

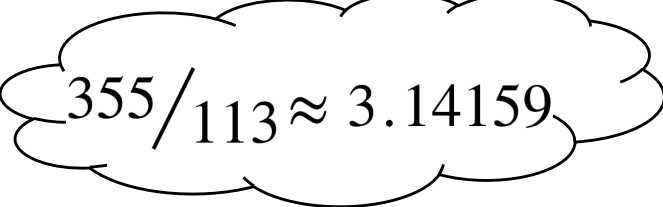
How to use
the back calculator program
“denomfind”
for approximated proportions

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Terminology (1/2)

- A **fraction** is specified in the form of **numerator / denominator** .
- A **proportion** is the decimal value of a fraction.
Its approximation is an **approximated proportion**,
which would be simply called a proportion herein.
- $\mathbb{N} = \{1, 2, 3, \dots\}$: The set of all natural numbers.
- $\mathbb{Z} = \{0, \pm 1, \pm 2, \pm 3, \dots\}$: consists of integers.
- $\mathbb{R} = \{x \mid -\infty < x < +\infty\}$: all the real numbers.


$$355/113 \approx 3.14159$$

Terminology (2/2)

- There are many ways to **round** a number :
 - Round half up (most commonly used!)
 - Round up / Round down
 - Round half to even (ISO 31-0 , JIS Z 8401, IEEE 754)
 - Round half to odd
- **TSV** is Tab-Separated Values (cf. CSV with comma).

Regarding this document :

- Explains
 - how to use the command **denomfind**.
- Not explains
 - the internal design in detail.

“denomfind” is a CLI program.

- CLI = Command Line Interface. Not a GUI.
- “denomfind” is a program of a Perl script.
- You can install :
 - By “cpan” or “cpanm” command.
 - cpanm is recommendable considering the un-installment.
 - **cpanm App::denomfind**
 - **cpanm -U App::denomfind # uninstall**
 - Not only from metacpan.org but also from GitHub.

Examples 1 — 0.3, 0.33, and 33.3%

```
> denomfind 0.3
denom  fit  0.3
3      1    1/3
4      1    1/4
6.     1    2/6
7      1    2/7
8.     1    2/8
9.     1    3/9
10     1    3/10
11     1    3/11
12     1    3/12~4/12
13     1    4/13
14.    1    4/14
15     1    4/15~5/15
```

```
> denomfind -M0 0.33
denom  fit  0.33
3      1    1/3
40     1    13/40
43     1    14/43
46     1    15/46
49     1    16/49
52     1    17/52
55     1    18/55
58     1    19/58
61     1    20/61
64     1    21/64
67     1    22/67
70     1    23/70
```

```
> denomfind -M0 -D-3% 33.3%
denom  fit  0.333
3      1    1/3-.033%
400    1    133/400+.050%
403    1    134/403+.049%
406    1    135/406+.049%
409    1    136/409+.048%
412    1    137/412+.048%
415    1    138/415+.047%
418    1    139/418+.046%
421    1    140/421+.046%
424    1    141/424+.045%
427    1    142/427+.045%
430    1    143/430+.044%
```

Each fraction is shown on each line.

- "**denom**" means **denominator**.
- 12 **denoms** $\in \mathbb{N}$ are **back calculated** with a **feasible numerator** $\in \mathbb{Z}$ regarding the given proportion is **rounded**.
- Each of **fraction form** is shown in cyan color.
- **-D-3%** on the most right image specifies to show the **gap** to the proportion.
- "**fit**" (red) will be explained in next page.

Regarding the **reducible fractions** :

- A *denom* with period (.) : roughly means the fraction is **reducible**.
- To be more exactly (explained later) : the numerators and its corresp. denominators all combined are divisible by their GCD > 1.
- "**-M0**" specifies : not to show the the "reducible" fraction *i.e.* $2/6 = 3/9 = 4/12 = ..$ are hidden.

Example 2: proportions with a common denominator

```
> tabs -4
> denomfind -y3..4 -D5% 63.3% 54.6% 13.3% 10.3%
denom  fit  0.633  0.546  0.133  0.103
196 3  124/196=63.26531%  107/196=54.59184%  26/196=13.26531%  [20.09 20.286)
218 3  138/218=63.30275%  119/218=54.58716%  29/218=13.30275%  [22.345 22.563)
240 3  152/240=63.33333%  131/240=54.58333%  32/240=13.33333%  [24.6 24.84)
271 3  [171.4075 171.6785) 148/271=54.61255%  36/271=13.28413%  28/271=10.33210%
300 3  190/300=63.33333%  [163.65 163.95) 40/300=13.33333%  31/300=10.33333%
324 3  205/324=63.27160%  177/324=54.62963%  43/324=13.27160%  [33.21 33.534)
330 3  209/330=63.33333%  [180.015 180.345) 44/330=13.33333%  34/330=10.30303%
339 3  [214.4175 214.7565) 185/339=54.57227%  45/339=13.27434%  35/339=10.32448%
346 3  219/346=63.29480%  189/346=54.62428%  46/346=13.29480%  [35.465 35.811)
360 3  228/360=63.33333%  [196.38 196.74) 48/360=13.33333%  37/360=10.27778%
368 4  233/368=63.31522%  201/368=54.61957%  49/368=13.31522%  38/368=10.32609%
377 3  [238.4525 238.8295) 206/377=54.64191%  50/377=13.26260%  39/377=10.34483%
4 ratios are given. 12 denominators have found up to 377. (denomfind)
```

- The output forms a **TSV table**.
- The **right 4 columns** here corresponds with proportions 63.3%, 54.6%, 13.3%, 10.3%.
- The 2nd column **fit** means how many among the (4) proportions can get at least a numerator $\in \mathbb{Z}$ with each **denom** value.
- **-y3..4** specifies filtering on **fit**. i.e. **fit** with the value 0,1,2 are omitted.
- **-D5%** specifies to show the retrieved fraction value with **5 decimal places in %**.
- The intervals in faint color indicate the set of the possible numerator on \mathbb{R} , which does not contain any integer \mathbb{Z} .
- The command **tabs -4** adjusts the screen setting of tab intervals.
- The smallest possible denominator $\in \mathbb{N}$ to yield the 4 rounded proportions is **368**.

Usage of **denomfind**

1. To **find** the possible denominator with given multiple rounded proportions.
 - One can check whether the sample size is large enough.
2. To **check** and to **correct** the numbers such as denominator and rounded proportions.
 - Quite often, numbers appearing on reports contain a small number of mistakes.
3. To know how the proportions are rounded.
 - If the rounding half up is performed on a number twice in a specific way, 3.45% can turn to be 4% via 3.5%.
 - Deciphering how the numbers are rounded may conclude **how carefully the document is yielded**.

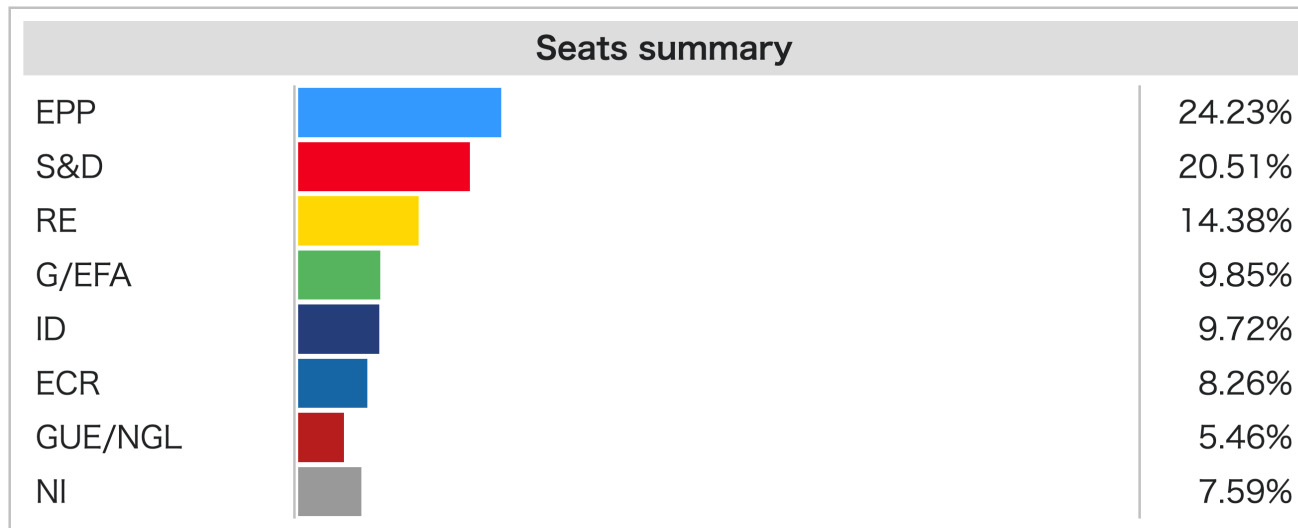
Feature of **denomfind**

Simple interface despite the various options.

— How to interact with the program is intentionally designed.

1. Run such as **denomfind 0.167 0.714** firstly.
2. The output is easily understandable.
3. You gradually increase functions to use such as options and other commands.
4. The necessary functions are abundantly provided.
5. Online manual is provided : **denomfind --help**
6. Demo is also provided.
You can try **denomfind -T1** (1 is changeable.)

Example 3. Seats summary of 2019 European Parliament Election



https://en.wikipedia.org/wiki/2019_European_Parliament_election

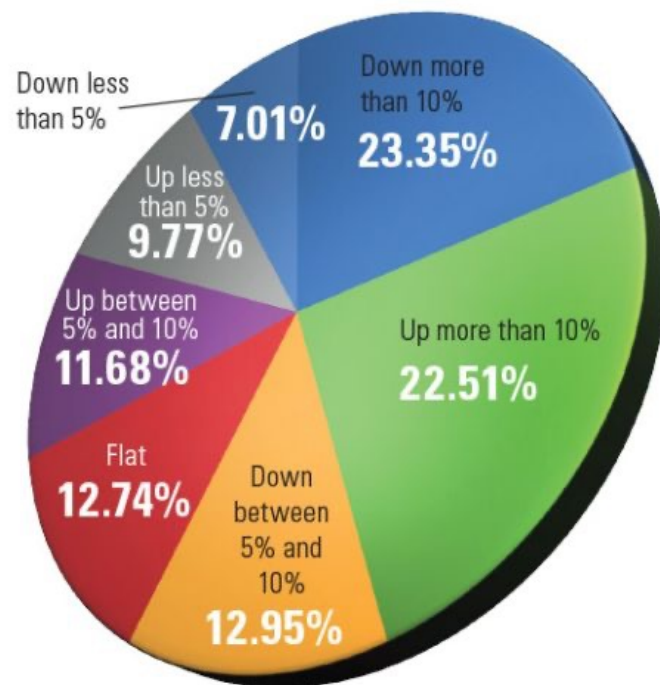
```
> tabs -6
> denomfind -y, -g7 -% 24.23 20.51 14.38 9.85 9.72 8.26 5.46 7.59
denom fit 0.2423 0.2051 0.1438 0.0985 0.0972 0.0826 0.0546 0.0759
751 8 182/751 154/751 108/751 74/751 73/751 62/751 41/751 57/751
1502. 8 364/1502 308/1502 216/1502 148/1502 146/1502 124/1502 82/1502 114/1502
2253. 8 546/2253 462/2253 324/2253 222/2253 219/2253 186/2253 123/2253 171/2253
3004. 8 728/3004 616/3004 432/3004 296/3004 292/3004 248/3004 164/3004 228/3004
3755. 8 910/3755 770/3755 540/3755 370/3755 365/3755 310/3755 205/3755 285/3755
3900 8 945/3900 800/3900 561/3900 384/3900 379/3900 322/3900 213/3900 296/3900
4032 8 977/4032 827/4032 580/4032 397/4032 392/4032 333/4032 220/4032 306/4032
8 ratios are given. 7 denominators have found up to 4032. (denomfind)
>
```

The total seat number seems **751** (if < 1000)
from the 8 proportion percentages.

-y, filters the *fit* number being the largest (8; the number of proportions).
-g7 specifies to get 7 candidates. **-%** specifies percentages are given.

Example4. From a pie chart.

GROWERS: HOW DOES YOUR OPERATION'S 2015 PRODUCTION COMPARE TO 2014?



```
> denomfind -M0 -a0.01% -y, -% 23.35 22.51 12.95 12.74 11.68 9.77 7.01
denom  fit      0.2335  0.2251  0.1295  0.1274  0.1168  0.0977  0.0701
471    7       110/471 106/471 61/471  60/471  55/471  46/471  33/471
2270   7       530/2270 511/2270 294/2270 289/2270 265/2270 222/2270 159/2270
2425   7       566/2425 546/2425 314/2425 309/2425 283/2425 237/2425 170/2425
2510   7       586/2510 565/2510 325/2510 320/2510 293/2510 245/2510 176/2510
2527   7       590/2527 569/2527 327/2527 322/2527 295/2527 247/2527 177/2527
2612   7       610/2612 588/2612 338/2612 333/2612 305/2612 255/2612 183/2612
2639   7       616/2639 594/2639 342/2639 336/2639 308/2639 258/2639 185/2639
2724   7       636/2724 613/2724 353/2724 347/2724 318/2724 266/2724 191/2724
2741   7       640/2741 617/2741 355/2741 349/2741 320/2741 268/2741 192/2741
2835   7       662/2835 638/2835 367/2835 361/2835 331/2835 277/2835 199/2835
2866   7       669/2866 645/2866 371/2866 365/2866 335/2866 280/2866 201/2866
2879   7       672/2879 648/2879 373/2879 367/2879 336/2879 281/2879 202/2879
7 ratios are given. 12 denominators have found up to 2879. (denomfind)
>
```

The total number of answerer seems to be 471.

”The response was overwhelming, as 750 of you weighed in — including 545 growers — providing valuable insight in an online survey.”

<https://www.growingproduce.com/fruits/fruit-growers-expect-sweet-16/>

Various options in rounding

Assuming the rounding

- “round down” (floor ; e.g. $0.345 \rightarrow 0.34$) : **-f**
- “round up” (ceil ; e.g. $0.345 \rightarrow 0.35$) : **-c**
- “round half up” is done twice (e.g. $0.345 \rightarrow 0.35 \rightarrow 0.4$) : **-5 2**
- “round half to even” (e.g. 0.335 and $0.345 \rightarrow 0.34$) : **-5 e**
- “round half to odd” (e.g. 0.345 and $0.355 \rightarrow 0.35$) : **-5 o**
- Allowing the error within $\pm 1\%$: **-a 0.01** or **-a 1%**

Options in the denominator filtering

- `-g 100` : getting 100 candidates in denominators from the smallest (1).
- `-g 123,100` : getting 100 candidates in denominators from the 123.
- `-g 123,-10` : getting 10 candidates from the 123 in descending order.

- `-y ..` : showing **every denominator** as long as specified by `-g` option.
- `-y ,` : only showing the denominators when **every given proportion** has at least one corresponding integer numerator.
- `-y 1..` : showing the denominators when at least one of given proportion has the corresponding integer numerator. (**Default**)
- `-y -2..` : showing the denominators when every given proportion has the corresponding integer numerator allowing the **exceptions** within 2 of the proportions.

`N..M` means the numerical range. `N..` means n to the maximum. `..M` means zero to M. When N or M is negative, it means (the maximum)-abs(N or M). Those types of range or a single number can be combined by comma(,).

Options in output

- **-D0** : showing the fraction form such as **10/33**. (**Default** ※)
- **-D3** : showing also with 3 decimal places such as **10/33=.303**
- **-D4%** : in 4 decimal places in percentage such as **10/33=30.3030%**
- **-D-5** : showing the difference to realize the given proportion with 5 decimal places **10/33-.00003** for a given proportion **0.303**
- **-D-6%** : showing the difference to realize the given proportion with 6 decimal places such as **10/33-. 00303%** for a proportion **0.303**
- **-I** : showing the interval of possible numerators on \mathbb{R} , not only \mathbb{Z} .
If the interval contains any integer it is shown in green color.
- **-Q** : showing the numerators in a simplest way.
Extra1. When only one proportion is given,
the denominator is shown with its prime factorization as well.
Extra2. To see all the numerators are odd ($2q+1$) or even ($2q$),
if they have a common reminder R against a divisor D ,
they are shown with a form “ $(Dq+R)$ ” as well.

※ If **-D** , **-I** and **-Q** are not given, **-D0** is regarded to be specified internally.