

The Sieve of Eratosthenes for finding primes

Reference: Ziegenbalg: Algorithmen von Hammurapi bis Gödel, 4. Auflage, Springer-Spektrum, Wiesbaden 2016, section 3.2.3

1 A version essentially using arrays

```
(%i1) Eratosthenes_Array(UpperLimit) :=
/* as similar as possible to the BYTE version - with correct result */
block([A, i, k],
  A : make_array(fixnum, UpperLimit+1),
  for i : 0 thru UpperLimit do (A[i] : i),
  A[1] : 0,
  i : 2,
  while i*i <= UpperLimit do
    (k : i+i,
     while k <= UpperLimit do
       (A[k] : 0,
        k : k+i),
      i : i+1),
    delete(0, listarray(A)) ) $ ;      /* the result is a list with the zeroes removed */
```

```
(%i2) Eratosthenes_Array(1000);
```

```
(%o2) [2,3,5,7,11,13,17,19,23,29,31,37,41,43,47,53,59,61,67,71,73,79,
83,89,97,101,103,107,109,113,127,131,137,139,149,151,157,163,167,173,
179,181,191,193,197,199,211,223,227,229,233,239,241,251,257,263,269,
271,277,281,283,293,307,311,313,317,331,337,347,349,353,359,367,373,
379,383,389,397,401,409,419,421,431,433,439,443,449,457,461,463,467,
479,487,491,499,503,509,521,523,541,547,557,563,569,571,577,587,593,
599,601,607,613,617,619,631,641,643,647,653,659,661,673,677,683,691,
701,709,719,727,733,739,743,751,757,761,769,773,787,797,809,811,821,
823,827,829,839,853,857,859,863,877,881,883,887,907,911,919,929,937,
941,947,953,967,971,977,983,991,997]
```

2 A version using lists and delete

```
(%i3) Eratosthenes_List(UpperLimit) :=
  block([E, i, k],
    E : makelist(j, j, 1, UpperLimit),
    E[1] : 0,
    i : 2,
    while i*i <= UpperLimit do
      (k : i+i,
        while k <= UpperLimit do
          (E[k] : 0,
            k : k+i),
          i : i+1),
      E : delete(0, E),
    E) $ ;
```

```
(%i4) Eratosthenes_List(1000);
```

```
(%o4) [2,3,5,7,11,13,17,19,23,29,31,37,41,43,47,53,59,61,67,71,73,79,
83,89,97,101,103,107,109,113,127,131,137,139,149,151,157,163,167,173,
179,181,191,193,197,199,211,223,227,229,233,239,241,251,257,263,269,
271,277,281,283,293,307,311,313,317,331,337,347,349,353,359,367,373,
379,383,389,397,401,409,419,421,431,433,439,443,449,457,461,463,467,
479,487,491,499,503,509,521,523,541,547,557,563,569,571,577,587,593,
599,601,607,613,617,619,631,641,643,647,653,659,661,673,677,683,691,
701,709,719,727,733,739,743,751,757,761,769,773,787,797,809,811,821,
823,827,829,839,853,857,859,863,877,881,883,887,907,911,919,929,937,
941,947,953,967,971,977,983,991,997]
```

3 A version using sublist with predicate instead of delete

```
(%i5) Eratosthenes_SubList(UpperLimit) :=
  /* for avoiding the destructive delete-command */
  block([E, i, k],
    E : makelist(j, j, 1, UpperLimit),
    E[1] : 0,
    i : 2,
    while i*i <= UpperLimit do
      (k : i+i,
        while k <= UpperLimit do
          (E[k] : 0,
            k : k+i),
          i : i+1),
      sublist(E, lambda([x], not(is(x=0)))) ) $ ;
```

```
(%i6) Eratosthenes_SubList(1000);
(%o6) [2,3,5,7,11,13,17,19,23,29,31,37,41,43,47,53,59,61,67,71,73,79,
83,89,97,101,103,107,109,113,127,131,137,139,149,151,157,163,167,173,
179,181,191,193,197,199,211,223,227,229,233,239,241,251,257,263,269,
271,277,281,283,293,307,311,313,317,331,337,347,349,353,359,367,373,
379,383,389,397,401,409,419,421,431,433,439,443,449,457,461,463,467,
479,487,491,499,503,509,521,523,541,547,557,563,569,571,577,587,593,
599,601,607,613,617,619,631,641,643,647,653,659,661,673,677,683,691,
701,709,719,727,733,739,743,751,757,761,769,773,787,797,809,811,821,
823,827,829,839,853,857,859,863,877,881,883,887,907,911,919,929,937,
941,947,953,967,971,977,983,991,997]
```

Some tests regarding equality

```
(%i7) 2+3=5;
(%o7) 5=5

(%i8) is(2+3=5);
(%o8) true

(%i9) is(lambda([x], not(x=0))(2)) /* the "non-zero"-predicate */;
(%o9) true

(%i10) E1: [0,1,0,2,0,0,3,0,0,0,4,0,0,0];
(E1) [0,1,0,2,0,0,3,0,0,0,4,0,0,0]

(%i11) sublist(E1, lambda([x], not(is(x=0))));
(%o11) [1,2,3,4]

(%i12) functions;
(%o12) [Eratosthenes_Array( UpperLimit ),Eratosthenes_List( UpperLimit ),
Eratosthenes_SubList( UpperLimit )]
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4 Timing

```
(%i13) timer(all);
(%o13) [Eratosthenes_Array, Eratosthenes_List, Eratosthenes_SubList]

(%i14) timer;
(%o14) [Eratosthenes_SubList, Eratosthenes_List, Eratosthenes_Array]
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(%i15) Eratosthenes_Array(10000);

(%o15) [2,3,5,7,11,13,17,19,23,29,31,37,41,43,47,53,59,61,67,71,73,79,
83,89,97,101,103,107,109,113,127,131,137,139,149,151,157,163,167,173,
179,181,191,193,197,199,211,223,227,229,233,239,241,251,257,263,269,
271,277,281,283,293,307,311,313,317,331,337,347,349,353,359,367,373,
379,383,389,397,401,409,419,421,431,433,439,443,449,457,461,463,467,
479,487,491,499,503,509,521,523,541,547,557,563,569,571,577,587,593,
599,601,607,613,617,619,631,641,643,647,653,659,661,673,677,683,691,
701,709,719,727,733,739,743,751,757,761,769,773,787,797,809,811,821,
823,827,829,839,853,857,859,863,877,881,883,887,907,911,919,929,937,
941,947,953,967,971,977,983,991,997,1009,1013,1019,1021,1031,1033,
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1123,1129,1151,1153,1163,1171,1181,1187,1193,1201,1213,1217,1223,
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2011,2017,2027,2029,2039,2053,2063,2069,2081,2083,2087,2089,2099,
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2531,2539,2543,2549,2551,2557,2579,2591,2593,2609,2617,2621,2633,
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| <i>function</i>             | <i>time//call</i>      | <i>calls</i> | <i>runtime</i> | <i>gctime</i> |
|-----------------------------|------------------------|--------------|----------------|---------------|
| <i>Eratosthenes_SubList</i> | 3.453 sec              | 1            | 3.453 sec      | 0             |
| <i>Eratosthenes_List</i>    | 4.828 sec              | 1            | 4.828 sec      | 0             |
| <i>Eratosthenes_Array</i>   | 0.172 sec              | 1            | 0.172 sec      | 0             |
| <i>total</i>                | 2.8176666666666666 sec | 3            | 8.453 sec      | 0             |


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