Tool zoo

Choosing the right vectorization method

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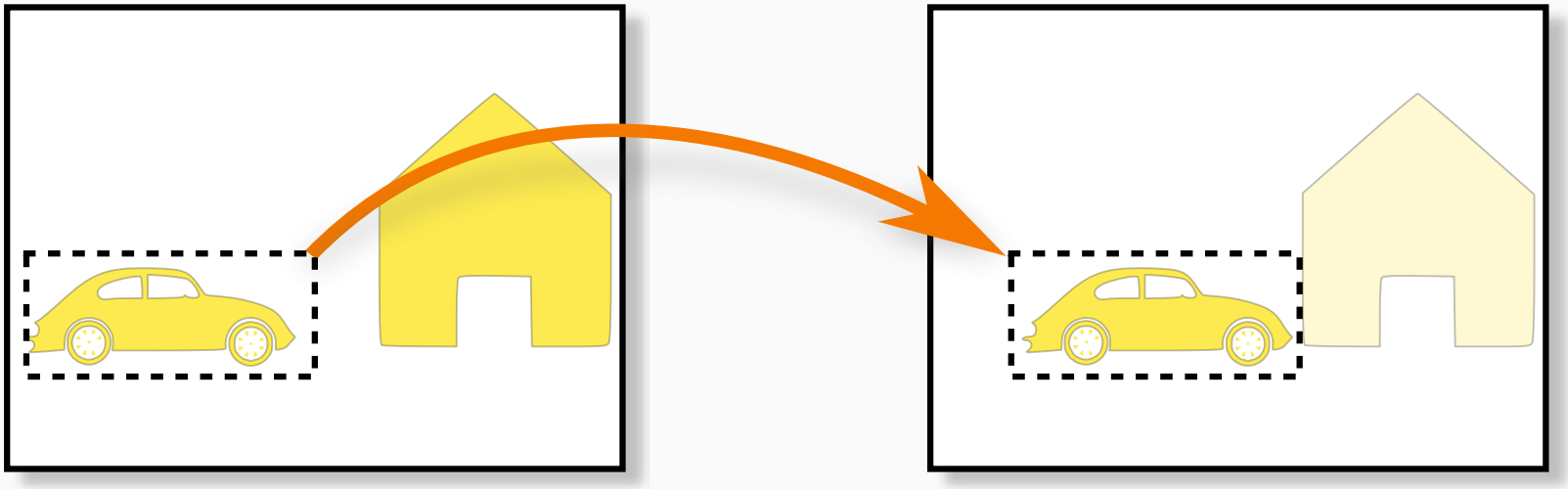
Motion estimation

Block-based motion estimation



Block-based motion estimation

Compare blocks by sum of pixelwise absolute difference.

```
for (i = 0; i < nBlocks_y; ++i)
      for (j = 0; j < nBlocks_x; ++j)
          for (n = 0; n < nCandidates; ++n)
              sad = calcSAD(...);
              // ... find max similarity, e.g. min sad
```

Vectorization methods

Autovectorization

```
for (sad=0, y=0; y < blockHeight; y++) {
    for (x=0; x < blockWidth; x++) {
        idx = y*linewidth + x;
        sad += abs(a[idx] - b[idx]);
}   }
```

Autovectorization

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- Improve performance by
  1. remove explicit index calculation
  2. using compile-time known loop length
  3. mark pointers with `restrict`
  4. align pointers

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- Activation by optimization switch `-O3`
- Improve performance by
  1. remove explicit index calculation
  2. using compile-time known loop length
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  4. align pointers
- Zero code adaption

OpenMP SIMD

```
for (sad=0, y=0, pA=a, pB=b; y < 16; ++y) {
    #pragma omp simd reduction(+:sad)
        aligned(pA,pB:16) linear(pA,pB:1)
    for (int x = 0; x < 16; x++)
        sad += std::abs(pA[x] - pB[x]);
    pA += lineWidth; pB += lineWidth;
}
```

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- Introduced with OpenMP 4.0
- Possibility for many compiler hints
- Very few code adaption

Array slicing notation

```
for (sad=0, y=0, pA=a, pB=b; y < 16; ++y) {
    tmp[0:16] = std::abs(pA[0:16] - pB[0:16]);
    sad += __sec_reduce_add(tmp[0:16]);
    pA += lineWidth; pB += lineWidth;
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- Introduced with Cilk Plus
- Integrated in gcc 4.9+, few platforms
- Medium code adaption

Instruction-set intrinsics

```
__m128i rSad = _mm_setzero_si128();
for (y=0, pA=a, pB=b; y < 16; y++) {
    __m128i rA = _mm_load_si128(pA);
    __m128i rB = _mm_load_si128(pB);
    __m128i rT = _mm_sad_epu8(rA, rB);
    rSad += _mm_adds_epu16(rSad, rT);
    pA += lineWidth; pB += lineWidth;
}
sad = _mm_extract_epi16(rSad, 0)+_mm_extract_epi16(rSad, 4);
```

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- Few platforms, less portability

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```
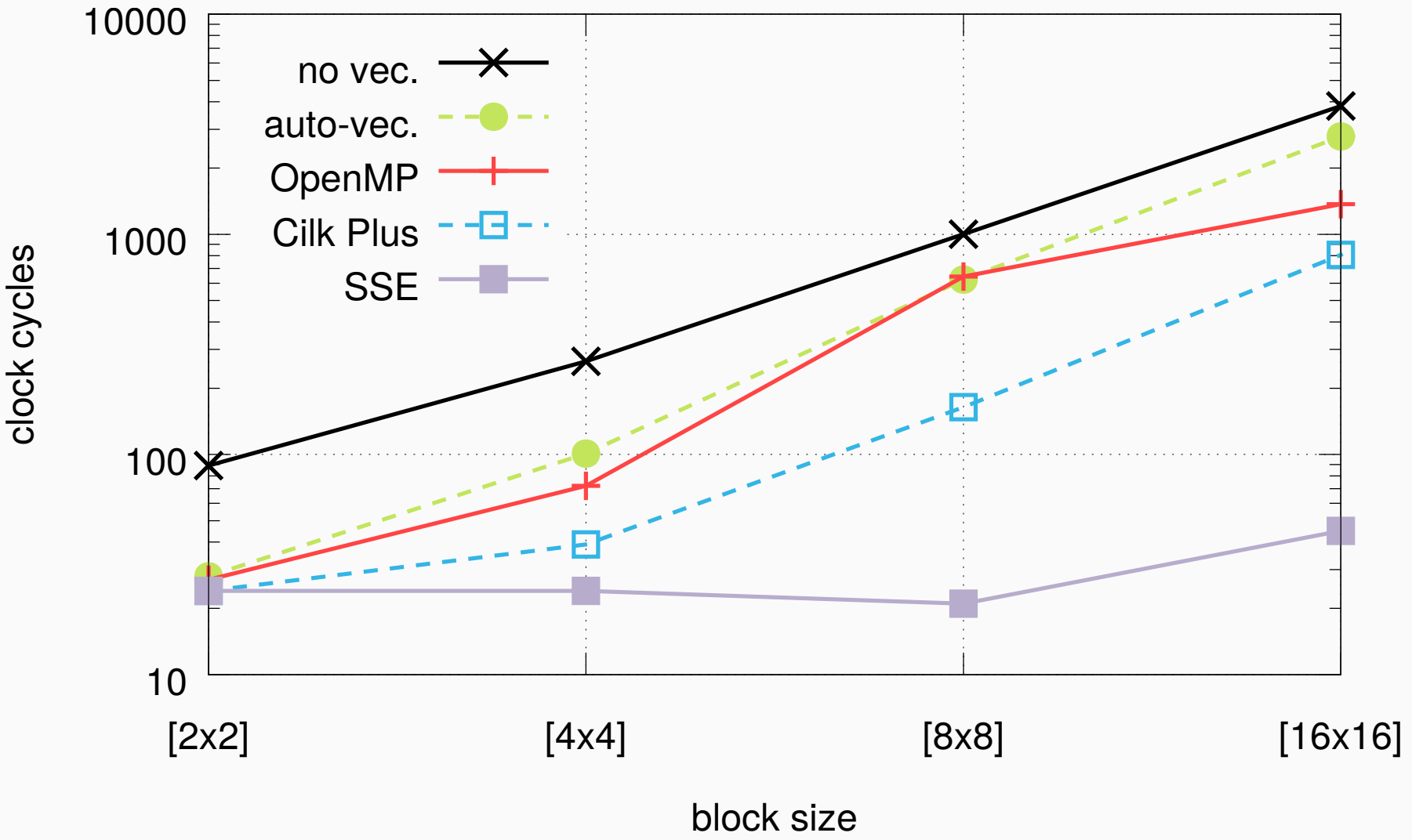
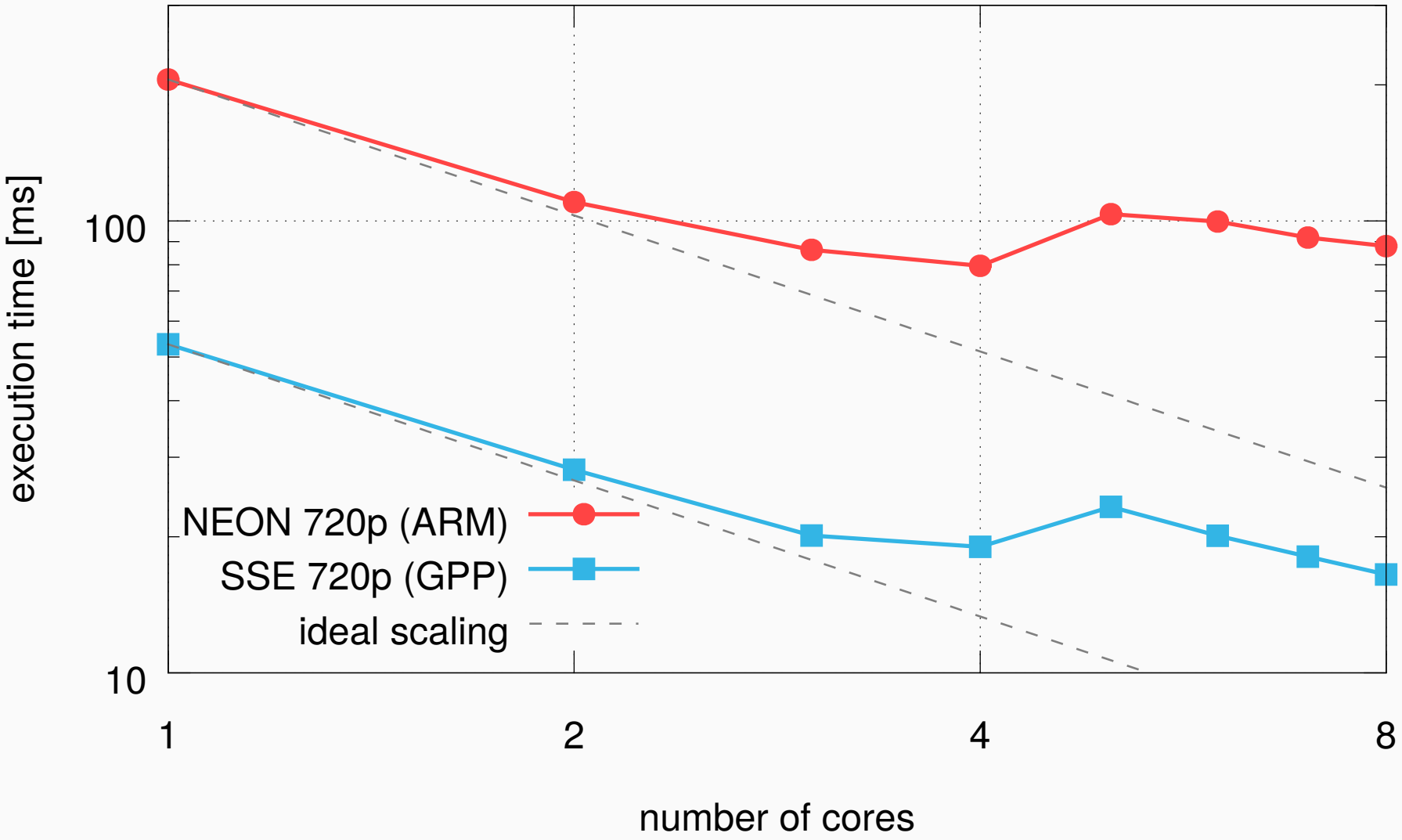

- Low level accelerator access
- Few platforms, less portability
- Huge code adaption

Performance evaluation

Cycle count comparison

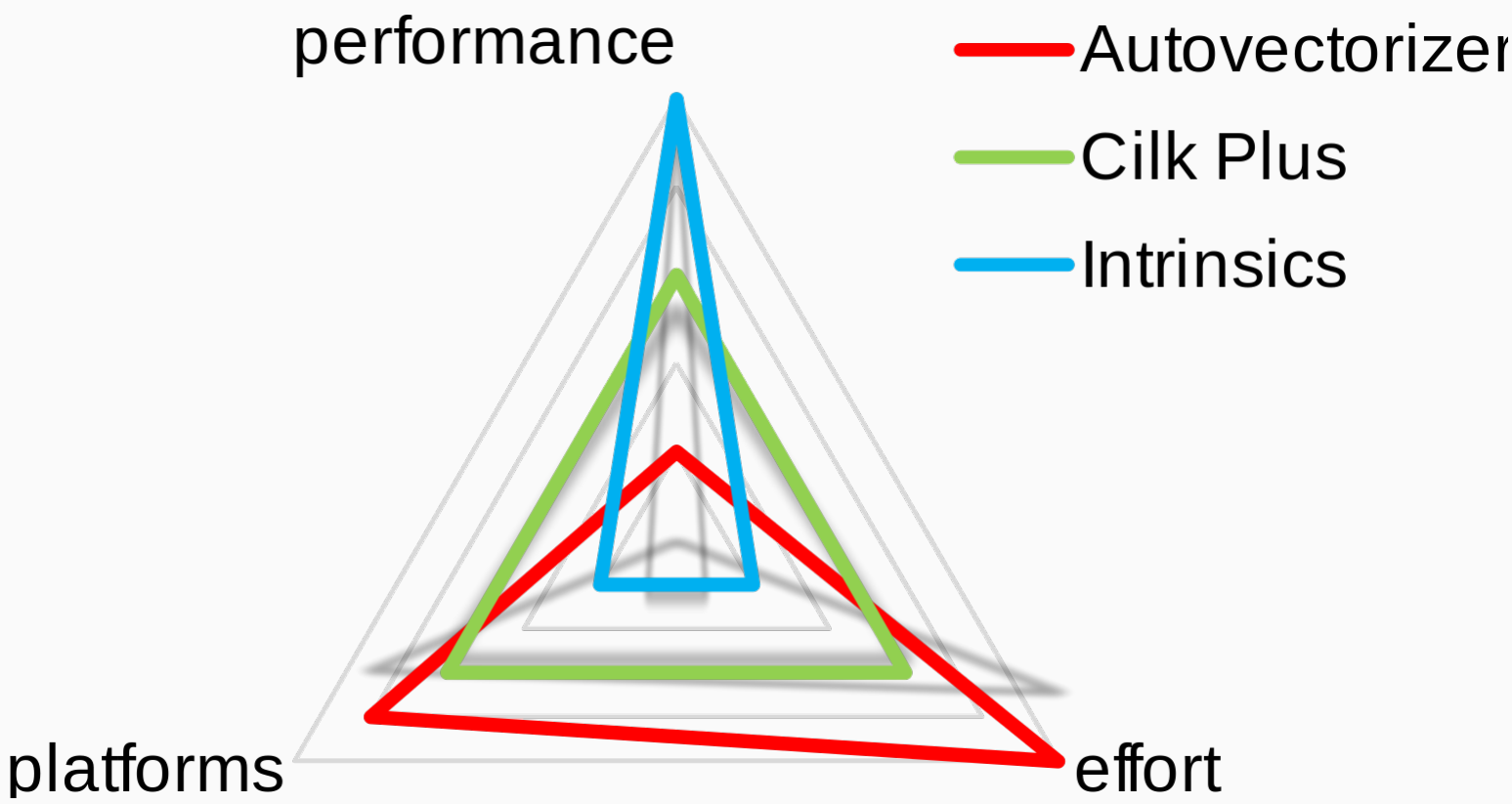


Additional outer parallelization

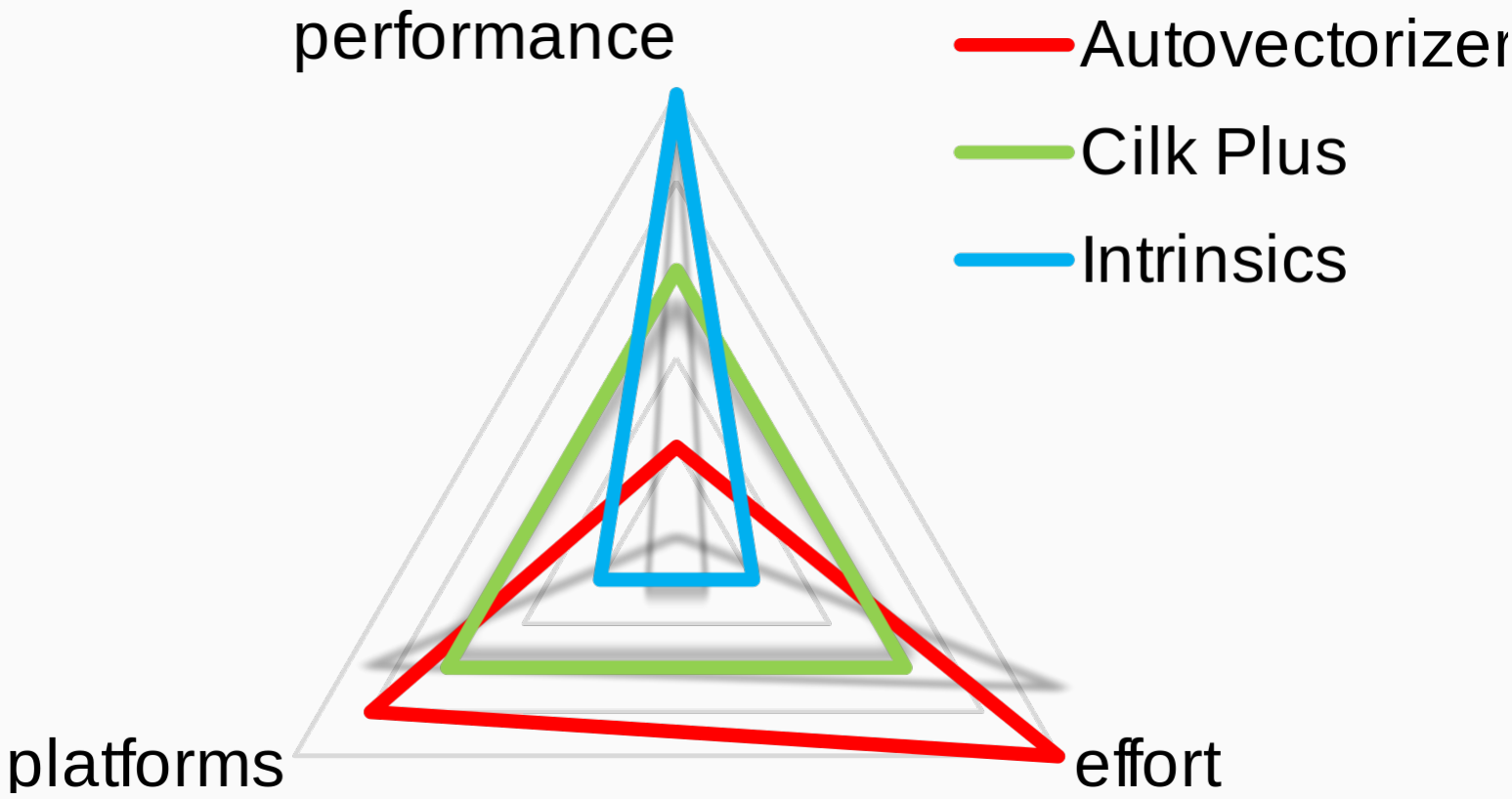


Conclusion

Summary


performance
Autovectorizer
Cilk Plus
Intrinsics
platforms
effort

Summary



Choice of vectorization method is strongly application specific.

`Boost.SIMD`, `Halide` and many others are also worth a try.

Questions?