ACSL INTRODUCES A NEW ELEMENTARY DIVISION

Registration

Any student in grades 3 - 6 may participate as part of a registered school or organization.

Each school or organization may give the contest to as many students as they choose for a single registration fee of $50.

There will be 4 contests given at the local level throughout the school year on 4 different computer science topics.

Schools may choose to submit a team score for each contest out of a total of 25 points (just the top 5 individual scores) which will be ranked internationally.

LOCAL CONTESTS

For each contest, materials will be provided to teach students a particular topic in Computer Science at the elementary school level.

The topics covered are Computer Number Systems, Prefix / Infix / Postfix Notation, Boolean Algebra, and Graph Theory.

Students will be given a 5-question test of questions on the given topic that encourages the use of strong problem solving skills to get the correct answer.

The top 5 students for each separate contest make up each group's team score that is submitted to the League for publication.

Contest 1 - Computer Number Systems

Students will be taught the basics of the binary number system because all computers use 0s and 1s to represent instructions and data values.

Students will learn the concepts of number theory in bases 2, 8, and 16 as they relate to the decimal number system that they are familiar with.

Students will be able to convert to and from bases 8 and 16 by using groups of binary digits.

Students will use the concepts of carrying and borrowing that they already know to perform addition and subtraction in bases 8 and 16.

Sample Questions - Computer Number Systems

1. **What is the value of 11101001011_2 in base 16?**

   By grouping digits, the binary number 11101001011_2 = $0111\ 0100\ 1011_2$ = **$74B_{16}$**.

2. **What is the value of $1ACE_{16}$ + 456_{16} in hexadecimal?**

   E (14) + 6 = 20 so carry the 1 and keep the 4. C (12) + 5 + 1 = 18
   so carry the 1 and keep the 2. A (10) + 4 + 1 = 15 which is F so there is nothing to carry.
   The answer is **$1F24_{16}$**.

3. **What is the value of 135_8 in base 10?**

   $135_8 = 1 \times 8^2 + 3 \times 8^1 + 5 \times 8^0 = 64 + 24 + 5 =$ **93_{10}**.

Sample Questions - Computer Number Systems

4. **On the RGB color table, the color "sky blue" is the hexadecimal number '#38B0DE'. What is the decimal value for the blue component?**

   The RED component is '38', the GREEN component is 'B0', and the BLUE component is 'DE'.
   Therefore, $DE_{16} = 13 \times 16 + 14 \times 1 = 208 + 14 = \mathbf{222_{10}}$.

5. **What is the average of the following three numbers in base 10?**
   $\mathbf{10011_2, 21_8, 1E_{16}}$

   $10011_2 = 1*1 + 1*2 + 0*4 + 0*8 + 1*16 = 19$
   $21_8, = 2*8 + 1 = 17$
   $1E_{16} = 1*16 + 14 = 30$
   The average is calculated as follows: $(19 + 17 + 30) / 3 = 66 / 3 = \mathbf{22}_{10}$.

Contest 2 - Prefix/Infix/Postfix Notation

Students will be taught how to represent arithmetic expressions in prefix or postfix notation since neither requires an order of operations.

Students will learn to convert an expression from infix form that they know to either prefix (operator first) or postfix (operator last) form.

Students will be able to evaluate arithmetic expressions that are written in either prefix or postfix notation.

Students will use the order of operations in an infix expression correctly to write equivalent prefix and postfix expressions.

Sample Questions - Prefix/Infix/Postfix

1. **Evaluate the postfix expression:**
   3 4 + 7 2 - *

   3 4 + = 3 + 4 = 7 and 7 2 - = 7 - 2 = 5. Therefore, 7 * 5 = **35**.

2. **Translate the following infix expression into prefix.**
   (6 + 3) / (7 - 1) * 3 ^ 2

   (6 + 3) is written as + 6 3.
   (7 - 1) is written as - 7 1.
   3 ^ 2 is done next because of the order of operations so it is ^ 3 2.
   Division and multiplication are done left to right.
   The final answer is *** /+ 6 3 - 7 1 ^ 3 2**

Sample Questions - Prefix/Infix/Postfix

3. **Evaluate the following prefix expression:**
   *** ^ / + + 4 9 2 - 4 1 2 9**

   Convert to infix: * ^ / + + 4 9 2 - 4 1 2 9 = * ^ / + (4+9) 2 (4-1) 2 9 = * ^ / ((4+9) + 2) (4-1) 2 9
   = * ^ (((4+9) + 2) / (4-1)) 2 9 = * ((((4+9) + 2) / (4-1)) ^ 2) 9
   = (((((4+9) + 2) / (4-1)) ^ 2) * 9)

   Evaluate: (((13 + 2) / 3) ^ 2) * 9 = (15 / 3) ^ 2) * 9 = (5 ^ 2) * 9 = 25 * 9 = **225**

4. **Translate the following infix expression to postfix:**
   ((7 + 8) / (6 - 1)) ^ 2 * 4

   ((7 + 8) / (6 - 1)) ^ 2 * 4 = ((7 8 +) / (6 1 -)) ^ 2 * 4 = (((7 8 +) (6 1 -) /) ^ 2) * 4 =
   (((7 8 +) (6 1 -) /) 2 ^) * 4 = ((((7 8 +) (6 1 -) /) 2 ^) 4 *) = **7 8 + 6 1 - / 2 ^ 4 ***

Contest 3 - Boolean Algebra

Students will be taught how to make logical decisions by combining TRUE and FALSE values with the NOT, AND, and OR operators.

Students will learn how to use Truth Tables to evaluate Boolean or logical expressions that have only TRUE and FALSE values.

Students will be able to use basic rules to simplify Boolean or logical expressions into expressions that are easier to evaluate.

Students will use algebraic notation to represent complex and simplified Boolean or logical expressions.

Sample Problems - Boolean Algebra

1. **Determine if the following statement is TRUE or FALSE in mathematics:**
   3+4>6 AND 7-2>6

   The statement 3+4>6 is TRUE while the statement 7-2>6 is FALSE so the entire statement is FALSE because both must be TRUE for the entire statement to be TRUE. The answer is **FALSE**.

2. **How many ordered pairs make the following expression TRUE?**
   ~(~(A * (A + B)) + (B * ~A))

1	2	3	4	5	6	7	8	9
A	B	A+B	A*(A+B)	~4	~A	B*~A	5 + 7	~8
1	1	1	1	0	0	0	0	1
1	0	1	1	0	0	0	0	1
0	1	1	0	1	1	1	1	0
0	0	0	0	1	1	0	1	0

Therefore, the answer is (1,1) and (1,0).

Sample Problems - Boolean Algebra

3. **Simplify (NOT A OR A AND NOT B) AND (NOT A AND B)**

   (NOT A OR A AND NOT B) AND (NOT A AND B) = (NOT A AND NOT A AND B) OR (A AND NOT A AND B AND NOT B) = NOT A AND B OR 0 = **NOT A AND B**

4. **Which of the following Boolean algebra expressions are equivalent?**
   a) A * ~(B + ~A) b) A * ~B c) A * ~(~B + A)

1	2	3	4	5	6	7	8	9	10	11
A	B	~A	~B	B+~A	~B+A	~5	~6	A*7	A*~B	A*8
1	1	0	0	1	1	0	0	0	0	0
1	0	0	1	0	1	1	0	1	1	0
0	1	1	0	1	0	0	1	0	0	0
0	0	1	1	1	1	0	0	0	0	0

Look at columns 9, 10, 11. **(a) & (b) are equivalent.**

Contest 4 - Graph Theory

Students will be taught how graphs can be used to represent real-life situations in order to use algorithms to solve problems.

Students will learn how to draw graphs given a set of vertices and edges and identify the vertices and edges given an actual graph.

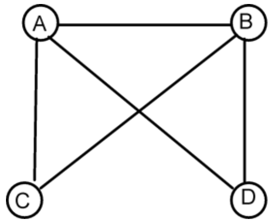
Students will be able to determine if a graph is traversable by using whether the vertices are even or odd.

Students will use the definition of a cycle in a graph to find what cycles of various lengths actually exist.

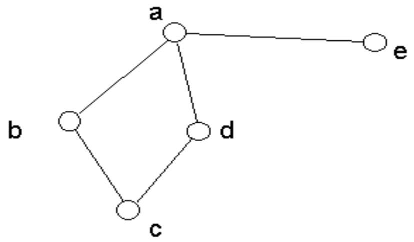
Sample Problems - Graph Theory

1. **Find the number of different cycles contained in the graph with vertices {A,B,C,D} and edges {AB, BC, AC, AD, DB}.**

   The graph is to the right. By inspection, the cycles are ABDA and ABCA. Thus, there are **2** cycles in the graph. Three vertices are needed.



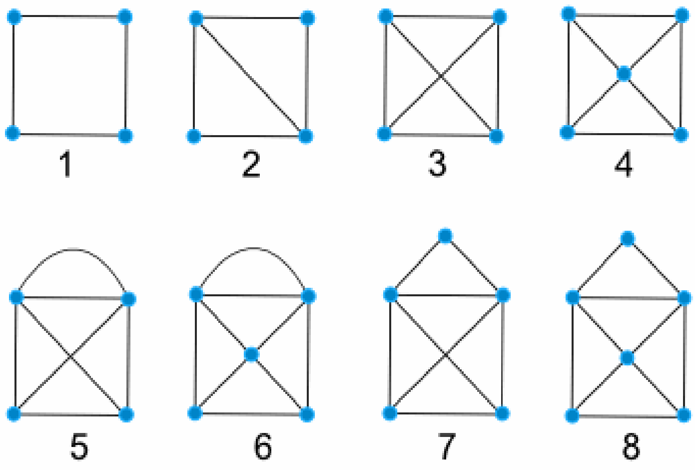
2. **Given the following graph, write the precise definition by listing the set of vertices and the set of edges.**



The set of vertices is {a,b,c,d,e} and the set of edges is {ab,ad,bc,cd,ae}.
Edges can be written in either order since it is an undirected graph.

Sample Problems - Graph Theory

3. **Which of the following graphs is NOT traversable?**



Vertices are listed from the top of each Graph to the bottom and left to right.

The table is as follows:

	V	A	B	C	D	E	F	Y/N
1	4	2	2	2	2			Y
2	4	3	2	2	3			Y
3	4	3	3	3	3			N
4	5	3	3	4	3	3		N
5	4	4	4	3	3			Y
6	5	4	4	4	3	3		Y
7	5	2	4	4	3	3		Y
8	6	2	4	4	4	3	3	Y

The answer is graphs 3 and 4.

Reasons to Participate

The earlier students are exposed to concepts in Computer Science, the more they will choose to learn as much as possible before graduating.

The Computer Science Teachers' Association (CSTA) has developed a K-12 curriculum framework and these topics introduce core concepts.

All elementary students benefit by exposure to these concepts while exceptional students are challenged to excel in problem solving.

This introduction will prepare them very well for competing in the existing Junior, Intermediate, and Senior Divisions for grades 6-12.

Where to get more information

Go to www.acsl.org to find out how the other Divisions (Junior, Intermediate, and Senior) of the American Computer Science League actually work if you have not participated at all before.

Download the ACSL Flyer and/or the Registration Form, fill it out, and mail it with a purchase order or a check for $50 made out to the American Computer Science League. You will receive email confirmation and all materials will be made available to you as needed.

Contact Carlen Blackstone, one of the members of the Executive Team, with questions or for more information at carlen@acsl.org at any time. Additional teacher resources and support will be offered free of charge.