VOBLA: **Vehicle for Optimized Basic Linear Algebra** - DSL for programming linear algebra libraries and linear algebra solutions.

VOBLA compiler generates PENCIL, a domain independent intermediate language (IL).

PENCIL is designed for efficient mapping to accelerator architectures such as GPUs.

PENCIL is compiled to efficient, platform-specific OpenCL code using polyhedral techniques.

Performance of generated OpenCL code on average 2.5X faster than straightforward OpenCL implementations.

This approach improves programmer productivity and performance portability.

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**VOBLA to PENCIL to OpenCL Compilation Flow**

```plaintext
function gemm(alpha: Value, in A: SparseIterable<Value>[m][k],
in B: Value[k][n], beta: Value, out C: Value[m][n])
{
    Cij *= betaforall _, _, Cij in C.sparse;
    C[i][j] += alpha*A[i][l]*B[l][j]
    for i, l, Ail in A.sparse, j in 0:n-1;
}
```

---

**Domain: linear algebra**

Matrix-vector multiplication

\[
\begin{bmatrix}
  y_1 \\
  y_2 \\
  \vdots \\
  y_n \\
\end{bmatrix} = \begin{bmatrix}
  a_{1,1} & 0 & \cdots & 0 & 0 \\
  a_{2,1} & a_{2,2} & \cdots & 0 & 0 \\
  \vdots & \vdots & \ddots & \vdots & \vdots \\
  a_{n,1} & a_{n,2} & \cdots & a_{n,i} & a_{n,n} \\
\end{bmatrix} \begin{bmatrix}
  x_1 \\
  x_2 \\
  \vdots \\
  x_n \\
\end{bmatrix}
\]

**DSL compiler generates PENCIL code**

```
sum(Aij*x[j] forall j, Aij in (A[i][*]).sparse)
```

**PENCIL compiler generates optimized OpenCL code**

```
#pragma pencil independent reduction(+: acc)
for (int j = 0; j <= i; j++)
    acc += A[i][j]*x[j];
y[i] = acc;
```

---

**Execution time (normalized)**

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<tr>
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<th>saxpy</th>
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