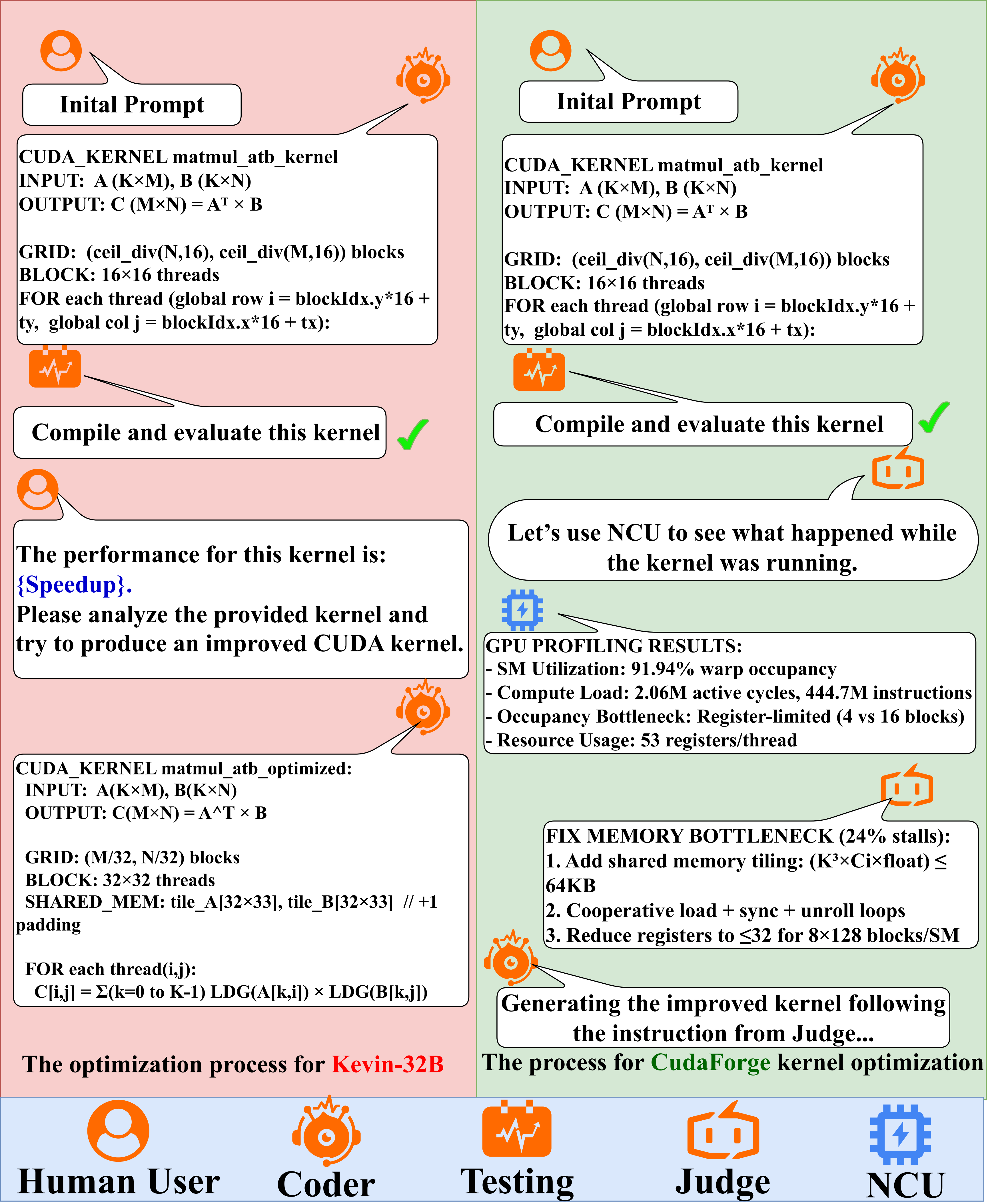

Inital Prompt

```
CUDA_KERNEL matmul_atb_kernel
INPUT:  A (K×M), B (K×N)
OUTPUT: C (M×N) = Aᵀ × B

GRID:  (ceil_div(N,16), ceil_div(M,16)) blocks
BLOCK: 16×16 threads
FOR each thread (global row i = blockIdx.y*16 +
ty,  global col j = blockIdx.x*16 + tx):
```

Compile and evaluate this kernel ✓

The performance for this kernel is: {Speedup}. Please analyze the provided kernel and try to produce an improved CUDA kernel.

```
CUDA_KERNEL matmul_atb_optimized:
  INPUT:  A(K×M), B(K×N)
  OUTPUT: C(M×N) = A^T × B

  GRID: (M/32, N/32) blocks
  BLOCK: 32×32 threads
  SHARED_MEM: tile_A[32×33], tile_B[32×33]  // +1
padding

  FOR each thread(i,j):
   C[i,j] = Σ(k=0 to K-1) LDG(A[k,i]) × LDG(B[k,j])
```

The optimization process for Kevin-32B

Inital Prompt

```
CUDA_KERNEL matmul_atb_kernel
INPUT:  A (K×M), B (K×N)
OUTPUT: C (M×N) = Aᵀ × B

GRID:  (ceil_div(N,16), ceil_div(M,16)) blocks
BLOCK: 16×16 threads
FOR each thread (global row i = blockIdx.y*16 +
ty,  global col j = blockIdx.x*16 + tx):
```

Compile and evaluate this kernel ✓

Let's use NCU to see what happened while the kernel was running.

GPU PROFILING RESULTS:
- SM Utilization: 91.94% warp occupancy
- Compute Load: 2.06M active cycles, 444.7M instructions
- Occupancy Bottleneck: Register-limited (4 vs 16 blocks)
- Resource Usage: 53 registers/thread

FIX MEMORY BOTTLENECK (24% stalls):
1. Add shared memory tiling: (K^3×Ci×float) ≤ 64KB
2. Cooperative load + sync + unroll loops
3. Reduce registers to ≤32 for 8×128 blocks/SM

Generating the improved kernel following the instruction from Judge...

The process for CudaForge kernel optimization