

26 Questions Programmers Ask

1	Where in the code is the text in this error message?
2	Where is the code involved in the implementation of this behavior?
3	Where is the entity named something like this?
4	What are the parts of this type? (methods, local variables)
5	Where does this type fit in the type hierarchy?
6	Where is this field declared in the type hierarchy?
7	Who implements this interface or these abstract methods?
8	Where is this method called or type referenced?
9	When during execution is this method called?
10	Where are instances of this class created?
11	Where is this variable or data structure being accessed?
12	What data can we access from this object?
13	What does the declaration or definition of this look like?
14	What are the arguments to this function?
15	What are the values of these arguments at runtime?
16	What does this data structure look like at runtime?
17	How can data be passed to this point in the code?
18	Under what circumstances is this method called or exception thrown?
19	What are the differences between these similar parts of the code or files?
20	What is the purpose of this code? variable?
21	Why am I getting this error?
22	Where am I getting an error?
23	How do I write this code/test case? How did you know?
24	Why is/isn't this event occurring?

25	What do I do next?
26	“Where is it __verb__ (changing) the __noun__ (current player mark)?“

Dialogue Templates for a Conversational Agent (CA)

These describe potential techniques a CA might use to answer the programming questions.

- This is the broad version of the question.

Example - Example of a real question that might be asked.

Source - Where we got the broad questions. The ones labeled “Us” were observed in our user studies.

Detail - Explains the scenario and discusses the intricacies of how the questions can be asked.

Input - A list of discrete items that must be parsed from the Questions. The format is as follows:

- 1) Name of Item -> this categorizes this specific input with a name. For example, “Method Name” or “Line Number”
- 2) “exampleCodeName” -> this is the name of a method, variable, etc. that is usually taken directly from one of the example questions in the Example section.

Separators:

- a) **+** -> a separator for multiple inputs
- b) **Optional +** -> the input to the right is optional
- c) **Or** -> the input is either the one of the left or the right depending on how the question is asked

Algorithm - A potential technique used to find the answer.

Answer - An example response dialogue.

1	Where in the code is the text in this error message?
Example	“Where is the bracket it is referring to?” (In this scenario, the programmer might be getting an unexpected character ‘{’ error)
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	There is some text or code segment in the error output that the programmer wants to locate.
Input	The text the user wants to search for - “{”
Algorithm	We query the error output for the text from the Input. If we find it, it might be accompanied by a line number. If not, we can do some grep/ctrl-f searching. If the search comes back with a few entries, we can use that as our answer. If the grep search has a bunch of entries, we can indicate that there are a lot of answers and give them a few examples.
Answer	“It’s on line 14 of the TicTacToe.java file”

2	Where is the code involved in the implementation of this behavior?
Example	“Is the vertical test implemented yet?”

Source	Us & SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The programmer is asking for the location of a certain feature implemented in the code. The feature may or may not exist.
Input	Feature Name - "vertical test"
Algorithm	JIRiSS is an Eclipse plugin that allows you to query source code with natural language. We query using the "Feature Name" Input. If the top few results (1-3) are of a certain level of confidence, those few are the answer. If the confidence level does not reach a certain threshold, we fail to find an answer. In this case where we fail to find a few confident answers, we could give an answer that encapsulates most of the low-confidence results. For example, if the vast majority of results are within a particular class or file, we could say, "The feature might be within this class somewhere".
Answer	"Could it be the 'vTest' method on line 14 of Test.java?"

3	Where is the entity named something like this?
Example	"Where is the vTest method?" "Where is exampleVariable?"
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The user is trying to find an entity (variable, method, class, etc.). We cannot assume the entity exists. The Input might not be spelled correctly, so some leeway is required.
Input	Variable/Method/etc. Name - "vTest"
Algorithm	If a simple grep/ctrl-f search does not return anything, use the feature location techniques from above. The programmer might implicitly desire the location of the declaration vs the usage of a method/variable, so we will have to find some way to detect that.
Answer	"It's defined on line 14 of Tests.java"

4	What are the parts of this type? (methods, local variables)
Example	"What methods are in this class?"
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The programmer wants the methods or instance variables of a class. They might even want some local variables from within methods, although that's a bit trickier to answer.
Input	Context Location - "this class" + Parts - "methods"
Algorithm	We can easily query Eclipse's Outline View to get the parts to a class. If a class has too many methods to list verbally, we will want to figure out with methods are the most important ones and visually list the full list. As for local variables within a method, we could parse the method and list all the variables defined. If there are too many

	variables to list, we might only list the ones in the outermost scope.
Answer	"It's got vTest, dTest, uTest, along with a few others. (display list of methods)"

5	Where does this type fit in the type hierarchy?
Example	"Who is the parent of exampleChildClass's parent?"
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The programmer is asking about the child/parent/sibling relationship between classes/interfaces.
Input	Context Name - "exampleChildClass" + Relationship - "parent's parent"
Algorithm	<p>To determine the "Relationship" Input, we will need to parse of the dependency tagging of the question. There are many ways to convey relationships in language: "Parent of exampleChildClass" "exampleChildClass's parent" "inherits from exampleParentClass".</p> <p>To parse the dependency tags, we start at the Context Name "exampleChildClass" and then see what dependencies it has to words such as "parent/child/sibling/etc." and verbs like "inherits/extends". We should be able to parse any combination such as "child's siblings" or "parents of the children of exampleChildClass's parent" or "child's parent's child"</p> <p>Once we have the inputs determined, we can easily query Eclipse's Type Hierarchy Viewer to get our answer(s).</p>
Answer	"exampleChildClass's parent's parent is exampleGrandpaClass."

6	Where is this field declared in the type hierarchy?
Example	"Which classes define exampleVariable?" "Does any class override exampleMethod?"
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The programmer is asking which class/sub-class within a type hierarchy define/override a certain instance variable/method.
Input	Field Name - "testVariable" optional + Scope (the type hierarchy we are talking about)
Algorithm	We can use a grep/ctrl-f search within the Scope to find what method/variable the programmer is specifically talking about. From there, Eclipse has a Hierarchy View/Show Inheritance Tree function that will give us our answer.
Answer	"A couple classes override it. exampleChildClass overrides exampleMethod on line 14 of class.java and exampleChildClass2 does too on line 15 of class2.java"

7	Who implements this interface or these abstract methods?
Example	"What class uses exampleInterface?" "Where is exampleAbstractMethod

	implemented?”
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A..
Detail	The programmer is asking what classes implement an interface and ask where abstract methods are implemented. Abstract methods are just the methods of an abstract class. Subclasses of the abstract class may or may not implement the abstract methods. If they don't implement them all, the class must be abstract. NOTE: Might separate this into 2 questions in the future
Input	Context Name - “exampleInterface”
Algorithm	Eclipse comes with a “search for implementers” function. If there are too many results, we can say the first few and display the rest.
Answer	“exampleClass implements exampleInterface”

8	Where is this method called or type referenced?
Example	“Where is exampleMethod called?” “Is exampleType referenced in exampleClass?”
Source	Us & SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The programmer wants to know the location that a method or type is used.
Input	Subject Name - “exampleType” optional + Narrowed Scope “exampleClass”
Algorithm	Eclipse has a “find references” tool that can be used. The references found must be inside the narrowed scope. If none are in the narrowed scope, but some are outside, we can say so to the programmer.
Answer	“It's in testClass in the testMethod on line 14” “It's not used in testClass, but it is used elsewhere”

9	When during execution is this method called?
Example	“When does exampleMethod get called?” “Does exampleMethod get called after exampleMethod2?”
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	This is during debugging, the programmer what to know at what time does a method or line of code gets called. “Time” will have to be relative to other events at occur at runtime.
Input	Method/Line of Code - “exampleMethod” optional + prepositions - “after “exampleMethod2”
Algorithm	We can ask the programmer if they want PairBuddy to start a debugging session for them with breakpoints at the “Method/Line of Code” in the Input. Additionally, the

	events in the prepositions will have breakpoints so we can check in what order are the breakpoints reached. Once the debugging session comes to its first breakpoint, we respond with “looks like exampleMethod gets called first” and when they resume debugging and hit another breakpoint we continue “and then exampleMethod2 is called” and so on.
Answer	“We can start a debugging session to test that out. Would you like me to start one for you?” “Looks like exampleMethod gets called first” *programmer continues* “and then exampleMethod2”

10	Where are instances of this class created?
Example	“Where are instance of exampleClass?” “exampleClass is used, right?” “Are there instances of exampleClass within exampleClass2?”
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	We just want to find instances of a particular class.
Input	Class Name - “exampleClass” optional + Narrowed Scope “exampleClass2”
Algorithm	Eclipse has a “find references” tool. This will directly give us some answers. We can pick the first few to use in the response.
Answer	“exampleClass is used in exampleClass2 a lot” “exampleClass is used on line 14, 28, and 49 in exampleClass2.”

11	Where is this variable or data structure being accessed?
Example	“Where is exampleVariable getting used?” “Where is the tree used?”
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The programmer wants to know when a variable is used. A data structure in Java would most likely be a root node that points to other instances of some sort of node class, so this might be difficult to answer.
Input	Variable/Data Structure name “exampleVariable”
Algorithm	Eclipse has a “find references” function that we can query to get our answer. If the query returns too many lines, we can just say the first three and then display the rest.
Answer	“It’s used on line 14, 28, 58, and a bunch of other places.”

12	What data can we access from this object?
Example	“What can we access from exampleObject?”
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...

Detail	This could be either a simple class with instance variable or even a data access object that accesses an underlying database.
Input	Object/Variable Name - "exampleObject"
Algorithm	We can query Eclipse Outline View for instance variables. We should be able to ignore data access objects since their use is fairly rare and we can't find any tools to detect their existence.
Answer	"exampleObject has member variables exampleVariable, exampleObject2, exampleObject3, and many others" (display others)

13	What does the declaration or definition of this look like?
Example	"Where is exampleVariable declared?" "Where is exampleMethod defined?"
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The programmer wants to be directed to the definition or declaration of an variable or method.
Input	Variable/Method Name - "exampleVariable"
Algorithm	Eclipse has a "Go To Definition" function that we can query to get the location of the definition. We can also move to the location the definition within the IDE's interface itself so the programmer can look at the surrounding code.
Answer	"It's defined on line 14 of example.java"

14	What are the arguments to this function?
Example	"What's the next parameter?" "What's the 3rd parameter" "Is this the 2nd parameter?"
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The programmer is asking all sorts of questions about function arguments. They could ask about all of them, a particular subset, the "next" "previous" "next 2", etc.
Input	optional Function Name - "testMethod" optional + Subset - "2nd"
Algorithm	The programmer will probably not indicate the function name but instead assume PairBuddy knows to use the function he is currently working on. We can query Eclipse's parameter hints to get a list of all the parameters. Comments describing each parameter can be extracted since javadoc is standardized. If there are a lot of parameters, or the comments are really long, we might display it instead with a response like "here's the documentation for this parameter" or something like that
Answer	"The first is an int named exampleParam and is 'the number iterations'" "It has 3 parameters, exampleParam1, exampleParam2, and exampleParam3"

15	What are the values of these arguments at runtime?
Example	"What is the value of exampleVariable at runtime?"
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The programmer either wants to know what are the arguments for all of the calls to a certain function at runtime, or what are the arguments to a specific function call are.
Input	Function Name - "testFunction"
Algorithm	We will prompt the programmer to see if they would like to start a debugging session with breakpoints either at the function definition or the function call. This will allow us to access the arguments at runtime. We could either audibly respond with the values or, if the list is too long, list the first few and display the rest.
Answer	"Would you like to start a debugging session with a breakpoint to the function?" "Looks like the arguments are 10, "example", and "example2." "Here they are." (display values)

16	What does this data structure look like at runtime?
Example	"Is exampleObject populated at runtime?" "What does exampleObject look like when we run it?"
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The programmer wants to see the structure/data within a data structure. Using classic debugging, it can be difficult to get a good image of a data structure, so visualizing it would be nice. If they ask if a data structure is populated, that might mean it "has some data" or "is full", so the distinction is tricky.
Input	Object/Data Name - "exampleObject"
Algorithm	There is some research done into data structure visualization and an open-source Eclipse Plugin named JIVE/JOVE that we can query for a visualization. It will take some effort to integrate for sure, but is a good solution. We will prompt the user if they want to run the program to create the visualization before we do so.
Answer	"I can visualize the object's structure if we run the program, do you want me to start it up?" "Here's what it looks like"

17	How can data be passed to this point in the code?
Example	"How can I pass exampleVariable to exampleMethod?"
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The programmer wants to pass variables or objects into other methods that are most likely within differing scopes, but it will most likely require passing through middle-man

	methods to get there.
Input	Source Variable - "exampleVariable" + Destination Method - "exampleMethod"
Algorithm	The Eclipse Plugin JIVE/JOVE can generate sequence diagrams at runtime, so we can use those sequence diagrams to determine a path from the source to the destination. A sequence diagram is just a tree structure, so it should be easy enough. We are unsure whether this will always answer the question correctly, but we'll have to see.
Answer	"exampleVariable can be passed to thisMiddleMethod and then to exampleMethod" "I can't find a path from exampleVariable to exampleMethod, sorry"

18	Under what circumstances is this method called or exception thrown?
Example	"Is exampleMethod ever called?" "When is the exception called?"
Source	Us & SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The programmer wants to know when a method is called at runtime. They also want to know when an exception is thrown relative to events within their code.
Input	Method Name - "exampleMethod"
Algorithm	For methods, we can prompt the programmer to start a debugging session with a breakpoint at the desired method. Additionally, we can use the Eclipse Plugin JIVE/JOVE to generate sequence diagrams to allow the programmer to understand the sequence of events that happened up to the breakpoint. For exceptions, eclipse allows us to pause debugging when an exception is thrown and we can use the same sequence diagrams.
Answer	"Do you want to use visual debugging to find out?" "Here's all the events that lead up to this. Does this help?"

19	Us & What are the differences between these similar parts of the code or files?
Example	"What's the difference between exampleTest and exampleTest2 test cases?" Are these methods different?"
Source	SILLITO ET AL.: ASKING AND ANSWERING QUESTIONS DURING A...
Detail	The user is either asking for the functional or the literal difference between code. "Literal" meaning things like variable names (or other things that don't affect the functionality) are included in "difference".
Input	Names of Test Cases/Methods/Classes/etc - "exampleTest1, exampleTest2"
Algorithm	For test cases, since we can generate test cases automatically based on scenarios, we can compare the flow of the test cases. If the test cases are the same except for one step or if they are wildly different, we will tell the programmer that. For methods, we can use a simple diff between the two blocks of code. Ideally, we would check if

	they are functionally different and ignore variable names, but we were unable to find anything that will do that in Java. We also need to be able to compare more than 2 things at the same time.
Answer	"Looks like they're exactly the same." "I highlighted/displayed the lines that are different"

20	What is the purpose of this code? variable?
Example	"What does exampleVariable do?"
Source	Us & Andrew J. Ko: Information Needs in Collocated Software Development Teams
Detail	The programmer wants to know the purpose or function of a class/method/variable is.
Input	Name of Code - "exampleClass"
Algorithm	Since Pair Buddy focuses on debugging and test driven development, we should first check if the item is a test case. To do this, we can use feature location techniques described in (2). If the confidence is high enough, we can use this as our answer. If no, we can list the javadoc comments at the declaration of the code items if any.
Answer	"This looks like it might be test case 1" "The comments describe testMethod. 'Queries the database for pictures of cats'"

21	Why am I getting this error?
Example	"What's with the error?"
Source	Us
Detail	The programmer wants to know the cause of an error they are getting either in the console or using Code Assist/Intellisense (red squiggly lines).
Input	Optionally Location - "line 14"
Algorithm	If the programmer does not indicate a location and there is no error in the console, we will take the first autodetected red squiggly error to use as the input. We have a list of canned responses for each error type that tells what a common reason for each error is. If it's not in the list, do a stack overflow search. If they say that it doesn't help, we give up and apologize.
Answer	"stack overflow errors are usually caused by infinite looping" "I'm not sure, but here's an answer on stackoverflow if that helps"

22	Where is the source of the error?
Example	"Where is the error?"

Source	Us
Detail	The programmer wants to know where the source of error they are getting is located. Similar to (21), but here, they ask for a location, not a reason. They might know where the error technically is but want to know the source.
Input	None
Algorithm	We can only give them the line number that the error code gives us. We will use the same strategy as above to suggest the reason for the error, but we won't suggest StackOverflow since they asked where and not why. They can just follow up if they want it.
Answer	"It's on line 14. Might be because there's an infinite loop somewhere, but I'm not sure exactly where."

23	How do I write this code/test case? How did you know?
Example	"How do I write the vertical test?"
Source	Us
Detail	The programmer is writing tests and wants to know how to write it. They might request code, but we can't write code for them.
Input	Test Name - "vertical test"
Algorithm	Can create test case using Stanford NLP > Frames > Activity Diagrams > Test Cases like described in some research [Prerana Pradeepkumar Rane]. So we have a group of test cases. We need to match the Input to one of these test cases. We can tell the programmer the sequence of events that makes up the test case. If the programmer asks how we generated the test cases, we can take them step by step through the algorithm. Might be a good learning opportunity for them.
Answer	"The sequence of events for the vertical test is 'With a blank board, player one places a mark at 0,0, player two places...' "We generated the test case based off this scenario. After using NLP we..."

24	Why is/isn't this event occurring?
Example	"Why isn't exampleFunction being called" "Why is exampleValue changing?"
Source	Andrew J. Ko: Designing the Whyline: A Debugging Interface for Asking Questions about Program Behavior
Detail	The functionality of their code does not match their expectations, so they are asking why/why not a certain event occurred.

Input	Object Name - "exampleVariable" + Verb "becomes" + details "more than 3"
Algorithm	<p>The Eclipse Plugin: JIVE/JOVE has what they call "Query Based Debugging" where you can break on a value changing, object creation, etc. This allows us to see why an event is occurring, but it does not let us see why an event is not occurring, so we can only partially answer this question.</p> <p>The hard part is parsing the input. A closer look at parsing the input for this question is required.</p> <p>We should also prompt the user before starting a debugging session.</p>
Answer	"Would you like me to start a custom debugging session to find that event?" "I'm not sure. I can't tell when an event doesn't occur." "exampleVariable becomes more than 3 here"

25	What do I do next?
Example	"What's next?"
Source	Us
Detail	We found this question was asked a lot of the time at the beginning of the our user studies. It might also be asked when they are lost or have just finished something.
Input	Nothing
Algorithm	<p>We can instruct them to do another test case that they haven't done yet. This requires us to detect which test cases they have completed. We could use feature location methods described in (2) to determine which test case is least likely to have been completed. If they say that they've already done a test, we'll mark the test case as completed if they ask the same question later.</p> <p>If there are any errors in the code, we could direct them to the error and suggest that they fix it.</p>
Answer	"Have you done the horzantle test yet?" "You have an error on line 14 that you could try to fix"