Exercício 2 (BIKE) - Trabalho Prático 3

Grupo 6:

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imports

In [948…
```
import hashlib
import os
from sage.all import GF, PolynomialRing, ceil
import math
```

Paramêtros

Tamanho Polinomial $\rightarrow r = 12323$: .

Row weight $(w/2 = 71) \rightarrow w = 142$: .

Error weight $\rightarrow t = 134$: .

Length of m**,** σ**, and** K**.** $\rightarrow \ell = 256$:

In [949…
```
# Parametros
# Tamanho do anel
r = 12323
w = 142    # Row weight
t = 134    # Error weight
ell = 256  # Shared secret size in bits

# Anel R = F₂[X] / (Xʳ - 1)
F2 = GF(2)          # Campo finito com 2 elementos
P = PolynomialRing(F2, 'x')  # Anel de polinômios F₂[x]
x = P.gen()         # Gerador do anel de polinômios
R = P.quotient(x**r - 1)  # Anel quociente F₂[x]/(x^r - 1)
```

Funções Auxiliares

`poly_to_bytes`

1. Converte um polinômio em uma sequência de bytes:
   - Garante que os coeficientes tenham o comprimento correto;
   - Transforma em uma string de bits e converte em bytes.

In [950…
```
def poly_to_bytes(p, length):
    # Converter o Coeficiente do polinômio para uma string de bits
    coeffs = p.list() + [0] * (length - len(p.list()))
```

```
    # Juntar os coeficientes em uma string de bits
    bitstr = ''.join(str(int(c)) for c in coeffs)

    # Calcular o comprimento necessário em bytes
    byte_length = ceil(length / 8)

    # Preencher com zeros se necessário
    padded_bitstr = bitstr.ljust(byte_length * 8, '0')

    # Converter a string de bits em bytes
    return bytes(int(padded_bitstr[i:i+8], 2) for i in range(0, len(padded_bitst
```

`xor_bytes`

1. Realiza o XOR entre duas sequências de bytes.

In [951…
```
def xor_bytes(a, b):
    return bytes(x ^ y for x, y in zip(a, b))
```

`WSHAKE256_PRF`

1. Gera posições distintas para polinômios esparsos usando SHAKE256:
    - Utiliza hashlib.shake_256 para gerar bytes;
    - Converte em inteiros de 32 bits;
    - Calcula posições distintas com base na especificação.

In [952…
```
def WSHAKE256_PRF(seed, length, wt):

    # Shake256
    shake = hashlib.shake_256()
    shake.update(seed)
    stream_bytes = shake.digest(wt * 4)  # wt 32-bit ints

    # Converter o stream de bytes em inteiros
    s = [int.from_bytes(stream_bytes[i*4:(i+1)*4], 'big') for i in range(wt)]
    wlist = []
    present = set()

    # Gerar a lista de posições
    for i in range(wt - 1, -1, -1):
        pos = i + (length - i) * s[i] // 2**32
        if pos not in present and pos < length:
            wlist.append(pos)
            present.add(pos)
        else:
            wlist.append(i)
            present.add(i)
    return wlist
```

`sample_polynomial_from_positions`

1. Cria um polinômio em $\mathcal{R}$ com coeficientes 1 nas posições indicadas

In [953…
```
def sample_polynomial_from_positions(positions, length):
    # Criar um polinômio com coeficientes 0  de comprimento 'length'
    coeffs = [0] * length
```

```
    # Definir os coeficientes 1 nas posições especificadas
    for pos in positions:
        coeffs[pos] = 1

    # Criar o polinômio a partir dos coeficientes
    return R(P(coeffs))
```

Hashing Functions

`H(m, r, t)`

1. Mapeia uma mensagem de 256 bits para dois polinômios $(\mathbf{e}_0, \mathbf{e}_1)$ com peso total t:
   - Usa WSHAKE256_PRF para gerar t posições distintas;
   - Distribui as posições entre $\mathbf{e}_0$ e $\mathbf{e}_1$.

In [954…
```
# Hash function H: {0,1}²⁵⁶ → E_t
def H(m, r, t):
    positions = WSHAKE256_PRF(m, 2 * r, t)
    e0_coeffs = [0] * r
    e1_coeffs = [0] * r
    for pos in positions:
        if pos < r:
            e0_coeffs[pos] = 1
        else:
            e1_coeffs[pos - r] = 1
    e0 = R(P(e0_coeffs))
    e1 = R(P(e1_coeffs))
    return e0, e1
```

`L(e0, e1, r)`

1. Mapeia dois polinômios para uma string de 256 bits:
   - Converte os polinômios em bytes;
   - Aplica SHA384 e retorna os primeiros 32 bytes.

In [955…
```
def L(e0, e1, r):
    input_bytes = poly_to_bytes(e0, r) + poly_to_bytes(e1, r)
    return hashlib.sha384(input_bytes).digest()[:32]  # 256 bits = 32 bytes
```

`K(m, c, r)`

1. Mapeia a mensagem e o ciphertext para a chave partilhada:
   - Concatena m, c_0 (em bytes) e c_1;
   - Usa SHA384 para gerar 256 bits.

In [956…
```
def K(m, c, r):
    c0, c1 = c
    input_bytes = m + poly_to_bytes(c0, r) + c1
    return hashlib.sha384(input_bytes).digest()[:32]
```

BGF (Black-Gray-Flip)

`getHammingWeight`

1. Calcula o peso de Hamming (número de bits 1) de uma sequência binária de comprimento especificado.

In [957…
```python
def getHammingWeight(tmp, length):
    return sum(int(tmp[i]) for i in range(length))
```

`recompute_syndrome`

1. Atualiza o síndrome s após a inversão de um bit na posição pos do vetor de erro, considerando as matrizes de paridade compactadas $\mathbf{h}_0$ e $\mathbf{h}_1$.

In [958…
```python
def recompute_syndrome(s, pos, h0_compact, h1_compact, r):

    # se pos < r, atualiza o síndrome usando h0_compact
    if pos < r:
        for j in range(len(h0_compact)):
            if h0_compact[j] <= pos:
                s[(pos - h0_compact[j]) % r] ^= 1
            else:
                s[(r - h0_compact[j] + pos) % r] ^= 1

    # se pos >= r, atualiza o síndrome usando h1_compact
    else:
        pos -= r
        for j in range(len(h1_compact)):
            if h1_compact[j] <= pos:
                s[(pos - h1_compact[j]) % r] ^= 1
            else:
                s[(r - h1_compact[j] + pos) % r] ^= 1
```

`ctr`

1. Calcula o contador de paridade insatisfeita (número de verificações de paridade violadas) para uma coluna específica da matriz de paridade, dado o síndrome.

In [959…
```python
def ctr(h_compact_col, position, s, r):
    count = 0
    for i in range(len(h_compact_col)):
        index = (h_compact_col[i] + position) % r
        if s[index]:
            count += 1
    return count
```

`getCol`

1. Converte uma representação compactada de uma linha da matriz de paridade ($\mathbf{h}_0$ ou $\mathbf{h}_1$) em uma representação compactada da coluna correspondente.

In [960…
```python
def getCol(h_compact_row, r):
    h_compact_col = [0] * len(h_compact_row)
```

```
    if h_compact_row[0] == 0:
        h_compact_col[0] = 0
        for i in range(1, len(h_compact_row)):
            h_compact_col[i] = r - h_compact_row[len(h_compact_row) - i]
    else:
        for i in range(len(h_compact_row)):
            h_compact_col[i] = r - h_compact_row[len(h_compact_row) - 1 - i]
    return h_compact_col
```

`flipAdjustedErrorPosition`

1. Inverte um bit na posição ajustada do vetor de erro, considerando a estrutura do BIKE.

In [961…

```
def flipAdjustedErrorPosition(e, position, r):
    adjustedPosition = position
    if position != 0 and position != r:
        adjustedPosition = (position > r) and ((2 * r - position) + r) or (r - p
    e[adjustedPosition] ^= 1
```

`BFMaskedIter`

1. Executa uma iteração mascarada do algoritmo de decodificação, invertendo bits no vetor de erro com base em uma máscara e um limiar.

In [962…

```
def BFMaskedIter(e, s, mask, T, h0_compact, h1_compact, h0_compact_col, h1_compa
    pos = [0] * (2 * r)
    for j in range(r):
        counter = ctr(h0_compact_col, j, s, r)
        if counter >= T and mask[j]:
            flipAdjustedErrorPosition(e, j, r)
            pos[j] = 1
    for j in range(r, 2 * r):
        counter = ctr(h1_compact_col, j - r, s, r)
        if counter >= T and mask[j]:
            flipAdjustedErrorPosition(e, j, r)
            pos[j] = 1
    for j in range(2 * r):
        if pos[j]:
            recompute_syndrome(s, j, h0_compact, h1_compact, r)
```

`BFIter`

1. Executa uma iteração principal do algoritmo BGF, classificando posições como "black" ou "gray" com base em contadores de paridade e ajustando o vetor de erro.

In [963…

```
def BFIter(e, black, gray, s, T, tau, h0_compact, h1_compact, h0_compact_col, h1
    pos = [0] * (2 * r)
    for j in range(r):
        counter = ctr(h0_compact_col, j, s, r)
        if counter >= T:
            flipAdjustedErrorPosition(e, j, r)
            pos[j] = 1
            black[j] = 1
        elif counter >= T - tau:
            gray[j] = 1
    for j in range(r, 2 * r):
```

```
        counter = ctr(h1_compact_col, j - r, s, r)
        if counter >= T:
            flipAdjustedErrorPosition(e, j, r)
            pos[j] = 1
            black[j] = 1
        elif counter >= T - tau:
            gray[j] = 1
    for j in range(2 * r):
        if pos[j]:
            recompute_syndrome(s, j, h0_compact, h1_compact, r)
```

`BGF_decoder`

1. Implementa o decodificador BGF completo, executando iterações para corrigir erros no vetor de erro com base no síndrome e nas matrizes de paridade.

In [964…

```
def BGF_decoder(e, s, h0_compact, h1_compact, r, w, t, NbIter=5, tau=3):
    e = [0] * (2 * r)
    h0_compact_col = getCol(h0_compact, r)
    h1_compact_col = getCol(h1_compact, r)
    black = [0] * (2 * r)
    gray = [0] * (2 * r)
    for i in range(1, NbIter + 1):
        black = [0] * (2 * r)
        gray = [0] * (2 * r)
        S = getHammingWeight(s, r)
        T = max(math.ceil(0.0069722 * S + 13.530), 36)  # Threshold ajustado par
        BFIter(e, black, gray, s, T, tau, h0_compact, h1_compact, h0_compact_col
        if i == 1:
            T_mask = (w // 2 + 1) // 2 + 1
            BFMaskedIter(e, s, black, T_mask, h0_compact, h1_compact, h0_compact
            BFMaskedIter(e, s, gray, T_mask, h0_compact, h1_compact, h0_compact_
        if getHammingWeight(s, r) == 0:
            print("Decodificação bem-sucedida!\n")
            return e

    return None  # Falha na decodificação
```

BIKE Implementatioon

A função `KeyGen` é responsável por gerar o par de chaves pública e privada:

1. Gerar Componentes da Chave Privada:
   - Criar dois polinómios esparsos, $\mathbf{h}_0$ e $\mathbf{h}_1$, no anel $\mathcal{R}$;
   - Cada polinómio deve ter exatamente $w/2$ coeficientes iguais a 1, onde w é o peso da linha;
   - Utilizar uma função pseudoaleatória, como `WSHAKE256-PRF`, com uma semente, para escolher $w/2$ posições distintas para os coeficientes 1 em cada polinómio.
2. Calcular a Chave Pública:
   - Calcular $\mathbf{h} = \mathbf{h}_1 \cdot \mathbf{h}_0^{-1}$ em $\mathcal{R}$.

- Para que $\mathbf{h}_0$ seja invertível, $w/2$ é definido como um número ímpar, garantindo esta propriedade no anel.

3. Gerar uma String Aleatória:

- Produzir uma string $\sigma \in \{0,1\}^{256}$ de 256 bits, utilizando um gerador de números aleatórios seguro. Esta string é usada como recurso de reserva no desencapsulamento, caso a decodificação falhe.

In [965…
```python
# Key Generation
def KeyGen(r, w):
    seed_h0 = os.urandom(32)
    positions_h0 = WSHAKE256_PRF(seed_h0, r, w // 2)
    h0 = sample_polynomial_from_positions(positions_h0, r)

    seed_h1 = os.urandom(32)
    positions_h1 = WSHAKE256_PRF(seed_h1, r, w // 2)
    h1 = sample_polynomial_from_positions(positions_h1, r)

    h = h1 * h0.inverse_of_unit()  # Compute h = h₁ * h₀⁻¹ in R
    sigma = os.urandom(32)

    sk = (h0, h1, sigma)  # Private key
    pk = h                # Public key
    return sk, pk
```

A função `Encaps` é responsável por gerar uma chave secreta partilhada e o seu ciphertext utilizando a chave pública.

1. Escolher uma Mensagem Aleatória:

- Gerar uma string aleatória $m \in \{0,1\}^{256}$ de 256 bits com um gerador seguro.

2. Gerar Vetores de Erro:

- Aplicar uma função hash $\mathbf{H}$ (ex.: SHAKE256) a m para criar os vetores de erro $(\mathbf{e}_0, \mathbf{e}_1)$, com peso total de Hamming t (ex.: $t = 134$ para nível 1).

3. Calcular o Ciphertext:

- $c_0 = \mathbf{e}_0 + \mathbf{e}_1 \cdot \mathbf{h}$ em $\mathcal{R}$;
- $c_1 = m \oplus \mathbf{L}(\mathbf{e}_0, \mathbf{e}_1)$, onde $\mathbf{L}$ (ex.: SHA384) mapeia os vetores de erro para uma string de 256 bits;
- O ciphertext é $c = (c_0, c_1)$.

4. Calcular a Chave Secreta:

- $K = \mathbf{K}(m, c)$, onde $\mathbf{K}$ (ex.: SHA384) faz hash de m e c.

In [966…
```python
# Encapsulation
def Encaps(pk, r, t):
    h = pk
    m = os.urandom(32)  # m ←$ {0,1}²⁵⁶
    e0, e1 = H(m, r, t)
    c0 = e0 + e1 * h
    c1 = xor_bytes(m, L(e0, e1, r))
    c = (c0, c1)
```

```
    K_shared = K(m, c, r)
    return K_shared, c
```

A função `Decaps` é responsável por recuperar a chave secreta partilhada a partir do ciphertext usando a chave privada.

1. Decodificar o Ciphertext:
   - Calcular o síndrome $s = c_0 \cdot \mathbf{h}_0$ em $\mathcal{R}$.
   - Usar um decodificador (BGF) para recuperar os vetores de erro $\mathbf{e}' = (\mathbf{e}'_0, \mathbf{e}'_1)$.
2. Recuperar a Mensagem:
   - $m' = c_1 \oplus \mathbf{L}(\mathbf{e}'_0, \mathbf{e}'_1)$, com $\mathbf{L}$ igual à usada em `Encaps`
3. Verificar e Calcular a Chave:
   - Verificar se $\mathbf{e}' = \mathbf{H}(m')$ (usando a mesma $\mathbf{H}$ de `Encaps`)
   - Se verdadeiro: $K = \mathbf{K}(m', c)$.
   - Se falso (falha na decodificação): $K = \mathbf{K}(\sigma, c)$, usando σ como reserva.

In [967…

```
# Decapsulation (with simulated decoder)
def Decaps(sk, c, r, t):
    h0, h1, sigma = sk
    c0, c1 = c

    # Simulate decoder: assume it correctly recovers e0 and e1
    h0 = sk[0]  # Primeira parte da chave privada
    c0 = c[0]   # Primeira parte do ciphertext
    s = (c0 * h0).list()  # Síndrome como lista
    s = [int(coeff) for coeff in s]  # Converter para inteiros Python
    h0_list = [int(coeff) for coeff in sk[0].list()]
    h1_list = [int(coeff) for coeff in sk[1].list()]

    dec = BGF_decoder([0] * (2 * r), r * [0], h0_list, h1_list, r, w, t)
    e0_prime = R(P(dec[:r]))
    e1_prime = R(P(dec[r:2 * r]))

    m_prime = xor_bytes(c1, L(e0_prime, e1_prime, r))

    e0_check, e1_check = H(m_prime, r, t)
    c0_prime = e0_check + e1_check * (h1 * h0.inverse_of_unit())
    c1_prime = xor_bytes(m_prime, L(e0_check, e1_check, r))

    if c0 == c0_prime and c1 == c1_prime:
        return K(m_prime, c, r)
    else:
        return K(sigma, c, r)
```

Run

In [968…

```
print("======= BIKE - Key Encapsulation Mechanism ======= \n")
sk, pk = KeyGen(r, w)
print("Chave Gerada com sucesso.")
print("Chave Pública:", pk)
print("Chave Privada:", sk)
```

```
# Encapsulate
K_enc, c = Encaps(pk, r, t)
print("\nEncapsulação completa!")

# Decapsulate
print("\n======= DESCOMPACTANDO =======")
K_dec = Decaps(sk, c, r, t)
```

```
======= BIKE - Key Encapsulation Mechanism =======

Chave Gerada com sucesso.
Chave Pública: xbar^12322 + xbar^12318 + xbar^12315 + xbar^12314 + xbar^12313 + x
bar^12311 + xbar^12309 + xbar^12308 + xbar^12306 + xbar^12300 + xbar^12299 + xbar
^12298 + xbar^12295 + xbar^12294 + xbar^12293 + xbar^12292 + xbar^12290 + xbar^12
287 + xbar^12285 + xbar^12284 + xbar^12278 + xbar^12276 + xbar^12275 + xbar^12274
+ xbar^12273 + xbar^12268 + xbar^12266 + xbar^12264 + xbar^12263 + xbar^12262 + x
bar^12260 + xbar^12258 + xbar^12253 + xbar^12252 + xbar^12251 + xbar^12249 + xbar
^12248 + xbar^12247 + xbar^12246 + xbar^12241 + xbar^12240 + xbar^12239 + xbar^12
230 + xbar^12229 + xbar^12228 + xbar^12225 + xbar^12223 + xbar^12220 + xbar^12213
+ xbar^12212 + xbar^12210 + xbar^12208 + xbar^12207 + xbar^12206 + xbar^12204 + x
bar^12203 + xbar^12202 + xbar^12200 + xbar^12199 + xbar^12198 + xbar^12196 + xbar
^12194 + xbar^12191 + xbar^12190 + xbar^12185 + xbar^12184 + xbar^12183 + xbar^12
182 + xbar^12181 + xbar^12180 + xbar^12179 + xbar^12178 + xbar^12176 + xbar^12175
+ xbar^12174 + xbar^12173 + xbar^12169 + xbar^12165 + xbar^12159 + xbar^12158 + x
bar^12156 + xbar^12152 + xbar^12151 + xbar^12150 + xbar^12149 + xbar^12148 + xbar
^12147 + xbar^12145 + xbar^12143 + xbar^12142 + xbar^12141 + xbar^12139 + xbar^12
138 + xbar^12137 + xbar^12136 + xbar^12133 + xbar^12132 + xbar^12131 + xbar^12127
+ xbar^12126 + xbar^12125 + xbar^12123 + xbar^12121 + xbar^12120 + xbar^12118 + x
bar^12117 + xbar^12110 + xbar^12109 + xbar^12106 + xbar^12105 + xbar^12104 + xbar
^12102 + xbar^12099 + xbar^12098 + xbar^12097 + xbar^12095 + xbar^12094 + xbar^12
093 + xbar^12091 + xbar^12084 + xbar^12083 + xbar^12081 + xbar^12079 + xbar^12078
+ xbar^12077 + xbar^12068 + xbar^12065 + xbar^12062 + xbar^12060 + xbar^12059 + x
bar^12057 + xbar^12056 + xbar^12051 + xbar^12050 + xbar^12048 + xbar^12039 + xbar
^12037 + xbar^12036 + xbar^12030 + xbar^12029 + xbar^12028 + xbar^12024 + xbar^12
023 + xbar^12019 + xbar^12018 + xbar^12017 + xbar^12014 + xbar^12013 + xbar^12009
+ xbar^12008 + xbar^12002 + xbar^11999 + xbar^11998 + xbar^11995 + xbar^11994 + x
bar^11992 + xbar^11990 + xbar^11988 + xbar^11987 + xbar^11984 + xbar^11983 + xbar
^11982 + xbar^11980 + xbar^11978 + xbar^11977 + xbar^11975 + xbar^11973 + xbar^11
970 + xbar^11968 + xbar^11967 + xbar^11963 + xbar^11961 + xbar^11959 + xbar^11957
+ xbar^11956 + xbar^11954 + xbar^11953 + xbar^11947 + xbar^11946 + xbar^11942 + x
bar^11941 + xbar^11939 + xbar^11937 + xbar^11936 + xbar^11935 + xbar^11932 + xbar
^11929 + xbar^11927 + xbar^11926 + xbar^11924 + xbar^11919 + xbar^11916 + xbar^11
915 + xbar^11914 + xbar^11911 + xbar^11910 + xbar^11909 + xbar^11908 + xbar^11907
+ xbar^11905 + xbar^11902 + xbar^11898 + xbar^11895 + xbar^11894 + xbar^11893 + x
bar^11891 + xbar^11889 + xbar^11888 + xbar^11887 + xbar^11886 + xbar^11885 + xbar
^11884 + xbar^11882 + xbar^11880 + xbar^11878 + xbar^11877 + xbar^11875 + xbar^11
874 + xbar^11873 + xbar^11872 + xbar^11868 + xbar^11866 + xbar^11865 + xbar^11863
+ xbar^11862 + xbar^11858 + xbar^11857 + xbar^11852 + xbar^11851 + xbar^11848 + x
bar^11842 + xbar^11841 + xbar^11840 + xbar^11839 + xbar^11837 + xbar^11833 + xbar
^11831 + xbar^11830 + xbar^11826 + xbar^11825 + xbar^11824 + xbar^11821 + xbar^11
820 + xbar^11818 + xbar^11817 + xbar^11816 + xbar^11813 + xbar^11812 + xbar^11809
+ xbar^11806 + xbar^11805 + xbar^11802 + xbar^11798 + xbar^11797 + xbar^11794 + x
bar^11789 + xbar^11780 + xbar^11776 + xbar^11775 + xbar^11773 + xbar^11771 + xbar
^11770 + xbar^11767 + xbar^11766 + xbar^11764 + xbar^11763 + xbar^11758 + xbar^11
757 + xbar^11754 + xbar^11746 + xbar^11745 + xbar^11744 + xbar^11737 + xbar^11736
+ xbar^11735 + xbar^11734 + xbar^11730 + xbar^11728 + xbar^11723 + xbar^11722 + x
bar^11715 + xbar^11714 + xbar^11713 + xbar^11712 + xbar^11709 + xbar^11705 + xbar
^11704 + xbar^11703 + xbar^11701 + xbar^11694 + xbar^11690 + xbar^11689 + xbar^11
685 + xbar^11684 + xbar^11682 + xbar^11681 + xbar^11679 + xbar^11678 + xbar^11675
+ xbar^11672 + xbar^11670 + xbar^11668 + xbar^11665 + xbar^11664 + xbar^11663 + x
bar^11661 + xbar^11660 + xbar^11659 + xbar^11656 + xbar^11655 + xbar^11654 + xbar
^11653 + xbar^11652 + xbar^11651 + xbar^11650 + xbar^11649 + xbar^11647 + xbar^11
643 + xbar^11641 + xbar^11639 + xbar^11638 + xbar^11637 + xbar^11636 + xbar^11634
+ xbar^11631 + xbar^11629 + xbar^11625 + xbar^11624 + xbar^11623 + xbar^11619 + x
bar^11618 + xbar^11617 + xbar^11616 + xbar^11614 + xbar^11609 + xbar^11608 + xbar
^11605 + xbar^11604 + xbar^11602 + xbar^11601 + xbar^11598 + xbar^11597 + xbar^11
594 + xbar^11593 + xbar^11592 + xbar^11591 + xbar^11590 + xbar^11589 + xbar^11588
+ xbar^11587 + xbar^11586 + xbar^11585 + xbar^11581 + xbar^11580 + xbar^11576 + x
```

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bar^11575 + xbar^11574 + xbar^11572 + xbar^11571 + xbar^11570 + xbar^11567 + xbar
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557 + xbar^11555 + xbar^11554 + xbar^11549 + xbar^11548 + xbar^11546 + xbar^11545
+ xbar^11544 + xbar^11543 + xbar^11542 + xbar^11540 + xbar^11539 + xbar^11538 + x
bar^11537 + xbar^11536 + xbar^11535 + xbar^11534 + xbar^11533 + xbar^11530 + xbar
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513 + xbar^11510 + xbar^11508 + xbar^11506 + xbar^11501 + xbar^11498 + xbar^11496
+ xbar^11492 + xbar^11491 + xbar^11490 + xbar^11488 + xbar^11485 + xbar^11483 + x
bar^11481 + xbar^11479 + xbar^11476 + xbar^11475 + xbar^11472 + xbar^11467 + xbar
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+ xbar^11438 + xbar^11436 + xbar^11435 + xbar^11434 + xbar^11433 + xbar^11432 + x
bar^11429 + xbar^11428 + xbar^11427 + xbar^11425 + xbar^11422 + xbar^11420 + xbar
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404 + xbar^11402 + xbar^11398 + xbar^11397 + xbar^11395 + xbar^11394 + xbar^11393
+ xbar^11392 + xbar^11390 + xbar^11388 + xbar^11383 + xbar^11381 + xbar^11380 + x
bar^11378 + xbar^11377 + xbar^11376 + xbar^11375 + xbar^11373 + xbar^11370 + xbar
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352 + xbar^11351 + xbar^11347 + xbar^11344 + xbar^11343 + xbar^11340 + xbar^11339
+ xbar^11338 + xbar^11336 + xbar^11334 + xbar^11333 + xbar^11330 + xbar^11329 + x
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+ xbar^11287 + xbar^11286 + xbar^11283 + xbar^11280 + xbar^11277 + xbar^11275 + x
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+ xbar^11243 + xbar^11242 + xbar^11239 + xbar^11238 + xbar^11237 + xbar^11236 + x
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+ xbar^11191 + xbar^11184 + xbar^11183 + xbar^11180 + xbar^11179 + xbar^11176 + x
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+ xbar^11135 + xbar^11134 + xbar^11132 + xbar^11130 + xbar^11129 + xbar^11128 + x
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+ xbar^11090 + xbar^11087 + xbar^11085 + xbar^11082 + xbar^11080 + xbar^11075 + x
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043 + xbar^11039 + xbar^11038 + xbar^11035 + xbar^11034 + xbar^11033 + xbar^11031
+ xbar^11028 + xbar^11026 + xbar^11020 + xbar^11019 + xbar^11016 + xbar^11015 + x
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+ xbar^10977 + xbar^10976 + xbar^10975 + xbar^10972 + xbar^10968 + xbar^10964 + x
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+ xbar^10926 + xbar^10924 + xbar^10922 + xbar^10921 + xbar^10920 + xbar^10919 + x
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+ xbar^10877 + xbar^10875 + xbar^10874 + xbar^10873 + xbar^10870 + xbar^10867 + x
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835 + xbar^10833 + xbar^10832 + xbar^10830 + xbar^10828 + xbar^10827 + xbar^10826
+ xbar^10825 + xbar^10824 + xbar^10822 + xbar^10820 + xbar^10819 + xbar^10818 + x
```

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bar^10816 + xbar^10815 + xbar^10814 + xbar^10813 + xbar^10809 + xbar^10808 + xbar
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785 + xbar^10784 + xbar^10783 + xbar^10782 + xbar^10781 + xbar^10780 + xbar^10777
+ xbar^10774 + xbar^10768 + xbar^10766 + xbar^10765 + xbar^10764 + xbar^10762 + x
bar^10761 + xbar^10760 + xbar^10759 + xbar^10757 + xbar^10756 + xbar^10755 + xbar
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+ xbar^10732 + xbar^10731 + xbar^10730 + xbar^10728 + xbar^10725 + xbar^10724 + x
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+ xbar^10595 + xbar^10593 + xbar^10592 + xbar^10591 + xbar^10589 + xbar^10588 + x
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+ xbar^10555 + xbar^10551 + xbar^10550 + xbar^10548 + xbar^10547 + xbar^10546 + x
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+ xbar^10504 + xbar^10503 + xbar^10502 + xbar^10501 + xbar^10500 + xbar^10499 + x
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+ xbar^10456 + xbar^10455 + xbar^10454 + xbar^10453 + xbar^10451 + xbar^10449 + x
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+ xbar^10420 + xbar^10418 + xbar^10417 + xbar^10416 + xbar^10414 + xbar^10413 + x
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+ xbar^10364 + xbar^10361 + xbar^10359 + xbar^10355 + xbar^10354 + xbar^10353 + x
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+ xbar^10307 + xbar^10306 + xbar^10302 + xbar^10300 + xbar^10299 + xbar^10297 + x
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+ xbar^10259 + xbar^10257 + xbar^10256 + xbar^10255 + xbar^10254 + xbar^10253 + x
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+ xbar^10219 + xbar^10218 + xbar^10217 + xbar^10216 + xbar^10215 + xbar^10214 + x
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+ xbar^10173 + xbar^10172 + xbar^10171 + xbar^10168 + xbar^10166 + xbar^10163 + x
bar^10162 + xbar^10160 + xbar^10157 + xbar^10156 + xbar^10155 + xbar^10154 + xbar
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141 + xbar^10139 + xbar^10138 + xbar^10137 + xbar^10136 + xbar^10134 + xbar^10133
+ xbar^10129 + xbar^10126 + xbar^10124 + xbar^10123 + xbar^10121 + xbar^10120 + x
```

```
bar^10118 + xbar^10117 + xbar^10116 + xbar^10115 + xbar^10114 + xbar^10113 + xbar
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103 + xbar^10097 + xbar^10095 + xbar^10094 + xbar^10090 + xbar^10089 + xbar^10088
+ xbar^10084 + xbar^10080 + xbar^10079 + xbar^10078 + xbar^10077 + xbar^10074 + x
bar^10071 + xbar^10070 + xbar^10069 + xbar^10066 + xbar^10064 + xbar^10060 + xbar
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+ xbar^10028 + xbar^10026 + xbar^10025 + xbar^10024 + xbar^10021 + xbar^10020 + x
bar^10019 + xbar^10018 + xbar^10016 + xbar^10014 + xbar^10012 + xbar^10007 + xbar
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xbar^9984 + xbar^9983 + xbar^9981 + xbar^9980 + xbar^9977 + xbar^9976 + xbar^9974
+ xbar^9973 + xbar^9972 + xbar^9971 + xbar^9970 + xbar^9969 + xbar^9968 + xbar^99
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+ xbar^9930 + xbar^9927 + xbar^9926 + xbar^9924 + xbar^9922 + xbar^9921 + xbar^99
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+ xbar^9871 + xbar^9867 + xbar^9865 + xbar^9864 + xbar^9862 + xbar^9861 + xbar^98
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+ xbar^9816 + xbar^9815 + xbar^9814 + xbar^9811 + xbar^9810 + xbar^9809 + xbar^98
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+ xbar^9655 + xbar^9653 + xbar^9650 + xbar^9649 + xbar^9648 + xbar^9646 + xbar^96
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bar^9626 + xbar^9624 + xbar^9623 + xbar^9620 + xbar^9619 + xbar^9618 + xbar^9616
+ xbar^9613 + xbar^9612 + xbar^9611 + xbar^9610 + xbar^9608 + xbar^9606 + xbar^96
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bar^9580 + xbar^9579 + xbar^9577 + xbar^9574 + xbar^9571 + xbar^9570 + xbar^9569
+ xbar^9568 + xbar^9567 + xbar^9566 + xbar^9565 + xbar^9563 + xbar^9562 + xbar^95
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bar^9535 + xbar^9534 + xbar^9531 + xbar^9530 + xbar^9529 + xbar^9526 + xbar^9525
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bar^9482 + xbar^9481 + xbar^9478 + xbar^9477 + xbar^9475 + xbar^9474 + xbar^9472
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^9441 + xbar^9440 + xbar^9439 + xbar^9435 + xbar^9434 + xbar^9432 + xbar^9430 + x
bar^9428 + xbar^9427 + xbar^9424 + xbar^9420 + xbar^9418 + xbar^9416 + xbar^9415
+ xbar^9414 + xbar^9412 + xbar^9411 + xbar^9409 + xbar^9407 + xbar^9398 + xbar^93
97 + xbar^9395 + xbar^9394 + xbar^9391 + xbar^9390 + xbar^9389 + xbar^9387 + xbar
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bar^9358 + xbar^9356 + xbar^9352 + xbar^9351 + xbar^9349 + xbar^9347 + xbar^9346
+ xbar^9345 + xbar^9343 + xbar^9341 + xbar^9337 + xbar^9335 + xbar^9334 + xbar^93
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```
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^9322 + xbar^9320 + xbar^9319 + xbar^9315 + xbar^9313 + xbar^9312 + xbar^9311 + x
bar^9310 + xbar^9305 + xbar^9304 + xbar^9303 + xbar^9302 + xbar^9301 + xbar^9299
+ xbar^9298 + xbar^9294 + xbar^9293 + xbar^9291 + xbar^9287 + xbar^9285 + xbar^92
84 + xbar^9281 + xbar^9280 + xbar^9278 + xbar^9275 + xbar^9274 + xbar^9273 + xbar
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+ xbar^9244 + xbar^9241 + xbar^9238 + xbar^9236 + xbar^9233 + xbar^9232 + xbar^92
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+ xbar^9189 + xbar^9187 + xbar^9186 + xbar^9185 + xbar^9184 + xbar^9183 + xbar^91
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bar^9157 + xbar^9156 + xbar^9150 + xbar^9148 + xbar^9146 + xbar^9145 + xbar^9144
+ xbar^9141 + xbar^9140 + xbar^9139 + xbar^9137 + xbar^9135 + xbar^9134 + xbar^91
33 + xbar^9132 + xbar^9131 + xbar^9127 + xbar^9125 + xbar^9124 + xbar^9120 + xbar
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bar^9102 + xbar^9101 + xbar^9100 + xbar^9099 + xbar^9098 + xbar^9097 + xbar^9095
+ xbar^9094 + xbar^9092 + xbar^9089 + xbar^9087 + xbar^9086 + xbar^9083 + xbar^90
74 + xbar^9072 + xbar^9071 + xbar^9069 + xbar^9066 + xbar^9065 + xbar^9064 + xbar
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+ xbar^9035 + xbar^9034 + xbar^9033 + xbar^9032 + xbar^9030 + xbar^9028 + xbar^90
24 + xbar^9019 + xbar^9018 + xbar^9017 + xbar^9016 + xbar^9014 + xbar^9013 + xbar
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+ xbar^8979 + xbar^8978 + xbar^8976 + xbar^8975 + xbar^8974 + xbar^8971 + xbar^89
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+ xbar^8934 + xbar^8932 + xbar^8929 + xbar^8928 + xbar^8926 + xbar^8924 + xbar^89
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bar^8890 + xbar^8889 + xbar^8887 + xbar^8886 + xbar^8885 + xbar^8884 + xbar^8883
+ xbar^8882 + xbar^8879 + xbar^8876 + xbar^8873 + xbar^8871 + xbar^8868 + xbar^88
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+ xbar^8826 + xbar^8825 + xbar^8823 + xbar^8821 + xbar^8820 + xbar^8819 + xbar^88
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+ xbar^8778 + xbar^8777 + xbar^8776 + xbar^8775 + xbar^8770 + xbar^8769 + xbar^87
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+ xbar^8718 + xbar^8717 + xbar^8716 + xbar^8714 + xbar^8713 + xbar^8711 + xbar^87
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+ xbar^8622 + xbar^8620 + xbar^8619 + xbar^8615 + xbar^8611 + xbar^8610 + xbar^86
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^8594 + xbar^8589 + xbar^8588 + xbar^8587 + xbar^8584 + xbar^8583 + xbar^8581 + x
bar^8580 + xbar^8579 + xbar^8578 + xbar^8575 + xbar^8571 + xbar^8569 + xbar^8567
+ xbar^8566 + xbar^8564 + xbar^8563 + xbar^8561 + xbar^8557 + xbar^8556 + xbar^85
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bar^8528 + xbar^8526 + xbar^8525 + xbar^8522 + xbar^8521 + xbar^8516 + xbar^8515
+ xbar^8506 + xbar^8503 + xbar^8497 + xbar^8496 + xbar^8495 + xbar^8491 + xbar^84
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bar^8368 + xbar^8366 + xbar^8361 + xbar^8355 + xbar^8354 + xbar^8353 + xbar^8348
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+ xbar^8241 + xbar^8240 + xbar^8239 + xbar^8237 + xbar^8236 + xbar^8233 + xbar^82
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+ xbar^7760 + xbar^7759 + xbar^7758 + xbar^7757 + xbar^7755 + xbar^7754 + xbar^77
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+ xbar^7612 + xbar^7611 + xbar^7610 + xbar^7609 + xbar^7607 + xbar^7605 + xbar^76
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+ xbar^7519 + xbar^7517 + xbar^7512 + xbar^7509 + xbar^7508 + xbar^7507 + xbar^75
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+ xbar^6998 + xbar^6997 + xbar^6996 + xbar^6995 + xbar^6994 + xbar^6993 + xbar^69
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+ xbar^6619 + xbar^6617 + xbar^6613 + xbar^6611 + xbar^6609 + xbar^6608 + xbar^66
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^6587 + xbar^6585 + xbar^6584 + xbar^6583 + xbar^6580 + xbar^6579 + xbar^6578 + x
bar^6577 + xbar^6576 + xbar^6573 + xbar^6569 + xbar^6566 + xbar^6565 + xbar^6563
+ xbar^6559 + xbar^6555 + xbar^6553 + xbar^6550 + xbar^6549 + xbar^6548 + xbar^65
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^6537 + xbar^6536 + xbar^6535 + xbar^6533 + xbar^6532 + xbar^6531 + xbar^6529 + x
bar^6527 + xbar^6526 + xbar^6518 + xbar^6515 + xbar^6513 + xbar^6511 + xbar^6510
+ xbar^6509 + xbar^6504 + xbar^6499 + xbar^6496 + xbar^6494 + xbar^6493 + xbar^64
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+ xbar^6446 + xbar^6445 + xbar^6443 + xbar^6440 + xbar^6439 + xbar^6438 + xbar^64
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bar^6415 + xbar^6413 + xbar^6412 + xbar^6409 + xbar^6407 + xbar^6406 + xbar^6402
+ xbar^6401 + xbar^6400 + xbar^6399 + xbar^6397 + xbar^6395 + xbar^6391 + xbar^63
90 + xbar^6389 + xbar^6388 + xbar^6387 + xbar^6385 + xbar^6384 + xbar^6382 + xbar
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bar^6368 + xbar^6366 + xbar^6365 + xbar^6364 + xbar^6363 + xbar^6357 + xbar^6354
+ xbar^6350 + xbar^6347 + xbar^6345 + xbar^6344 + xbar^6341 + xbar^6339 + xbar^63
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+ xbar^6242 + xbar^6240 + xbar^6239 + xbar^6235 + xbar^6234 + xbar^6233 + xbar^62
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+ xbar^6187 + xbar^6185 + xbar^6184 + xbar^6180 + xbar^6178 + xbar^6177 + xbar^61
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72 + xbar^6171 + xbar^6168 + xbar^6167 + xbar^6166 + xbar^6164 + xbar^6162 + xbar
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bar^6148 + xbar^6146 + xbar^6145 + xbar^6143 + xbar^6142 + xbar^6140 + xbar^6139
+ xbar^6138 + xbar^6135 + xbar^6133 + xbar^6131 + xbar^6126 + xbar^6122 + xbar^61
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+ xbar^6067 + xbar^6066 + xbar^6059 + xbar^6058 + xbar^6049 + xbar^6048 + xbar^60
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+ xbar^5916 + xbar^5909 + xbar^5908 + xbar^5907 + xbar^5904 + xbar^5902 + xbar^59
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+ xbar^5617 + xbar^5614 + xbar^5613 + xbar^5611 + xbar^5609 + xbar^5606 + xbar^56
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+ xbar^5350 + xbar^5347 + xbar^5345 + xbar^5344 + xbar^5343 + xbar^5342 + xbar^53
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+ xbar^5025 + xbar^5024 + xbar^5020 + xbar^5018 + xbar^5016 + xbar^5015 + xbar^50
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+ xbar^4548 + xbar^4546 + xbar^4545 + xbar^4542 + xbar^4541 + xbar^4538 + xbar^45
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+ xbar^4241 + xbar^4240 + xbar^4239 + xbar^4237 + xbar^4236 + xbar^4234 + xbar^42
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+ xbar^4063 + xbar^4059 + xbar^4056 + xbar^4054 + xbar^4052 + xbar^4051 + xbar^40
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^4038 + xbar^4036 + xbar^4035 + xbar^4033 + xbar^4031 + xbar^4030 + xbar^4027 + x
bar^4024 + xbar^4022 + xbar^4020 + xbar^4019 + xbar^4018 + xbar^4017 + xbar^4014
+ xbar^4011 + xbar^4008 + xbar^4005 + xbar^4003 + xbar^3996 + xbar^3995 + xbar^39
94 + xbar^3993 + xbar^3992 + xbar^3980 + xbar^3974 + xbar^3973 + xbar^3971 + xbar
^3968 + xbar^3967 + xbar^3965 + xbar^3963 + xbar^3961 + xbar^3958 + xbar^3955 + x
bar^3954 + xbar^3953 + xbar^3952 + xbar^3951 + xbar^3944 + xbar^3942 + xbar^3941
+ xbar^3936 + xbar^3934 + xbar^3932 + xbar^3931 + xbar^3930 + xbar^3929 + xbar^39
28 + xbar^3922 + xbar^3921 + xbar^3920 + xbar^3918 + xbar^3915 + xbar^3914 + xbar
^3913 + xbar^3910 + xbar^3907 + xbar^3906 + xbar^3905 + xbar^3904 + xbar^3903 + x
bar^3902 + xbar^3901 + xbar^3900 + xbar^3897 + xbar^3892 + xbar^3891 + xbar^3890
+ xbar^3888 + xbar^3887 + xbar^3885 + xbar^3882 + xbar^3879 + xbar^3878 + xbar^38
76 + xbar^3875 + xbar^3870 + xbar^3865 + xbar^3864 + xbar^3863 + xbar^3859 + xbar
^3858 + xbar^3857 + xbar^3856 + xbar^3855 + xbar^3852 + xbar^3850 + xbar^3849 + x
bar^3847 + xbar^3846 + xbar^3844 + xbar^3840 + xbar^3839 + xbar^3838 + xbar^3837
+ xbar^3835 + xbar^3834 + xbar^3833 + xbar^3831 + xbar^3829 + xbar^3828 + xbar^38
26 + xbar^3822 + xbar^3821 + xbar^3819 + xbar^3817 + xbar^3815 + xbar^3814 + xbar
^3812 + xbar^3808 + xbar^3804 + xbar^3802 + xbar^3798 + xbar^3796 + xbar^3790 + x
bar^3788 + xbar^3787 + xbar^3786 + xbar^3781 + xbar^3780 + xbar^3777 + xbar^3776
+ xbar^3772 + xbar^3770 + xbar^3769 + xbar^3765 + xbar^3764 + xbar^3762 + xbar^37
59 + xbar^3758 + xbar^3756 + xbar^3752 + xbar^3751 + xbar^3750 + xbar^3748 + xbar
^3747 + xbar^3746 + xbar^3744 + xbar^3743 + xbar^3741 + xbar^3738 + xbar^3737 + x
bar^3735 + xbar^3734 + xbar^3730 + xbar^3729 + xbar^3724 + xbar^3723 + xbar^3721
+ xbar^3719 + xbar^3718 + xbar^3716 + xbar^3706 + xbar^3705 + xbar^3704 + xbar^37
```

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02 + xbar^3701 + xbar^3695 + xbar^3692 + xbar^3691 + xbar^3689 + xbar^3688 + xbar
^3687 + xbar^3686 + xbar^3685 + xbar^3683 + xbar^3681 + xbar^3678 + xbar^3677 + x
bar^3676 + xbar^3675 + xbar^3674 + xbar^3672 + xbar^3670 + xbar^3668 + xbar^3667
+ xbar^3666 + xbar^3665 + xbar^3664 + xbar^3663 + xbar^3660 + xbar^3659 + xbar^36
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^3636 + xbar^3635 + xbar^3633 + xbar^3632 + xbar^3629 + xbar^3628 + xbar^3626 + x
bar^3622 + xbar^3615 + xbar^3614 + xbar^3613 + xbar^3612 + xbar^3608 + xbar^3606
+ xbar^3605 + xbar^3604 + xbar^3603 + xbar^3602 + xbar^3601 + xbar^3599 + xbar^35
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^3572 + xbar^3571 + xbar^3570 + xbar^3569 + xbar^3568 + xbar^3567 + xbar^3566 + x
bar^3565 + xbar^3563 + xbar^3562 + xbar^3561 + xbar^3560 + xbar^3555 + xbar^3553
+ xbar^3552 + xbar^3551 + xbar^3550 + xbar^3549 + xbar^3548 + xbar^3546 + xbar^35
45 + xbar^3544 + xbar^3543 + xbar^3540 + xbar^3539 + xbar^3537 + xbar^3534 + xbar
^3532 + xbar^3529 + xbar^3527 + xbar^3525 + xbar^3522 + xbar^3521 + xbar^3519 + x
bar^3517 + xbar^3515 + xbar^3514 + xbar^3510 + xbar^3509 + xbar^3507 + xbar^3506
+ xbar^3505 + xbar^3504 + xbar^3503 + xbar^3502 + xbar^3498 + xbar^3497 + xbar^34
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^3479 + xbar^3474 + xbar^3473 + xbar^3471 + xbar^3470 + xbar^3469 + xbar^3466 + x
bar^3465 + xbar^3463 + xbar^3460 + xbar^3458 + xbar^3453 + xbar^3452 + xbar^3450
+ xbar^3448 + xbar^3446 + xbar^3445 + xbar^3443 + xbar^3440 + xbar^3438 + xbar^34
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^3423 + xbar^3422 + xbar^3421 + xbar^3420 + xbar^3414 + xbar^3413 + xbar^3408 + x
bar^3406 + xbar^3403 + xbar^3400 + xbar^3399 + xbar^3397 + xbar^3393 + xbar^3391
+ xbar^3389 + xbar^3388 + xbar^3382 + xbar^3379 + xbar^3378 + xbar^3377 + xbar^33
73 + xbar^3372 + xbar^3371 + xbar^3370 + xbar^3369 + xbar^3368 + xbar^3366 + xbar
^3364 + xbar^3363 + xbar^3362 + xbar^3361 + xbar^3359 + xbar^3357 + xbar^3355 + x
bar^3352 + xbar^3349 + xbar^3347 + xbar^3346 + xbar^3343 + xbar^3342 + xbar^3339
+ xbar^3338 + xbar^3337 + xbar^3336 + xbar^3335 + xbar^3334 + xbar^3330 + xbar^33
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+ xbar^3286 + xbar^3283 + xbar^3281 + xbar^3279 + xbar^3277 + xbar^3276 + xbar^32
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bar^3239 + xbar^3238 + xbar^3236 + xbar^3231 + xbar^3230 + xbar^3229 + xbar^3227
+ xbar^3225 + xbar^3217 + xbar^3216 + xbar^3214 + xbar^3211 + xbar^3209 + xbar^32
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+ xbar^3168 + xbar^3167 + xbar^3166 + xbar^3164 + xbar^3162 + xbar^3160 + xbar^31
58 + xbar^3157 + xbar^3154 + xbar^3153 + xbar^3146 + xbar^3145 + xbar^3144 + xbar
^3143 + xbar^3142 + xbar^3141 + xbar^3139 + xbar^3136 + xbar^3134 + xbar^3132 + x
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+ xbar^3114 + xbar^3112 + xbar^3104 + xbar^3103 + xbar^3102 + xbar^3101 + xbar^30
99 + xbar^3098 + xbar^3097 + xbar^3096 + xbar^3095 + xbar^3093 + xbar^3090 + xbar
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bar^3081 + xbar^3079 + xbar^3074 + xbar^3072 + xbar^3068 + xbar^3065 + xbar^3064
+ xbar^3060 + xbar^3058 + xbar^3056 + xbar^3055 + xbar^3053 + xbar^3052 + xbar^30
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bar^3023 + xbar^3022 + xbar^3019 + xbar^3018 + xbar^3017 + xbar^3015 + xbar^3014
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^2991 + xbar^2990 + xbar^2988 + xbar^2987 + xbar^2986 + xbar^2984 + xbar^2983 + x
bar^2978 + xbar^2977 + xbar^2972 + xbar^2971 + xbar^2970 + xbar^2968 + xbar^2966
+ xbar^2965 + xbar^2964 + xbar^2963 + xbar^2962 + xbar^2961 + xbar^2957 + xbar^29
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bar^2929 + xbar^2927 + xbar^2924 + xbar^2922 + xbar^2920 + xbar^2917 + xbar^2915
+ xbar^2911 + xbar^2910 + xbar^2909 + xbar^2907 + xbar^2905 + xbar^2901 + xbar^29
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```
00 + xbar^2897 + xbar^2896 + xbar^2894 + xbar^2893 + xbar^2891 + xbar^2890 + xbar
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bar^2877 + xbar^2876 + xbar^2874 + xbar^2872 + xbar^2868 + xbar^2865 + xbar^2864
+ xbar^2863 + xbar^2860 + xbar^2858 + xbar^2857 + xbar^2856 + xbar^2855 + xbar^28
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+ xbar^2817 + xbar^2814 + xbar^2812 + xbar^2811 + xbar^2808 + xbar^2807 + xbar^28
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+ xbar^2766 + xbar^2762 + xbar^2761 + xbar^2759 + xbar^2758 + xbar^2757 + xbar^27
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+ xbar^2714 + xbar^2713 + xbar^2712 + xbar^2711 + xbar^2708 + xbar^2707 + xbar^27
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bar^2679 + xbar^2677 + xbar^2676 + xbar^2675 + xbar^2665 + xbar^2662 + xbar^2660
+ xbar^2659 + xbar^2658 + xbar^2657 + xbar^2656 + xbar^2653 + xbar^2652 + xbar^26
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bar^2631 + xbar^2630 + xbar^2629 + xbar^2626 + xbar^2621 + xbar^2614 + xbar^2612
+ xbar^2611 + xbar^2610 + xbar^2609 + xbar^2608 + xbar^2603 + xbar^2602 + xbar^26
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+ xbar^2560 + xbar^2558 + xbar^2557 + xbar^2556 + xbar^2552 + xbar^2551 + xbar^25
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+ xbar^2507 + xbar^2506 + xbar^2504 + xbar^2501 + xbar^2499 + xbar^2498 + xbar^24
97 + xbar^2495 + xbar^2494 + xbar^2493 + xbar^2492 + xbar^2491 + xbar^2490 + xbar
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bar^2472 + xbar^2471 + xbar^2469 + xbar^2468 + xbar^2467 + xbar^2466 + xbar^2465
+ xbar^2463 + xbar^2461 + xbar^2459 + xbar^2458 + xbar^2456 + xbar^2453 + xbar^24
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bar^2422 + xbar^2421 + xbar^2419 + xbar^2417 + xbar^2415 + xbar^2411 + xbar^2408
+ xbar^2407 + xbar^2406 + xbar^2405 + xbar^2404 + xbar^2402 + xbar^2399 + xbar^23
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bar^2377 + xbar^2374 + xbar^2373 + xbar^2368 + xbar^2367 + xbar^2366 + xbar^2362
+ xbar^2360 + xbar^2359 + xbar^2358 + xbar^2357 + xbar^2356 + xbar^2355 + xbar^23
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bar^2323 + xbar^2321 + xbar^2319 + xbar^2316 + xbar^2315 + xbar^2314 + xbar^2311
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bar^2211 + xbar^2210 + xbar^2209 + xbar^2203 + xbar^2201 + xbar^2197 + xbar^2196
+ xbar^2195 + xbar^2194 + xbar^2192 + xbar^2190 + xbar^2189 + xbar^2188 + xbar^21
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bar^2166 + xbar^2165 + xbar^2164 + xbar^2160 + xbar^2153 + xbar^2152 + xbar^2151
+ xbar^2150 + xbar^2148 + xbar^2147 + xbar^2146 + xbar^2144 + xbar^2143 + xbar^21
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37 + xbar^2136 + xbar^2135 + xbar^2132 + xbar^2131 + xbar^2129 + xbar^2127 + xbar
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+ xbar^2103 + xbar^2102 + xbar^2098 + xbar^2096 + xbar^2094 + xbar^2089 + xbar^20
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+ xbar^2049 + xbar^2046 + xbar^2045 + xbar^2044 + xbar^2041 + xbar^2040 + xbar^20
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bar^2012 + xbar^2011 + xbar^2010 + xbar^2009 + xbar^2007 + xbar^2006 + xbar^2005
+ xbar^2003 + xbar^2002 + xbar^1999 + xbar^1997 + xbar^1995 + xbar^1993 + xbar^19
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bar^1954 + xbar^1951 + xbar^1949 + xbar^1948 + xbar^1947 + xbar^1945 + xbar^1941
+ xbar^1938 + xbar^1934 + xbar^1932 + xbar^1930 + xbar^1929 + xbar^1928 + xbar^19
26 + xbar^1918 + xbar^1917 + xbar^1915 + xbar^1913 + xbar^1911 + xbar^1909 + xbar
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bar^1890 + xbar^1889 + xbar^1887 + xbar^1885 + xbar^1882 + xbar^1881 + xbar^1880
+ xbar^1878 + xbar^1877 + xbar^1875 + xbar^1874 + xbar^1871 + xbar^1869 + xbar^18
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bar^1842 + xbar^1841 + xbar^1838 + xbar^1837 + xbar^1834 + xbar^1832 + xbar^1831
+ xbar^1830 + xbar^1826 + xbar^1825 + xbar^1824 + xbar^1821 + xbar^1819 + xbar^18
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^1650 + xbar^1649 + xbar^1647 + xbar^1646 + xbar^1645 + xbar^1643 + xbar^1642 + x
bar^1639 + xbar^1638 + xbar^1637 + xbar^1634 + xbar^1631 + xbar^1629 + xbar^1627
+ xbar^1626 + xbar^1625 + xbar^1624 + xbar^1621 + xbar^1617 + xbar^1615 + xbar^16
11 + xbar^1607 + xbar^1606 + xbar^1604 + xbar^1603 + xbar^1602 + xbar^1598 + xbar
^1597 + xbar^1593 + xbar^1589 + xbar^1588 + xbar^1587 + xbar^1586 + xbar^1584 + x
bar^1583 + xbar^1581 + xbar^1580 + xbar^1578 + xbar^1576 + xbar^1571 + xbar^1568
+ xbar^1567 + xbar^1566 + xbar^1564 + xbar^1562 + xbar^1560 + xbar^1559 + xbar^15
56 + xbar^1553 + xbar^1551 + xbar^1549 + xbar^1548 + xbar^1546 + xbar^1544 + xbar
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bar^1526 + xbar^1523 + xbar^1522 + xbar^1521 + xbar^1520 + xbar^1518 + xbar^1517
+ xbar^1516 + xbar^1515 + xbar^1514 + xbar^1513 + xbar^1512 + xbar^1508 + xbar^15
06 + xbar^1502 + xbar^1501 + xbar^1500 + xbar^1499 + xbar^1498 + xbar^1497 + xbar
^1496 + xbar^1495 + xbar^1494 + xbar^1491 + xbar^1490 + xbar^1486 + xbar^1485 + x
bar^1483 + xbar^1480 + xbar^1477 + xbar^1475 + xbar^1473 + xbar^1470 + xbar^1469
+ xbar^1468 + xbar^1465 + xbar^1463 + xbar^1462 + xbar^1461 + xbar^1458 + xbar^14
57 + xbar^1454 + xbar^1453 + xbar^1451 + xbar^1449 + xbar^1448 + xbar^1445 + xbar
^1443 + xbar^1442 + xbar^1441 + xbar^1439 + xbar^1437 + xbar^1434 + xbar^1431 + x
bar^1430 + xbar^1429 + xbar^1424 + xbar^1422 + xbar^1421 + xbar^1418 + xbar^1417
+ xbar^1416 + xbar^1415 + xbar^1413 + xbar^1405 + xbar^1404 + xbar^1402 + xbar^14
01 + xbar^1400 + xbar^1399 + xbar^1397 + xbar^1394 + xbar^1392 + xbar^1389 + xbar
^1388 + xbar^1387 + xbar^1385 + xbar^1384 + xbar^1383 + xbar^1380 + xbar^1379 + x
bar^1378 + xbar^1377 + xbar^1376 + xbar^1375 + xbar^1374 + xbar^1373 + xbar^1371
+ xbar^1367 + xbar^1366 + xbar^1363 + xbar^1361 + xbar^1358 + xbar^1356 + xbar^13
```

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55 + xbar^1353 + xbar^1350 + xbar^1345 + xbar^1343 + xbar^1342 + xbar^1340 + xbar
^1331 + xbar^1330 + xbar^1329 + xbar^1327 + xbar^1326 + xbar^1324 + xbar^1323 + x
bar^1322 + xbar^1321 + xbar^1320 + xbar^1319 + xbar^1316 + xbar^1314 + xbar^1313
+ xbar^1310 + xbar^1309 + xbar^1307 + xbar^1301 + xbar^1300 + xbar^1299 + xbar^12
95 + xbar^1292 + xbar^1291 + xbar^1289 + xbar^1287 + xbar^1285 + xbar^1284 + xbar
^1283 + xbar^1282 + xbar^1279 + xbar^1278 + xbar^1277 + xbar^1273 + xbar^1271 + x
bar^1264 + xbar^1263 + xbar^1260 + xbar^1258 + xbar^1256 + xbar^1255 + xbar^1254
+ xbar^1252 + xbar^1251 + xbar^1250 + xbar^1249 + xbar^1247 + xbar^1246 + xbar^12
45 + xbar^1244 + xbar^1243 + xbar^1242 + xbar^1241 + xbar^1234 + xbar^1233 + xbar
^1232 + xbar^1231 + xbar^1230 + xbar^1227 + xbar^1223 + xbar^1219 + xbar^1218 + x
bar^1217 + xbar^1216 + xbar^1215 + xbar^1213 + xbar^1212 + xbar^1211 + xbar^1210
+ xbar^1209 + xbar^1208 + xbar^1207 + xbar^1205 + xbar^1203 + xbar^1202 + xbar^12
01 + xbar^1199 + xbar^1198 + xbar^1196 + xbar^1194 + xbar^1193 + xbar^1187 + xbar
^1183 + xbar^1180 + xbar^1174 + xbar^1171 + xbar^1170 + xbar^1169 + xbar^1168 + x
bar^1165 + xbar^1164 + xbar^1162 + xbar^1161 + xbar^1158 + xbar^1155 + xbar^1153
+ xbar^1151 + xbar^1149 + xbar^1148 + xbar^1147 + xbar^1146 + xbar^1145 + xbar^11
44 + xbar^1143 + xbar^1142 + xbar^1139 + xbar^1133 + xbar^1130 + xbar^1127 + xbar
^1126 + xbar^1124 + xbar^1123 + xbar^1122 + xbar^1121 + xbar^1114 + xbar^1113 + x
bar^1111 + xbar^1110 + xbar^1107 + xbar^1104 + xbar^1103 + xbar^1102 + xbar^1101
+ xbar^1098 + xbar^1094 + xbar^1093 + xbar^1091 + xbar^1089 + xbar^1087 + xbar^10
86 + xbar^1083 + xbar^1078 + xbar^1070 + xbar^1069 + xbar^1068 + xbar^1067 + xbar
^1066 + xbar^1062 + xbar^1060 + xbar^1059 + xbar^1058 + xbar^1057 + xbar^1055 + x
bar^1053 + xbar^1052 + xbar^1051 + xbar^1049 + xbar^1047 + xbar^1045 + xbar^1041
+ xbar^1038 + xbar^1035 + xbar^1033 + xbar^1032 + xbar^1031 + xbar^1025 + xbar^10
24 + xbar^1023 + xbar^1020 + xbar^1017 + xbar^1014 + xbar^1010 + xbar^1009 + xbar
^1007 + xbar^1004 + xbar^1001 + xbar^1000 + xbar^997 + xbar^995 + xbar^994 + xbar
^993 + xbar^992 + xbar^988 + xbar^987 + xbar^984 + xbar^979 + xbar^978 + xbar^977
+ xbar^976 + xbar^974 + xbar^969 + xbar^966 + xbar^964 + xbar^962 + xbar^960 + xb
ar^959 + xbar^957 + xbar^956 + xbar^954 + xbar^949 + xbar^948 + xbar^946 + xbar^9
45 + xbar^937 + xbar^927 + xbar^926 + xbar^925 + xbar^924 + xbar^922 + xbar^921 +
xbar^920 + xbar^918 + xbar^916 + xbar^915 + xbar^914 + xbar^913 + xbar^910 + xbar
^908 + xbar^907 + xbar^905 + xbar^903 + xbar^900 + xbar^899 + xbar^898 + xbar^897
+ xbar^896 + xbar^895 + xbar^894 + xbar^892 + xbar^891 + xbar^890 + xbar^887 + xb
ar^886 + xbar^885 + xbar^884 + xbar^883 + xbar^881 + xbar^880 + xbar^875 + xbar^8
74 + xbar^873 + xbar^870 + xbar^866 + xbar^864 + xbar^863 + xbar^860 + xbar^855 +
xbar^854 + xbar^852 + xbar^851 + xbar^848 + xbar^846 + xbar^845 + xbar^840 + xbar
^839 + xbar^838 + xbar^837 + xbar^835 + xbar^834 + xbar^831 + xbar^830 + xbar^829
+ xbar^828 + xbar^827 + xbar^824 + xbar^823 + xbar^819 + xbar^818 + xbar^817 + xb
ar^816 + xbar^814 + xbar^812 + xbar^808 + xbar^807 + xbar^805 + xbar^804 + xbar^8
03 + xbar^800 + xbar^799 + xbar^798 + xbar^797 + xbar^795 + xbar^794 + xbar^791 +
xbar^790 + xbar^788 + xbar^787 + xbar^785 + xbar^783 + xbar^781 + xbar^779 + xbar
^776 + xbar^775 + xbar^774 + xbar^773 + xbar^772 + xbar^770 + xbar^766 + xbar^762
+ xbar^761 + xbar^759 + xbar^758 + xbar^754 + xbar^753 + xbar^752 + xbar^751 + xb
ar^745 + xbar^744 + xbar^743 + xbar^741 + xbar^737 + xbar^736 + xbar^734 + xbar^7
32 + xbar^731 + xbar^729 + xbar^728 + xbar^727 + xbar^725 + xbar^723 + xbar^720 +
xbar^719 + xbar^717 + xbar^716 + xbar^715 + xbar^710 + xbar^709 + xbar^708 + xbar
^703 + xbar^702 + xbar^699 + xbar^698 + xbar^697 + xbar^696 + xbar^695 + xbar^692
+ xbar^691 + xbar^690 + xbar^688 + xbar^687 + xbar^684 + xbar^679 + xbar^674 + xb
ar^672 + xbar^668 + xbar^664 + xbar^661 + xbar^659 + xbar^657 + xbar^654 + xbar^6
52 + xbar^650 + xbar^645 + xbar^644 + xbar^643 + xbar^642 + xbar^640 + xbar^639 +
xbar^638 + xbar^637 + xbar^633 + xbar^632 + xbar^631 + xbar^629 + xbar^628 + xbar
^626 + xbar^625 + xbar^622 + xbar^621 + xbar^620 + xbar^619 + xbar^616 + xbar^613
+ xbar^611 + xbar^609 + xbar^608 + xbar^607 + xbar^606 + xbar^601 + xbar^600 + xb
ar^597 + xbar^596 + xbar^593 + xbar^592 + xbar^591 + xbar^589 + xbar^587 + xbar^5
85 + xbar^583 + xbar^582 + xbar^580 + xbar^579 + xbar^578 + xbar^575 + xbar^574 +
xbar^571 + xbar^570 + xbar^569 + xbar^567 + xbar^564 + xbar^563 + xbar^562 + xbar
^561 + xbar^560 + xbar^559 + xbar^557 + xbar^556 + xbar^554 + xbar^552 + xbar^549
+ xbar^548 + xbar^547 + xbar^546 + xbar^545 + xbar^537 + xbar^536 + xbar^533 + xb
ar^532 + xbar^531 + xbar^524 + xbar^523 + xbar^520 + xbar^517 + xbar^513 + xbar^5
11 + xbar^510 + xbar^509 + xbar^508 + xbar^507 + xbar^506 + xbar^504 + xbar^503 +
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xbar^498 + xbar^497 + xbar^496 + xbar^494 + xbar^493 + xbar^492 + xbar^491 + xbar
^489 + xbar^487 + xbar^486 + xbar^483 + xbar^479 + xbar^476 + xbar^474 + xbar^473
+ xbar^472 + xbar^470 + xbar^469 + xbar^468 + xbar^467 + xbar^466 + xbar^465 + xb
ar^464 + xbar^461 + xbar^458 + xbar^456 + xbar^453 + xbar^445 + xbar^444 + xbar^4
43 + xbar^442 + xbar^439 + xbar^436 + xbar^435 + xbar^434 + xbar^430 + xbar^428 +
xbar^427 + xbar^426 + xbar^425 + xbar^423 + xbar^419 + xbar^416 + xbar^415 + xbar
^413 + xbar^411 + xbar^410 + xbar^406 + xbar^404 + xbar^402 + xbar^401 + xbar^397
+ xbar^395 + xbar^394 + xbar^393 + xbar^392 + xbar^391 + xbar^390 + xbar^389 + xb
ar^387 + xbar^386 + xbar^382 + xbar^380 + xbar^378 + xbar^375 + xbar^372 + xbar^3
71 + xbar^370 + xbar^367 + xbar^366 + xbar^364 + xbar^363 + xbar^362 + xbar^361 +
xbar^359 + xbar^358 + xbar^357 + xbar^354 + xbar^352 + xbar^351 + xbar^350 + xbar
^348 + xbar^346 + xbar^345 + xbar^344 + xbar^343 + xbar^342 + xbar^341 + xbar^340
+ xbar^338 + xbar^334 + xbar^331 + xbar^329 + xbar^327 + xbar^326 + xbar^325 + xb
ar^322 + xbar^317 + xbar^316 + xbar^315 + xbar^314 + xbar^311 + xbar^308 + xbar^3
06 + xbar^305 + xbar^303 + xbar^302 + xbar^301 + xbar^299 + xbar^297 + xbar^295 +
xbar^293 + xbar^290 + xbar^289 + xbar^288 + xbar^287 + xbar^286 + xbar^284 + xbar
^283 + xbar^281 + xbar^280 + xbar^279 + xbar^278 + xbar^277 + xbar^276 + xbar^274
+ xbar^273 + xbar^271 + xbar^270 + xbar^268 + xbar^267 + xbar^263 + xbar^262 + xb
ar^259 + xbar^258 + xbar^257 + xbar^256 + xbar^254 + xbar^253 + xbar^251 + xbar^2
50 + xbar^248 + xbar^246 + xbar^244 + xbar^243 + xbar^242 + xbar^237 + xbar^232 +
xbar^229 + xbar^227 + xbar^226 + xbar^223 + xbar^222 + xbar^220 + xbar^219 + xbar
^217 + xbar^211 + xbar^210 + xbar^207 + xbar^198 + xbar^191 + xbar^187 + xbar^185
+ xbar^184 + xbar^182 + xbar^179 + xbar^178 + xbar^175 + xbar^173 + xbar^171 + xb
ar^167 + xbar^165 + xbar^163 + xbar^162 + xbar^161 + xbar^159 + xbar^157 + xbar^1
55 + xbar^154 + xbar^152 + xbar^145 + xbar^142 + xbar^141 + xbar^140 + xbar^138 +
xbar^134 + xbar^132 + xbar^131 + xbar^129 + xbar^128 + xbar^125 + xbar^124 + xbar
^122 + xbar^121 + xbar^119 + xbar^118 + xbar^116 + xbar^115 + xbar^111 + xbar^110
+ xbar^106 + xbar^105 + xbar^104 + xbar^102 + xbar^101 + xbar^100 + xbar^99 + xba
r^97 + xbar^95 + xbar^94 + xbar^93 + xbar^91 + xbar^88 + xbar^85 + xbar^84 + xbar
^83 + xbar^82 + xbar^81 + xbar^78 + xbar^77 + xbar^76 + xbar^74 + xbar^73 + xbar^
72 + xbar^70 + xbar^69 + xbar^68 + xbar^67 + xbar^66 + xbar^65 + xbar^64 + xbar^6
3 + xbar^62 + xbar^60 + xbar^56 + xbar^55 + xbar^54 + xbar^53 + xbar^48 + xbar^46
+ xbar^43 + xbar^42 + xbar^41 + xbar^39 + xbar^38 + xbar^37 + xbar^34 + xbar^24 +
xbar^23 + xbar^19 + xbar^18 + xbar^12 + xbar^7 + xbar^5 + xbar^4 + xbar^3 + xbar
+ 1
Chave Privada: (xbar^12188 + xbar^11882 + xbar^11852 + xbar^11351 + xbar^11331 +
xbar^11246 + xbar^11078 + xbar^10860 + xbar^10731 + xbar^10175 + xbar^10025 + xba
r^9930 + xbar^9906 + xbar^9748 + xbar^9400 + xbar^9387 + xbar^9258 + xbar^9180 +
xbar^9088 + xbar^8861 + xbar^8404 + xbar^8391 + xbar^8337 + xbar^8238 + xbar^8233
+ xbar^8144 + xbar^7985 + xbar^7939 + xbar^7906 + xbar^7736 + xbar^7467 + xbar^73
16 + xbar^7080 + xbar^6769 + xbar^6723 + xbar^6683 + xbar^6642 + xbar^6561 + xbar
^6400 + xbar^5841 + xbar^5635 + xbar^5595 + xbar^5559 + xbar^5499 + xbar^4908 + x
bar^4627 + xbar^4417 + xbar^4177 + xbar^4148 + xbar^4020 + xbar^4000 + xbar^3359
+ xbar^3023 + xbar^2579 + xbar^2398 + xbar^2060 + xbar^2059 + xbar^1913 + xbar^18
90 + xbar^1667 + xbar^1224 + xbar^1059 + xbar^1005 + xbar^985 + xbar^668 + xbar^5
28 + xbar^289 + xbar^169 + xbar^81 + xbar^25 + xbar^11, xbar^12281 + xbar^12043 +
xbar^11835 + xbar^11702 + xbar^11572 + xbar^11468 + xbar^11385 + xbar^11136 + xba
r^10658 + xbar^10540 + xbar^10259 + xbar^10190 + xbar^9938 + xbar^9718 + xbar^960
2 + xbar^9320 + xbar^9210 + xbar^9191 + xbar^8732 + xbar^8730 + xbar^8172 + xbar^
7898 + xbar^7609 + xbar^7550 + xbar^7187 + xbar^7063 + xbar^6738 + xbar^6518 + xb
ar^6324 + xbar^6116 + xbar^6078 + xbar^5579 + xbar^5402 + xbar^5400 + xbar^5259 +
xbar^5248 + xbar^5247 + xbar^5073 + xbar^4970 + xbar^4939 + xbar^4718 + xbar^4647
+ xbar^4620 + xbar^4495 + xbar^4362 + xbar^4175 + xbar^4128 + xbar^4034 + xbar^39
64 + xbar^3954 + xbar^3933 + xbar^3925 + xbar^3888 + xbar^3647 + xbar^2962 + xbar
^2882 + xbar^2794 + xbar^2193 + xbar^2021 + xbar^1735 + xbar^1673 + xbar^1454 + x
bar^1369 + xbar^1236 + xbar^774 + xbar^771 + xbar^520 + xbar^512 + xbar^200 + xba
r^193 + xbar^184, b'\xee&\x18\x10\xdd\xc3\x01m\xdeg\xcc,\xb9k\x074\xc0\x9fDq\xf0
\x94\x98\xdfD\xdb\x1f\xc3\x8c-+X')
```

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Encapsulação completa!

======= DESCOMPACTANDO =======
Decodificação bem-sucedida!
```