

# Modular Arithmetic

For CP

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# The Modulo Operator

- For an integer  $a$ , and modulo (integer)  $m$
- $b = a \% m$ ,  $b$  is the remainder  $a$  when divided by  $m$
- i.e repeatedly subtracting  $m$  from  $a$  until  $a < m$

# Modular Addition

- Int a, int b, int mod
- Find  $(a+b) \% \text{mod}$
- What if  $(a+b)$  overflows?
- $(a+b) \% \text{mod} = ( (a \% \text{mod}) + (b \% \text{mod}) ) \% \text{mod}$

# Modular Multiplication

- Int a, int b, int mod
- Find  $(a * b) \% \text{mod}$
- But  $a * b$  may overflow
- $(a * b) \% \text{mod} = ((a \% \text{mod}) * (b \% \text{mod})) \% \text{mod}$

# Problem #1

- <https://leetcode.com/problems/maximum-subarray-min-product/>
- <https://leetcode.com/problems/sum-of-floored-pairs/>
- <https://leetcode.com/problems/largest-palindrome-product/>

# Binary Exponentiation

```
• public static long bincpow(long a, long b, long m) {  
•   a %= m;  
•   long res = 1;  
•   while (b > 0) {  
•     if (b%2==1) {  
•       res = res * a % m;  
•     }  
•     a = a * a % m;  
•     b >>= 1;  
•   }  
•   return res;  
• }
```

# Modular Division

- `public static long moddiv(long a, long b, long m) {`
- `return (a%m * binpow(b,m-2,m)%m)%m;`
- `}`



# Sieve of Eratosthenes

	2	3	<del>4</del>	5	<del>6</del>	7	<del>8</del>	<del>9</del>	<del>10</del>
11	<del>12</del>	13	<del>14</del>	<del>15</del>	<del>16</del>	17	<del>18</del>	19	<del>20</del>
<del>21</del>	<del>22</del>	23	<del>24</del>	<del>25</del>	<del>26</del>	<del>27</del>	<del>28</del>	29	<del>30</del>
31	<del>32</del>	<del>33</del>	<del>34</del>	<del>35</del>	<del>36</del>	37	<del>38</del>	<del>39</del>	<del>40</del>
41	<del>42</del>	43	<del>44</del>	<del>45</del>	<del>46</del>	47	<del>48</del>	<del>49</del>	<del>50</del>
<del>51</del>	<del>52</del>	53	<del>54</del>	<del>55</del>	<del>56</del>	<del>57</del>	<del>58</del>	59	<del>60</del>
61	<del>62</del>	<del>63</del>	<del>64</del>	<del>65</del>	<del>66</del>	67	<del>68</del>	<del>69</del>	<del>70</del>
71	<del>72</del>	73	<del>74</del>	<del>75</del>	<del>76</del>	<del>77</del>	<del>78</del>	79	<del>80</del>
<del>81</del>	<del>82</del>	83	<del>84</del>	<del>85</del>	<del>86</del>	<del>87</del>	<del>88</del>	<del>89</del>	<del>90</del>
<del>91</del>	<del>92</del>	<del>93</del>	<del>94</del>	<del>95</del>	<del>96</del>	97	<del>98</del>	<del>99</del>	<del>100</del>

# Problem Set

- <https://codeforces.com/contest/1881/problem/D>
- (difficult) <https://codeforces.com/contest/1886/problem/D>