

プログラミングタスクにおける**ノウハウ知識**を理解
するためのタスク指向知能グラフの提案

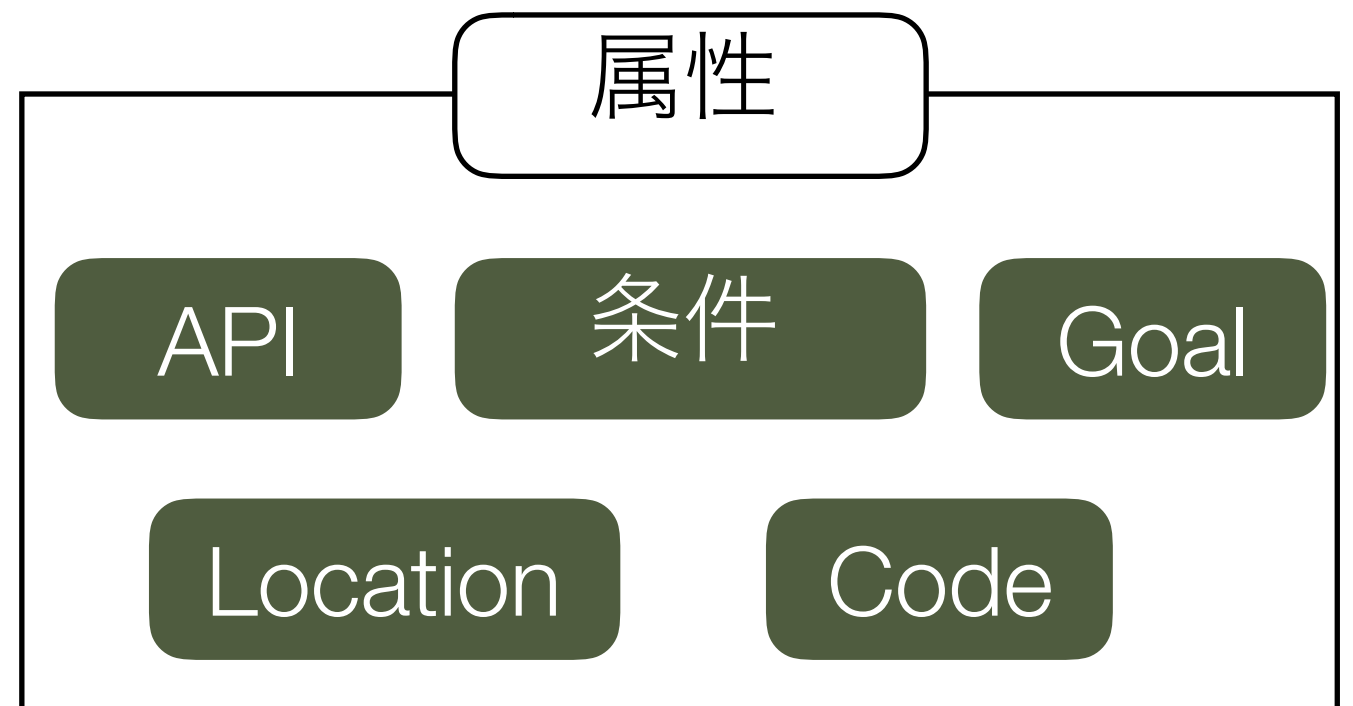
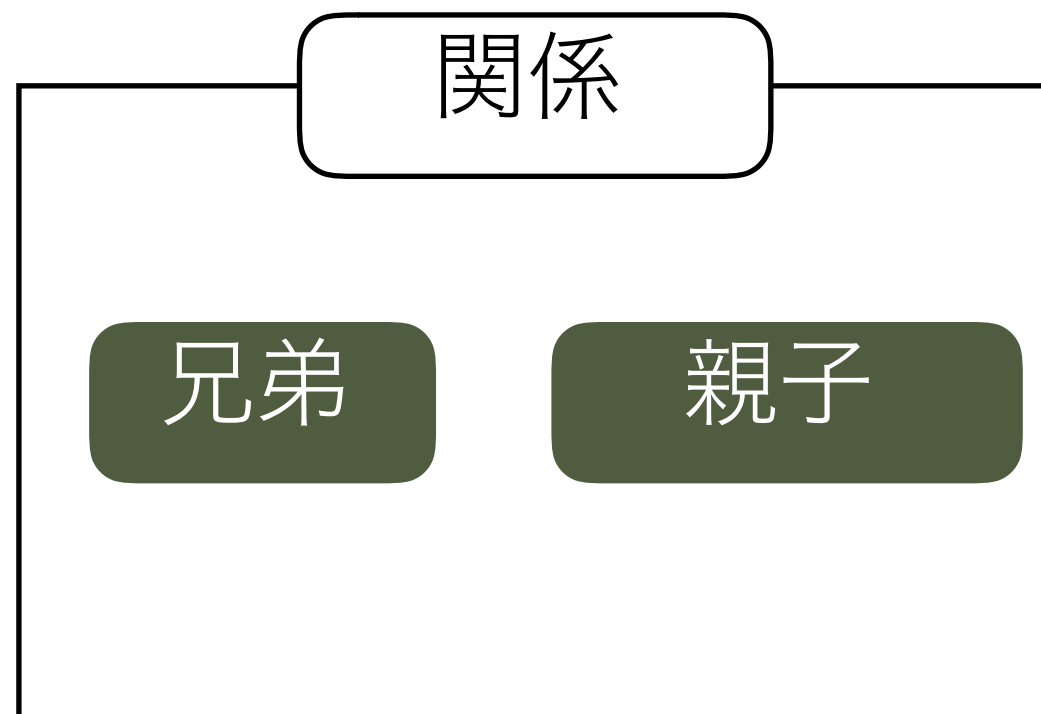
Know-How in Programming Tasks: From Textual Tutorials to Task-Oriented Knowledge Graph

Jiamou Sun*, Zhenchang Xing*, Rui Chu*, Helai Bai*, Jinshui Wang⁺, Xin Peng[‡]

発表者：作島大智

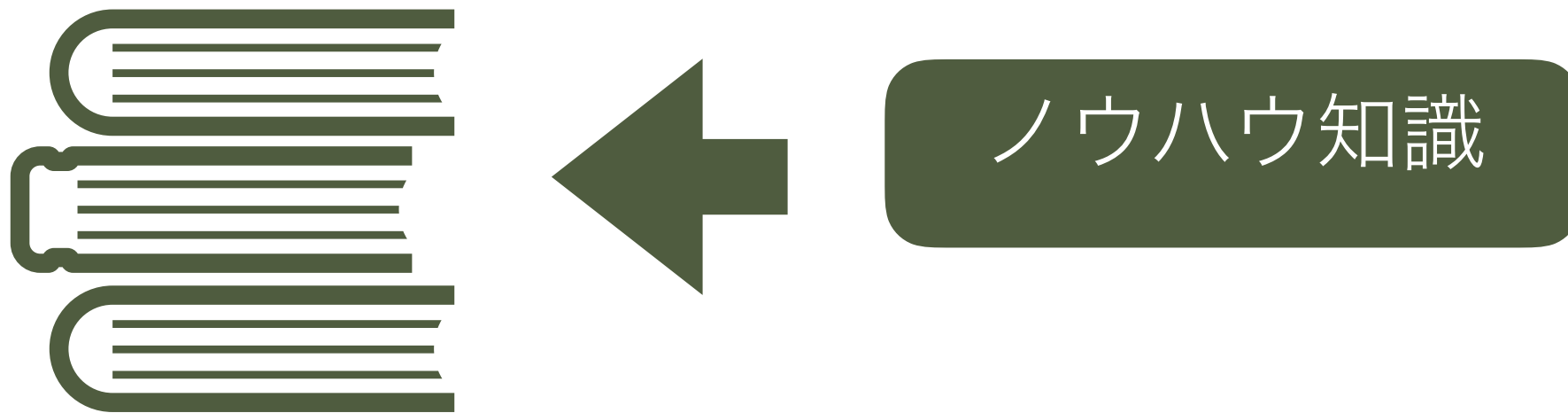
ノウハウ知識

- ・ タスク解決アクティビティとその関係性および属性



テキストチュートリアル

- ・ プログラミングタスクにおいてノウハウ知識が記載されているドキュメント



問題点と目的

問題点

- ノウハウ知識が記載されているチュートリアルは半構造的
- 理解するのが困難
 - どこを参照すればいいのかわからない

目的

プログラミングタスクのノウハウの知識を
より発見しやすく， 理解しやすくする。

概要

- テキストチュートリアルでプログラミングタスクのノウハウを発見・理解するための**情報障壁の調査**
- ノウハウ知識をタスク指向の知識グラフに変換する**オープン情報抽出方法**の開発
- プログラミングのHow-to質問に答えるための**アクティビティ中心の検索エンジン**の開発
- 開発した知識グラフの品質と検索エンジンの**有効性の評価**

データセット

- StackOverflow
 - Androidタグ付きの閲覧数が多い上位20個
 - タイトルが「How to ...」で始まっている
 - Android公式チュートリアルが存在するかどうか
引用範囲はどの程度なのか
- 公式ドキュメントがあるが質問している or
公式ドキュメントに加えて追加説明を行なっている
質問に着目する

質問者の努力あり + 公式ドキュメントあり

TABLE I: Statistic of 20 top-viewed, Android-tagged, how-to questions on Stack Overflow (A.E-Additional Explanation; DirExcerpt-Direct Excerpt; StL-Step Level, xSt-x Steps, SuL-Subsection Level, xSu-x Subsections, xAW-x Average Words, Atte-Attempted)

Questions	Atte	DirExcerpt or Paraphrased	A.E	Link to Tutorial	Complexity of Tutorial
1.How to display Toast in Android?	Yes	DirExcerpt	No	The Basics	StL, 2St, 48AW
2.How to set the text color of TextView in code?	Yes	No Tutorial			
3.How to Change Android SDK Path tools	No	Paraphrased	No	Update with SDK Manager	SuL, 1Su, 626AW
4.How to hide the title bar for an Activity in XML with existing custom theme	Yes	DirExcerpt	No	Hide the Status Bar on Android 4.0 and Lower	SuL, 2Su, 268AW
5.How to start new activity on button click	No	Paraphrased	No	Build an Intent	SuL, 4Su, 396AW
6.How to change fontFamily of TextView in Android	Yes	Paraphrased	Yes	Adding fonts to a TextView	StL, 1St, 17AW
7.How to add an image to the drawable folder?	Yes	Paraphrased	Yes	Create action bar or tab icon	SuL, 1Su, 454AW
8.How to make a background 20% transparent on Android	No	Paraphrased	Yes	Color	SuL, 1Su, 281AW
9.How to change background color in android app Themes	No	Paraphrased	Yes	Styles and	SuL, 3Su, 136AW
10.How to add manifest permission to an application?	Yes	DirExcerpt	No	Connect to the network	StL, 1St, 16AW
11.How to use putExtra() and getExtra() for string data	Yes	Paraphrased	Yes	Start another activity	SuL, 2Su, 341AW
12.How to open the Google Play Store directly from my Android application?	Yes	No Tutorial			
13.How to change the status bar color in android	No	Paraphrased	Yes	Customize the default theme	SuL, 2Su, 521AW
14.How to manage startActivityForResult on Android?	No	Paraphrased	Yes	Start the Activity	SuL, 2Su, 87AW
15.How to use SharedPreferences in Android to store, fetch and edit values	No	DirExcerpt	Yes	Save key-value data	SuL, 3Su, 198AW
16.How to run a Runnable thread in Android at defined intervals?	Yes	No Tutorial			
17.How to convert a Drawable to a Bitmap?	Yes	Paraphrased	No	Load Bitmaps Efficiently	SuL, 2Su, 180AW
18.How to pass an object from one activity to another on Android	No	Paraphrased	Yes	Start another activity	SuL, 2Su, 341AW
19.How to check certificate name and alias in keystore files?	Yes	No Tutorial			
20.How to send an object from one Android Activity to another using Intents?	Yes	Paraphrased	No	Parcelables and Bundles	SuL, 2Su, 229AW

公式ドキュメントがないものは対象外

TABLE I: Statistic of 20 top-viewed, Android-tagged, how-to questions on Stack Overflow (A.E-Additional Explanation; DirExcept-Direct Excerpt; StL-Step Level, xSt-x Steps, SuL-Subsection Level, xSu-x Subsections, xAW-x Average Words, Atte-Attempted)

Questions	Atte	DirExcept or Paraphrased	A.E	Link to Tutorial	Complexity of Tutorial
1.How to display Toast in Android?	Yes	DirExcept	No	The Basics	StL, 2St, 48AW
~~2.How to set the text color of TextView in code?~~	~~Yes~~	~~No Tutorial~~			
3.How to Change Android SDK Path tools	No	Paraphrased	No	Update with SDK Manager	SuL, 1Su, 626AW
4.How to hide the title bar for an Activity in XML with existing custom theme	Yes	DirExcept	No	Hide the Status Bar on Android 4.0 and Lower	SuL, 2Su, 268AW
5.How to start new activity on button click	No	Paraphrased	No	Build an Intent	SuL, 4Su, 396AW
6.How to change fontFamily of TextView in Android	Yes	Paraphrased	Yes	Adding fonts to a TextView	StL, 1St, 17AW
7.How to add an image to the drawable folder?	Yes	Paraphrased	Yes	Create action bar or tab icon	SuL, 1Su, 454AW
8.How to make a background 20% transparent on Android	No	Paraphrased	Yes	Color	SuL, 1Su, 281AW
9.How to change background color in android app Themes	No	Paraphrased	Yes	Styles and	SuL, 3Su, 136AW
10.How to add manifest permission to an application?	Yes	DirExcept	No	Connect to the network	StL, 1St, 16AW
11.How to use putExtra() and getExtra() for string data	Yes	Paraphrased	Yes	Start another activity	SuL, 2Su, 341AW
~~12.How to open the Google Play Store directly from my Android application?~~	~~Yes~~	~~No Tutorial~~			
13.How to change the status bar color in android	No	Paraphrased	Yes	Customize the default theme	SuL, 2Su, 521AW
14.How to manage startActivityForResult on Android?	No	Paraphrased	Yes	Start the Activity	SuL, 2Su, 87AW
15.How to use SharedPreferences in Android to store, fetch and edit values	No	DirExcept	Yes	Save key-value data	SuL, 3Su, 198AW
~~16.How to run a Runnable thread in Android at defined intervals?~~	~~Yes~~	~~No Tutorial~~			
17.How to convert a Drawable to a Bitmap?	Yes	Paraphrased	No	Load Bitmaps Efficiently	SuL, 2Su, 180AW
18.How to pass an object from one activity to another on Android	No	Paraphrased	Yes	Start another activity	SuL, 2Su, 341AW
~~19.How to check certificate name and alias in keystore files?~~	~~Yes~~	~~No Tutorial~~			
20.How to send an object from one Android Activity to another using Intents?	Yes	Paraphrased	No	Parcelables and Bundles	SuL, 2Su, 229AW

質問者の努力なし + 言い換え(抜粋)

TABLE I: Statistic of 20 top-viewed, Android-tagged, how-to questions on Stack Overflow (A.E-Additional Explanation; DirExcept-Direct Excerpt; StL-Step Level, xSt-x Steps, SuL-Subsection Level, xSu-x Subsections, xAW-x Average Words, Atte-Attempted)

Questions	Atte	DirExcept or Paraphrased	A.E	Link to Tutorial	Complexity of Tutorial
1.How to display Toast in Android?	Yes	DirExcerpt	No	The Basics	StL, 2St, 48AW
~~2.How to set the text color of TextView in code?~~	~~Yes~~	~~No Tutorial~~			
3.How to Change Android SDK Path tools	No	Paraphrased	No	Update with SDK Manager	SuL, 1Su, 626AW
4.How to hide the title bar for an Activity in XML with existing custom theme	Yes	DirExcerpt	No	Hide the Status Bar on Android 4.0 and Lower	SuL, 2Su, 268AW
5.How to start new activity on button click	No	Paraphrased	No	Build an Intent	SuL, 4Su, 396AW
6.How to change fontFamily of TextView in Android	Yes	Paraphrased	Yes	Adding fonts to a TextView	StL, 1St, 17AW
7.How to add an image to the drawable folder?	Yes	Paraphrased	Yes	Create action bar or tab icon	SuL, 1Su, 454AW
8.How to make a background 20% transparent on Android	No	Paraphrased	Yes	Color	SuL, 1Su, 281AW
9.How to change background color in android app Themes	No	Paraphrased	Yes	Styles and	SuL, 3Su, 136AW
10.How to add manifest permission to an application?	Yes	DirExcerpt	No	Connect to the network	StL, 1St, 16AW
11.How to use putExtra() and getExtra() for string data	Yes	Paraphrased	Yes	Start another activity	SuL, 2Su, 341AW
~~12.How to open the Google Play Store directly from my Android application?~~	~~Yes~~	~~No Tutorial~~			
13.How to change the status bar color in android	No	Paraphrased	Yes	Customize the default theme	SuL, 2Su, 521AW
14.How to manage startActivityForResult on Android?	No	Paraphrased	Yes	Start the Activity	SuL, 2Su, 87AW
15.How to use SharedPreferences in Android to store, fetch and edit values	No	DirExcerpt	Yes	Save key-value data	SuL, 3Su, 198AW
~~16.How to run a Runnable thread in Android at defined intervals?~~	~~Yes~~	~~No Tutorial~~			
17.How to convert a Drawable to a Bitmap?	Yes	Paraphrased	No	Load Bitmaps Efficiently	SuL, 2Su, 180AW
18.How to pass an object from one activity to another on Android	No	Paraphrased	Yes	Start another activity	SuL, 2Su, 341AW
~~19.How to check certificate name and alias in keystore files?~~	~~Yes~~	~~No Tutorial~~			
20.How to send an object from one Android Activity to another using Intents?	Yes	Paraphrased	No	Parcelables and Bundles	SuL, 2Su, 229AW

公式ドキュメントに追加の説明を記述した回答

TABLE I: Statistic of 20 top-viewed, Android-tagged, how-to questions on Stack Overflow (A.E-Additional Explanation; DirExcerpt-Direct Excerpt; StL-Step Level, xSt-x Steps, SuL-Subsection Level, xSu-x Subsections, xAW-x Average Words, Atte-Attempted)

Questions	Atte	DirExcerpt or Paraphrased	A.E	Link to Tutorial	Complexity of Tutorial
1.How to display Toast in Android?	Yes	DirExcerpt	No	The Basics	StL, 2St, 48AW
~~2.How to set the text color of TextView in code?~~	~~Yes~~	~~No Tutorial~~			
3.How to Change Android SDK Path tools	No	Paraphrased	No	Update with SDK Manager	SuL, 1Su, 626AW
4.How to hide the title bar for an Activity in XML with existing custom theme	Yes	DirExcerpt	No	Hide the Status Bar on Android 4.0 and Lower	SuL, 2Su, 268AW
5.How to start new activity on button click	No	Paraphrased	No	Build an Intent	SuL, 4Su, 396AW
6.How to change fontFamily of TextView in Android	Yes	Paraphrased	Yes	Adding fonts to a TextView	StL, 1St, 17AW
7.How to add an image to the drawable folder?	Yes	Paraphrased	Yes	Create action bar or tab icon	SuL, 1Su, 454AW
8.How to make a background 20% transparent on Android	No	Paraphrased	Yes	Color	SuL, 1Su, 281AW
9.How to change background color in android app Themes	No	Paraphrased	Yes	Styles and	SuL, 3Su, 136AW
10.How to add manifest permission to an application?	Yes	DirExcerpt	No	Connect to the network	StL, 1St, 16AW
11.How to use putExtra() and getExtra() for string data	Yes	Paraphrased	Yes	Start another activity	SuL, 2Su, 341AW
~~12.How to open the Google Play Store directly from my Android application?~~	~~Yes~~	~~No Tutorial~~			
13.How to change the status bar color in android	No	Paraphrased	Yes	Customize the default theme	SuL, 2Su, 521AW
14.How to manage startActivityForResult on Android?	No	Paraphrased	Yes	Start the Activity	SuL, 2Su, 87AW
15.How to use SharedPreferences in Android to store, fetch and edit values	No	DirExcerpt	Yes	Save key-value data	SuL, 3Su, 198AW
~~16.How to run a Runnable thread in Android at defined intervals?~~	~~Yes~~	~~No Tutorial~~			
17.How to convert a Drawable to a Bitmap?	Yes	Paraphrased	No	Load Bitmaps Efficiently	SuL, 2Su, 180AW
18.How to pass an object from one activity to another on Android	No	Paraphrased	Yes	Start another activity	SuL, 2Su, 341AW
~~19.How to check certificate name and alias in keystore files?~~	~~Yes~~	~~No Tutorial~~			
20.How to send an object from one Android Activity to another using Intents?	Yes	Paraphrased	No	Parcelables and Bundles	SuL, 2Su, 229AW

調査結果 (1/3)

- ・ タスクの意図の一貫性が損なわれる

4.How to hide the title bar for an Activity in XML with existing custom theme

検索

本文のまま

結果

スタイルとテーマ

関係のないページ

9.How to change background color in android app Themes

検索

背景色の変更

結果

カラーシステム

変更する方法について説明がない

タスクの質問とアクティビティの説明を一貫した
アクティビティ中心の表現にする必要がある

調査結果 (2/3)

- ・ 関連するチュートリアルはどこに書いてあるのか判断できない

6.How to change fontFamily of TextView in Android



関連チュートリアルテキスト



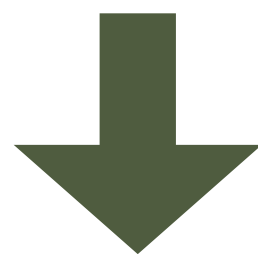
該当箇所を探すのが困難

5つのトップレベルの
サブセクション(全てフォント関連)

ドキュメントレベルの情報検索ではなく、
アクティビティ中心の知識検索が必要である

調査結果 (3/3)

低粒度のタスクアクティビティは**非構造的**に記述される
→関連するタスク解決知識の誤解・見落としが生じる



タスク解決知識を半構造化または非構造化テキストから
暗黙的な情報を**明示的なテキストに変換する**必要がある

調査結果のまとめ

-  タスクの質問とアクティビティの説明を一貫した
アクティビティ中心の表現にする必要がある
-  ドキュメントレベルの情報検索ではなく、
アクティビティ中心の知識検索が必要である
-  タスク解決知識を半構造化または非構造化テキストから
暗黙的な情報を**明示的なテキストに変換する**必要がある

ノウハウ知識をタスク指向知識グラフへ

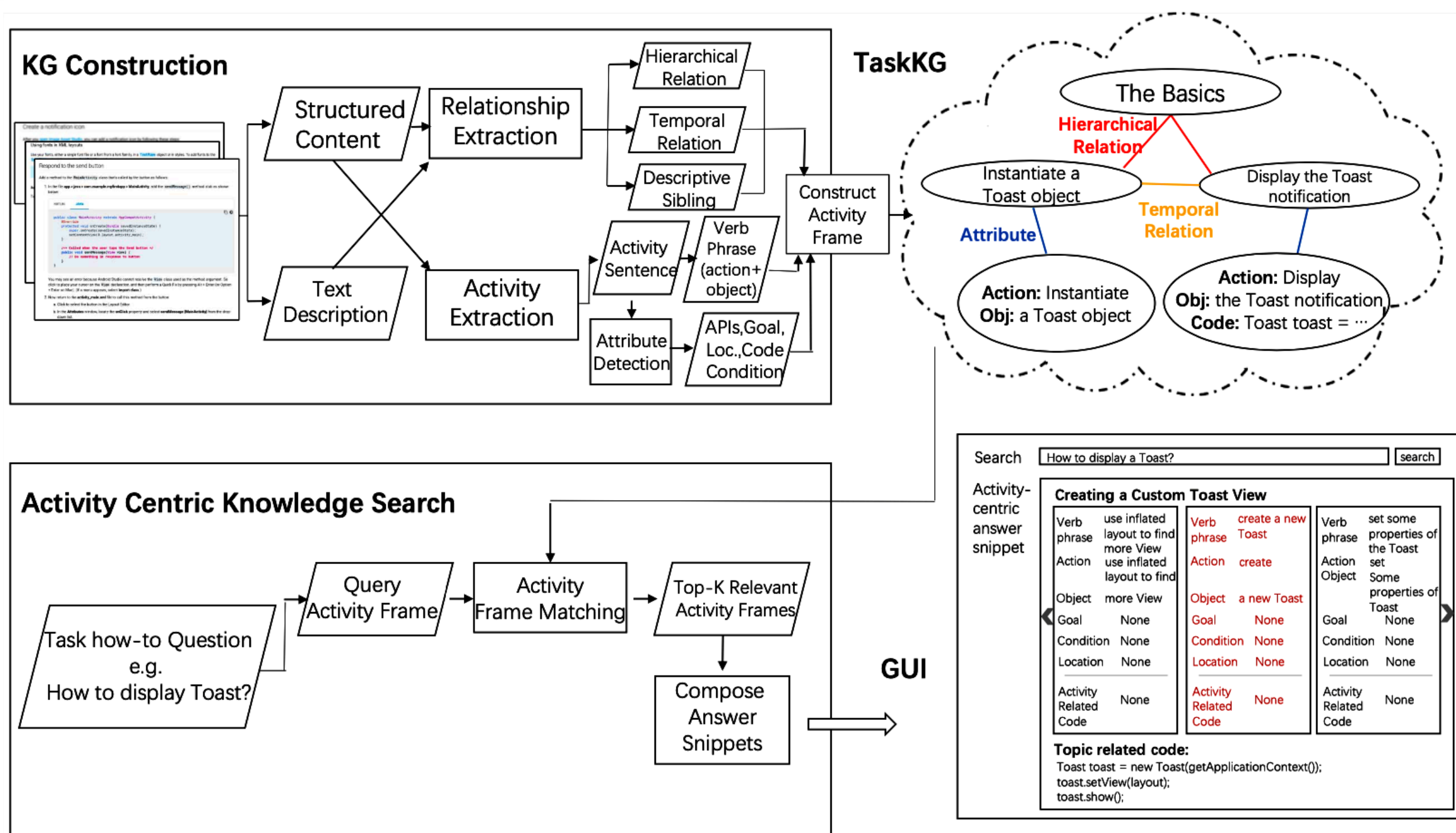


Fig. 2: Approach Overview

ノウハウ知識をタスク指向知識グラフへ

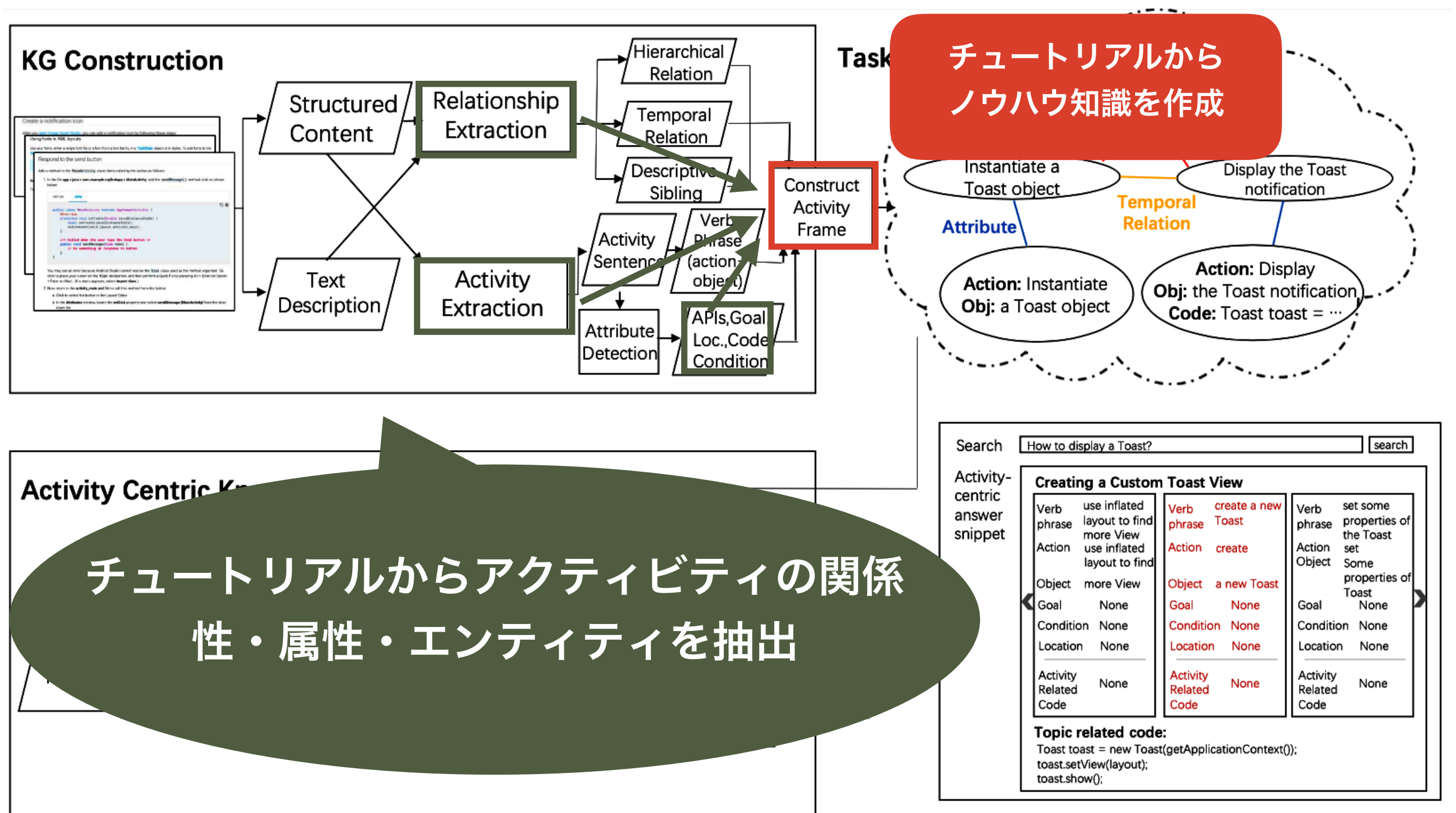
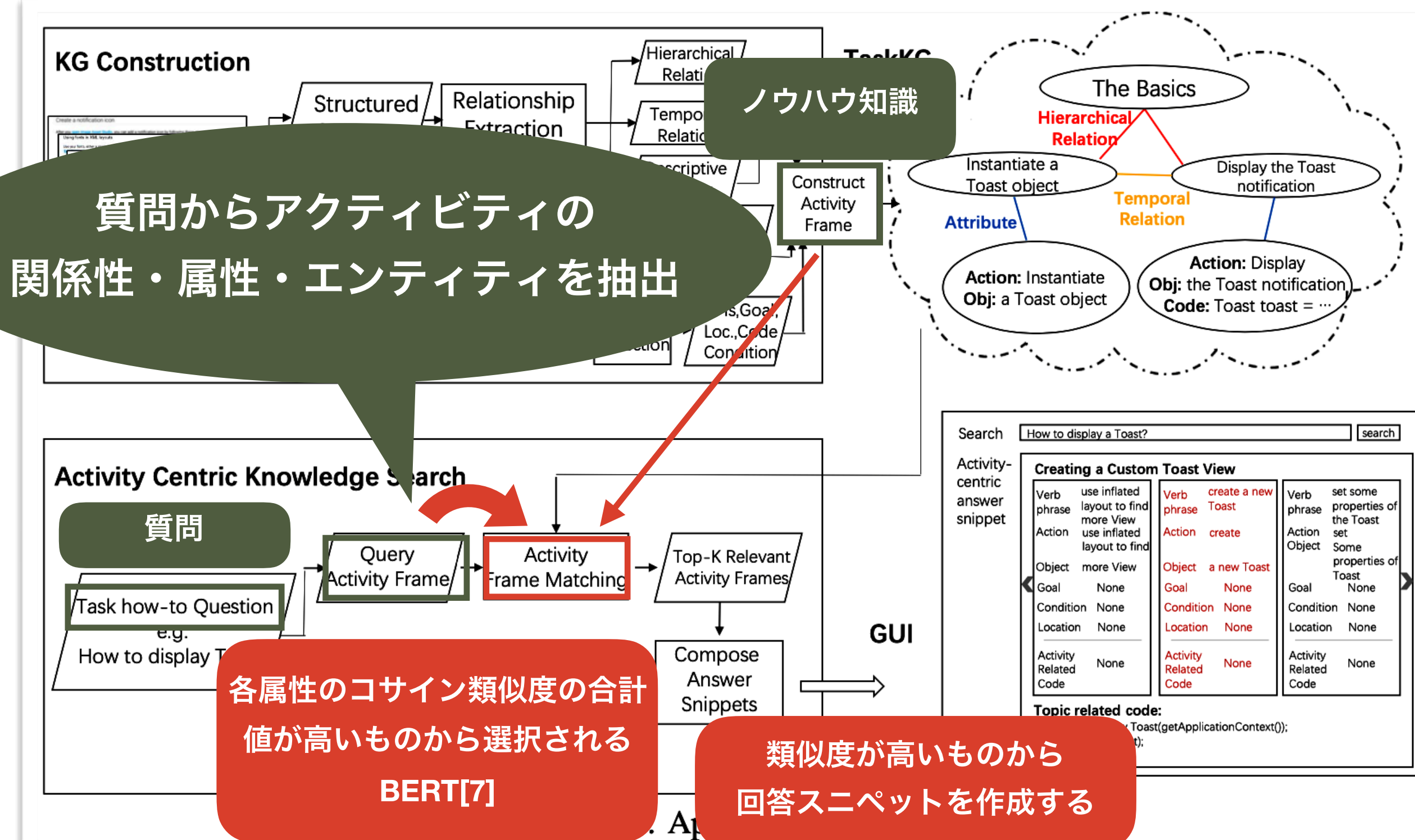


Fig. 2: Approach Overview

ノウハウ知識をタスク指向知識グラフへ



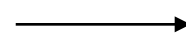
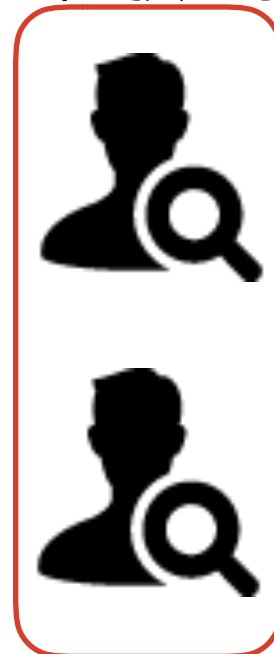
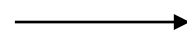
ユーザー調査

- 10人の開発者(Android開発経験あり4人)
- 8つのAndroid関係のHow-to質問
 - 難易度(easy3個, normal3個, hard2個)
 - 公式ガイドあり, 個人の努力ありのみ

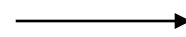
同程度の経験を持つペア

How-to質問

TABLE V: Eight Search Tasks in User Study	
1.How to display Toast in Android? Set duration to LENGTH_LONG and set text to "This is my Toast message!"	easy
2.How to hide the title bar for an Activity in XML with existing custom theme? Assume the android version is 4.0 and lower	easy
3.How to use SharedPreferences in Android to store, fetch and edit values? Write the process of get edit and apply SharedPreferences	easy
4.How to change fontFamily of TextView in Android? Assume you want to add the fontFamily "font_family_light" to TextView	medium
5.How to change background color in android app? Assume the color name for background is "@color/white" and you have to add name "white" with value "#FFFFFF" to the resources	medium
6.How to add manifest permission to an application? Assume you get error: WARN/System.err(223):java.net.SocketException:Permission denied (maybe missing INTERNET permission)	medium
7.How to start new activity on button click? Assume you have to launch a new activity, and you want to send a message with name "key" and value named value using putExtra	hard
8.How to manage startActivityForResult on Android? Write how you use startActivityForResult() to send the new Intent, and how you justify the returned result is OK within "onActivityResult"	hard



提案手法



Google検索
エンジン

結果

TABLE VI: Performance Comparison

Experimental Group		
	Ave Task Time (seconds)	# Correct Answers
P1	166.6	4
P2	147.8	6
P3	144.9	6
P4	141.6	7
P5	158.8	8
Ave $\pm$ stddev	151.9 $\pm$ 9.3	
Control Group		
P6	223.4	3
P7	251.3	5
P8	258.8	7
P9	296.0	7
P10	305.6	8
Ave $\pm$ stddev	267.0 $\pm$ 30.2	

結果

TABLE VI: Performance Comparison

Experimental Group	
	Ave Task Time (seconds)
P1	4
P2	6
P3	6
P4	7
P5	8
Average	
Control Group	
P6	3
P7	5
P8	7
P9	7
P10	8
Average	

正答数に違いはない

Google検索エンジンと
同等の結果

結果

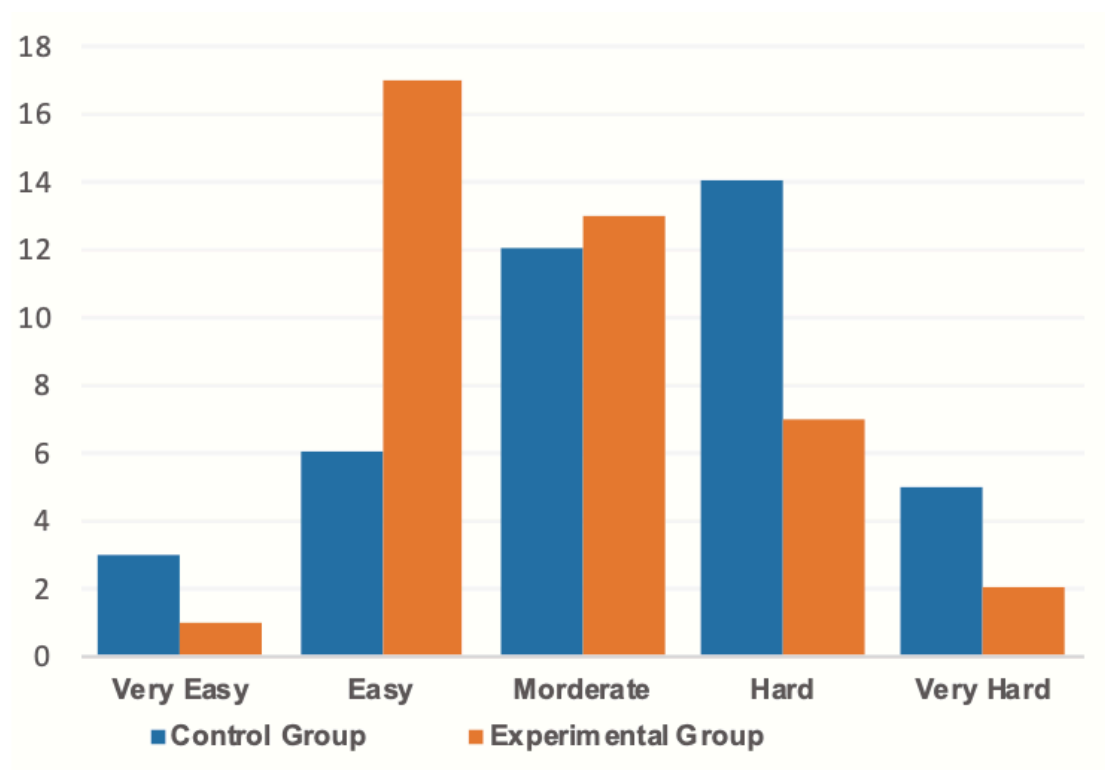
TABLE VI: Performance Comparison

Experimental Group		
	Ave Task Time (seconds)	# Correct Answers
P1	166.6	回答を見つけるまでの 時間が短い
P2	147.8	
P3	144.9	
P4	141.6	
P5	158.8	
Ave±stddev	151.9±9.3	
Control Group		
P6	223.4	回答を見つけるまでの 時間が長い
P7	251.3	
P8	258.8	
P9	296.0	
P10	305.6	
Ave±stddev	267.0±30.2	

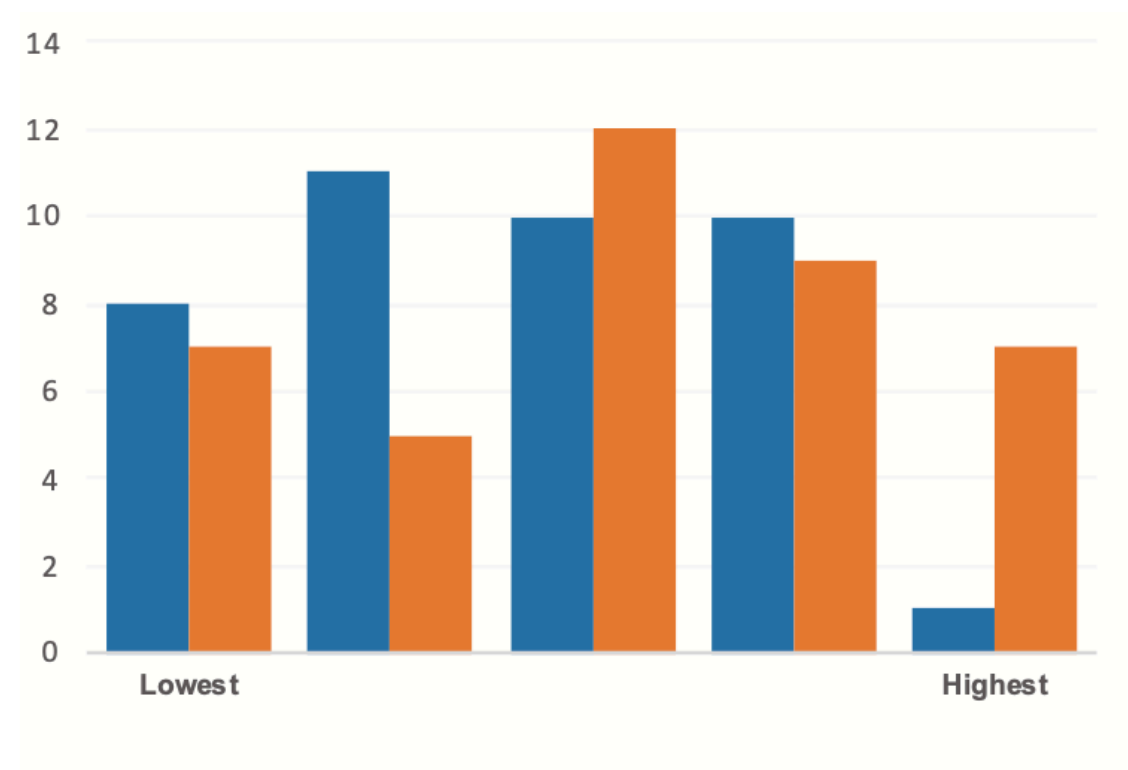
ユーザアンケート

(a) 被験者が問題の難易度をどのように感じたのか

(b) 自身の回答が正答であると考えているか



(a) Question Difficulty



(b) Answer Confidence

提案手法の方が簡単に感じ、正答数も多い

提案手法の有効性

- 正答数は変わらないが、回答するまでの時間が短い
- 比較的ユーザが質問内容を難しいと感じていない



- 規模は小さいが有効性があると判断

まとめ

- How-to質問に対して、 **文字列ではなくアクティビティを見つける**ことを支援する知識グラフベースのアプローチを提案
- 提案手法の有効性を確認
- 複数のチュートリアルドキュメントでも同様に実験し提案手法の一般化を目指す