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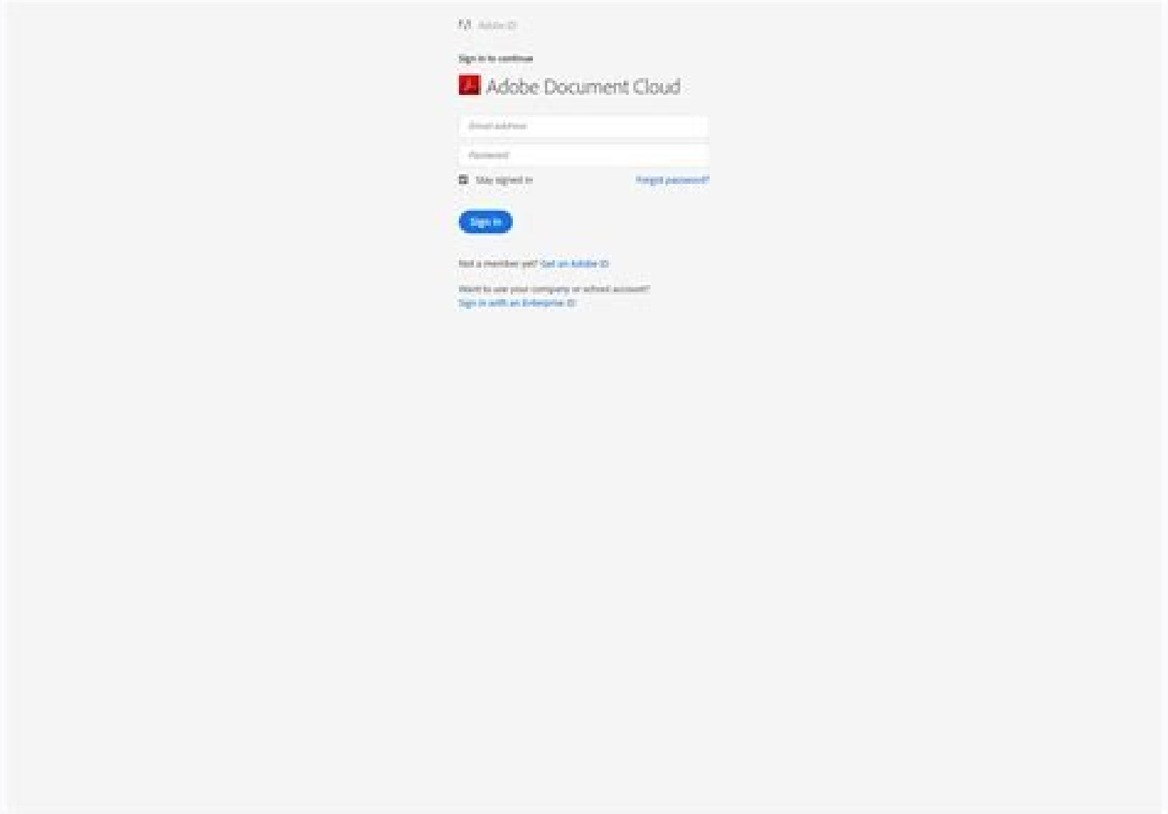
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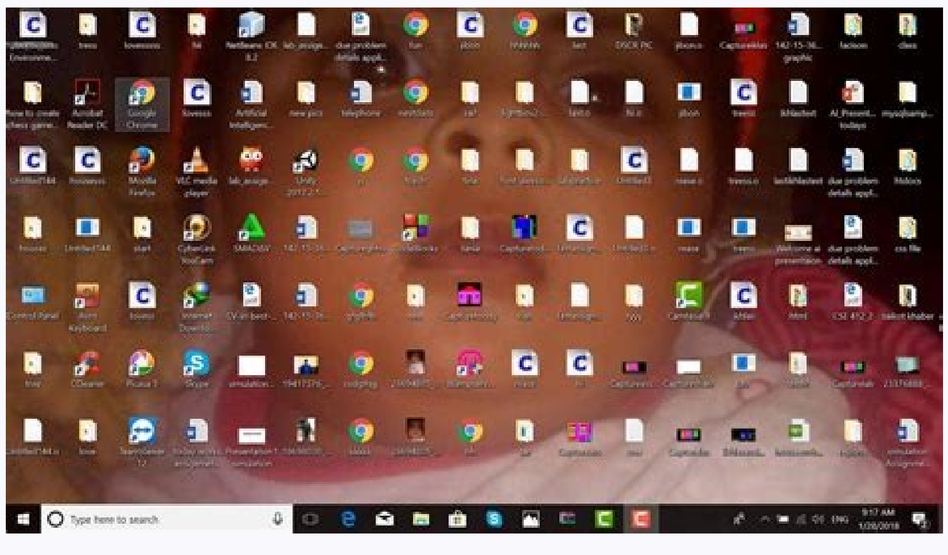

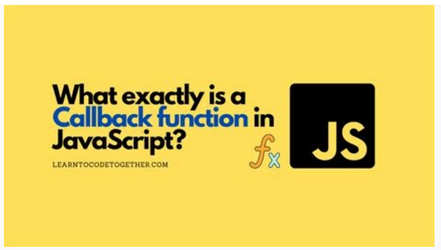

How to use callback functions.

If you learning or working on any programming language, someone has asked you to create a callback function. If you are a beginner, then you will get confused what is the callback function and how to create the callback function. Callback functions are a vital and often critical concept when the developers need to create drivers or custom libraries. This post will help you to understand the callback mechanism.What is the callback function in C with example?What is a callback?We will take the real scenario. Mr.John is going to the barbershop to trim his beard. There are many customers already waiting. The barber told John, there are few customers before you. I don’t know how long it will take to finish them. Please wait until I finish that. But Mr.John can’t wait as he has some other work to do. So, Mr.John decided to give his phone number to the barber and ask him to callback when he finish his work. The barber agreed. Now, Mr.John can do some other work that he wanted rather than waiting simply. The barber finishes his work after an hour. He called him. That’s how callback works in our day-to-day life. We can say many examples like this. But what is a callback in the C programming language?What is the callback function in C?In C or any other programming language, we will give the function address to another function or any other code. So, that code can call the function at any time whenever it needs. A callback function is a function that is called by using a function pointer.The following are some scenarios that help us in understanding the callback functions.Let’s say you are transferring the data using any communication. If you encounter an error, you have to inform the higher layer or upper layer. If you know the upper layer function’s address, then you can directly call that using the callback mechanism.In Embedded Systems, the developer creates a GPIO driver that has an interrupt service routine. When the interrupt fires, the driver has to inform the application layer. The driver doesn’t care about the functionality but only that at run-time it knows what function should be called when the interrupt fires. The code that will invoke the callback function within the module. This callback mechanism is often called as the signal handler.Difference between Function Pointer and Callback FunctionsA function pointer is a pointer that points to the function. Whereas, callback functions are function pointers passed as parameters of the function, which can be called back when an event occurs.In most instances, a callback will contain three pieces:The callback functionA callback registrationCallback executionExample CodeThe following code will help you to understand the callback mechanism. In the below code, callback_fn is a callback function and we are registering that callback function in the main function by assigning the callback function’s address (function pointer). Then we are passing the function pointer to the function test_loop. When the value is equal to 5, we will execute the callback function.// A simple C program to demonstrate callback mechanism #include // Callback Function which has no argument and no return value void callback_fn(void) { printf("In callback function"); } void test_loop(void (*fn)(void)) { for(int i = 0; i < 6; i++) { if(i == 5) { // callback execution (*fn) (); } printf("i = %d", i); } } int main() { // Registering the callback void (*fn_ptr)(void) = &callback_fn; // calling the function with the function pointer test_loop(fn_ptr); return 0; }Outputi = 0 i = 1 i = 2 i = 3 i = 4 In callback function i = 5 If you see the above output, we have called the callback_fn using the function pointer. Some people might ask why do we need a function pointer here. Instead, we can directly call the callback_fn itself like the below program.#include void callback_fn(void) { printf("In callback function"); } void test_loop(void) { for(int i = 0; i < 6; i++) { if(i == 5) { callback_fn() } printf("i = %d", i); } } int main() { test_loop(); return 0; }This program also generates the same output without the callback mechanism. That is awesome doubt.Here we just wrote a simple program to explain the callback function. But the actual case won’t be like this. That callback function won’t be present in the same file or library. It will be present in some other library. So we don’t know the name of the function. So, we will get the address of the function and then just call it. Now you are clear I guess.You can use typedef for the function pointer, which improves the readability. Refer to the example program.#include typedef void (*callback_)(void); // Callback Function which has no argument and no return value void callback_fn(void) { printf("In callback function"); } void test_loop(callback_ fn) { for(int i = 0; i < 6; i++) { if(i == 5) { // callback execution fn(); } printf("i = %d", i); } } int main() { // Registering the callback callback_ fn_ptr = &callback_fn; // calling the function with the function pointer test_loop(fn_ptr); return 0; }Callback function in C with argumentsCodeThe below code demonstrates the callback function with arguments.#include typedef void (*callback_)(int val); // Callback Function which has no argument and no return value void callback_fn(int val) { printf("In callback function, val = %d", val); } void test_loop(callback_ fn) { for(int i = 0; i < 6; i++) { if(i == 5) { // callback execution fn(i); } printf("i = %d", i); } } int main() { // Registering the callback callback_ fn_ptr = &callback_fn; // calling the function with the function pointer test_loop(fn_ptr); return 0; }Outputi = 0 i = 1 i = 2 i = 3 i = 4 In callback function, val = 5 i = 5 What are the advantages of the callback functions?The main advantage of using callbacks is that you can call a function that is defined in a higher software level from a lower software level subroutine.A callback can be used for notifications or signals.You can also read the below tutorials.Embedded Software | Firmware | Linux Devic Deriver | RTOS View Discussion Improve Article Save Article Like Article A callback is any executable code that is passed as an argument to other code, which is expected to call back (execute) the argument at a given time [Source : Wiki]. In simple language, If a reference of a function is passed to another function as an argument to call it, then it will be called as a Callback function.In C, a callback function is a function that is called through a function pointer.Below is a simple example in C to illustrate the above definition to make it more clear:#includevoid A(){ printf("I am function A");}void B(void (*ptr))(){ (*ptr) (); }int main(){ void (*ptr)() = &A; B(ptr); return 0;} I am function A In C++ STL, functors are also used for this purpose.This article is contributed by Ranju Kumari. If you like GeeksforGeeks and would like to contribute, you can also write an article using contribute.geeksforgeeks.org or mail your article to contribute@geeksforgeeks.org. See your article appearing on the GeeksforGeeks main page and help other Geeks.Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above. CServer Side ProgrammingProgramming The callback is basically any executable code that is passed as an argument to other code, that is expected to call back or execute the argument at a given time. We can define it in other words like this: If the reference of a function is passed to another function argument for calling, then it is called the callback function.In C we have to use a function pointer to call the callback function. The following code is showing how the callback function is doing its task.Example Code#include void my_function() { printf("This is a normal function."); } void my_callback_function(void (*ptr)()) { printf("This is callback function."); (*ptr)(); //calling the callback function } main() { void (*ptr)() = &my_function; my_callback_function(ptr); }OutputThis is callback function. This is a normal function. Updated on 30-Jul-2019 22:30:25 Function pointers are among the most powerful tools in C, but are a bit of a pain during the initial stages of learning. This article demonstrates the basics of function pointers, and how to use them to implement function callbacks in C. C++ takes a slightly different route for callbacks, which is another journey altogether. A pointer is a special kind of variable that holds the address of another variable. The same concept applies to function pointers, except that instead of pointing to variables, they point to functions. If you declare an array, say, int a[10]; then the array name a will in most contexts (in an expression or passed as a function parameter) “decay” to a non-modifiable pointer to its first element (even though pointers and arrays are not equivalent while declaring/defining them, or when used as operands of the sizeof operator). In the same way, for int func();, func decays to a non-modifiable pointer to a function. You can think of func as a const pointer for the time being. But can we declare a non-constant pointer to a function? Yes, we can — just like we declare a non-constant pointer to a variable: int (*ptrFunc) (); Here, ptrFunc is a pointer to a function that takes no arguments and returns an integer. DO NOT forget to put in the parenthesis, otherwise the compiler will assume that ptrFunc is a normal function name, which takes nothing and returns a pointer to an integer. Let’s try some code. Check out the following simple program: #include /* function prototype */ int func(int, int); int main(void) { int result; /* calling a function named func */ result = func(10,20); printf("result = %d",result); return 0; } /* func definition goes here */ int func(int x, int y) { return x+y; } As expected, when we compile it with gcc -g -o example1 example1.c and invoke it with ./example1, the output is as follows: result = 30 The above program calls func() the simple way. Let’s modify the program to call using a pointer to a function. Here’s the changed main() function: #include int func(int, int); int main(void) { int result1,result2; /* declaring a pointer to a function which takes two int arguments and returns an integer as result */ int (*ptrFunc)(int,int); /* assigning ptrFunc to func's address */ ptrFunc=func; /* calling func() through explicit dereference */ result1 = (*ptrFunc)(10,20); /* calling func() through implicit dereference */ result2 = ptrFunc(10,20); printf("result1 = %d result2 = %d",result1,result2); return 0; } int func(int x, int y) { return x+y; } The output has no surprises: result1 = 30 result2 = 30 A simple callback function At this stage, we have enough knowledge to deal with function callbacks. According to Wikipedia, “In computer programming, a callback is a reference to executable code, or a piece of executable code, that is passed as an argument to other code. This allows a lower-level software layer to call a subroutine (or function) defined in a higher-level layer.” Let’s try one simple program to demonstrate this. The complete program has three files: callback.c, reg_callback.h and reg_callback.c. /* callback.c */ #include #include"reg_callback.h" /* callback function definition goes here */ void my_callback(void) { printf("inside my_callback"); } int main(void) { /* initialize function pointer to my_callback */ callback ptr_my_callback=my_callback; printf("This is a program demonstrating function callback"); /* register our callback function */ register_callback(ptr_my_callback); printf("back inside main program"); return 0; } /* reg_callback.h */ typedef void (*callback)(void); void register_callback(callback ptr_reg_callback); /* reg_callback.c */ #include #include"reg_callback.h" /* registration goes here */ void register_callback(callback ptr_reg_callback) { printf("inside register_callback"); /* calling our callback function my_callback */ (*ptr_reg_callback)(); } Compile, link and run the program with gcc -Wall -o callback callback.c reg_callback.c and ./callback: This is a program demonstrating function callback inside register_callback inside my_callback back inside main program The code needs a little explanation. Assume that we have to call a callback function that does some useful work (error handling, last-minute clean-up before exiting, etc.), after an event occurs in another part of the program. The first step is to register the callback function, which is just passing a function pointer as an argument to some other function (e.g., register_callback) where the callback function needs to be called. We could have written the above code in a single file, but have put the definition of the callback function in a separate file to simulate real-life cases, where the callback function is in the top layer and the function that will invoke it is in a different file layer. So the program flow is like what can be seen in Figure 1. Figure 1: Program flow The higher layer function calls a lower layer function as a normal call and the callback mechanism allows the lower layer function to call the higher layer function through a pointer to a callback function. This is exactly what the Wikipedia definition states. Use of callback functions One use of callback mechanisms can be seen here: / * This code catches the alarm signal generated from the kernel Asynchronously */ #include #include #include struct sigaction act; /* signal handler definition goes here */ void sig_handler(int signo, siginfo_t *si, void *ucontext) { printf("Got alarm signal %d",signo); /* do the required stuff here */ } int main(void) { act.sa_sigaction = sig_handler; act.sa_flags = SA_SIGINFO; /* register signal handler */ sigaction(SIGALRM, &act, NULL); /* set the alarm for 10 sec */ alarm(10); /* wait for any signal from kernel */ pause(); /* after signal handler execution */ printf("back to main"); return 0; } Signals are types of interrupts that are generated from the kernel, and are very useful for handling asynchronous events. A signal-handling function is registered with the kernel, and can be invoked asynchronously from the rest of the program when the signal is delivered to the user process. Figure 2 represents this flow. Figure 2: Kernel callback Callback functions can also be used to create a library that will be called from an upper-layer program, and in turn, the library will call user-defined code on the occurrence of some event. The following source code (insertion_main.c, insertion_sort.c and insertion_sort.h), shows this mechanism used to implement a trivial insertion sort library. The flexibility lets users call any comparison function they want. /* insertion_sort.h */ typedef int (*callback)(int, int); void insertion_sort(int *array, int n, callback comparison); /* insertion_main.c */ #include #include"insertion_sort.h" int ascending(int a, int b) { return a > b; } int descending(int a, int b) { return a < b; } int even_first(int a, int b) { /* code goes here */ } int odd_first(int a, int b) { /* code goes here */ } int main(void) { int i; int choice; int array[10] = {22,66,55,11,99,33,44,77,88,0}; printf("ascending 1: descending 2: even_first 3: odd_first 4: quit 5"); printf("enter your choice = "); scanf("%d",&choice); switch(choice) { case 1: insertion_sort(array,10, ascending); break; case 2: insertion_sort(array,10, descending); case 3: insertion_sort(array,10, even_first); break; case 4: insertion_sort(array,10, odd_first); break; case 5: exit(0); default: printf("no such option"); } printf("after insertion_sort"); for(i=0;i

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