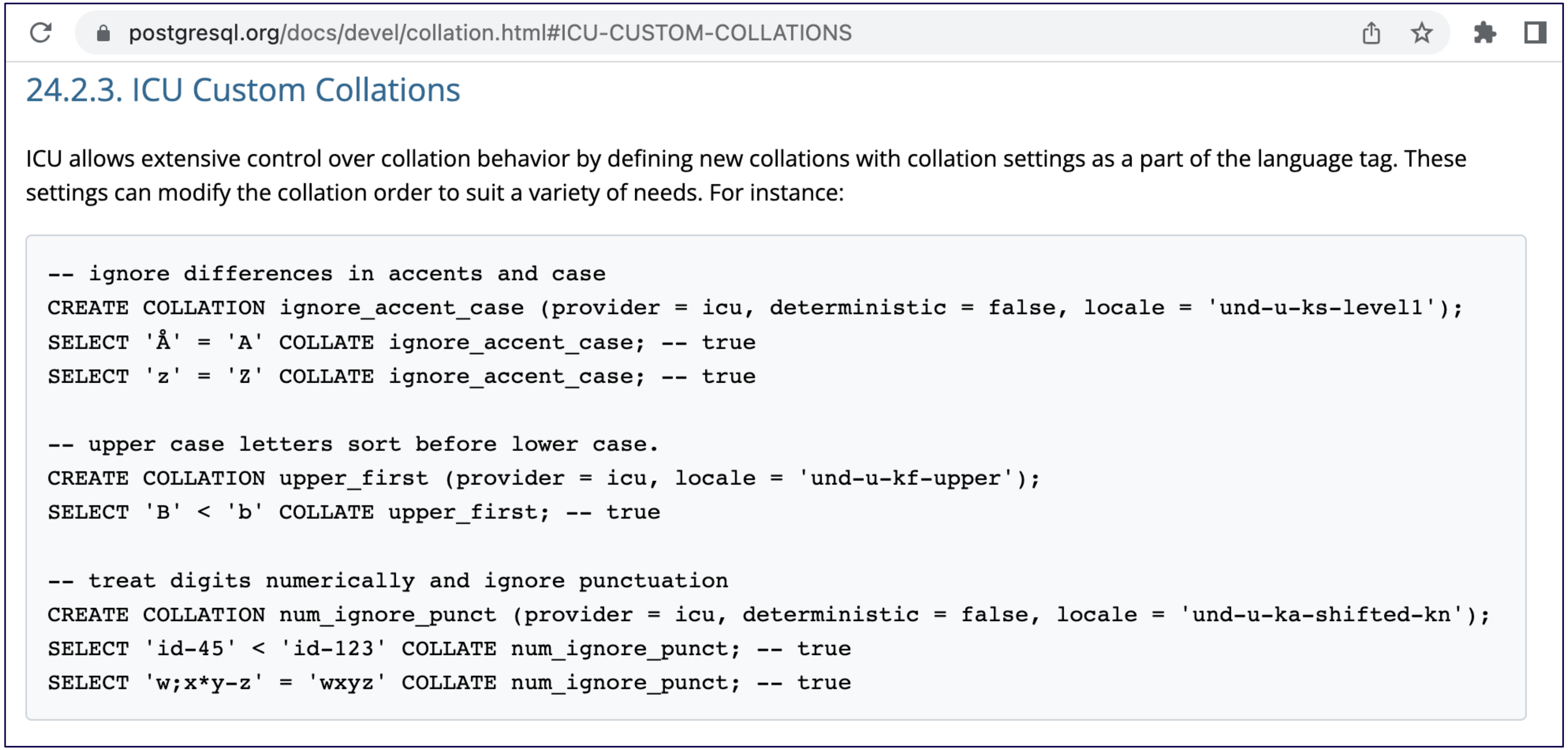
Comparison of two strings (collation) in ICU is determined by a multi-level process, where textual features are grouped into "levels". Treatment of each level is controlled by the collation settings. Higher levels correspond to finer textual features.

Table 24.1 shows which textual feature differences are considered significant when determining equality at the given level. The unicode character `U+2063` is an invisible separator, and as seen in the table, is ignored for at all levels of comparison less than `identic`.

Table 24.1. ICU Collation Levels

Level	Description	`'f' = 'f'`	`'ab' = U&'a\2063b'`	`'x-y' = 'x_y'`	`'g' = 'G'`	`'n' = 'ñ'`	`'y' = 'z'`
level1	Base Character	true	true	true	true	true	false
level2	Accents	true	true	true	true	false	false
level3	Case/Variants	true	true	true	false	false	false
level4	Punctuation	true	true	false	false	false	false
identic	All	true	false	false	false	false	false

Advanced Collation Support with ICU

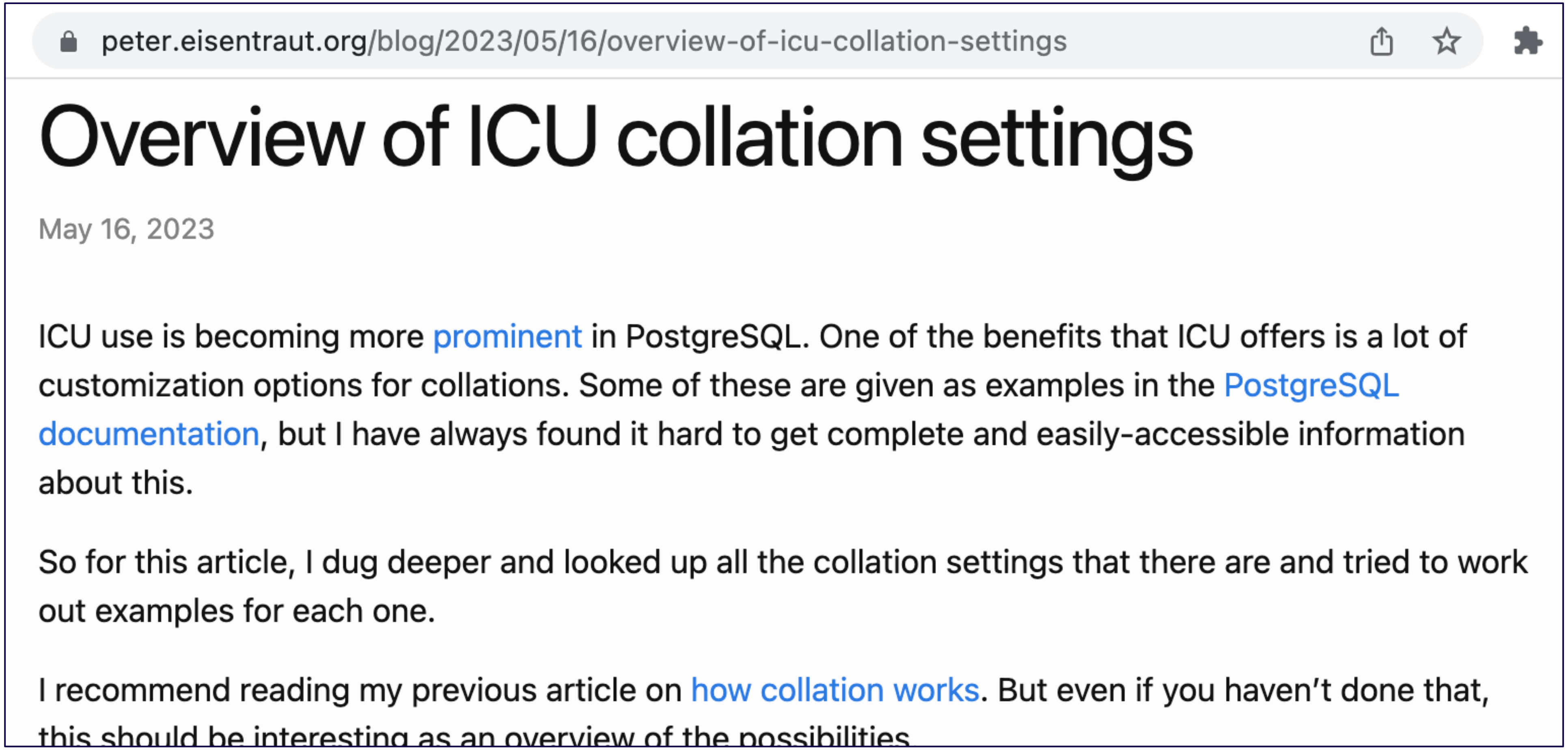

postgresql.org/docs/devel/collation.html#ICU-CUSTOM-COLLATIONS

24.2.3. ICU Custom Collations

ICU allows extensive control over collation behavior by defining new collations with collation settings as a part of the language tag. These settings can modify the collation order to suit a variety of needs. For instance:

```
-- ignore differences in accents and case
CREATE COLLATION ignore_accent_case (provider = icu, deterministic = false, locale = 'und-u-ks-level1');
SELECT 'Å' = 'A' COLLATE ignore_accent_case; -- true
SELECT 'z' = 'Z' COLLATE ignore_accent_case; -- true

-- upper case letters sort before lower case.
CREATE COLLATION upper_first (provider = icu, locale = 'und-u-kf-upper');
SELECT 'B' < 'b' COLLATE upper_first; -- true

-- treat digits numerically and ignore punctuation
CREATE COLLATION num_ignore_punct (provider = icu, deterministic = false, locale = 'und-u-ka-shifted-kn');
SELECT 'id-45' < 'id-123' COLLATE num_ignore_punct; -- true
SELECT 'w;x*y-z' = 'wxyz' COLLATE num_ignore_punct; -- true
```

Advanced Collation Support with ICU



peter.eisentraut.org/blog/2023/05/16/overview-of-icu-collation-settings

Overview of ICU collation settings

May 16, 2023

ICU use is becoming more prominent in PostgreSQL. One of the benefits that ICU offers is a lot of customization options for collations. Some of these are given as examples in the PostgreSQL documentation, but I have always found it hard to get complete and easily-accessible information about this.

So for this article, I dug deeper and looked up all the collation settings that there are and tried to work out examples for each one.

I recommend reading my previous article on how collation works. But even if you haven't done that, this should be interesting as an overview of the possibilities

Key Takeaways

- Assume there are exotic unexpected characters in your data
- When upgrading your operating system, (1) dump or (2) logical or (3) use old ICU/glibc or (4) use builtin C collation in pg17+
- Move toward default C collation with table and query level linguistic collation
- ICU brings powerful new capabilities around linguistic collation
  - Consider ICU when doing fuzzy comparisons or multi-lingual sorting

- Not a great idea to under-pay your administrators.
  Give them lots of thanks and some extra vacation time. 🏝️

PostgreSQL Happiness Hints

version:
jer_s/2022-04-26

Checksums and Huge Pages Enabled

Connection Pooling

- Centralized (e.g. pgbouncer) and decentralized (e.g. JDBC) architectures
- Recycle server connections (e.g. server_lifetime)
- Limit or avoid dynamic growth when practical – queue at a tier above the DB

Default Limits: Temp Usage, Statement & Idle Transaction Timeout

- Timeouts 5-15 minutes or lower, increase at session level if needed

Scaling

- Measure conn count in hundreds (not thousands), table count in thousands (not hundreds of thousands), relation size in GB (not TB), indexes per table in single digits (not double digits)
- Higher ranges work, but often require budget for experienced & expensive PostgreSQL staff
- To scale workloads, shard across instances or carefully partition tables

Updates and Upgrades

- PostgreSQL quarterly stable “minors” = security and critical fixes only
  - On Aurora: minors can have new development work
- Before major version upgrade, compare plans and latencies of top SQL on upgraded test copy
- Remember to upgrade extensions; it’s not automatic
- Stats/analyze after major version upgrade

Logging

- Minimum 1 month retention (on AWS: use max retention and publish to Cloudwatch)
- Log autovacuum minimum duration = 10 seconds or lower
- Log lock waits
- Log temp usage when close to the default limit
- On AWS: autovacuum force logging level = WARNING

Multiple Physical Data Centers (= Multi-AZ on AWS)

Physical Backups

- Minimum 1 month retention
- Regular restore testing

Logical Backups (at least one)

- Scheduled exports/dumps and redrive/replay
- Logical replication

Active Session Monitoring (= Performance Insights on AWS)

- Save snapshots of pg_stat_activity making sure to include wait events
- Keep historical data, minimum 1 month retention (hopefully much more)

SQL and Catalog and Other Database Statistics Monitoring

- Preload pg_stat_statements
- Save snapshots of pg_stat_statements and key statistics
  - Exec plans (eg. auto_explain or others), relation sizes (bytes & rows incl catalogs), unused indexes
  - Rates: tuple fetch & return, WAL record & fpi & byte, DDL, XID, subtransaction, multixact, conn
- Keep historical data, minimum 1 month retention (hopefully much more)

OS Monitoring (= Enhanced Monitoring on AWS)

- Granularity of 10 seconds or lower (1 second if possible)
- Keep historical data, minimum 1 month retention (hopefully much more)

Alarms

- **Average active sessions** (= dbload cloudwatch metric on AWS)
- Memory / swap
- Disk space: %space and %inodes (and free local storage on Aurora)
- Hot standby & logical replication lag / WAL size (disk space) on primary
- Unexpected errors in the logs, both database and application tier
- Maximum used transaction IDs (aka time to wraparound)
- Checkpoint: time since latest & warnings in log (doesn’t apply to Aurora)

Your feedback is important to us

Evaluate this session at:

www.PASSDataCommunitySummit.com/evaluation

Thank you

www.PASSDataCommunitySummit.com/evaluation

Jeremy Schneider

ardentperf.com

pgtreats.info/slack-invite

linkedin.com/in/ardentperf

@jer_s