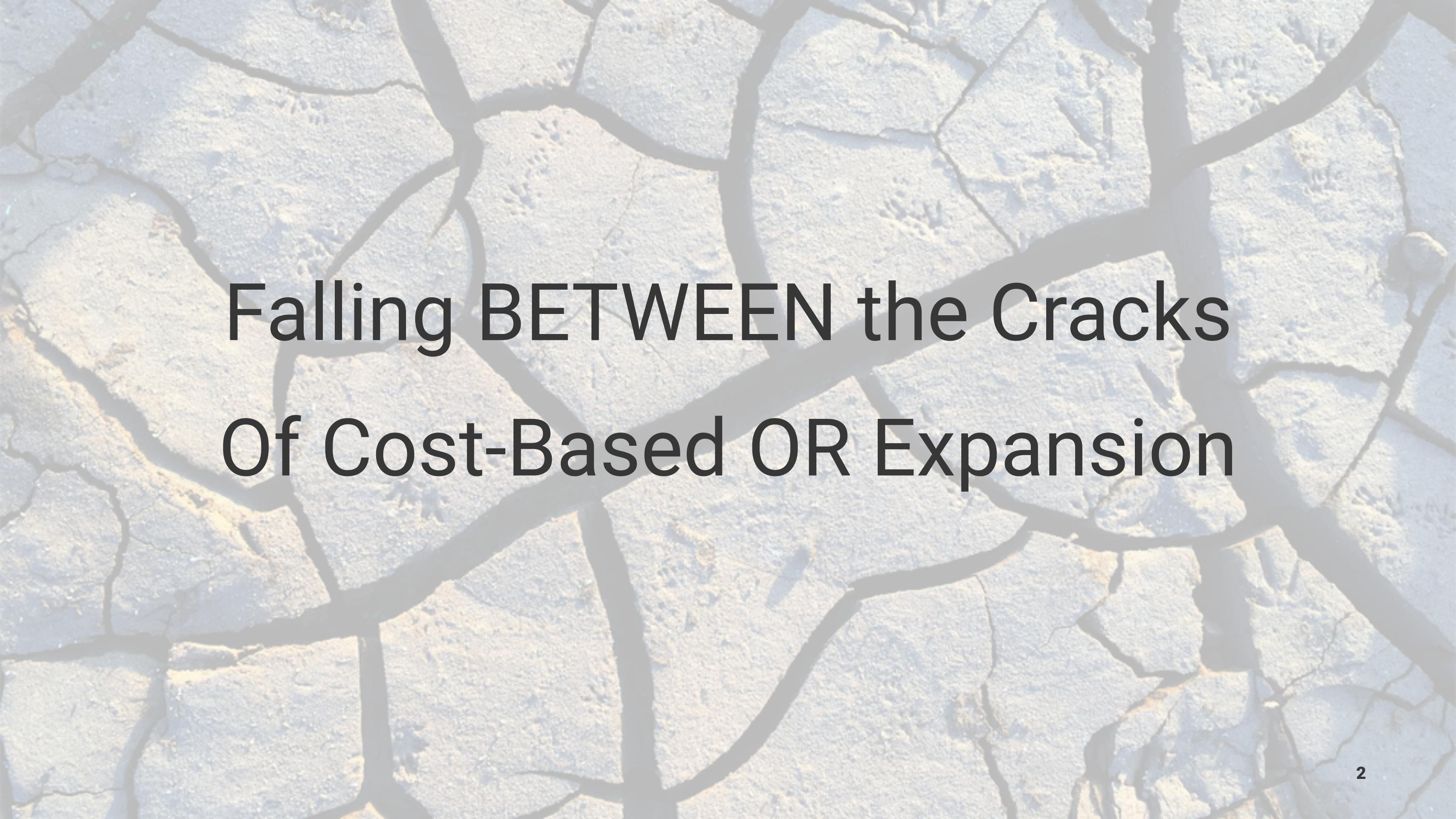
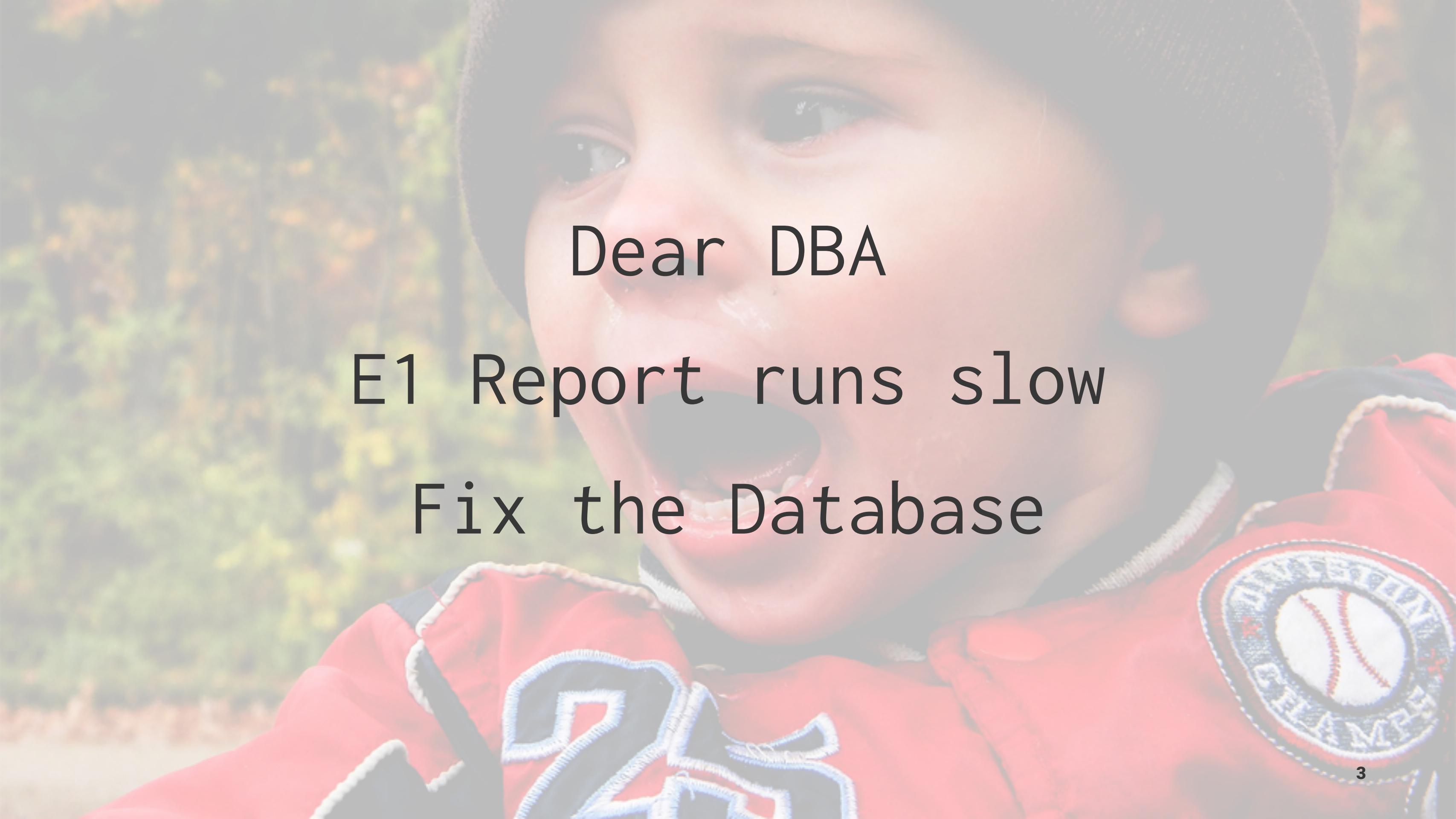




**Falling BETWEEN the Cracks  
Of Cost-Based OR Expansion**



**Falling BETWEEN the Cracks  
Of Cost-Based OR Expansion**



Dear DBA

E1 Report runs slow

Fix the Database







**LNNVL**

A man in a dark suit stands in front of a wall of numerous smoking firearms. He is looking slightly to his left with a neutral expression. The guns are arranged in rows, creating a dense, repetitive pattern behind him.

**SMOKING GUNS**

**LOTS OF SMOKING GUNS**

A woman with dark hair tied back, wearing a light blue button-down shirt, stands against a white background. She is smiling and pointing her right index finger upwards towards the top right corner of the frame.

Let's try with  
"\_optimizer\_cbqt\_or\_expansion"="off"



Wow so fast now! !!

Thanks







Guess it will take a week to understand  
but still end up with same "fix"

# Cost-Based OR Expansion (CBOE)

SQL> info+ cboe

TABLE: CB0E

INDEX_NAME	COLUMNS
I1	C1
I2	C2

-- Without Cost-Based OR Expansion

```
SQL> ALTER SESSION SET "_optimizer_cbqt_or_expansion"=off;
```

Session altered.

```
SQL> SELECT NULL FROM cboe WHERE c1 = 1 OR c2 = 1;
```

Id	Operation	Name
0	SELECT STATEMENT	
* 1	TABLE ACCESS FULL	CBOE

Predicate Information:

```
-----  
1 - filter(("C1"=1 OR "C2"=1))
```

```
-- With Cost Based OR Expansion (default)
SQL> ALTER SESSION SET "_optimizer_cbqt_or_expansion"=on;
```

Session altered.

```
SQL> SELECT NULL FROM cboe WHERE c1 = 1 OR c2 = 1;
```

↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓  
↓↓            CBOE            ↓↓  
↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓↓

```
SELECT NULL FROM cboe WHERE        c1 = 1
UNION ALL
SELECT NULL FROM cboe WHERE NOT (c1 = 1) AND c2 = 1
```

Id	Operation	Name	Rows
0	SELECT STATEMENT		2
1	VIEW	VW_ORE_3D763F05	2
2	UNION-ALL		2
* 3	INDEX RANGE SCAN	I1	1
* 4	TABLE ACCESS BY INDEX ROWID BATCHED	CBOE	1
* 5	INDEX RANGE SCAN	I2	1

Predicate Information (identified by operation id):

- 
- 3 - access("C1"=1)
  - 4 - filter(LNNVL("C1"=1))
  - 5 - access("C2"=1)

A cartoon illustration of a construction worker wearing a yellow hard hat and a red and orange plaid shirt, standing next to a blue cat. The worker has his arms raised in a 'shaka' hand gesture. They are holding a tool belt with various tools like a wrench and a screwdriver. In the background, there are white clouds and a blue sky.

We Can Build A Test Case!

Yes We Can!

SQL> info+ t

TABLE: T

ROWS :100 000

Columns

NAME	DATA TYPE	NULL	LOW_VALUE	HIGH_VALUE	NUM_DISTINCT	HISTOGRAM
C	NUMBER(2,0)	No	0	99	100	NONE
P	VARCHAR2(4000 BYTE)	Yes	XXXX<->XXXXXX	XXXX<->XXXX	1	NONE

Indexes

INDEX\_NAME            COLUMNS

I                      C

```
SQL> ALTER SESSION SET "_optimizer_cbqt_or_expansion"=off;
```

Session altered.

```
SQL> SELECT COUNT(*) FROM t WHERE (p IS NOT NULL) AND  
  ( (c BETWEEN 1 AND 2) OR (c BETWEEN 3 AND 4) OR (c BETWEEN 5 AND 6) OR (c BETWEEN 7 AND 8) OR  
  (c BETWEEN 9 AND 10) OR (c BETWEEN 11 AND 12) OR (c BETWEEN 13 AND 14) OR (c BETWEEN 15 AND 16) OR  
  (c BETWEEN 17 AND 18) OR (c BETWEEN 19 AND 20) OR (c BETWEEN 21 AND 22) OR (c BETWEEN 23 AND 24) OR  
  (c BETWEEN 25 AND 26) OR (c BETWEEN 27 AND 28) OR (c BETWEEN 29 AND 30) OR (c BETWEEN 31 AND 32) OR  
  (c BETWEEN 33 AND 34) OR (c BETWEEN 35 AND 36) OR (c BETWEEN 37 AND 38) OR (c BETWEEN 39 AND 40) OR  
  (c BETWEEN 41 AND 42) OR (c BETWEEN 43 AND 44) OR (c BETWEEN 45 AND 46) OR (c BETWEEN 47 AND 48) OR  
  (c BETWEEN 49 AND 50) OR (c BETWEEN 51 AND 52) OR (c BETWEEN 53 AND 54) OR (c BETWEEN 55 AND 56) OR  
  (c BETWEEN 57 AND 58) OR (c BETWEEN 59 AND 60) OR (c BETWEEN 61 AND 62) OR (c BETWEEN 63 AND 64) OR  
  (c BETWEEN 65 AND 66) OR (c BETWEEN 67 AND 68) OR (c BETWEEN 69 AND 70) OR (c BETWEEN 71 AND 72) OR  
  (c BETWEEN 73 AND 74) OR (c BETWEEN 75 AND 76) OR (c BETWEEN 77 AND 78) OR (c BETWEEN 79 AND 80) OR  
  (c BETWEEN 81 AND 82) OR (c BETWEEN 83 AND 84) OR (c BETWEEN 85 AND 86) OR (c BETWEEN 87 AND 88) OR  
  (c BETWEEN 89 AND 90) OR (c BETWEEN 91 AND 92) OR (c BETWEEN 93 AND 94) OR (c BETWEEN 95 AND 96) OR  
  (c BETWEEN 97 AND 98) );
```

COUNT(*)
-----
98000

Elapsed: 00:00:00.497

Id	Operation	Name	Starts	E-Rows	A-Rows
0	SELECT STATEMENT			1	1
1	SORT AGGREGATE			1	1
2	TABLE ACCESS FULL	T	1	77633	98000

```
SQL> ALTER SESSION SET "_optimizer_cbqt_or_expansion"="on";
```

Session altered.

```
SQL> SELECT COUNT(*) FROM t WHERE (p IS NOT NULL) AND  
  ( (c BETWEEN 1 AND 2) OR (c BETWEEN 3 AND 4) OR (c BETWEEN 5 AND 6) OR (c BETWEEN 7 AND 8) OR  
    (c BETWEEN 9 AND 10) OR (c BETWEEN 11 AND 12) OR (c BETWEEN 13 AND 14) OR (c BETWEEN 15 AND 16) OR  
    (c BETWEEN 17 AND 18) OR (c BETWEEN 19 AND 20) OR (c BETWEEN 21 AND 22) OR (c BETWEEN 23 AND 24) OR  
    (c BETWEEN 25 AND 26) OR (c BETWEEN 27 AND 28) OR (c BETWEEN 29 AND 30) OR (c BETWEEN 31 AND 32) OR  
    (c BETWEEN 33 AND 34) OR (c BETWEEN 35 AND 36) OR (c BETWEEN 37 AND 38) OR (c BETWEEN 39 AND 40) OR  
    (c BETWEEN 41 AND 42) OR (c BETWEEN 43 AND 44) OR (c BETWEEN 45 AND 46) OR (c BETWEEN 47 AND 48) OR  
    (c BETWEEN 49 AND 50) OR (c BETWEEN 51 AND 52) OR (c BETWEEN 53 AND 54) OR (c BETWEEN 55 AND 56) OR  
    (c BETWEEN 57 AND 58) OR (c BETWEEN 59 AND 60) OR (c BETWEEN 61 AND 62) OR (c BETWEEN 63 AND 64) OR  
    (c BETWEEN 65 AND 66) OR (c BETWEEN 67 AND 68) OR (c BETWEEN 69 AND 70) OR (c BETWEEN 71 AND 72) OR  
    (c BETWEEN 73 AND 74) OR (c BETWEEN 75 AND 76) OR (c BETWEEN 77 AND 78) OR (c BETWEEN 79 AND 80) OR  
    (c BETWEEN 81 AND 82) OR (c BETWEEN 83 AND 84) OR (c BETWEEN 85 AND 86) OR (c BETWEEN 87 AND 88) OR  
    (c BETWEEN 89 AND 90) OR (c BETWEEN 91 AND 92) OR (c BETWEEN 93 AND 94) OR (c BETWEEN 95 AND 96) OR  
    (c BETWEEN 97 AND 98) );
```

COUNT(*)
-----
98000

Elapsed: 00:00:05.090

Id	Operation	Name	Starts	E-Rows	A-Rows
0	SELECT STATEMENT		1	1	1
1	SORT AGGREGATE		1	1	1
2	VIEW	VW_ORE_1B35BA0F	1	26340	98000
3	UNION-ALL		1		98000
4	TABLE ACCESS BY INDEX ROWID BATCHED	T	1	3010	2000
5	INDEX RANGE SCAN	I	1	3010	2000
6	TABLE ACCESS BY INDEX ROWID BATCHED	T	1	2919	2000
7	INDEX RANGE SCAN	I	1	2919	2000
8	TABLE ACCESS BY INDEX ROWID BATCHED	T	1	2775	2000
9	INDEX RANGE SCAN	I	1	2775	2000
< >	< >	< >	< >	< >	< >
70	TABLE ACCESS BY INDEX ROWID BATCHED	T	1	2	2000
71	INDEX RANGE SCAN	I	1	2	2000
72	TABLE ACCESS BY INDEX ROWID BATCHED	T	1	1	2000
73	INDEX RANGE SCAN	I	1	1	2000
< >	< >	< >	< >	< >	< >
100	TABLE ACCESS BY INDEX ROWID BATCHED	T	1	1	2000
101	INDEX RANGE SCAN	I	1	1	2000
					<-- 97↔98



# Do Not

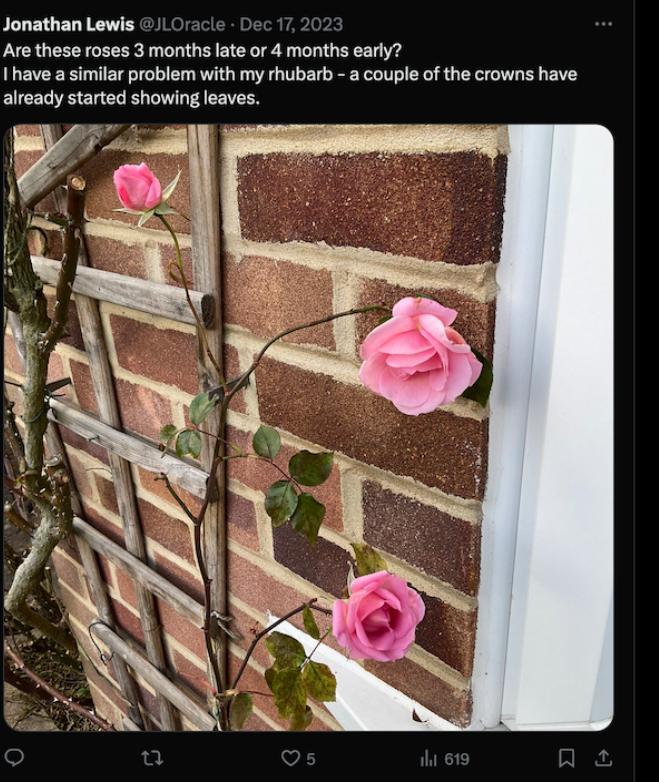
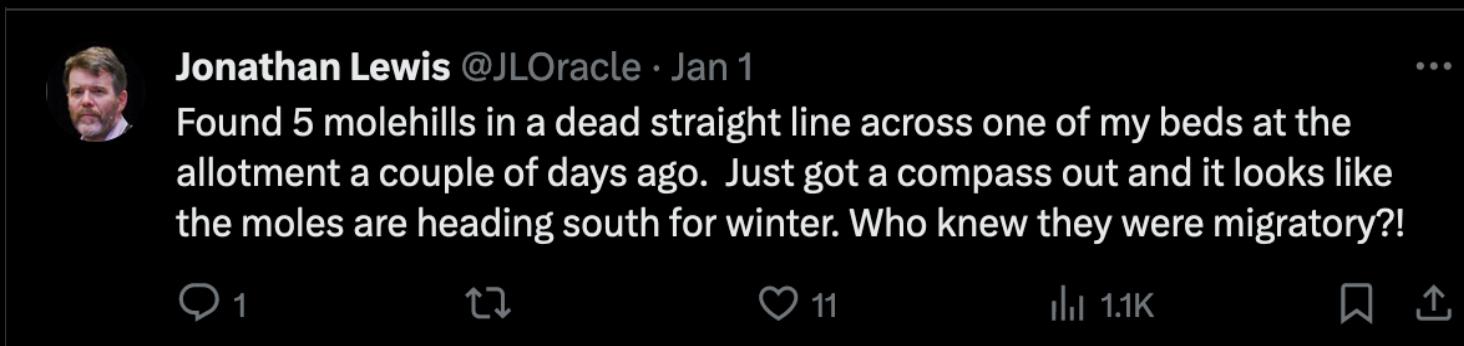
- 26,340 with transform
- 77,633 without transform
- Anything about the optimizer

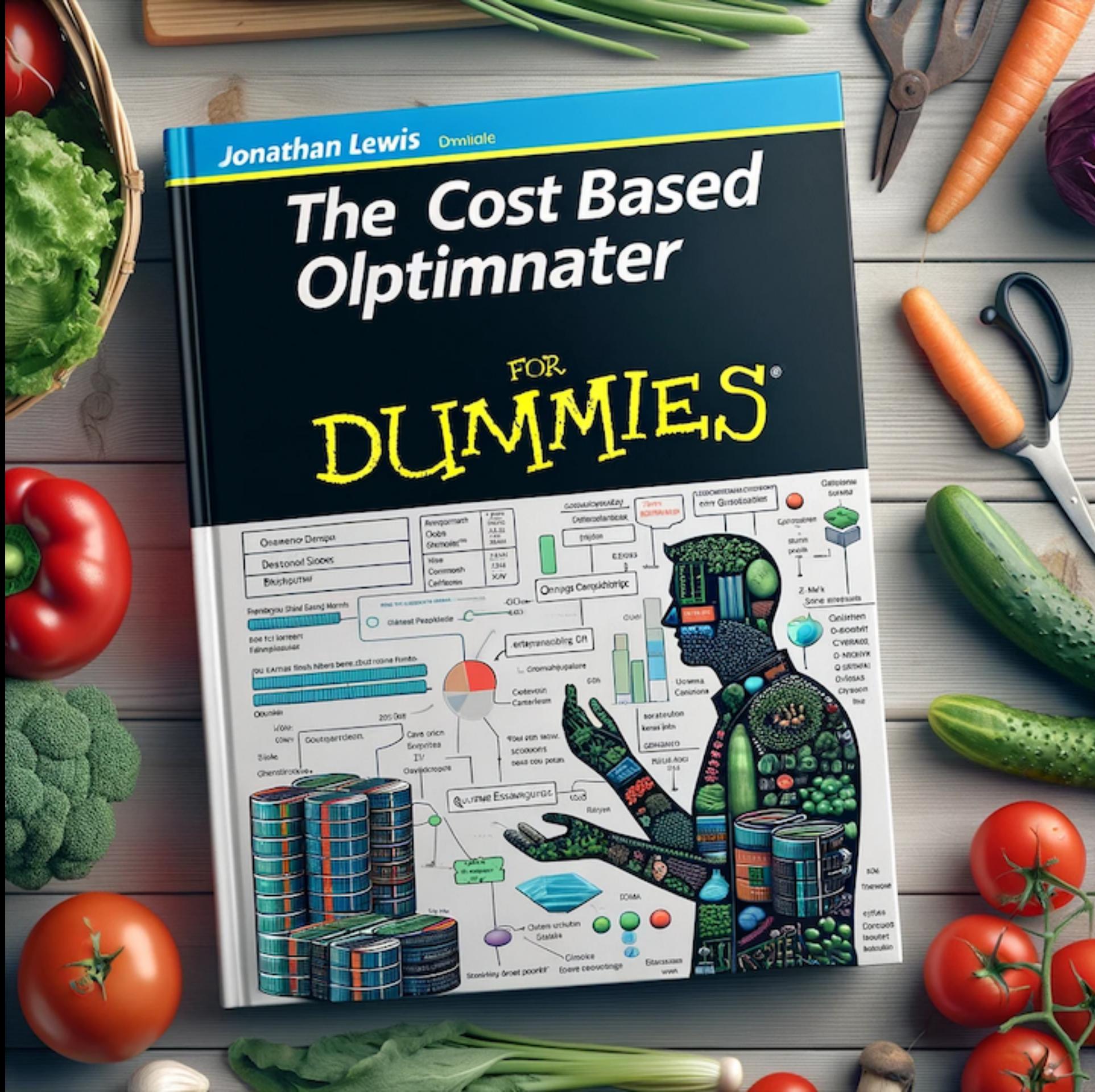
# Understand

# Explain

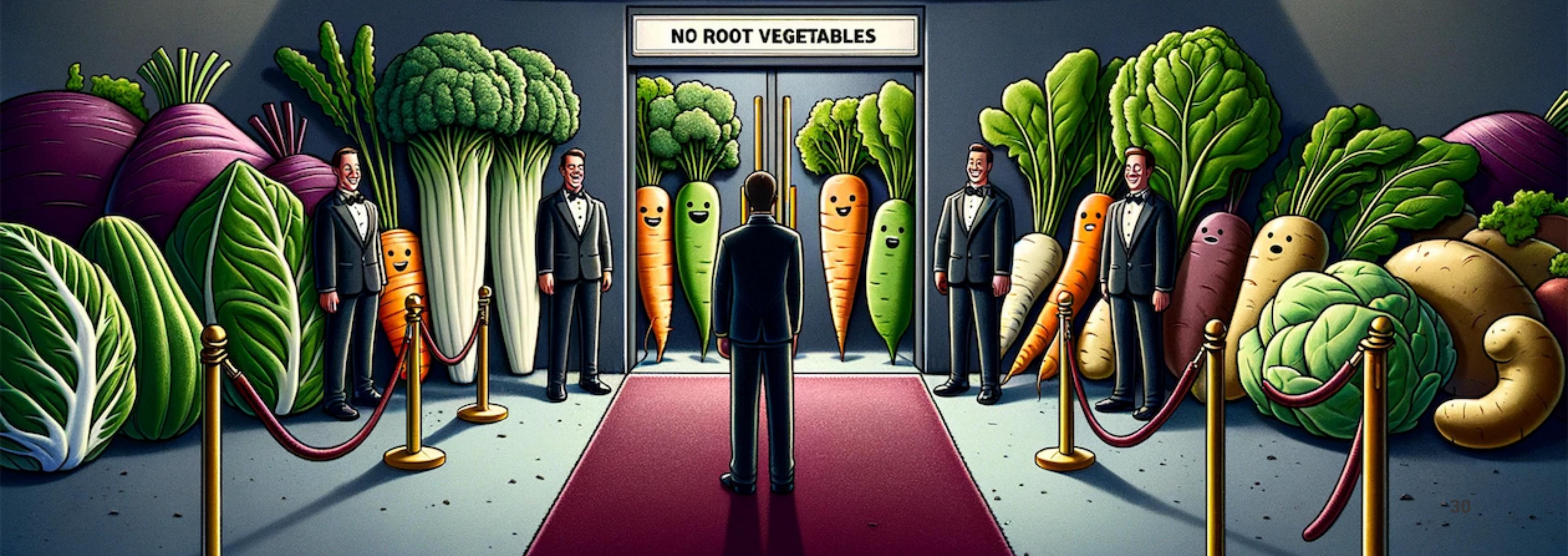
- Something about the optimizer
- 77,633 without transform
- 26,340 with transform







# CLUB SELECTIVITY



 A\_Rows

---

[c = 42]

---

1k

÷100k =

0.01

---

---

[c < 33]

---

33k

÷100k =

0.330

---

---

[33 < c < 66]

---

33k

÷100k =

0.330

---

---

[c > 66]

33k

÷100k =

0.330

**E\_Sel**

**E\_Rows**

---

[c = 42]

? \* ? = ?

---

[c < 33]

? \* ? = ?

---

[33 < c < 66]

? \* ? = ?

---

[c > 66]

? \* ? = ?

<b>Statistic</b>	<b>Value</b>
------------------	--------------

---

| dist\_vals(c) | 100 |

---

| lo\_val(c) | 0 |

---

| hi\_val(c) | 99 |

---

| num\_rows(t) | 100k |

[c = 42]

Statistic	Value
-----------	-------

---

dist_vals(c)	100
--------------	-----

---

lo_val(c)	0
-----------	---

---

hi_val(c)	99
-----------	----

---

num_rows(t)	100k
-------------	------

<b>Statistic</b>	<b>Value</b>
<code>dist_vals(c)</code>	100
<code>lo_val(c)</code>	0
<code>hi_val(c)</code>	99
<code>num_rows(t)</code>	100k

[ $c = 42$ ]

100 distinct values for  $c$

42 is *probably* 1 of them

<b>Statistic</b>	<b>Value</b>
<code>dist_vals(c)</code>	100
<code>lo_val(c)</code>	0
<code>hi_val(c)</code>	99
<code>num_rows(t)</code>	100k

[ $c = 42$ ]

100 distinct values for  $c$

42 is *probably* 1 of them

$E_{Sel} = 1/100$

<b>Statistic</b>	<b>Value</b>	[c < 33]	[c > 66]
		[33 < c < 66]	
dist_vals(c)	100		
lo_val(c)	0		
hi_val(c)	99		
num_rows(t)	100k		

Statistic	Value
-----------	-------

dist_vals(c)	100
--------------	-----

lo_val(c)	0
-----------	---

hi_val(c)	99
-----------	----

num_rows(t)	100k
-------------	------

[ $c < 33$ ] [ $c > 66$ ]

[ $33 < c < 66$ ]

0

↑

|

|

(99-0)

|

|

↓

99

Statistic	Value	[c < 33]	[c > 66]
dist_vals(c)	100	[33 < c < 66]	
lo_val(c)	0	0	0
hi_val(c)	99	↑ [c < 33] ↓  ----->33	
num_rows(t)	100k	(99-0)   [33 < c < 66]    ----->66  ----->33	↓ [c > 66] ↓ 99 99

Statistic	Value	[c < 33]	[c > 66]
dist_vals(c)	100	[33 < c < 66]	
lo_val(c)	0	0	0
hi_val(c)	99	↑ [c < 33]   (33-0)   ↓  ----->33	
num_rows(t)	100k	(99-0)   [33 < c < 66]   (66-33)   ↓  ----->66   ↑   [c > 66]   (99-66) ↓	99

<b>Statistic</b>	<b>Value</b>	[c < 33]	[c > 66]
dist_vals(c)	100	[33 < c < 66]	
lo_val(c)	0	0	0
hi_val(c)	99	↑ [c < 33] ↓	↑ (33-0)/99 ↓
num_rows(t)	100k	(99-0)   [33 < c < 66]   (66-33)/99	
		↓   ←-----→ 33   ↑	
		↓   ←-----→ 66   ↑	
		↓   [c > 66]   (99-66)/99	
		99	99

	<b>E_Sel</b>	<b>* num_rows</b>	<b>= E_Rows</b>	<b>A_Rows</b>
c = 42	0.01	* 100k	= 1,000	1,000
c < 33	0.333	* 100k	= 33,333	33,000
33 < c < 66	0.333	* 100k	= 33,333	33,000
c > 66	0.333	* 100k	= 33,333	33,000

## E\_Sel

---

c = n

---

1/100

c < m

---

m/99

m < c < n

---

(n-m)/99

c > n

---

1-n/99

---

0 < m < n < 99

# Combining Predicates



A photograph of a white, curly-haired dog, likely a Border Collie puppy, standing in a grassy field. The dog is facing towards the right of the frame. The background is a soft-focus green field.

# Jonathan's Border Cauli



[c is odd] AND [c < 50]

	A_Sel	A_Rows
[c is odd]	0.5	50k
[c < 50]	0.5	50k
[c is odd] AND [c < 50]	0.25	25k

$E_{Sel}[x \text{ AND } y]$

=  $E_{Sel}[x] * E_{Sel}[y]$

[c is odd] OR [c < 50]

<b>Predicate</b>	<b>A_Sel</b>	<b>A_Rows</b>
[c is odd]	0.5	50k
[c < 50]	0.5	50k
[c is odd] OR [c < 50]	0.75	75K

E\_Sel[x OR y]

= E\_Sel[x] + E\_Sel[y] - (E\_Sel[x] \* E\_Sel[y])

NOT [c < 10]

	A_Sel	A_Rows
[c < 10]	0.1	10K
NOT [c < 10]	0.9	90K
Let's pretend NULLs don't exist 🙄🙄		

$E_{Sel}[\text{NOT } x]$

$= 1 - E_{Sel}[x]$

$[c < 10]$  AND  $[c < 50]$

	A_Sel	A_Rows
[c < 10]	0.1	10k
[c < 50]	0.5	50k
[c < 10] AND [c < 50]	0.1	10k

$E\_Sel[x \text{ SAND } y]^{\text{ss}}$

= Sel[y]

---

<sup>ss</sup>y is a subset of x

[c is odd] OR [c is even]

	A_Sel	A_Rows
[c is odd]	0.5	50k
[c is even]	0.5	50k
[c is odd] OR [c is even]	1.0	100K

$$E\_Sel[x \text{ DOR } y]^{\text{dist}}$$
$$= E\_Sel[x] + E\_Sel[y]$$

---

<sup>dist</sup> x and y are distinct sets

$E\_Rows[x \text{ DOR } y]^{\text{dist}}$  $= E\_Rows[x] + E\_Rows[y]$ 

---

<sup>dist</sup> x and y are distinct sets

Half Way! We can do this!

A BEAR OF VERY LITTLE  
BRAIN



# Annotation

(c BETWEEN 1 AND 2)

(c BETWEEN 3 AND 4)

<><><><><><><><><><><><><><>

(c BETWEEN 95 AND 96)

(c BETWEEN 97 AND 98)

# Annotation

$B_1 \rightarrow (c \text{ BETWEEN } 1 \text{ AND } 2)$

$B_2 \rightarrow (c \text{ BETWEEN } 3 \text{ AND } 4)$

<><><><><><><><><><><><><>

$B_{4\ 8} \rightarrow (c \text{ BETWEEN } 95 \text{ AND } 96)$

$B_{4\ 9} \rightarrow (c \text{ BETWEEN } 97 \text{ AND } 98)$

# Annotation

$B_1 \rightarrow (c \text{ BETWEEN } 1 \text{ AND } 2)$

$B_n \text{ is } [c \text{ BETWEEN } 2n-1 \text{ AND } 2n]$

$B_2 \rightarrow (c \text{ BETWEEN } 3 \text{ AND } 4)$

Query is  $[B_1 \text{ OR } B_2 \dots B_{49}]$

<><><><><><><><><><><><><><>

$B_{48} \rightarrow (c \text{ BETWEEN } 95 \text{ AND } 96)$

$B_{49} \rightarrow (c \text{ BETWEEN } 97 \text{ AND } 98)$

# Annotation

$B_1 \rightarrow (c \text{ BETWEEN } 1 \text{ AND } 2)$

↓

$B_2 \rightarrow (c \text{ BETWEEN } 3 \text{ AND } 4)$

↓

<><><><><><><><><><><><><><>

↓

$B_{48} \rightarrow (c \text{ BETWEEN } 95 \text{ AND } 96)$

↓

$B_{49} \rightarrow (c \text{ BETWEEN } 97 \text{ AND } 98)$

↓

$B_{1-49}$

$B_n \text{ is } [c \text{ BETWEEN } 2n-1 \text{ AND } 2n]$

Query is  $[B_1 \text{ OR } B_2 \dots B_{49}]$

# Annotation

$B_1 \rightarrow (c \text{ BETWEEN } 1 \text{ AND } 2)$

↓

$B_2 \rightarrow (c \text{ BETWEEN } 3 \text{ AND } 4)$

↓

1

B<sub>48</sub> → (c BETWEEN 95 AND 96)

↓

B<sub>4</sub>9 → (c BETWEEN 97 AND 98)

↓

B1 - 4 9

$B_n$  is [c BETWEEN  $2n-1$  AND  $2n$ ]

**Query is [B<sub>1</sub> OR B<sub>2</sub> ... B<sub>49</sub> ]**

$B_{1-m}$  is  $[B_1 \text{ OR } B_2 \dots \text{ OR } B_m]$

# Query is [B<sub>1</sub> - 4 9 ]

● A\_Sel[B<sub>n</sub>]

● E\_Sel[B<sub>n</sub>]      vs      ● E\_Sel[B<sub>n</sub>]

● A\_Sel[c BETWEEN 2n-1 AND 2n]

= A\_Rows[c BETWEEN 2n-1 AND 2n]/100k

= 2k/100k

= 0.02



$E_{Sel}[c \text{ BETWEEN } 2n-1 \text{ AND } 2n]$

$$= E_{Sel}[(c = 2n-1) \text{ DOR } (2n-1 < c < 2n) \text{ DOR } (c = 2n)]$$

$$= E_{Sel}[c = 2n-1] + E_{Sel}[2n-1 < c < 2n] + E_{Sel}[c = 2n]$$

$$= 1/100 \quad + (2n - (2n-1))/99 \quad + 1/100$$

$$= 1/100 \quad + 1/99 \quad + 1/100$$

$$= 0.03010\dots$$



E\_Sel[c BETWEEN 2n-1 AND 2n]

$$= E_{Sel}[(c \geq 2n-1) \text{ AND } (c \leq 2n)]$$

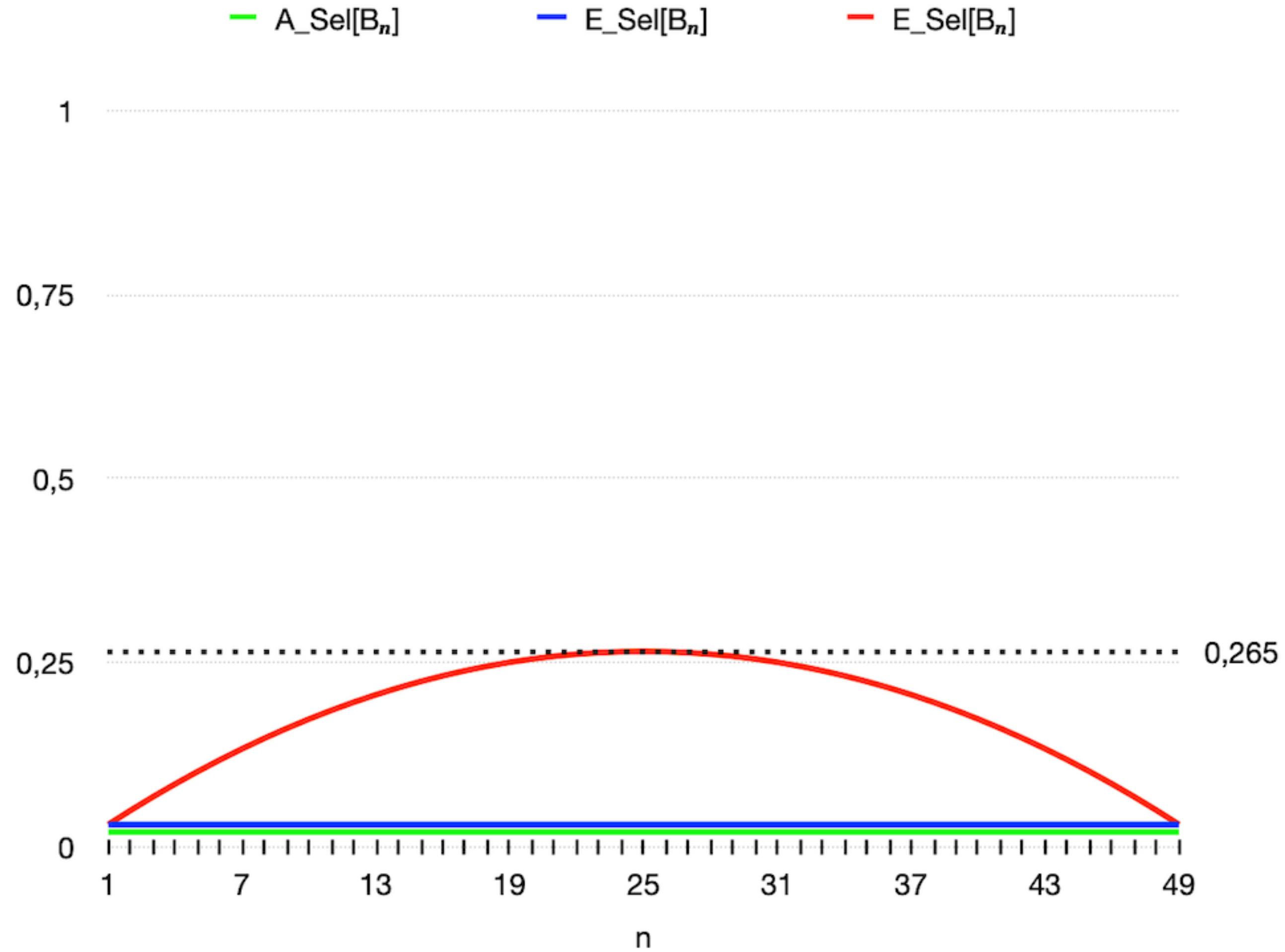
$$= E_{Sel}[c \geq 2n-1] * E_{Sel}[c \leq 2n]$$

$$= E_{Sel}[(c = 2n-1) \text{ DOR } (c > 2n-1)] * \\ E_{Sel}[(c < 2n) \text{ DOR } (c = 2n)]$$

$$= (E_{Sel}[c = 2n-1] + E_{Sel}[c > 2n-1]) * \\ (E_{Sel}[c < 2n] + E_{Sel}[c = 2n])$$

$$= (1/100 + 1 - (2n-1)/99) * (2n/99 + 1/100)$$

$$= 200n/9801 - 4n^2/9801 + 10099/990000$$



E\_Sel[c BETWEEN 49 AND 50]

= E\_Sel[(c >= 49) AND (c <= 50)]

= E\_Sel[c >= 49] \* E\_Sel[c <= 50]

= 0.515 \* 0.515

= 0.265





E\_Sel[B<sub>1</sub> ]

= 0.03010

 E\_Rows[B<sub>1</sub> ]

=  E\_Sel[B<sub>1</sub> ] \* 100k

= 0.03010 \* 100k

= 3010

B<sub>1</sub> – 2 is [B<sub>1</sub> DOR B<sub>2</sub>]

B<sub>1</sub> 1↔2

B<sub>2</sub> 3↔4

$$E_{Sel}[B_1 - 2]$$

$$= E_{Sel}[B_1 \text{ OR } B_2]$$

$$= E_{Sel}[B_1] + E_{Sel}[B_2] - (E_{Sel}[B_1] * E_{Sel}[B_2])$$

$$= 0.03010 \quad \quad \quad + 0.03010 \quad \quad \quad - (0.03010 \quad \quad \quad * 0.03010)$$

$$= 0.05929$$

 E\_Rows[B<sub>1 - 2</sub>]

=  E\_Sel[B<sub>1 - 2</sub>] \* 100k

= 0.05929 \* 100k

= 5929

$$E_{Sel}[B_1 - 3]$$

$$= E_{Sel}[B_1 - 2 \text{ OR } B_3]$$

$$= E_{Sel}[B_1 - 2] + E_{Sel}[B_3] - (E_{Sel}[B_1 - 2] * E_{Sel}[B_3])$$

$$= 0.05929 + 0.03010 - (0.05929 * 0.03010)$$

$$= 0.08760$$



$$E_{Sel}[B_1 - 4 \cdot 9]$$

$$= E_{Sel}[B_1 - 4 \cdot 8 \text{ OR } B_4 \cdot 9]$$

$$= E_{Sel}[B_1 - 4 \cdot 8] + \bullet E_{Sel}[B_4 \cdot 9] - \\ (E_{Sel}[B_1 - 4 \cdot 8] * \bullet E_{Sel}[B_4 \cdot 9])$$

$$= (0.76939 + 0.03010) - \\ (0.76939 * 0.03010)$$

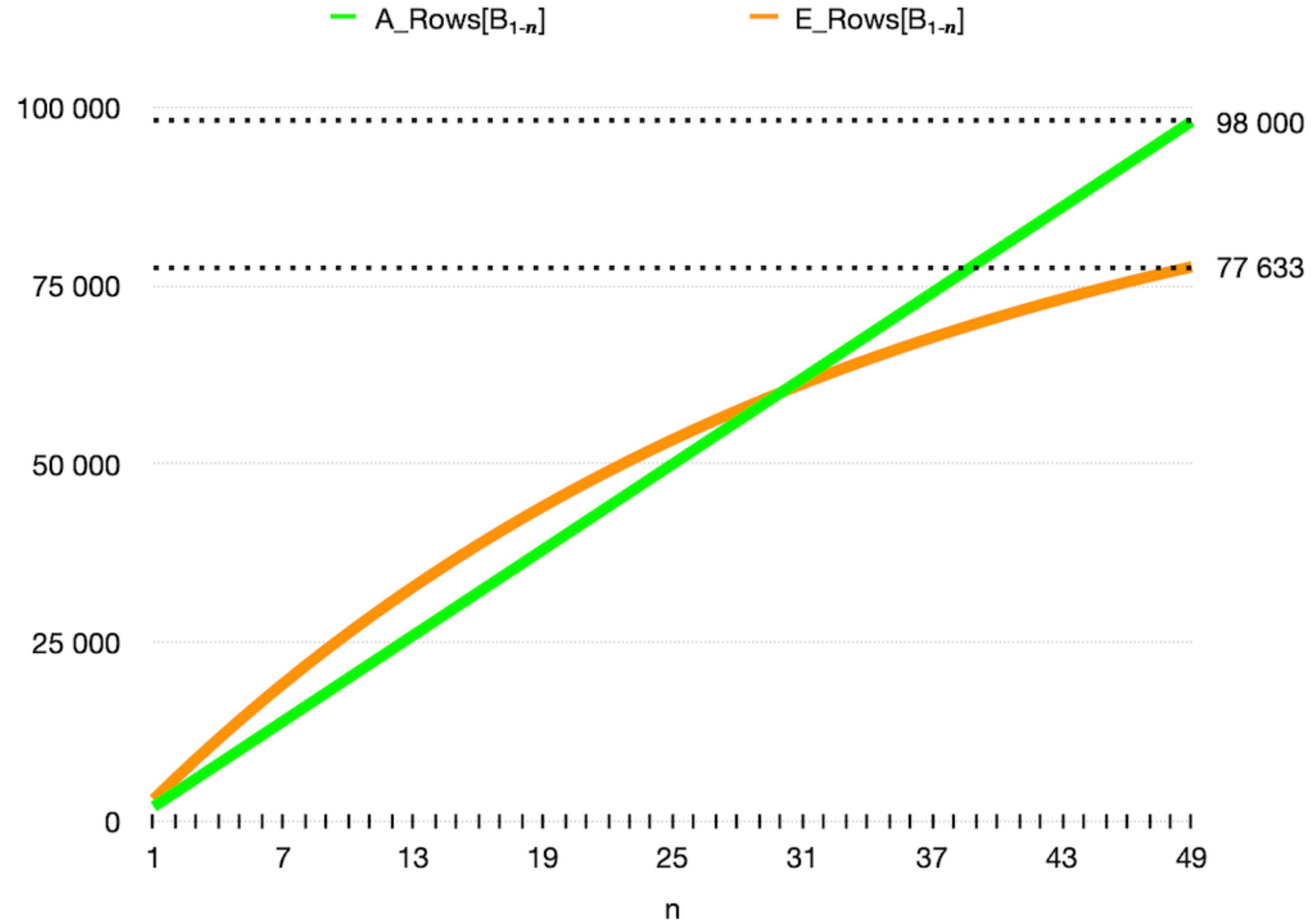
$$= 0.77633$$

 E\_Rows[B<sub>1 - 4 9</sub>]

$$= E_{Sel}[B_{1 - 4 9}] * 100k$$

$$= 0.77633 * 100k$$

$$= 77633$$



A BEAR OF VERY LITTLE  
BRAIN



# TrAnnotation







$T_n$  is [NOT  $B_1 \dots$  AND NOT  $B_{n-1}$  AND  $B_n$ ]

Transformed Query is [T<sub>1</sub> . . . UNION ALL T<sub>49</sub>]

$T_n$  is [NOT  $B_1 \dots$  AND NOT  $B_{n-1}$  AND  $B_n$ ]

Transformed Query is [T<sub>1</sub> . . . UNION ALL T<sub>49</sub> ]

$T_n$  is [NOT  $B_1 \dots$  AND NOT  $B_{n-1}$  AND  $B_n$ ]

Transformed Query is [T<sub>1</sub> . . . UNION ALL T<sub>49</sub> ]

$T_1 - m$  is  $[T_1 \text{ UNION ALL } T_2 \text{ UNION ALL } \dots \text{ } T_m]$

# Transformed Query is [T<sub>1</sub> – 4 9 ]

$E_{Sel}[T_n]$

=  $E_{Sel}[\text{NOT } B_1 \dots \text{ AND NOT } B_{n-1} \text{ AND } B_n]$

=  $E_{Sel}[\text{NOT } B_1] \dots * E_{Sel}[\text{NOT } B_{n-1}] * E_{Sel}[B_n]$

 A\_Sel[NOT B<sub>n</sub>]

 E\_Sel[NOT B<sub>n</sub>] vs  E\_Sel[NOT B<sub>n</sub>]

● A\_Sel[c NOT BETWEEN 2n-1 AND 2n]

$$= 98k/100k$$

$$= 0.98$$

$\bullet E_{Sel}[NOT\ B_n]$

$$= 1 - \bullet E_{Sel}[B_n]$$

$$= 1 - 0.03010$$

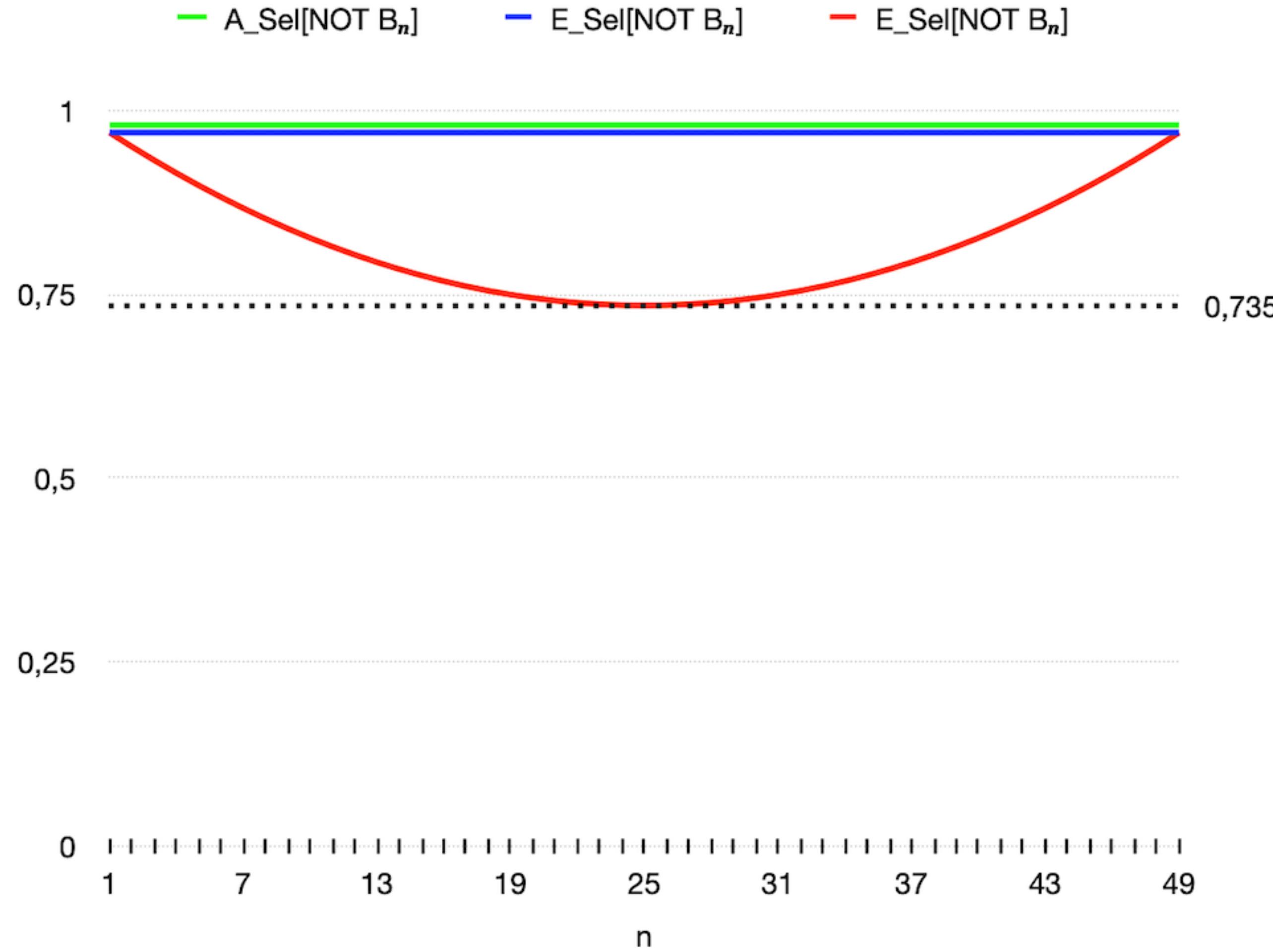
$$= 0.96990$$

$$\bullet E_{Sel}[NOT\ B_n]$$

$$= 1 - \bullet E_{Sel}[B_n]$$

$$= 1 - (200n/9801 - 4n^2/9801 + 10099/990000)$$

$$= 4n^2/9801 - 200n/9801 + 979901/990000$$







$E_{Sel}[T_n]$

=   $E_{Sel}[\text{NOT } B_1]$  . . . \*   $E_{Sel}[\text{NOT } B_{n-1}]$  \*   $E_{Sel}[B_n]$

 E\_Rows[T<sub>1</sub> - n]

= E\_Rows[T<sub>1</sub> DOR T<sub>2</sub> DOR ... DOR T<sub>n</sub>]

= E\_Rows[T<sub>1</sub>] ... + E\_Rows[T<sub>n</sub>]

= (E\_Sel[T<sub>1</sub>] \* 100k) ... + (E\_Sel[T<sub>n</sub>] \* 100k)

E\_Sel[T<sub>1</sub>]

= E\_Sel[B<sub>1</sub>] 

= 0.03010

 E\_Rows[T<sub>1</sub> ]

= E\_Sel[T<sub>1</sub> ] \* 100k

= 0.03010 \* 100k

= 3010

$T_2$  is [NOT  $B_1$  SAND  $B_2$ ]

NOT  $B_1$        $\emptyset$      $3 \leftarrow \dots \rightarrow 99$   
 $B_2$                  $3 \leftrightarrow 4$

$$E_{Sel}[T_2]$$

$$= \textcolor{red}{\bullet} E_{Sel}[\text{NOT } B_1] * \textcolor{blue}{\bullet} E_{Sel}[B_2]$$

$$= 0.96980 * 0.03010$$

$$= 0.02919$$

 E\_Rows[T<sub>1</sub> - 2 ]

$$= E_{\text{Rows}}[T_1] + (E_{\text{Sel}}[T_2] * 100000)$$

$$= 3010 + (0.02919 * 100000)$$

$$= 3010 + 2919$$

$$= 5929$$

$E_{Sel}[T_3]$

=  $E_{Sel}[\text{NOT } B_1 \text{ AND NOT } B_2 \text{ AND } B_3]$

=   $E_{Sel}[\text{NOT } B_1]$  \*   $E_{Sel}[\text{NOT } B_2]$  \*   $E_{Sel}[B_3]$

= 0.96980 \* 0.95062 \* 0.03010

= 0.02775

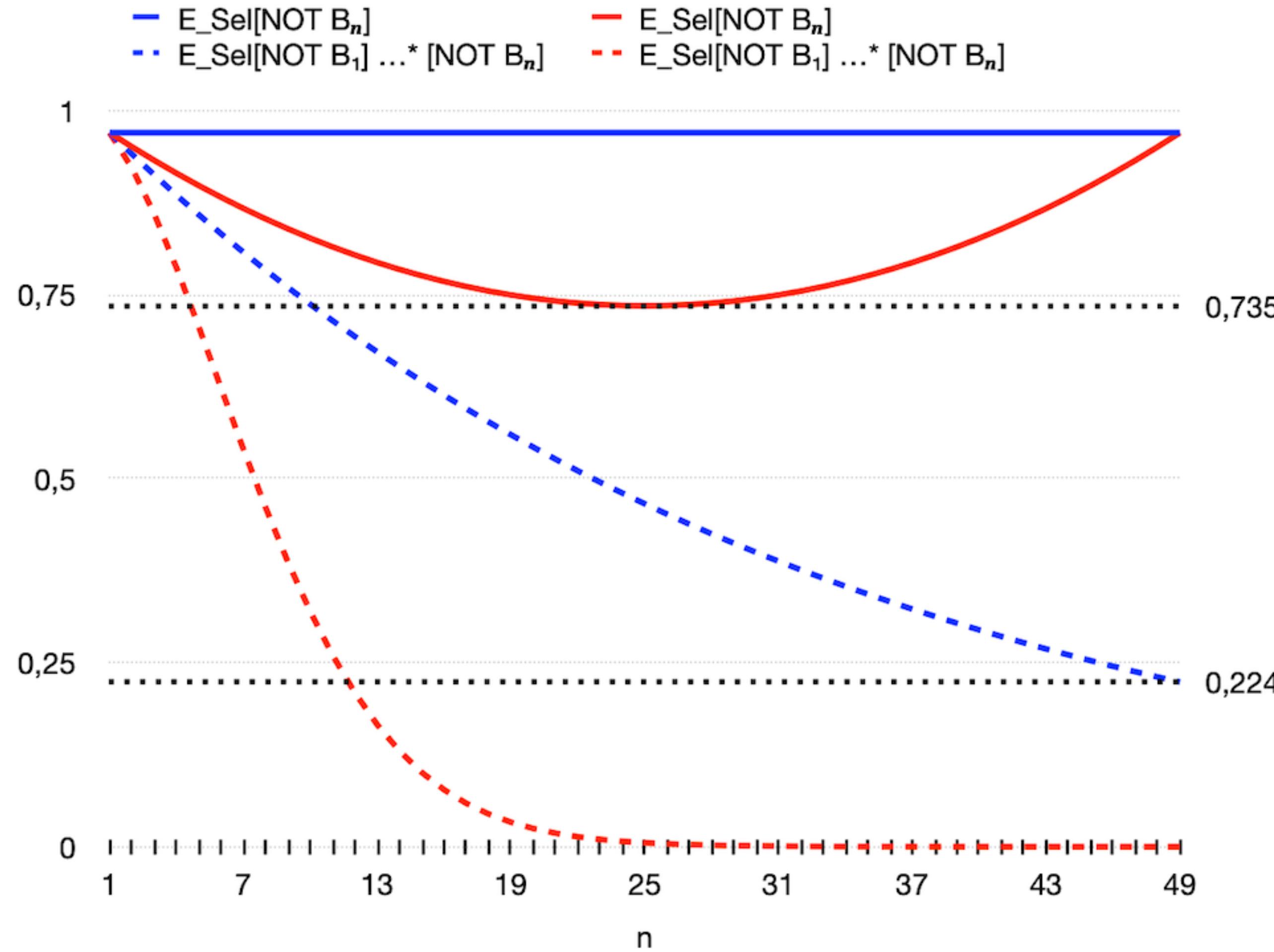
 E\_Rows[T<sub>1 - 3</sub>]

$$= E_{\text{Rows}}[T_{1-2}] + (E_{\text{Sel}}[T_3] * 100k)$$

$$= 5929 + (0.02775 * 100k)$$

$$= 5929 + 2775$$

$$= 8704$$



$E_{Sel}[T_{35}]$

$$= \textcolor{red}{\bullet} E_{Sel}[\text{NOT } B_1] \dots * \textcolor{red}{\bullet} E_{Sel}[\text{NOT } B_{34}] * \textcolor{blue}{\bullet} E_{Sel}[B_{35}]$$

$$\begin{aligned} &= 0.96 * 0.95 * 0.93 * 0.91 * 0.89 * 0.88 * 0.86 * 0.85 * 0.83 * 0.82 * \\ &\quad 0.81 * 0.80 * 0.79 * 0.78 * 0.77 * 0.76 * 0.76 * 0.75 * 0.74 * 0.74 * \\ &\quad 0.74 * 0.73 * 0.73 * 0.73 * 0.73 * 0.73 * 0.73 * 0.73 * 0.74 * 0.74 * \\ &\quad 0.74 * 0.75 * 0.76 * 0.76 * 0.03010 \end{aligned}$$

$$= 0.00001$$

E\_Rows[T<sub>1 - 35</sub>]

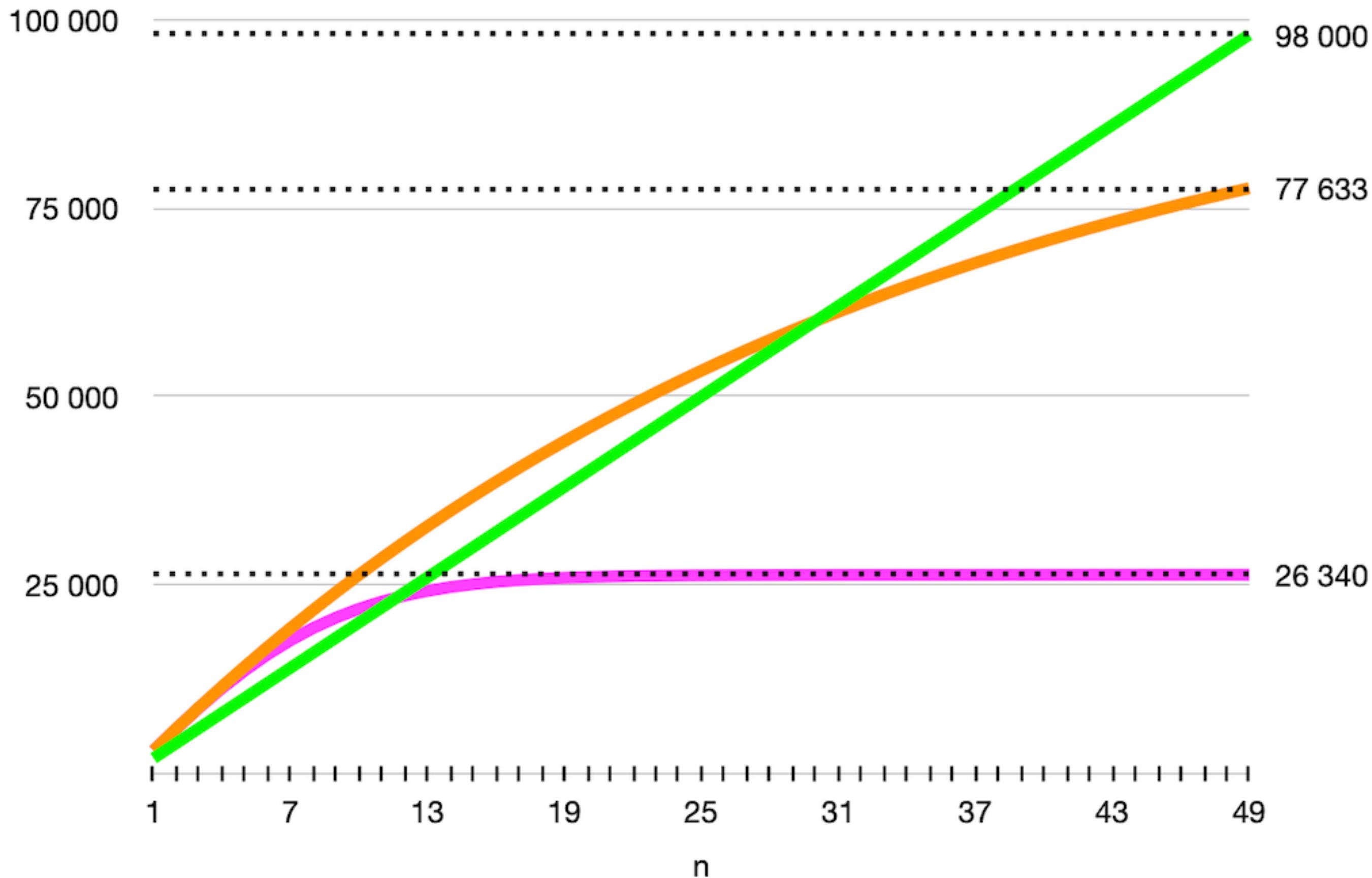
$$= E_{\text{Rows}}[T_{1 - 34}] + (E_{\text{Sel}}[T_{35}] * 100k)$$

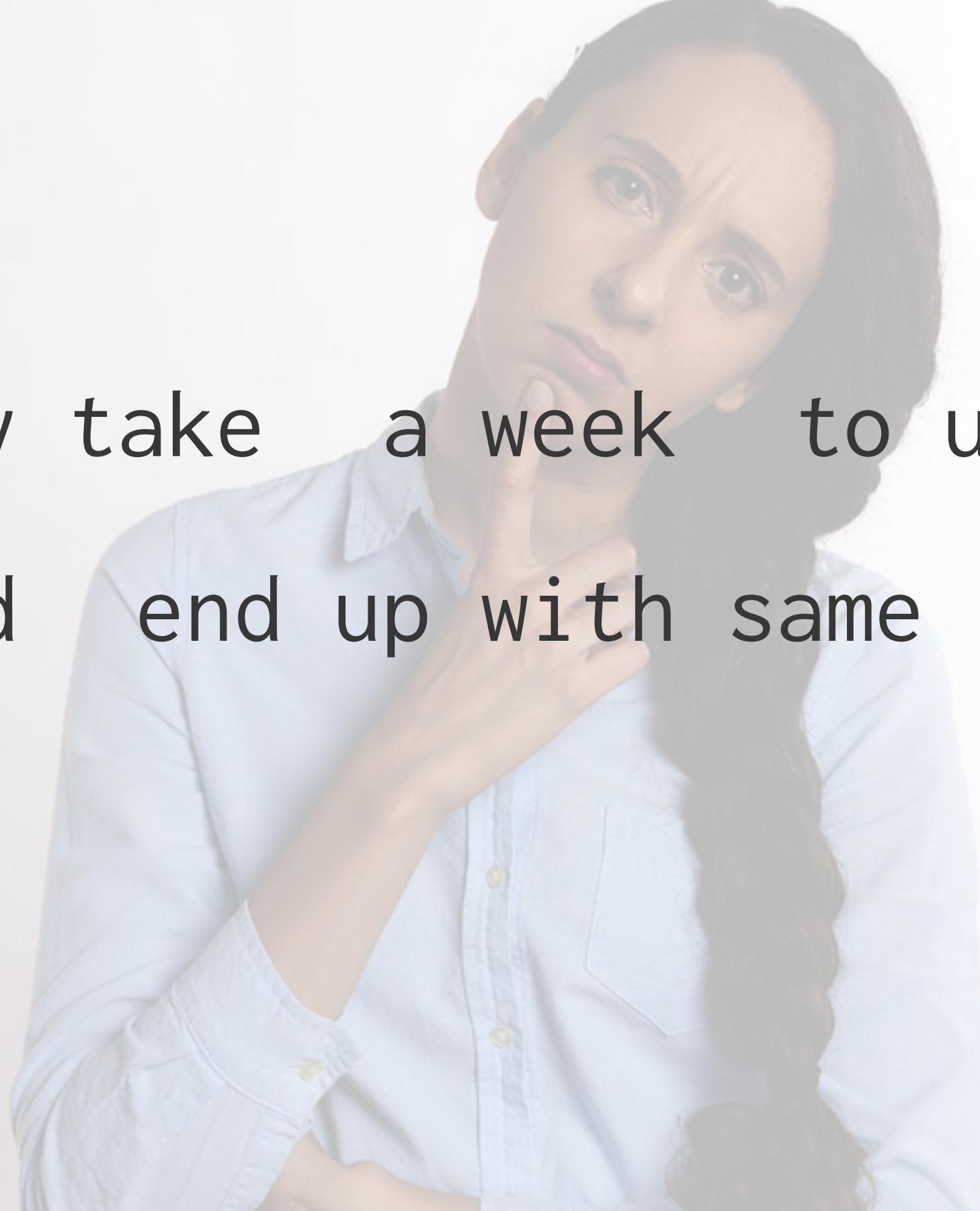
$$= 26325 + (0.00001 * 100k)$$

$$= 26325 + 1$$

$$= 26326$$

— A\_Rows[B<sub>1-n</sub>] — E\_Rows[B<sub>1-n</sub>] — E\_Rows[T<sub>1-n</sub>]



A woman with dark hair tied back, wearing a light blue button-down shirt, is shown from the chest up. She is looking directly at the camera with a thoughtful expression, her right hand resting against her chin. The background is plain white.

It may take a week to understand  
and end up with same "fix"

A woman with dark hair tied back, wearing a light blue button-down shirt, is shown from the chest up. She has her right hand resting against her chin, looking directly at the camera with a thoughtful expression.

It may take a week to understand  
and  end up with same "fix" 

A woman with dark hair, wearing a light blue denim-style button-down shirt, is shown from the chest up. She is resting her chin on her right hand, which is propped under her head, and is looking directly at the camera with a thoughtful expression.

It may take ~~a week~~ to understand  
and end up with same "fix"

# In The End

- Bug Opened <sup>b</sup>
- We set "\_optimizer\_cbqt\_or\_expansion"=off  
I'm NOT Recommending **you** do this!!!
- Greater Understanding of Optimizer

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<sup>b</sup> 34012219 - LNNVL LEADS TO COST UNDERESTIMATE FOR CB OR EXPANSION TRANSFORMATION

Id	Operation	Name	Starts	E-Rows	A-Rows
0	SELECT STATEMENT		1		1
1	SORT AGGREGATE		1	1	1
2	VIEW	VW_ORE_1B35BA0F	1	12040	8000
3	UNION-ALL		1	12040	8000
* 4	TABLE ACCESS BY INDEX ROWID BATCHED	T	1	3010	2000
* 5	INDEX RANGE SCAN	I	1	3010	2000
* 6	TABLE ACCESS BY INDEX ROWID BATCHED	T	1	3010	2000
* 7	INDEX RANGE SCAN	I	1	3010	2000
* 8	TABLE ACCESS BY INDEX ROWID BATCHED	T	1	3010	2000
* 9	INDEX RANGE SCAN	I	1	3010	2000
* 10	TABLE ACCESS BY INDEX ROWID BATCHED	T	1	3010	2000
* 11	INDEX RANGE SCAN	I	1	3010	2000

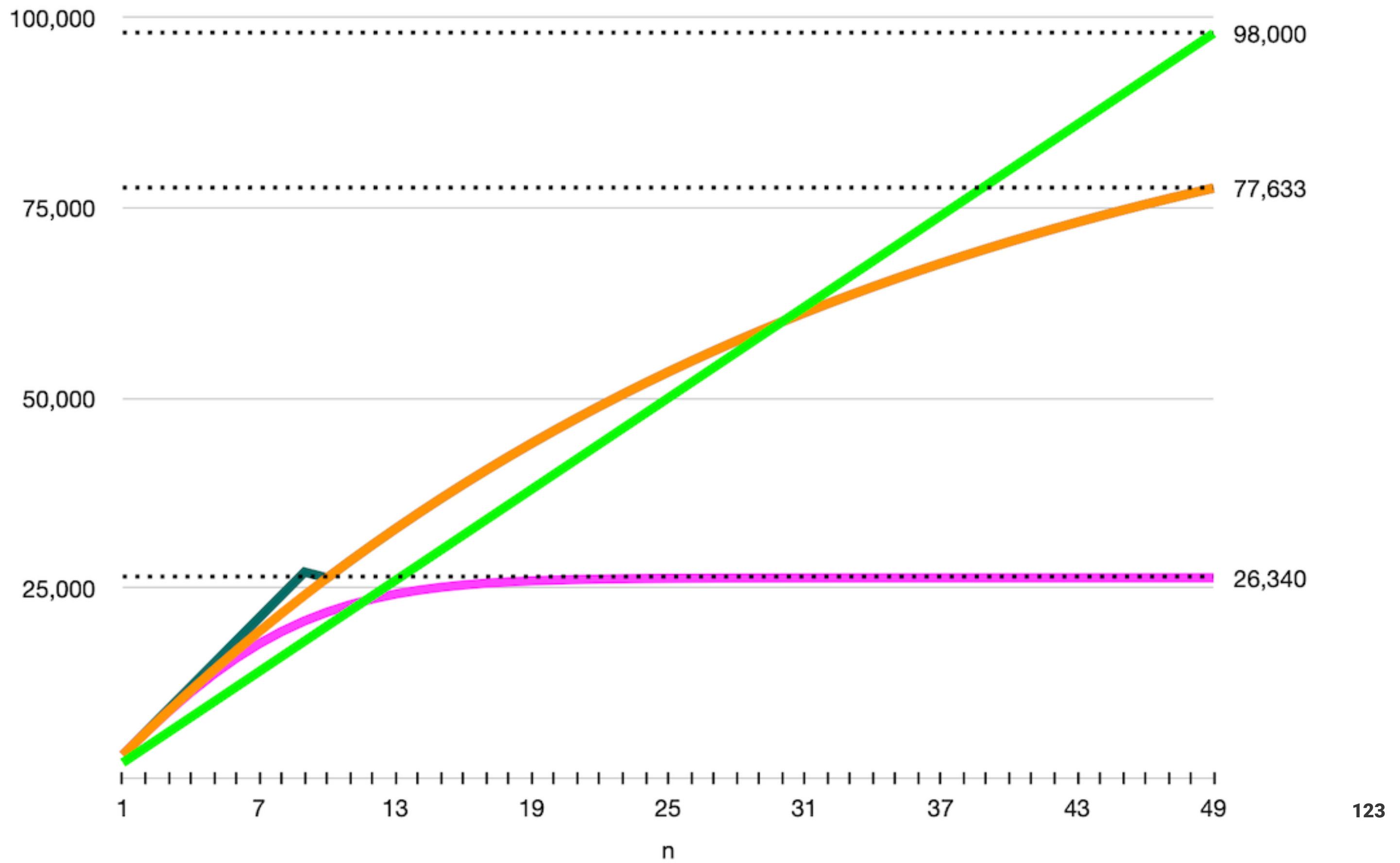
Predicate Information (identified by operation id):

```

4 - filter("P" IS NOT NULL)
5 - access("C">>=1 AND "C"<=2)
6 - filter("P" IS NOT NULL)
7 - access("C">>=3 AND "C"<=4)
8 - filter("P" IS NOT NULL)
9 - access("C">>=5 AND "C"<=6)
10 - filter("P" IS NOT NULL)
11 - access("C">>=7 AND "C"<=8)

```

— A\_Rows[B<sub>1-n</sub>] — E\_Rows[B<sub>1-n</sub>] — E\_Rows[T<sub>1-n</sub>] — E\_Rows[F<sub>1-n</sub>]



```
select count(*) from t where (p is not null) and  
    ((c between 0 and 2) or c (between 1 and 3));
```

0	SELECT STATEMENT		
1	SORT AGGREGATE		
2	VIEW	VW_ORE_1B35BA0F	
3	UNION-ALL		
* 4	INDEX RANGE SCAN	I	
* 5	TABLE ACCESS BY INDEX ROWID BATCHED	T	
* 6	INDEX RANGE SCAN	I	

Predicate Information (identified by operation id):

- 
- 4 - access("C">>=1 AND "C"<=3)
  - 5 - filter("P" IS NOT NULL)
  - 6 - access("C">>=0 AND "C"<1)

# Thanks for Listening!