Division with Excessive Quotient - by masaakimurakami

This is an advanced technique. In order to follow the examples it's a important to have a good working knowledge of the soroban technique Negative Numbers from Subtraction.

Division with excessive quotient needs some practice, but it makes bead movement more efficient (and beautiful). And furthermore, I think this would be a good first step to "the other side." A soroban master once said, "those who master 'the other side' master the art of the soroban." ;-)

There is an advanced technique called 'division with excessive quotient (過大商除法)', which doesn't need to re-add the number. It uses the other side of the board, I mean negative number's world represented by complement number notation.

EXAMPLE 1: For instance, when we calculate 15478839 / 387, it goes like this

```
abcdefghi
015478839 : assume 154.../38... would be 4 (perhaps), so we use 4 as a
            temporary quotient.
415478839 : subtract 4x3=12 from [b-c]
403478839 : subtract 4x8=32 from [c-d]
400278839 : subtract 4x7=28 from [d-e]... oh, the temp. quotient is too big,
            but subtract forcefully!
399998839 : now, look at the complementary negative number (negative number's world)
    [1161]  it is 1161, so let's determine 1161/387... maybe 3, because we
            are in the negative world we SUBTRACT 3 from [e]
399968839 : we are still in the negative world, so ADD 3x3=9 to [f-g]
399969739 : ADD 3x8=24 to [g-h]
399969979 : ADD 3x7=21 to [h-i], then the value is overflow to [e], means we
            are out of the other side!
399970000 : Answer is 39997
```

EXAMPLE 2: 151848/38 = 3996

```
 abcdefg
 0151848 : assume 151.../38... would be 4 (perhaps) so we use 4 as a
           temporary quotient.
 4151848 : subtract 4*3=12 from [b-c]
 4031848 : subtract 4*8=32 from [c-d]... temp quotient too big, subtract
           forcefully!
 3999848 : now, look at the complementary negative number (negative number's world)
    [152]  it is 152, 152/38...maybe 4, so SUBTRACT 4 from [d]
 3995848 : now in the negative world so we ADD 4*3=12 to [ef]
 3995968 : ADD 4*8=32 to [fg], overflow and out the other side!
 3996000 : Answer is 3996
```

Now let me show how we can easily revise our answers in the event that we assume an incorrect temporary quotient.

EXAMPLE 2a: When you assume wrong temporary quotient, you can easily fix this. For instance if you assume temp. quotient is 3, the operations would be...

```
 abcdefg
 .....
 3999848 : look at the complementary negative number (negative number's world)
    [152]  it is 152, 152/38...maybe 3, so SUBTRACT 3 from [d]
 3996848 : we're in the negative world so we ADD 3*3=9 to [ef]
 3996938 : ADD 3*8=24 to [fg]
 3996962 : look at the complementary negative numbers (negative number's world)
     [38]  it is 38, so 38/38 becomes 1, so SUBTRACT 1 from [d]
 3995962 : we add 1*3=3 to [ef]
 3995992 : add 1*8=8 to [fg]
 3996000 : Answer is 3996
```

EXAMPLE 2b: And now, if you assume it's 5,

```
abcdefg
.....
3999848 : look at the complementary negative number (negative number's world)
   [152]  it is 152, 152/38...maybe 5, so SUBTRACT 5 from [d]
3994848 : we're in the negative world so we ADD 5*3=15 to [ef]
3994998 : ADD 5*8=40 to [fg]
3995038 : now exit from the negative world. but we still have 38!
          ...we must modify the assumption to add 38/38=1
3996038 : subtract 1*3 from [ef]
3996008 : subtract 1*8 from [fg]
3996000 : Answer is 3996
```

EXAMPLE 3: 147288/38 = 3876

```
abcdefg
0147288 : try 4, 38x4=152, and subtract the value.
3995288 : into the upside-down negative world, complement# = 4712,
          temporary quotient would be 1 as 47/38=1, so subtract 1
          from [b]
3895288 : add 1x38 to [cde]
3899088 : still in the negative world, complement# = 912, temp.
          quotient would be 2 as 91/38=2, so subtract 2 from [c]
3879088 : add 2x38 [def]
3879848 : still in the negative world, complement# =152, temp.
          quotient would be 4 as 15/38=4, so subtract 4 from [d]
3875848 : add 4x38 to [efg]
3876000 : done!
```

Thanks to the people who devised and handed down this technique to the modern world, and Totton Heffelfinger for giving me the opportunities to introduce it.

- masaaki (September 2019)