What is the min of \( q(x) = x^2 + bx + c \) on the interval \([L, R]\)?

- Compute \( x_c \)
- If \( x_c \) is between \( L \) and \( R \)
  - Then min is at \( x_c \), so calculate \( q(x_c) = \frac{-b^2}{4} + c \)
- Otherwise
  - Min value is the minimum of \( q(L), q(R) \)

Detailed Algorithm

```matlab
% find min of q(x) = x*x + bx + c
% given b, c, L, R
xc = -b/2;  % critical value
if (L<=xc && xc<=R)
% calculate q(xc)
else
% calc q(L), q(R)
% find min of q(L), q(R)
end
```

Logical operators

- \&\& logical and: Are both conditions true?
  - E.g., we ask "is \( L \leq x \) and \( x \leq R \)?"
  - In our code: \( L \leq x \&\& x \leq R \)
- || logical or: Is at least one condition true?
  - E.g., we can ask if \( x \) is outside of \([L, R]\), i.e., "is \( x \leq L \) or \( R \leq x \)?"
  - In code: \( x \leq L || R \leq x \)
- ~ logical not: Negation
  - E.g., we can ask if \( x \) is not outside \([L, R]\).
  - In code: \( \sim (x \leq L \&\& R \leq x) \)
"false" is 0, "true" is non-zero

| X | Y | X && Y | X || Y | ~X |
|---|---|--------|-------|-----|
| 1 | 1 | 1      | 1     | 0   |
| 1 | 0 | 0      | 1     | 1   |
| 0 | 1 | 0      | 1     | 0   |
| 0 | 0 | 0      | 0     | 1   |

Logical operators will short-circuit
- "It's a good thing."
- Consider the compound condition:
  \[ L \leq x_c \land x_c \leq R \]
  - If \( L \) is greater than \( x_c \), then the 1st condition \( \Rightarrow false \). Then the entire compound condition must give false as well, no matter what \( x_c \) and \( R \) are.
  - A \&\& condition short-circuits to false if the left operand evaluates to false
  - A || condition short-circuits to _______ if

Always use logical operators for multiple conditions
Why is it wrong to use the expression
\[ L \leq x_c \leq R \]
for checking if \( x_c \) is in \([L, R]\)?

Example: Suppose \( L \) is 5, \( R \) is 8, and \( x_c \) is 10. We know that 10 is not in \([5, 8]\), but the expression \( L \leq x_c \leq R \) gives...

Top-Down Design

An algorithm is an idea. To use an algorithm you must choose a programming language and implement the algorithm.

Top-down design:
1. State problem
2. Define inputs & outputs
3. Design algorithm
4. Decomposition
5. Stepwise refinement
6. Convert algorithm to program

Example:
\[
\% \text{ find min of } q(x)=x^2+bx+c \\
\% \text{ given } b,c,L,R \\
x_c = -b/2; \% \text{ critical value} \\
\text{if } (L \leq x_c \&\& x_c \leq R) \\
\quad \% \text{ calculate } q(x_c) \\
\quad \text{else} \\
\quad \quad \% \text{ calc } q(L), q(R) \\
\quad \% \text{ find min of } q(L), q(R) \\
\text{end}
\]

Example:
\[
\% \text{ find min of } q(x)=x^2+bx+c \\
\% \text{ given } b,c,L,R \\
x_c = -b/2; \% \text{ critical value} \\
\text{if } (L \leq x_c \&\& x_c \leq R) \\
\quad q\text{Min}= -b*b/4+c; \% q(x_c) \\
\text{else} \\
\quad q_L= L*L + b*L + c; \% q(L) \\
\quad q_R= R*R + b*R + c; \% q(R) \\
\quad \text{if } (q_L < q_R) \\
\quad \quad q\text{Min}= q_L; \\
\quad \text{else} \\
\quad \quad q\text{Min}= q_R; \\
\text{end} \\
\text{end}
\]