

| Experimental test scenario | Developer | | | | | | | | | | | | Models | | | | | | | | | | | | | | | | | | | | | | | | |
|--|----------------|--------------|------|----------------|--------------|------|----------------|--------------|------|----------------|--------------|-------|----------------|--------------|--------|----------------|------------------|---------|----------------|--------------|-------------|----------------|--------------|-------|-------------------|--------------|---------|----------------|-------------------------|--------|----------------|--------------|---------|-----|--|--|----|
| | St 1 | | | St 2 | | | St 3 | | | St 4 | | | ChatGPT 4 | | | | Gemini 2.0 Flash | | | | DeepSeek-V3 | | | | Claude 3.5 Sonnet | | | | GitHub Copilot (GPT-4o) | | | | LLaMA 3 | | | | |
| | Execution Time | Flash Memory | SRAM | Execution Time | Flash Memory | SRAM | Execution Time | Flash Memory | SRAM | Execution Time | Flash Memory | SRAM | Execution Time | Flash Memory | SRAM | Execution Time | Flash Memory | SRAM | Execution Time | Flash Memory | SRAM | Execution Time | Flash Memory | SRAM | Execution Time | Flash Memory | SRAM | Execution Time | Flash Memory | SRAM | Execution Time | Flash Memory | SRAM | | | | |
| Newline printing | 12 | 1850 | 192 | 24 | 1842 | 192 | | | | 12 | E 1850 | G 192 | E 1 | 12 | E 1850 | G 192 | E 1 | 4 | 1776 | 192 | 2 | 20 | G 1860 | G 192 | E 1 | 20 | G 1860 | 192 | 2 | 20 | G 1860 | G 192 | E 1 | | | | |
| Strings merging | 132 | 3324 | 208 | 172 | 3520 | 208 | | | | 124 | L 3324 | G 208 | E 1 | 64 | L 1944 | G 198 | L 1 | 64 | L 1956 | E 198 | L 1 | 60 | L 1916 | E 198 | L 1 | 60 | L 1946 | E 198 | L 1 | 148 | G 3432 | G 208 | E 1 | | | | |
| Merging strings with other data types | 232 | 3568 | 214 | 264 | 3578 | 214 | | | | 172 | E 3568 | G 208 | E 1 | 148 | L 3168 | G 208 | E 1 | 148 | L 2058 | G 204 | L 1 | 152 | L 2046 | G 204 | L 1 | 244 | G 3428 | G 210 | E 1 | 244 | G 3428 | G 210 | E 1 | | | | |
| Char array to array conversion | 148 | 3178 | 208 | 112 | 3168 | 208 | | | | 140 | L 3178 | G 210 | E 1 | 112 | L 3168 | G 210 | E 1 | 140 | L 3178 | G 208 | E 1 | 140 | L 3178 | G 208 | E 1 | 140 | L 3178 | G 208 | E 1 | 128 | G 1946 | G 208 | E 1 | | | | |
| Char array to string conversion | 112 | 3106 | 212 | 876 | 3428 | 212 | | | | 112 | E 3106 | E 212 | E 1 | 112 | E 3106 | E 212 | E 1 | 112 | E 3106 | E 212 | E 1 | 112 | E 3106 | E 212 | E 1 | 112 | E 3106 | E 212 | E 1 | 112 | E 3106 | E 212 | E 1 | | | | |
| Finding test in a string | 216 | 3354 | 266 | 1124 | 3540 | 266 | | | | 132 | E 2012 | E 256 | E 1 | 112 | L 3328 | G 204 | L 1 | 164 | L 3328 | G 212 | L 1 | 104 | L 1862 | G 204 | L 1 | 172 | L 3330 | G 266 | E 1 | 160 | 2030 | E 256 | E 1 | | | | |
| Evaluating fixed values | 84 | 1858 | 200 | 180 | 3348 | 236 | | | | 84 | E 1890 | G 207 | G 1 | 84 | E 1858 | E 200 | E 1 | 92 | G 3448 | G 263 | G 1 | 84 | E 1858 | E 200 | E 1 | 84 | E 1858 | G 200 | E 1 | 84 | E 1858 | G 200 | E 1 | | | | |
| String manipulation using buffers | 440 | 3566 | 234 | 532 | 3554 | 234 | | | | 340 | L 3332 | G 234 | E 1 | 264 | L 1908 | G 220 | L 1 | 268 | L 1988 | G 224 | L 1 | 340 | L 3332 | G 234 | E 1 | 324 | L 3332 | G 234 | E 1 | 324 | L 3332 | G 234 | E 1 | | | | |
| Using F() macro with strings | 152 | 1908 | 192 | 172 | 1872 | 214 | | | | 160 | G 1908 | E 192 | E 1 | 148 | L 1906 | G 192 | E 1 | 148 | L 1910 | G 192 | E 1 | 192 | G 1898 | G 192 | E 1 | | | | | | | | | | | | |
| Storing test values in arrays | 84 | 1858 | 200 | 104 | 1942 | 236 | | | | 84 | E 1858 | E 200 | E 1 | 72 | L 1894 | G 192 | L 1 | 84 | E 1858 | E 200 | E 1 | 84 | E 1858 | E 200 | E 1 | 84 | E 1858 | E 200 | E 1 | 84 | E 1858 | E 200 | E 1 | | | | |
| String constant variables | 56 | 1854 | 196 | 68 | 3032 | 206 | | | | 56 | E 1854 | E 196 | E 1 | 48 | L 1890 | G 192 | L 1 | 60 | G 1872 | G 196 | L 1 | 56 | E 1854 | E 196 | E 1 | 56 | E 1854 | E 196 | E 1 | 56 | E 1854 | E 196 | E 1 | | | | |
| Using break statement in sequential search | 196 | 3336 | 258 | 216 | 3350 | 258 | | | | 72 | L 2000 | E 258 | E 1 | | | | | 72 | L 2000 | E 258 | E 1 | 72 | L 2000 | E 258 | E 1 | 72 | L 2000 | E 258 | E 1 | 72 | L 2000 | E 258 | E 1 | | | | |
| Static vs. non-static variables | 120 | 1882 | 193 | 132 | 1936 | 200 | | | | 132 | G 1998 | G 208 | G 1 | 132 | G 2000 | G 208 | G 1 | 132 | G 2004 | G 208 | G 1 | 133 | G 1998 | G 208 | G 1 | 132 | G 2000 | G 208 | G 1 | 132 | G 2000 | G 208 | G 1 | | | | |
| Global vs. local variables | 120 | 1882 | 193 | 132 | 1936 | 200 | | | | 120 | E 1908 | G 192 | E 1 | 132 | G 2000 | G 208 | G 1 | 120 | E 1908 | G 192 | L 1 | 120 | E 1938 | G 194 | G 1 | 132 | G 2000 | G 208 | G 1 | 120 | E 1908 | G 192 | L 1 | | | | |
| 2D array initialization | 284 | 1962 | 192 | 316 | 1970 | 192 | | | | 164 | L 1988 | E 192 | E 1 | 164 | L 1988 | G 192 | E 1 | 164 | L 1908 | G 192 | E 1 | 164 | L 1890 | L 194 | G 1 | 164 | L 1908 | E 192 | E 1 | 160 | G 2016 | G 192 | G 1 | | | | |
| Column-major order vs. row-major order | 60 | 1914 | 192 | 80 | 1924 | 192 | | | | 8 | L 1840 | E 192 | E 1 | 8 | L 1840 | E 192 | E 1 | 8 | L 1840 | E 192 | E 1 | 8 | L 1840 | E 192 | E 1 | 8 | L 1840 | E 192 | E 1 | 8 | L 1840 | E 192 | E 1 | | | | |
| Array access: pointers vs. indexes | 252 | 1976 | 192 | 252 | 1970 | 192 | | | | 216 | G 1988 | G 192 | E 1 | 252 | G 1986 | G 192 | E 1 | 252 | G 1956 | G 192 | E 1 | 252 | G 1942 | G 192 | E 1 | 216 | G 1968 | E 192 | E 1 | 216 | G 1968 | E 192 | E 1 | | | | |
| Data structures: arrays vs. structures | 404 | 2056 | 192 | 416 | 2030 | 192 | | | | 164 | L 1908 | E 192 | E 1 | 208 | E 1950 | L 198 | G 1 | 164 | L 1908 | E 192 | E 1 | 164 | L 1906 | E 196 | E 1 | 680 | G 2118 | G 214 | E 1 | 492 | G 1998 | E 192 | E 1 | | | | |
| Accessing structure elements | 208 | 1962 | 198 | 208 | 1908 | 192 | | | | 208 | E 1908 | E 192 | E 1 | 244 | G 1918 | G 198 | G 1 | 208 | E 1908 | E 192 | E 1 | 248 | E 1920 | E 198 | E 1 | 324 | G 1930 | G 208 | G 1 | 208 | E 1908 | E 192 | E 1 | | | | |
| I/O pins manipulation | 8 | 1858 | 192 | 16 | 2142 | 192 | | | | 16 | E 2142 | G 192 | E 1 | 16 | E 2142 | E 192 | E 1 | 16 | E 2142 | E 192 | E 1 | 16 | E 2142 | E 192 | E 1 | 2 | 100020 | G 2216 | E 192 | E 1 | 100020 | G 2216 | E 192 | E 1 | | | |
| I/O pins directions | 32 | 2010 | 192 | 36 | 2036 | 200 | | | | 32 | E 1884 | E 192 | E 1 | 8 | L 1856 | E 192 | E 1 | 32 | E 1884 | E 192 | E 1 | 8 | L 1856 | E 192 | E 1 | 32 | E 1884 | E 192 | E 1 | 32 | E 1884 | E 192 | E 1 | | | | |
| Macros vs. functions | 208 | 1908 | 192 | 208 | 1908 | 192 | | | | 208 | E 1908 | E 192 | E 1 | 324 | G 1930 | G 208 | G 1 | 208 | E 1908 | E 192 | E 1 | 372 | G 1938 | E 216 | E 1 | 324 | G 1930 | G 208 | G 1 | 208 | E 1908 | E 192 | E 1 | | | | |
| Function calls: direct vs. indirect | 252 | 1908 | 192 | 252 | 1908 | 192 | | | | 252 | E 1908 | E 192 | E 1 | 252 | E 1908 | E 192 | E 1 | 252 | E 1908 | E 192 | E 1 | 252 | E 1908 | E 192 | E 1 | 396 | G 1954 | G 212 | G 1 | 252 | E 1908 | E 192 | E 1 | | | | |
| Build-in functions vs. libraries | 100028 | 1934 | 208 | 100038 | 1934 | 216 | | | | 100028 | E 1934 | E 208 | E 1 | 100032 | E 1934 | E 208 | E 1 | 100028 | E 1934 | E 208 | E 1 | 100032 | E 1934 | E 208 | E 1 | 100032 | E 1934 | E 208 | E 1 | 100032 | E 1934 | E 208 | E 1 | | | | |
| Loop breaks | 152 | 1926 | 198 | 148 | 1926 | 198 | | | | 150 | E 1926 | E 98 | E 1 | 148 | L 1926 | E 198 | L 1 | 148 | L 1928 | E 198 | L 1 | 148 | L 1894 | E 192 | E 1 | 148 | E 1926 | E 198 | E 1 | 144 | L 1888 | E 198 | E 1 | | | | |
| Loop rolling vs. loop unrolling | 272 | 2024 | 192 | 276 | 1986 | 192 | | | | 164 | L 1908 | E 192 | E 1 | 220 | L 1950 | L 198 | G 1 | 164 | L 1908 | E 192 | E 1 | 164 | L 1874 | E 192 | E 1 | 244 | L 1926 | L 204 | G 1 | 164 | L 1908 | L 192 | E 1 | | | | |
| Data types selection | 444 | 1926 | 192 | 276 | 1986 | 192 | | | | 164 | L 1908 | E 192 | E 1 | 220 | L 1950 | L 198 | G 1 | 164 | L 1908 | E 192 | E 1 | 164 | L 1874 | E 192 | E 1 | 244 | E 1926 | L 204 | G 1 | 164 | L 1908 | L 192 | E 1 | | | | |
| Compound assignment operators | 324 | 3384 | 234 | 532 | 3554 | 234 | | | | 316 | L 3324 | G 234 | E 1 | 256 | L 2024 | E 258 | G 1 | 256 | L 2028 | E 262 | G 1 | 288 | E 3324 | E 202 | E 1 | 300 | L 3324 | L 234 | E 1 | 252 | 2004 | E 222 | E 1 | | | | |
| Fading LED | 5106428 | 2438 | 192 | 5126384 | 2442 | 192 | | | | 5126384 | E 2442 | E 192 | E 1 | 5126384 | E 2442 | E 192 | E 1 | 5126384 | E 2442 | E 192 | E 1 | 5126392 | E 2450 | E 192 | E 1 | | 5126384 | E 2442 | E 192 | E 1 | 5126384 | E 2442 | E 192 | E 1 | | | |
| Conditional statements: nested-if vs. switch | 164 | 1908 | 192 | 164 | 1908 | 192 | | | | 164 | E 1908 | E 192 | E 1 | 164 | E 1908 | E 192 | E 1 | 164 | E 1908 | E 192 | E 1 | 164 | E 1908 | E 192 | E 1 | 164 | E 1908 | E 192 | E 1 | 164 | E 1908 | E 192 | E 1 | | | | |
| Program pausing | 100112 | 1942 | 196 | 100404 | 1932 | 196 | | | | 100112 | E 1942 | G 196 | E 1 | 100072 | E 1926 | E 196 | E 1 | 100112 | E 1942 | E 196 | E 1 | 100096 | E 2014 | E 192 | E 1 | | 100112 | E 1942 | G 196 | E 1 | 100112 | E 1942 | G 196 | E 1 | | | |
| RQ1: (Overall Correctness): | | | | | | | | | | | | 30 | | | | | 25 | | | | | 28 | | | | | 21 | | | | | 27 | | | | | 25 |
| RQ2 (Code Performance): | Equal | 15 | 9 | 24 | 5 | 4 | 11 | 12 | 7 | 20 | | | | | 7 | 5 | 12 | | | | | 10 | 6 | 17 | | | | | 11 | 7 | 20 | | | | | | |
| | Greater | 4 | 11 | 2 | 6 | 11 | 8 | 3 | 7 | 3 | | | | | 7 | 3 | 6 | | | | | 10 | 12 | 8 | | | | | 7 | 7 | 4 | | | | | | |
| | Less | 11 | 10 | 4 | 14 | 10 | 6 | 13 | 14 | 5 | 9 | 9 | 3 | 7 | 6 | 10 | 9 | 2 | 7 | 11 | 1 | 10 | 2 | 7 | 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | |