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handout03.txt

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1 CS 202, Spring 2023
2 Handout 3 (Class 4)
3
4 1. Example to illustrate interleavings: say that thread tid1 executes f()
5 and thread tid2 executes g(). (Here, we are using the term "thread"
6 abstractly. This example applies to any of the approaches that fall
7 under the word "thread".)
8
9     a. [this is pseudocode]
10
11         int x;
12
13         int main(int argc, char** argv) {
14
15             tid tid1 = thread_create(f, NULL);
16             tid tid2 = thread_create(g, NULL);
17
18             thread_join(tid1);
19             thread_join(tid2);
20
21             printf("%d\n", x);
22         }
23
24         void f()
25         {
26             x = 1;
27             thread_exit();
28         }
29
30         void g()
31         {
32             x = 2;
33             thread_exit();
34         }
35
36
37         What are possible values of x after tid1 has executed f() and tid2 has
38         executed g()? In other words, what are possible outputs of the
39         program above?
40
41
42
43     b. Same question as above, but f() and g() are now defined as
44     follows:
45
46         int y = 12;
47
48         f() { x = y + 1; }
49         g() { y = y * 2; }
50
51         What are the possible values of x?
52
53
54
55     c. Same question as above, but f() and g() are now defined as
56     follows:
57
58         int x = 0;
59         f() { x = x + 1; }
60         g() { x = x + 2; }
61
62         What are the possible values of x?
63

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64 2. Linked list example
65
66     struct List_elem {
67         int data;
68         struct List_elem* next;
69     };
70
71     List_elem* head = 0;
72
73     insert(int data) {
74         List_elem* l = new List_elem;
75         l->data = data;
76         l->next = head;
77         head = l;
78     }
79
80     What happens if two threads execute insert() at once and we get the
81     following interleaving?
82
83     thread 1: l->next = head
84     thread 2: l->next = head
85     thread 2: head = l;
86     thread 1: head = l;
87

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88 3. Producer/consumer example:
89
90  /*
91   "buffer" stores BUFFER_SIZE items
92   "count" is number of used slots. a variable that lives in memory
93   "out" is next empty buffer slot to fill (if any)
94   "in" is oldest filled slot to consume (if any)
95   */
96
97   void producer (void *ignored) {
98       for (;;) {
99           /* next line produces an item and puts it in nextProduced */
100          nextProduced = means_of_production();
101          while (count == BUFFER_SIZE)
102              ; // do nothing
103          buffer [in] = nextProduced;
104          in = (in + 1) % BUFFER_SIZE;
105          count++;
106      }
107  }
108
109  void consumer (void *ignored) {
110      for (;;) {
111          while (count == 0)
112              ; // do nothing
113          nextConsumed = buffer[out];
114          out = (out + 1) % BUFFER_SIZE;
115          count--;
116          /* next line abstractly consumes the item */
117          consume_item(nextConsumed);
118      }
119  }
120
121  /*
122   what count++ probably compiles to:
123   reg1 <-- count      # load
124   reg1 <-- reg1 + 1    # increment register
125   count <-- reg1      # store
126
127   what count-- could compile to:
128   reg2 <-- count      # load
129   reg2 <-- reg2 - 1    # decrement register
130   count <-- reg2      # store
131  */
132
133  What happens if we get the following interleaving?
134
135   reg1 <-- count
136   reg1 <-- reg1 + 1
137   reg2 <-- count
138   reg2 <-- reg2 - 1
139   count <-- reg1
140   count <-- reg2
141

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142
143 4. Some other examples. What is the point of these?
144
145 [From S.V. Adve and K. Gharachorloo, IEEE Computer, December 1996,
146 66-76. http://rsim.cs.uiuc.edu/~sadve/Publications/computer96.pdf]
147
148 a. Can both "critical sections" run?
149
150     int flag1 = 0, flag2 = 0;
151
152     int main () {
153         tid id = thread_create (p1, NULL);
154         p2 (); thread_join (id);
155     }
156
157     void p1 (void *ignored) {
158         flag1 = 1;
159         if (!flag2) {
160             critical_section_1 ();
161         }
162     }
163
164     void p2 (void *ignored) {
165         flag2 = 1;
166         if (!flag1) {
167             critical_section_2 ();
168         }
169     }
170
171 b. Can use() be called with value 0, if p2 and p1 run concurrently?
172
173     int data = 0, ready = 0;
174
175     void p1 () {
176         data = 2000;
177         ready = 1;
178     }
179
180     int p2 () {
181         while (!ready) {}
182         use(data);
183     }
184
185 c. Can use() be called with value 0?
186
187     int a = 0, b = 0;
188
189     void p1 (void *ignored) { a = 1; }
190
191     void p2 (void *ignored) {
192         if (a == 1)
193             b = 1;
194     }
195
196     void p3 (void *ignored) {
197         if (b == 1)
198             use (a);
199     }

```