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Team Presentation #5

- CFG Generator

TEAM [T2]

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Project Overview

- First we take and analyze the team T5's project.
- If necessary, we have to modify and supplement it. (we will mark red)
- we do this project with the purpose of final implementation.

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Contents

- Structured Analysis
- Structured Design
- Source Code
- Demonstration

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Structured Analysis

Statement of Purpose [1/2]

CFG(Control Flow Graph) Generator

- Convert a C source code to CFG.
- CFG is printed in sorted text form according to each block's level.
  - Each block has block's name and major contents to be shown.
  - Each edge has a data of block to be connected.
  - Related block and edge are printed in the same line.
- Restriction of Input C source code
  - The C source code has 100~200 lines which includes main function.
  - It doesn't include pointers.
  - It is a single-file that doesn't have user defined header files.
  - Body of user defined functions should be ahead of main function.
  - Conditional statements should be wrapped in a brace({ }) at the next line of corresponding keyword.

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Statement of Purpose [2/2]

- When a user inputted incorrect command, the program show "help" that includes command syntax.
- When C source code inputted successfully, the program shows "success" message. Or in error case, the program shows "error" and terminates the program.
- Before the program converting CFG, shows "converting" message.
- After report generating process, the program shows the name of report file.
- Edges Recognition Algorithm, Basic Block Construction Algorithm, BFS Positioning Algorithm are used.

supplement

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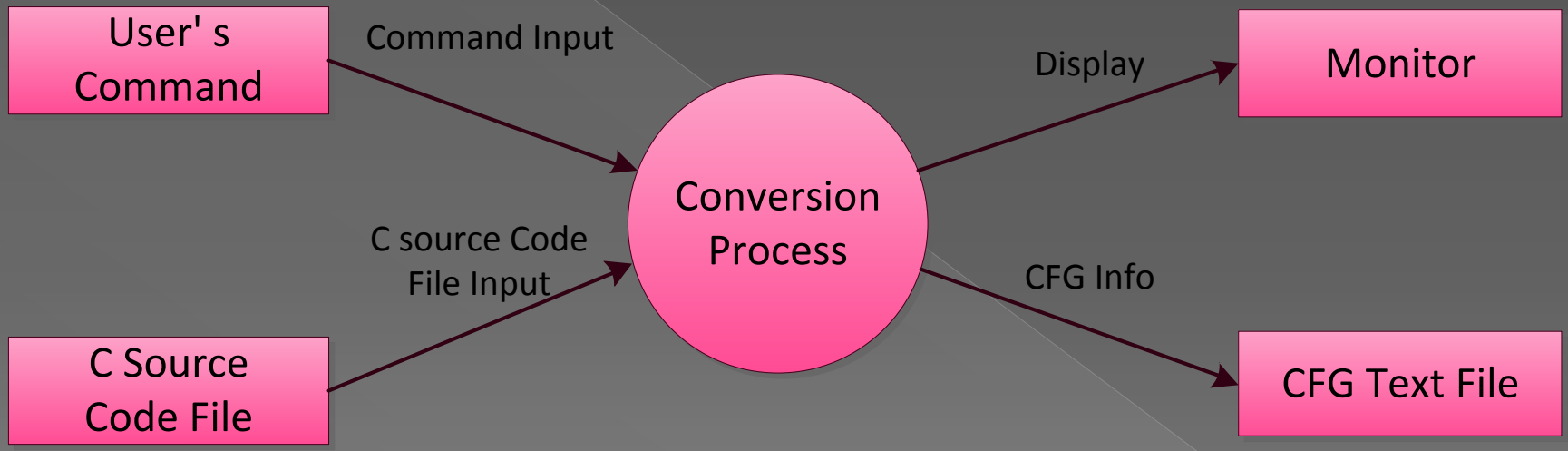
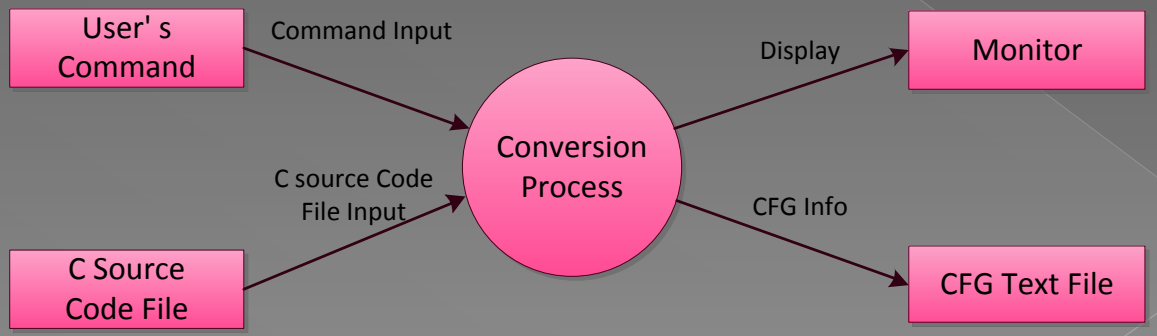
System Context Diagram



Event List

Input / Output Event	Description
Command Input	Receives a command from ***User's Command***
C Source Code File Input	Receives a C source code file
Display	Prints Commands' result and CFG's process to ***Monitor***
CFG Info	Prints converted CFG to ***CFG Text File***



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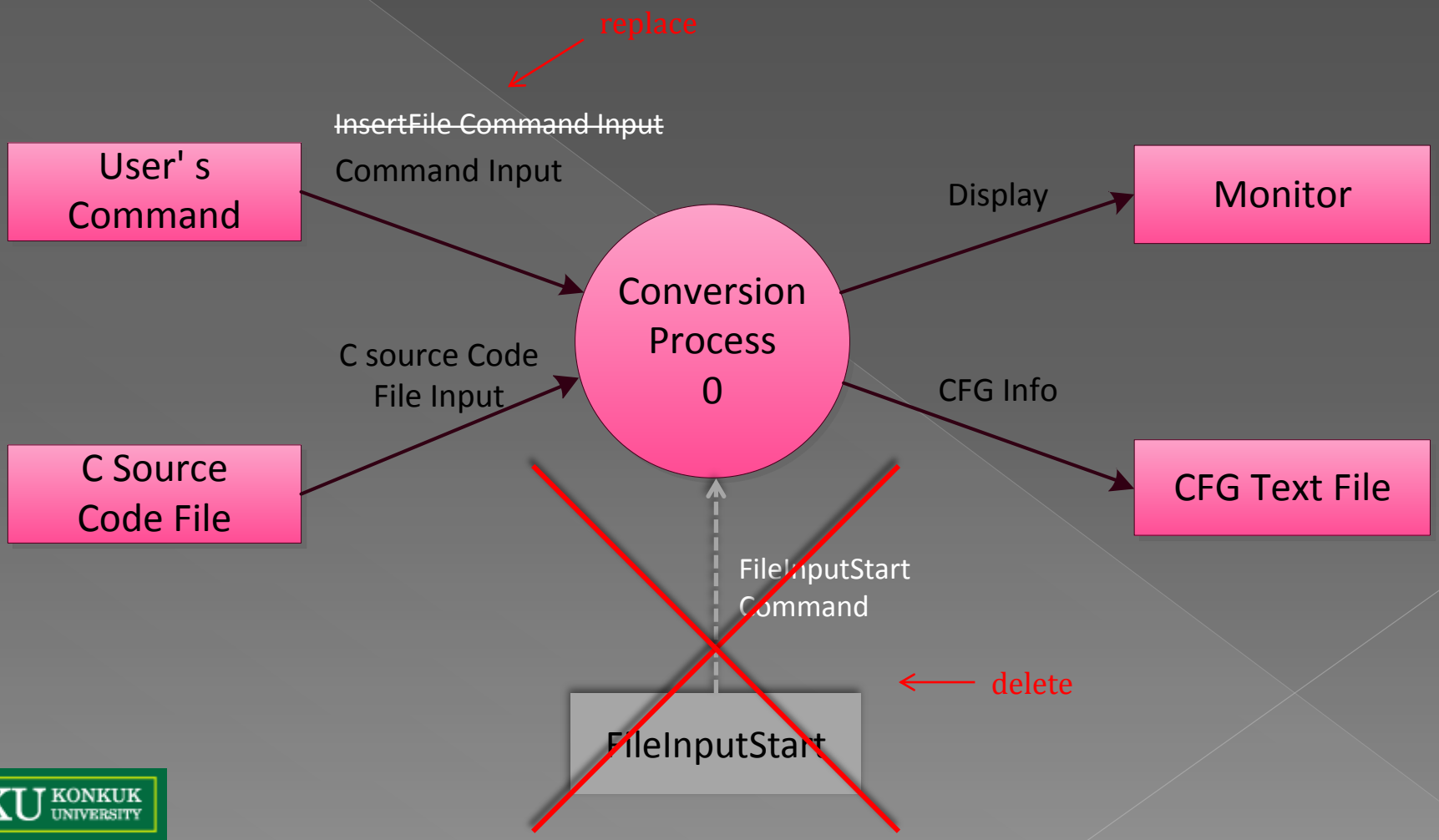
Data Flow Diagram – level 0



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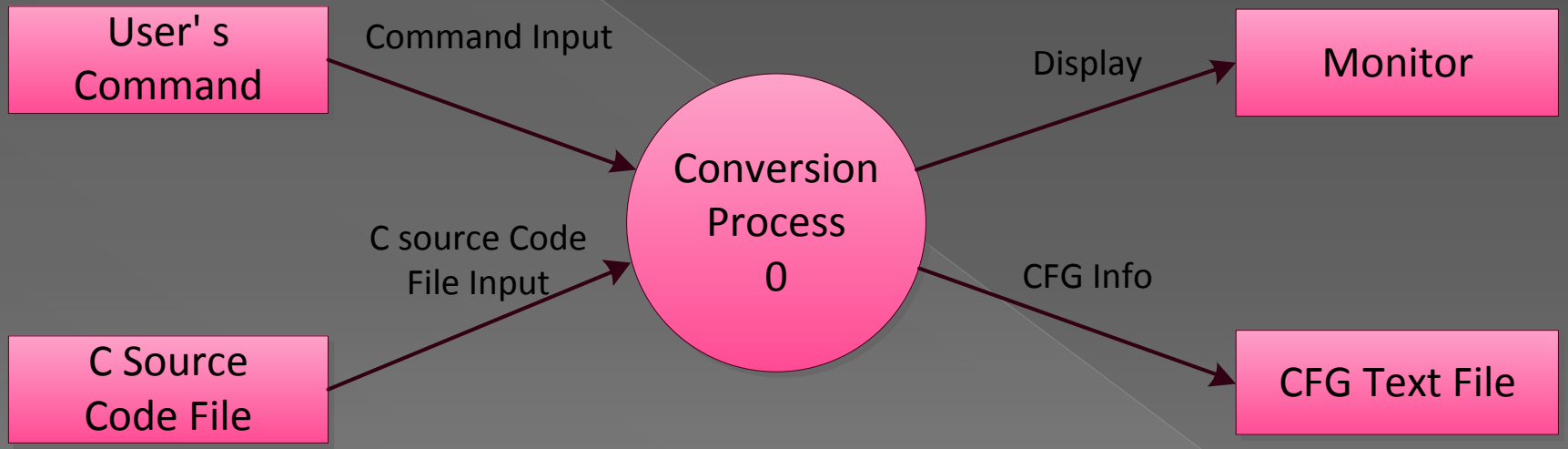
Data Flow Diagram – level 0



Data Dictionary – level 0

Data name	Description
Command Input	It is received command from ***User's Command***.
C Source Code File Input	It is inputted C source code file.
CFG Info	It is CFG data converted from inputted C source code.
Display	It is an output data contains system message caused by ***Command Info*** and CFG's process result to be sent to ***Monitor***.

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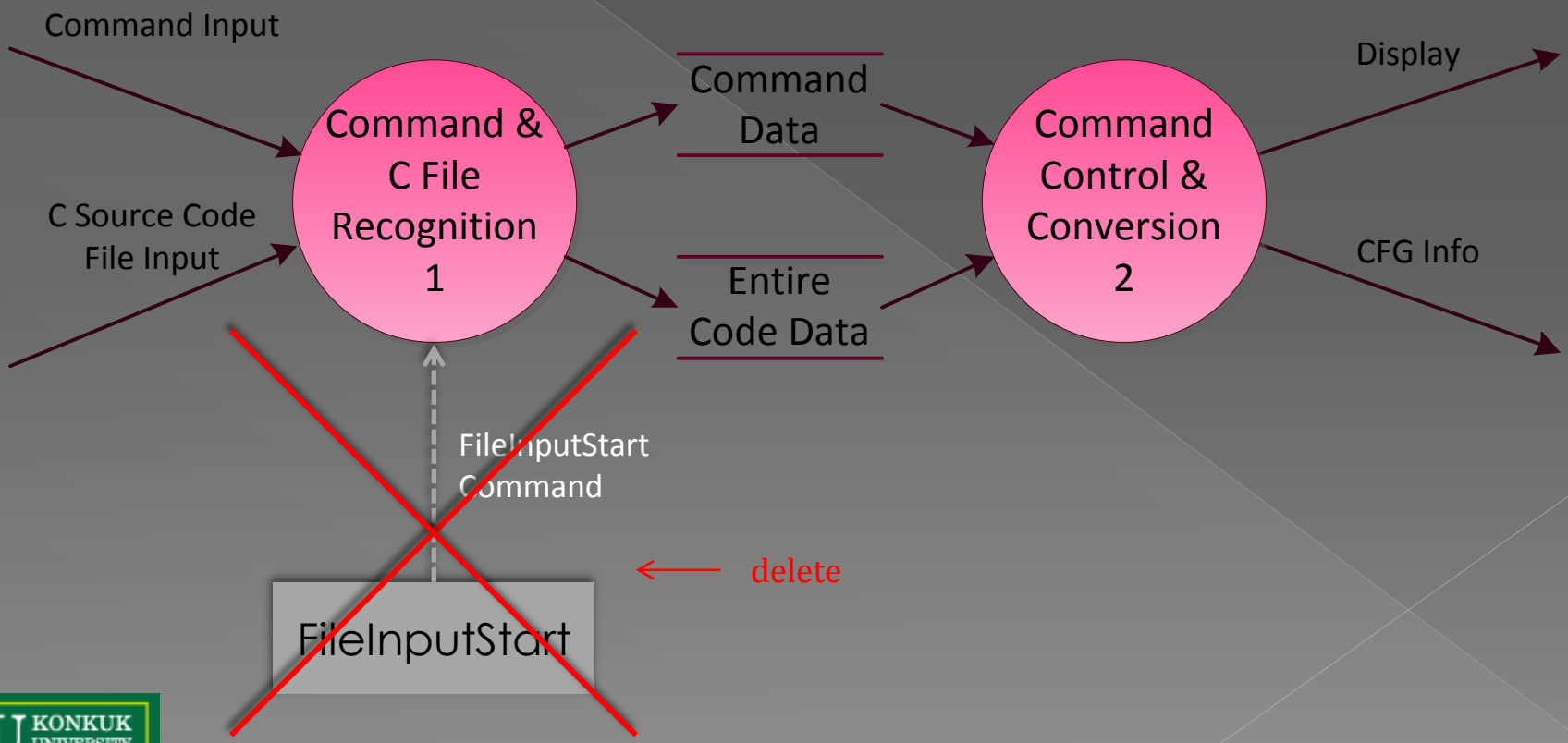
Data Flow Diagram – level 1



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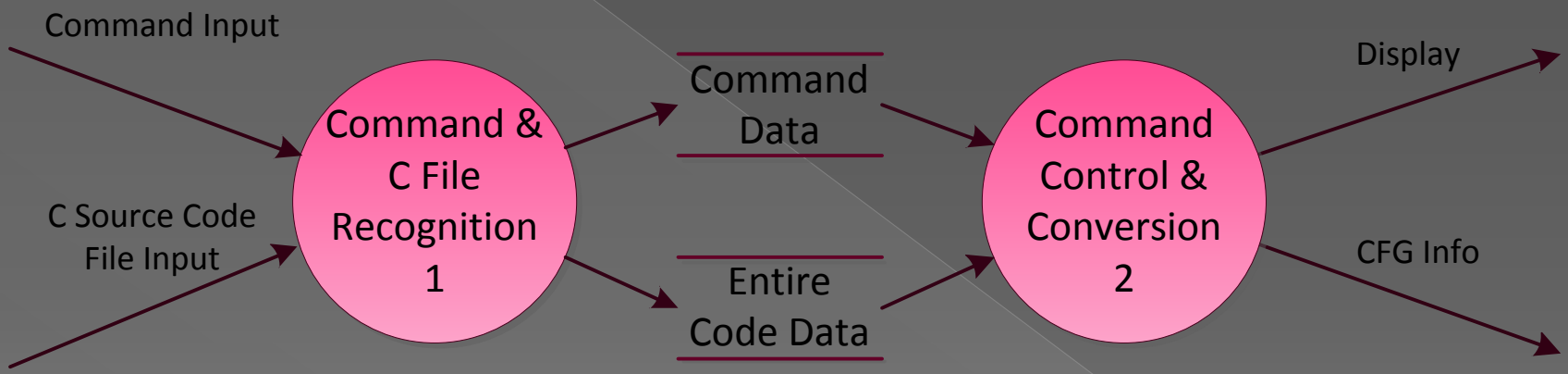
Data Flow Diagram – level 1



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Data Dictionary – level 1

Command Data	Description
Correctness Info	A boolean value meaning correctness of received command. (True/False)

revise : exclude filename (string)

Entire Code Data	Description
Numbered Code Data	It consists of ***C Source Code File Input*** and each corresponding line number.

revise : from Block&Edge Data

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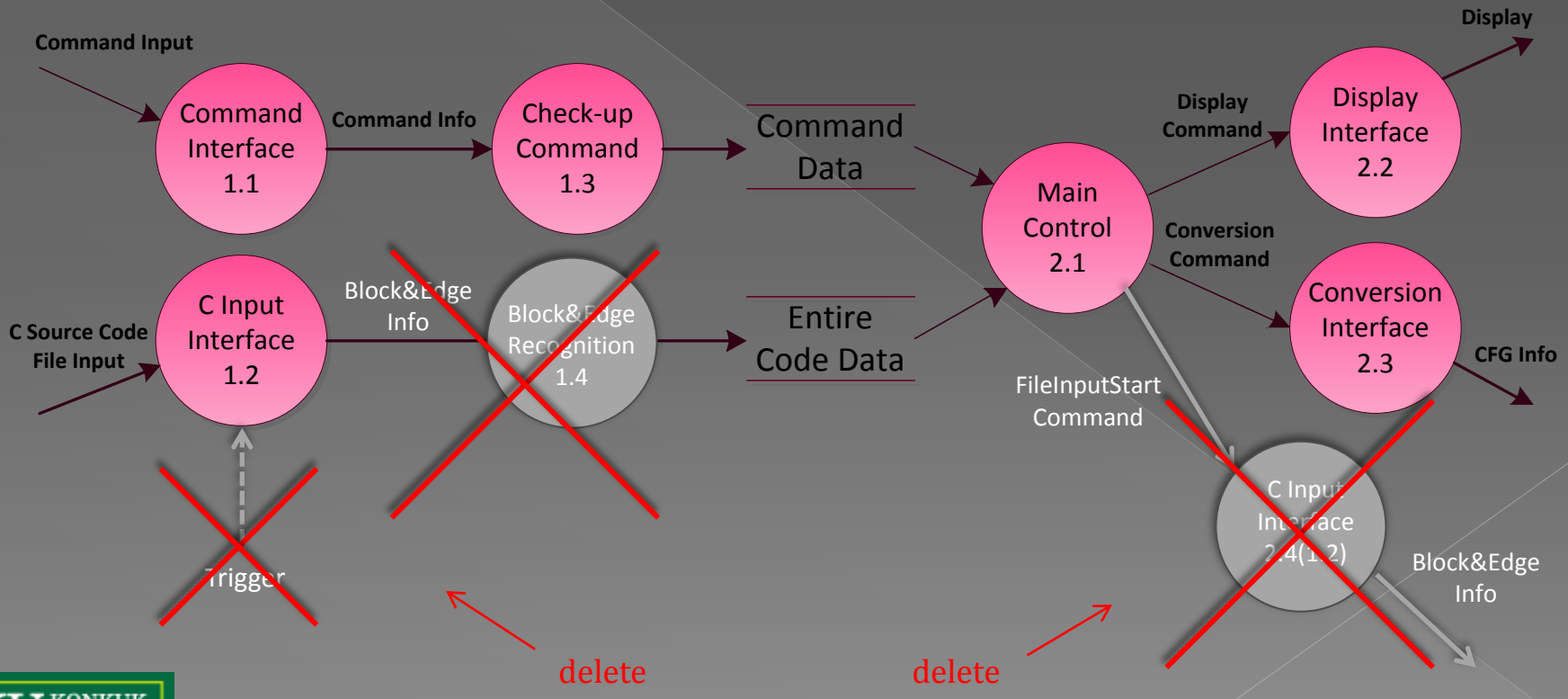
Data Flow Diagram – level 2



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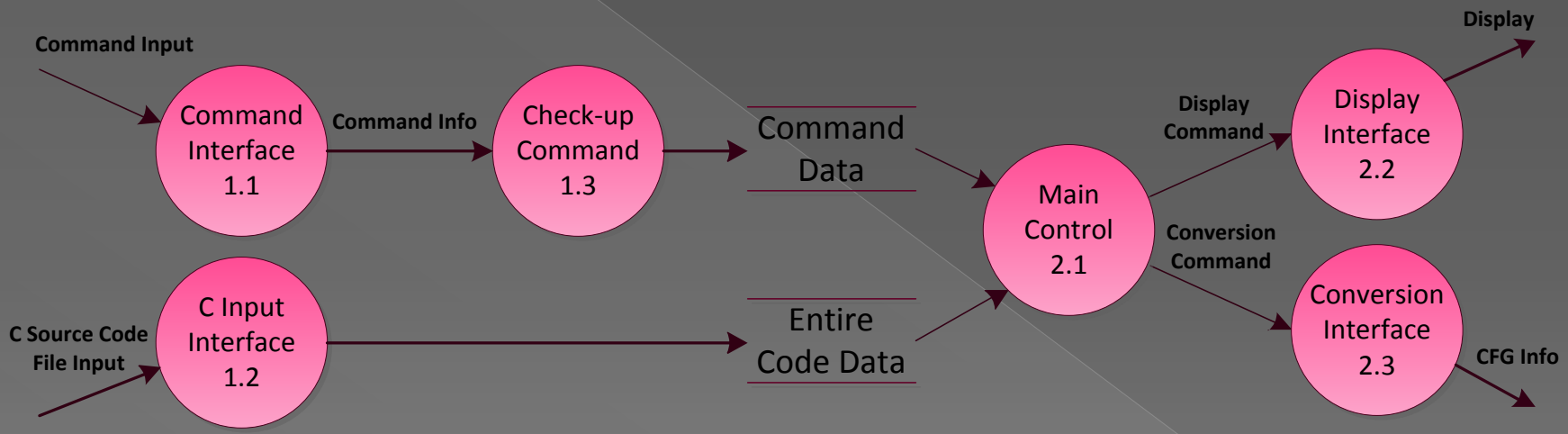
Data Flow Diagram – level 2



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Data Dictionary – level 2

Data name	Description
Command Info	It is a processed ***Command Input*** for ***Check-up Command*** to check correctness of received command.
Display Command	A data that shows system message or program's progress to be sent to ***Display Interface***.
Conversion Command	A CFG conversion data converted from ***Parsed Data*** to be sent to ***Conversion Interface***.

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Process Specification [1/3]

Reference No.	1.1
Name	Command Interface
Input	Command Input
Output	Command Info
Description	Receiving a ***Command Input*** of the ***User's Command***, converts it to ***Command Info*** that the system can make use of.

Reference No.	1.2
Name	C Input Interface
Input	C Source Code File Input
Output	Numbered Code Data
Description	Receiving a ***C Source Code File Input***, numbers off in order and save it to ***Entire Code Data***.

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Process Specification [2/3]

Reference No.	1.3
Name	Check-up Command
Input	Command Info
Output	Correctness Info
Description	Checking correctness of ***Command Info***, assigns an boolean value and sends ***Correctness Info*** to ***Command Data***.

Reference No.	2.2
Name	Display Interface
Input	Display Commands
Output	Display
Description	Receiving all sorts of ***Display Commands*** from sub processes, sends a ***Display*** converted from them to ***Monitor*** to be printed.

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Process Specification [3/3]

Reference No.	2.3
Name	Conversion Interface
Input	Conversion Command
Output	CFG Info
Description	Receiving ***Conversion Command***, converts it to final output ***CFG Info***. It enables CFG Generator to report with a text file by sending ***CFG Info*** to ***CFG Text File***.

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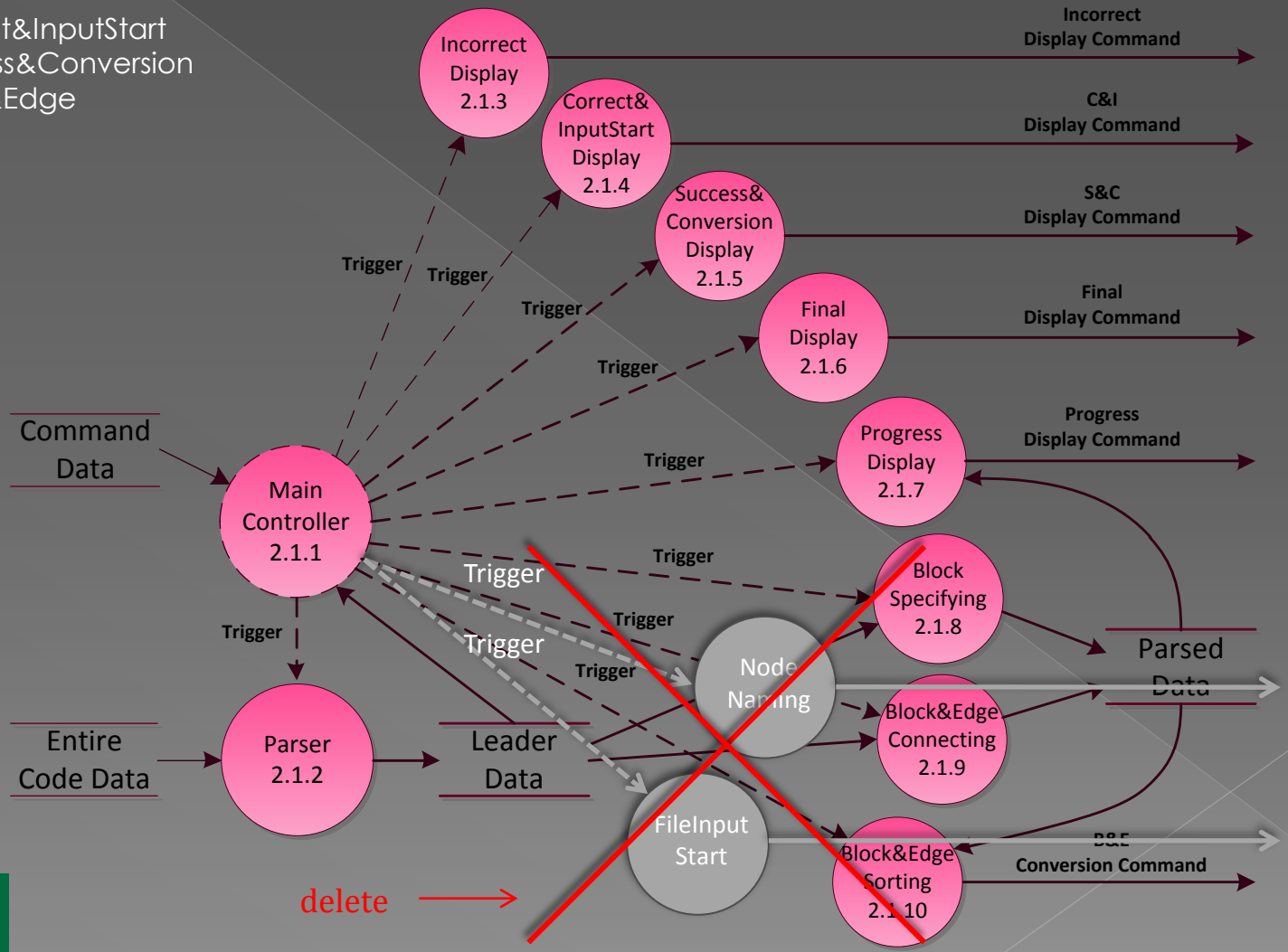
Data Flow Diagram – level 3

C&I : Correct&InputStart
S&C : Success&Conversion
B&E : Block&Edge



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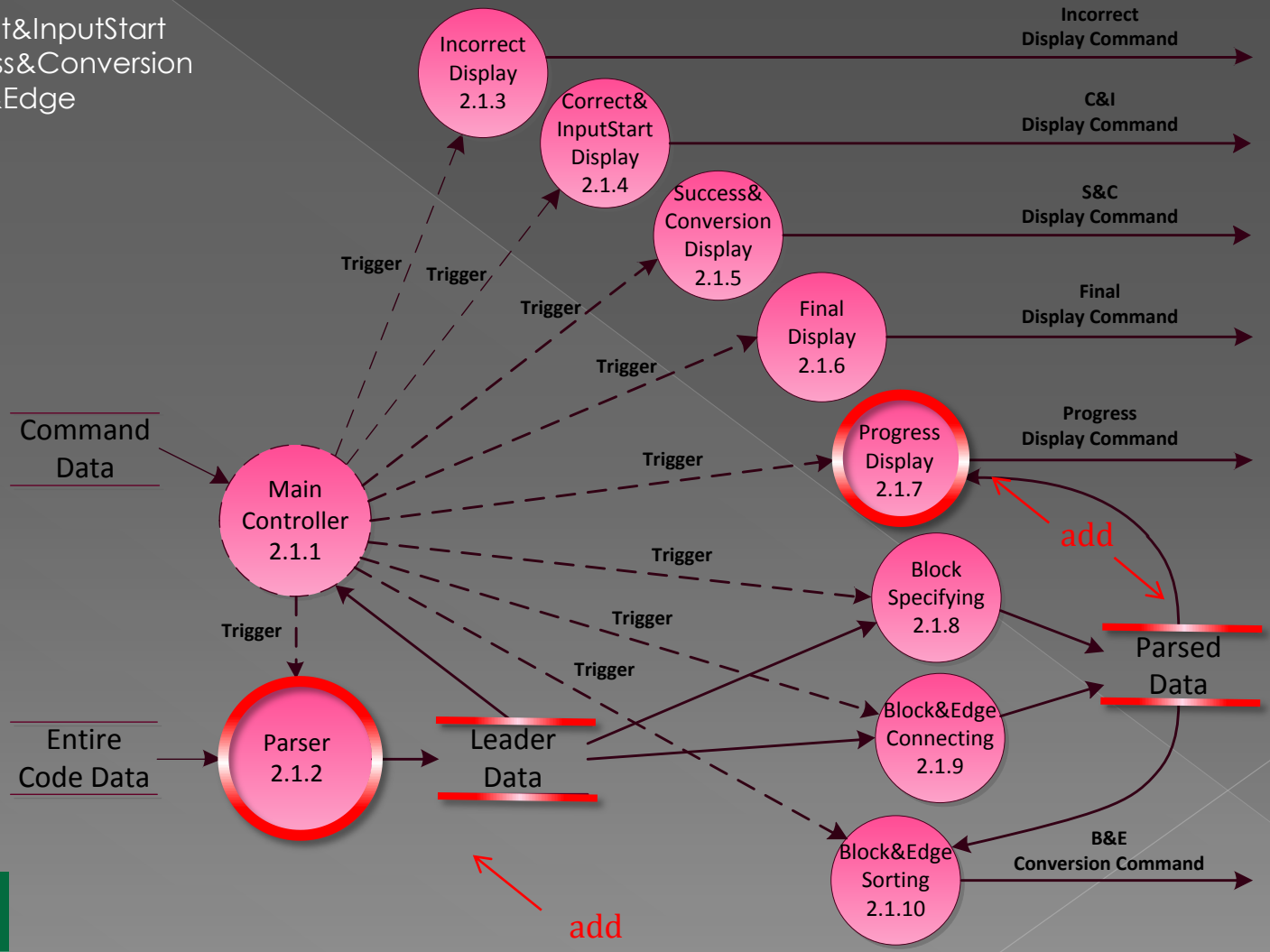
Data Flow Diagram – level 3

C&I : Correct&InputStart
S&C : Success&Conversion
B&E : Block&Edge



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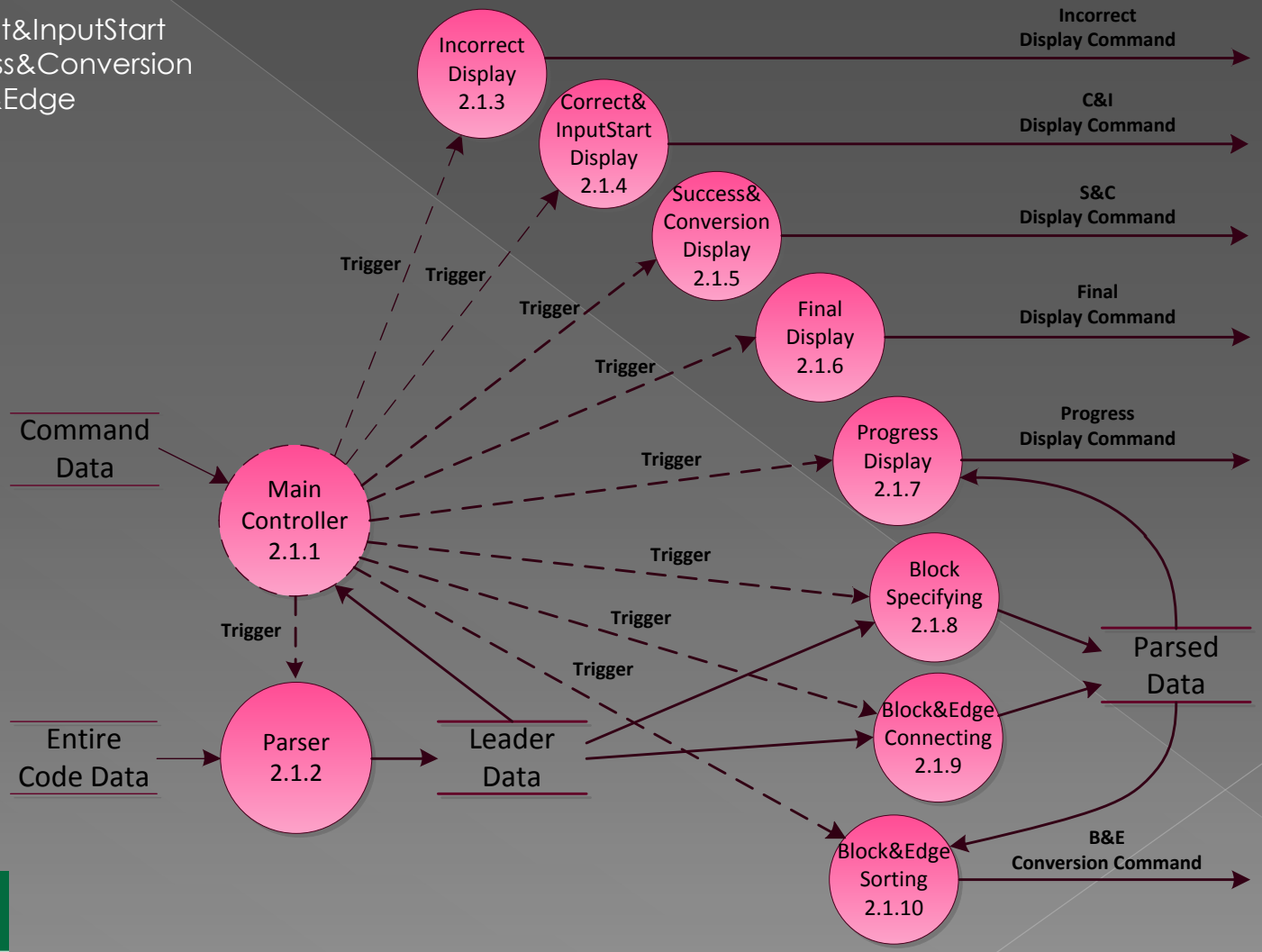
Data Flow Diagram – level 3

C&I : Correct&InputStart
S&C : Success&Conversion
B&E : Block&Edge



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Data Dictionary – level 3 [1/2]

Leader Data	Description
Raw Block Data	A raw data of code which can be a block (C keyword, assignment statement...).
Raw Edge Group Data	A group data of all raw edge data being decided and conditioned when ***Raw Block Data*** is formed.

Parsed Data	Description
Block Data	It consists of block's name, ID number, range of source code, and major contents.
Edge Group Data	A group data of all parsed edges. Each edge data consists of edge's ID number, condition of control flow, source block's ID number, and destination block's ID number.

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Data Dictionary – level 3 [2/2]

Data name	Description
Incorrect Display Command	A command data that contains error message meaning input of incorrect command and help message.
C&I Display Command	A command data that contains correct message meaning input of correct command and input start message meaning system will start to input of C source code file at once.
S&C Display Command	A command data that contains success message meaning system received input file successfully and conversion message meaning system will start to convert file to CFG at once.
Final Display Command	A command data that contains completion message meaning end of CFG converting and the name of report file.
Progress Display Command	A command data that contains execution order of C source code and progress.
B&E Conversion Command	A command data being sent to ***Conversion Interface*** to convert ***Parsed Data*** to final CFG.

Process Specification [1/5]

Reference No.	2.1.1
Name	Main Controller
Input	Leader Data, Correctness Info
Output	Trigger
Description	It triggers ***Parser*** and other processes which output ***Display Command*** or ***Conversion Command*** based on inputs (***Leader Data***, ***Correctness Info***).

Reference No.	2.1.2
Name	Parser
Input	Numbered Code Data, Trigger
Output	Leader Data
Description	Converting ***Numbered Code Data*** into ***Raw Block Data*** and ***Raw Edge Group Data***, stores them in the ***Leader Data***.

Process Specification [2/5]

C&I : Correct&InputStart

Reference No.	2.1.3
Name	Incorrect Display
Input	Trigger
Output	Incorrect Display Command
Description	When a user input incorrect command, sends ***Incorrect Display Command*** which consists of error message and help message to ***Display Interface***. Afterward, terminates program.

Reference No.	2.1.4
Name	Correct&InputStart Display
Input	Trigger
Output	C&I Display Command
Description	When a user input correct command, sends ***C&I Display Command*** which consists of correct message and input start message to ***Display Interface***.

Process Specification [3/5]

S&C : Success&Conversion

Reference No.	2.1.5
Name	Success&Conversion Display
Input	Trigger
Output	S&C Display Command
Description	When system receives input file successfully and ***Numbered Code Data*** is created, it sends ***S&C Display Command*** which consists of success message and conversion message to ***Display Interface***.

Reference No.	2.1.6
Name	Final Display
Input	Trigger
Output	Final Display Command
Description	After finishing parsing and sorting, sends ***Final Display Command*** which consists of completion message and the name of report file to ***Display Interface***. Afterward, terminates program.

Process Specification [4/5]

Reference No.	2.1.7
Name	Progress Display
Input	Parsed Data, Trigger
Output	Progress Display Command
Description	Receiving ***Parsed Data***, it sends ***Progress Display Command*** which shows execution order of C source code and progress to ***Display Interface***.

Reference No.	2.1.8
Name	Block Specifying
Input	Leader Data, Trigger
Output	Block Data
Description	Receiving incomplete ***Leader Data***, outputs ***Block Data*** specifying each block's concrete information.

Process Specification [5/5]

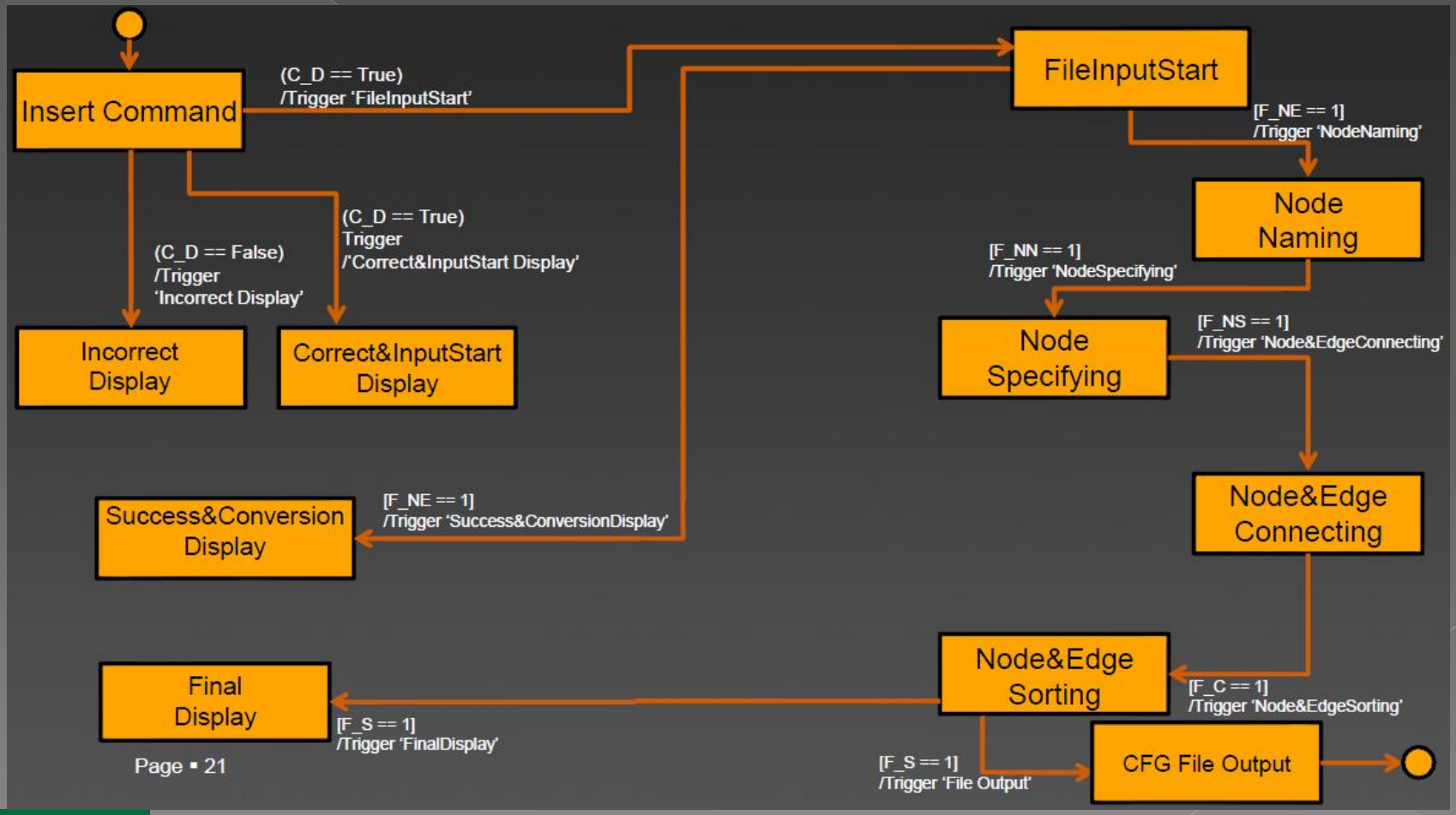
B&E : Block&Edge

Reference No.	2.1.9
Name	Block&Edge Connection
Input	Leader Data, Trigger
Output	Edge Group Data
Description	Receiving incomplete ***Leader Data***, outputs ***Edge Group Data*** whose each edge data corresponds with involved blocks.

Reference No.	2.1.10
Name	Block&Edge Sorting
Input	Parsed Data, Trigger
Output	B&E Conversion Command
Description	Receiving ***Parsed Data***, outputs ***B&E Conversion Command*** to be converted into final CFG in sorted text form according to each block's level.

State Machine for Main Controller 2.1.1

before



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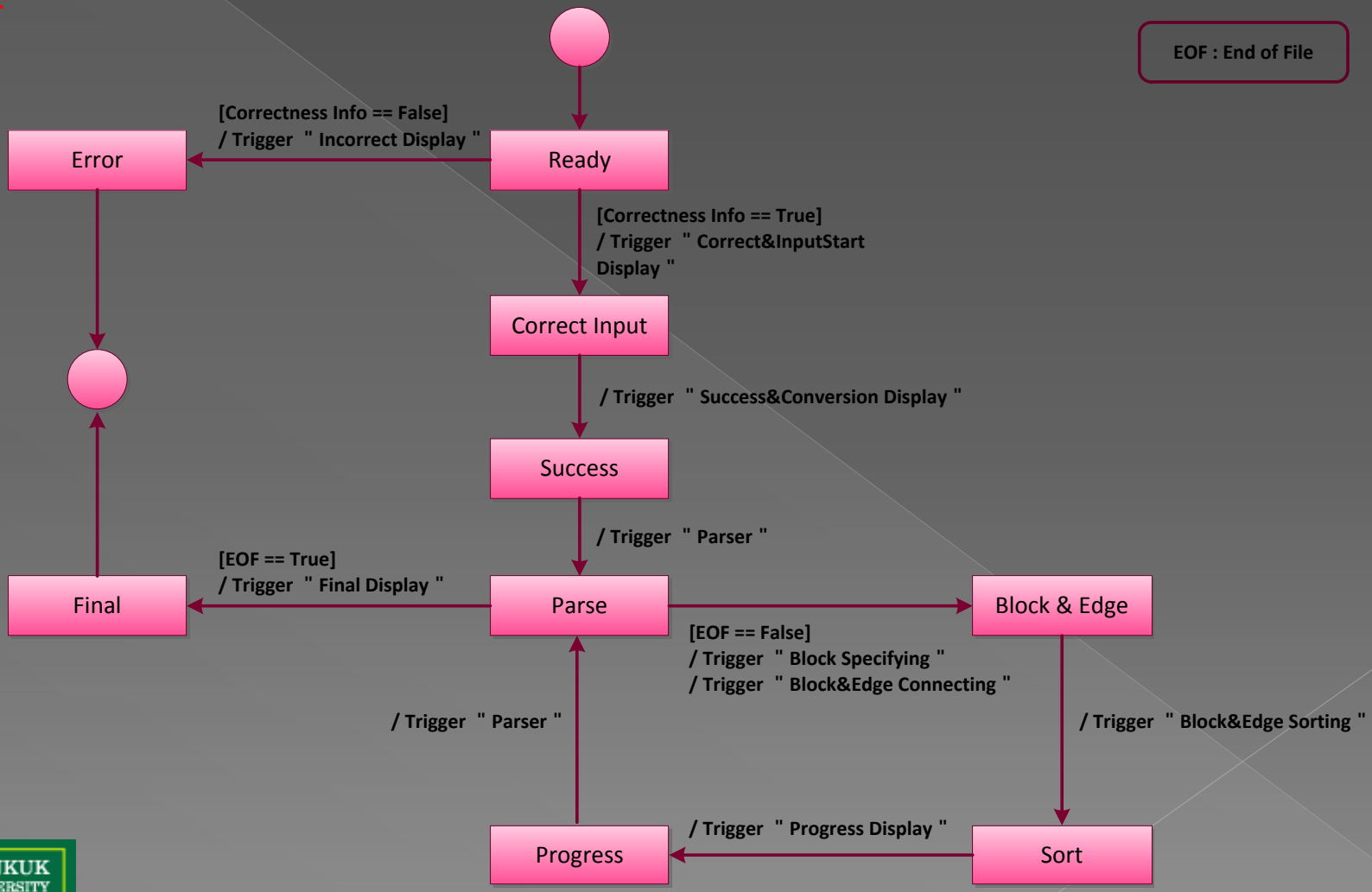
State Machine for Main Controller 2.1.1

after



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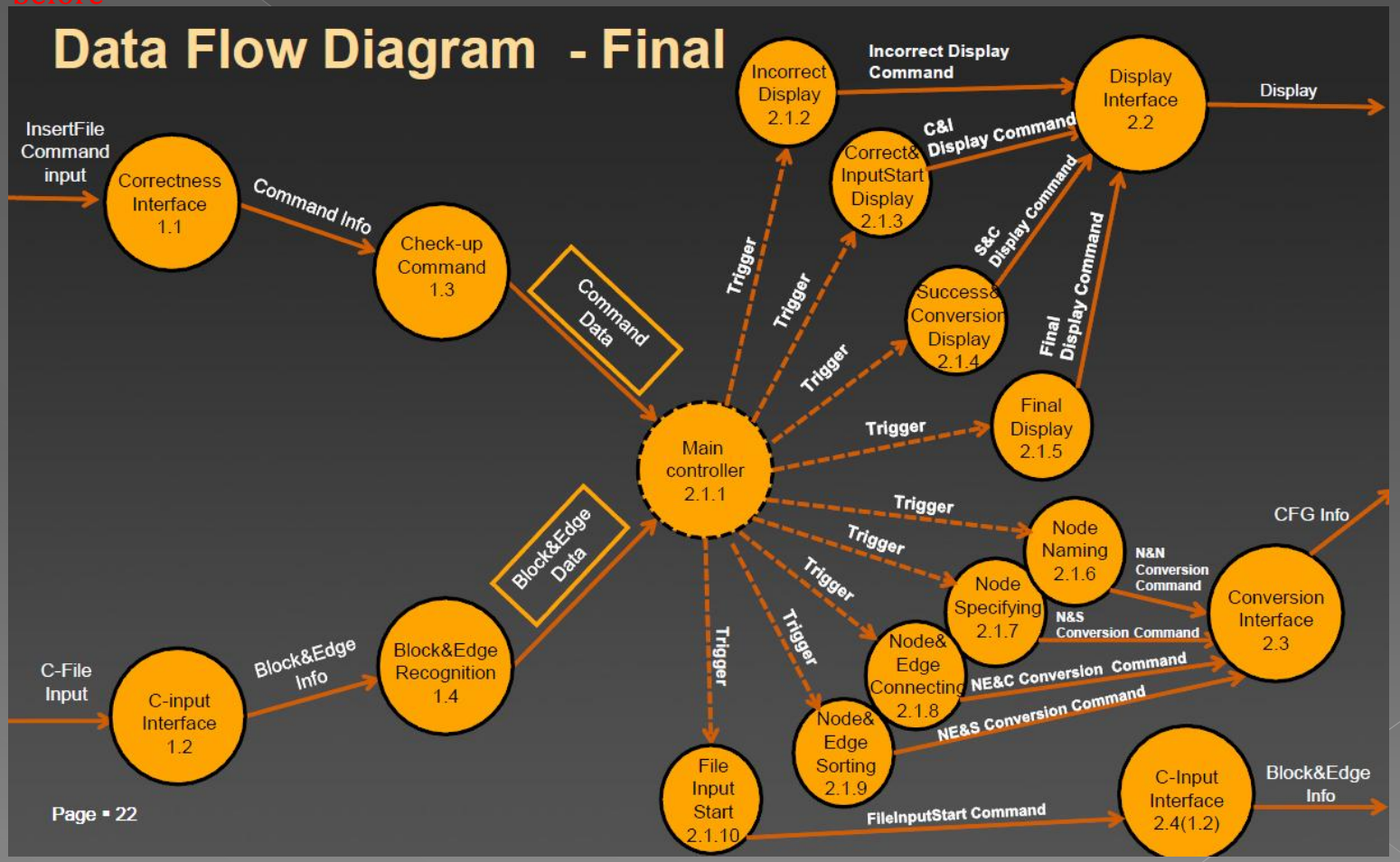
Data Flow Diagram - Overall

before



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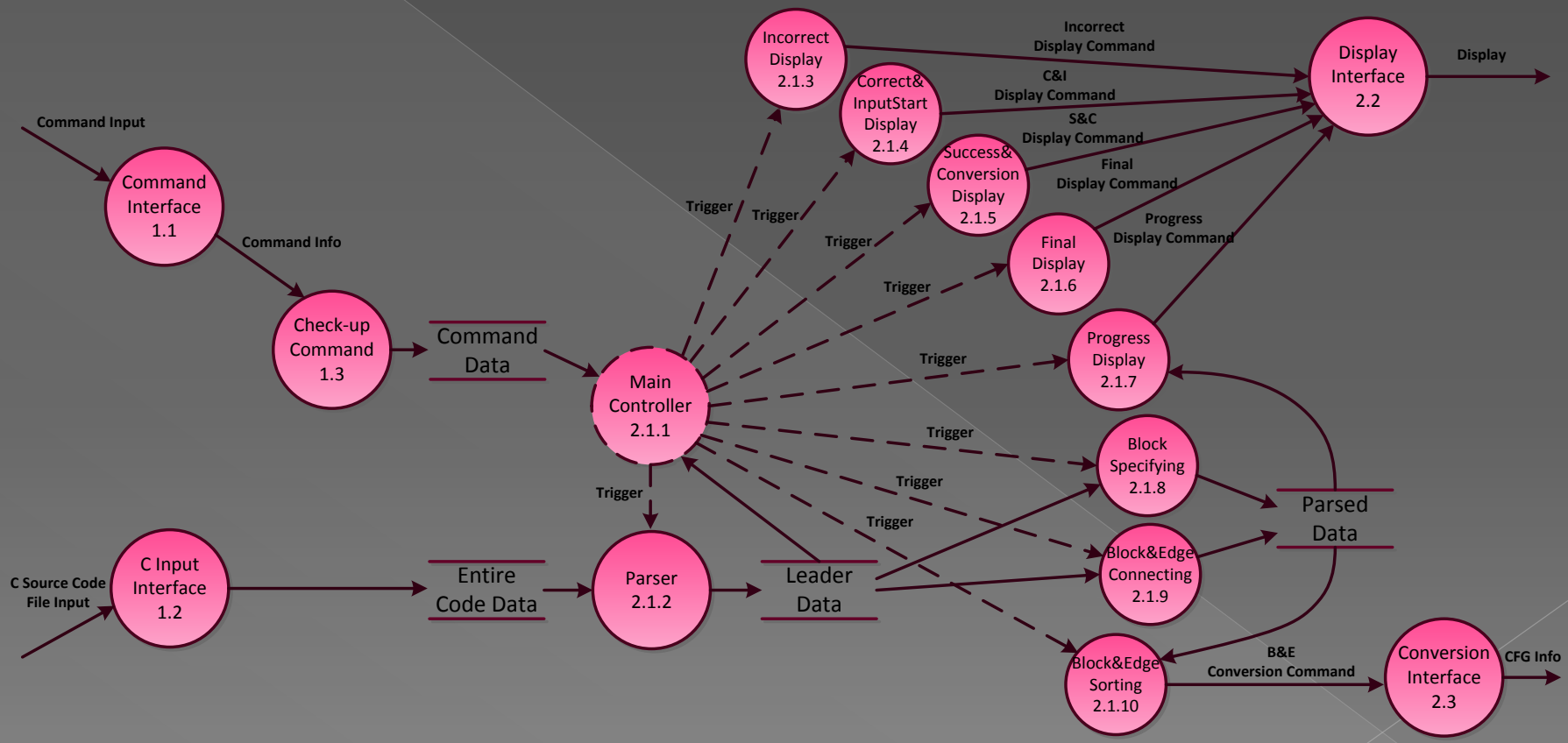
Data Flow Diagram - Overall

after



C&I : Correct&InputStart
S&C : Success&Conversion
B&E : Block&Edge

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Structured Design

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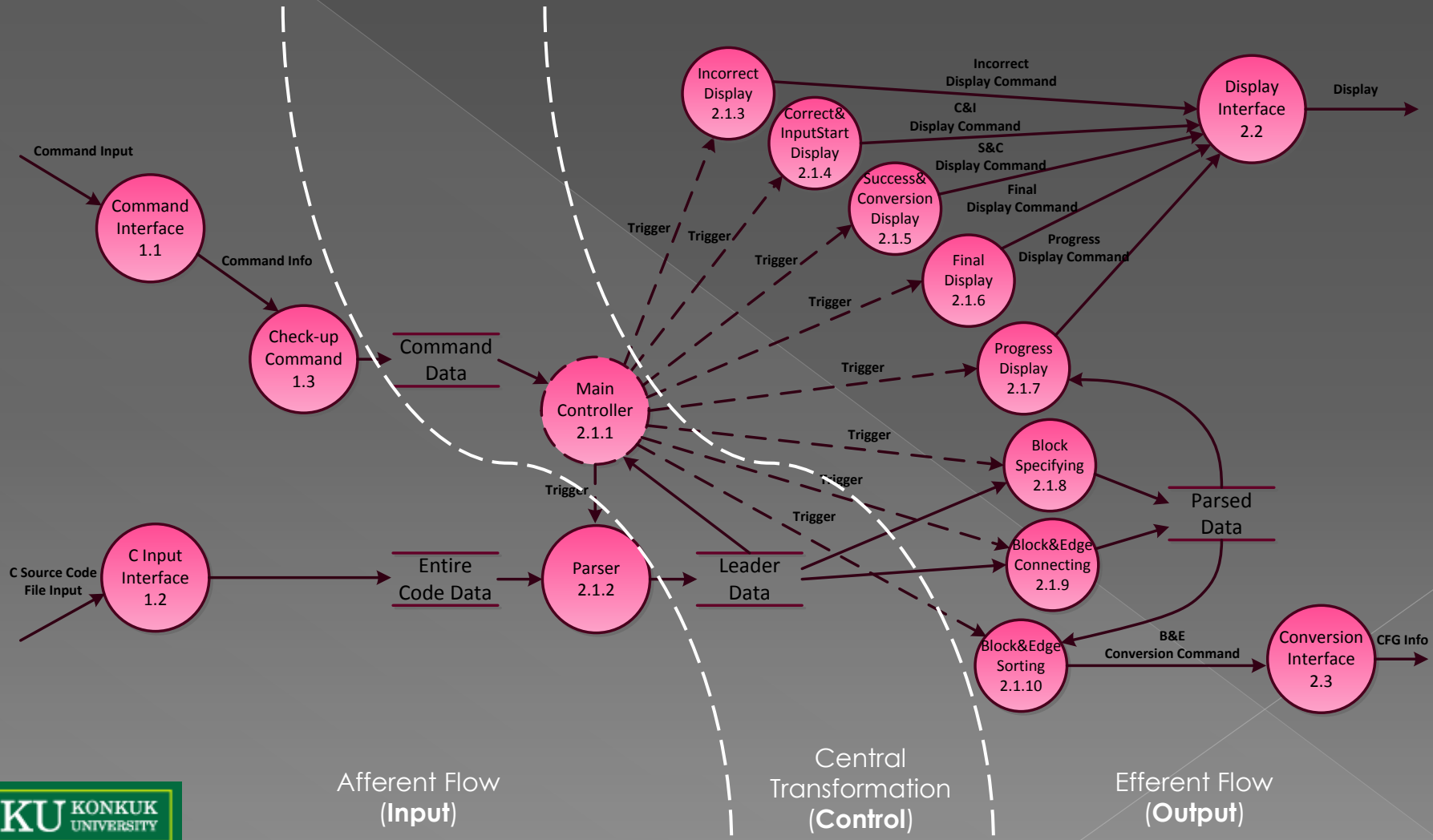
Structured Chart – Transform Analysis [1/2]



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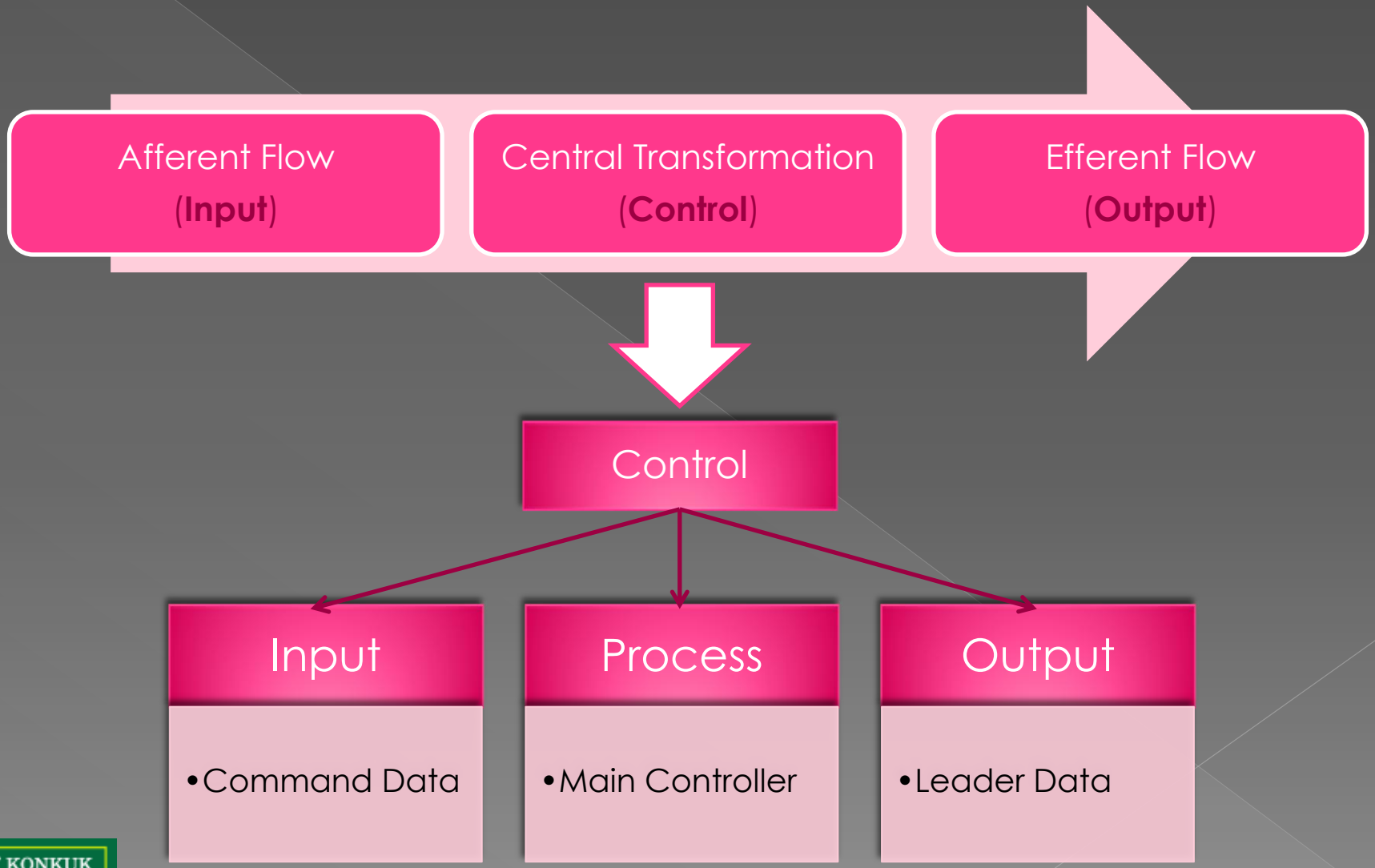
Structured Chart – Transform Analysis [2/2]



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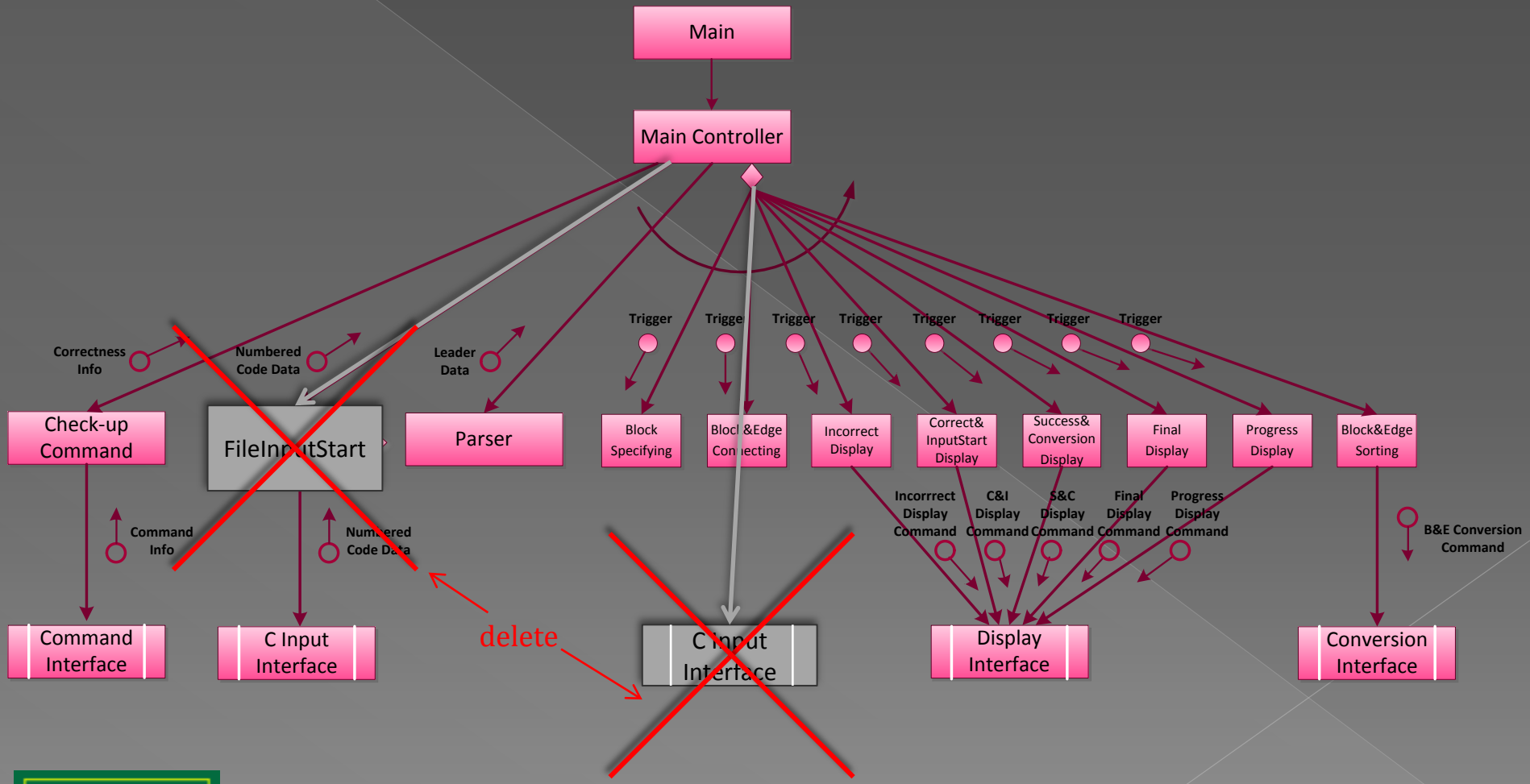
Structured Chart – CFG Generator



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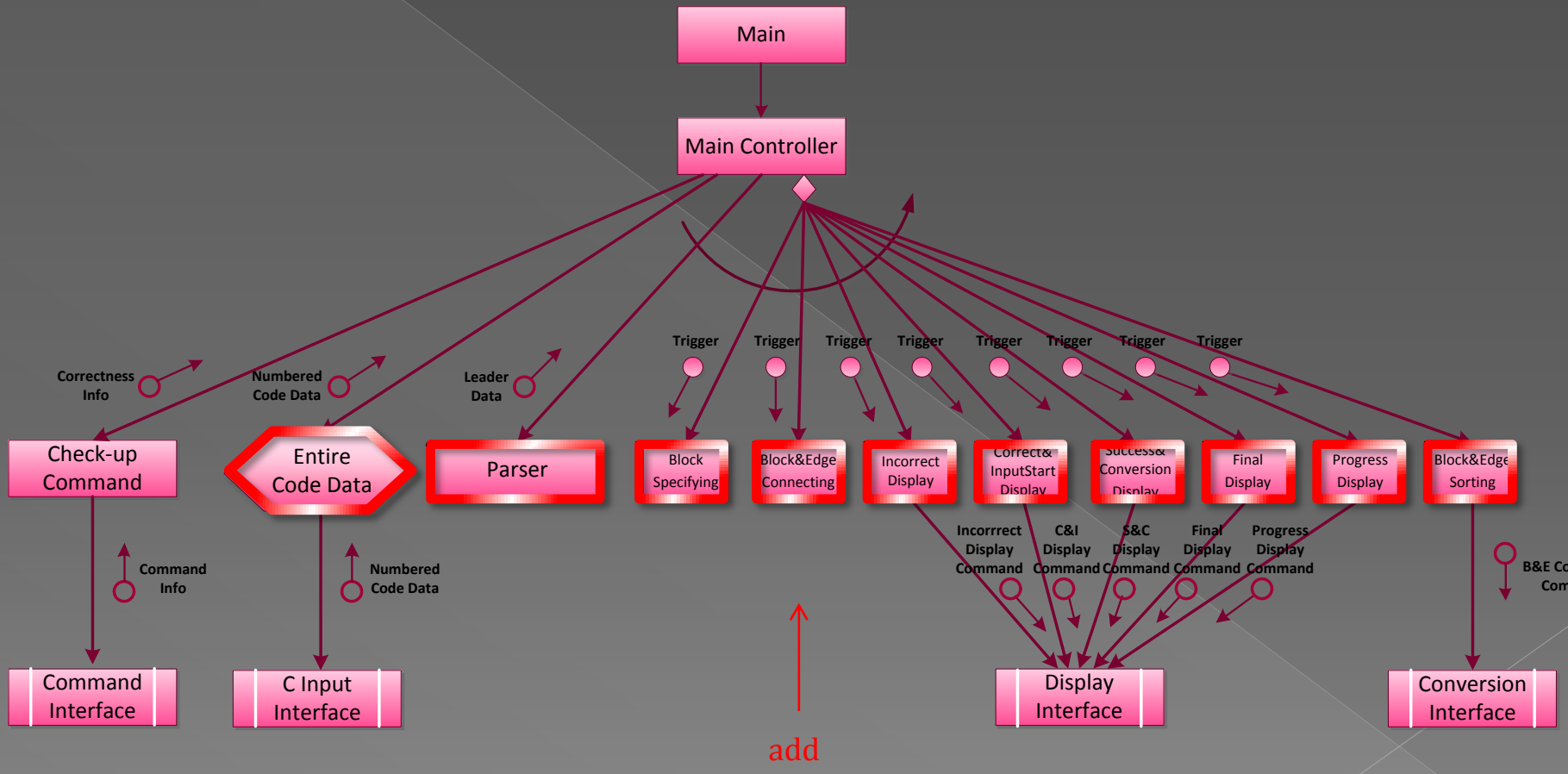
Structured Chart – CFG Generator



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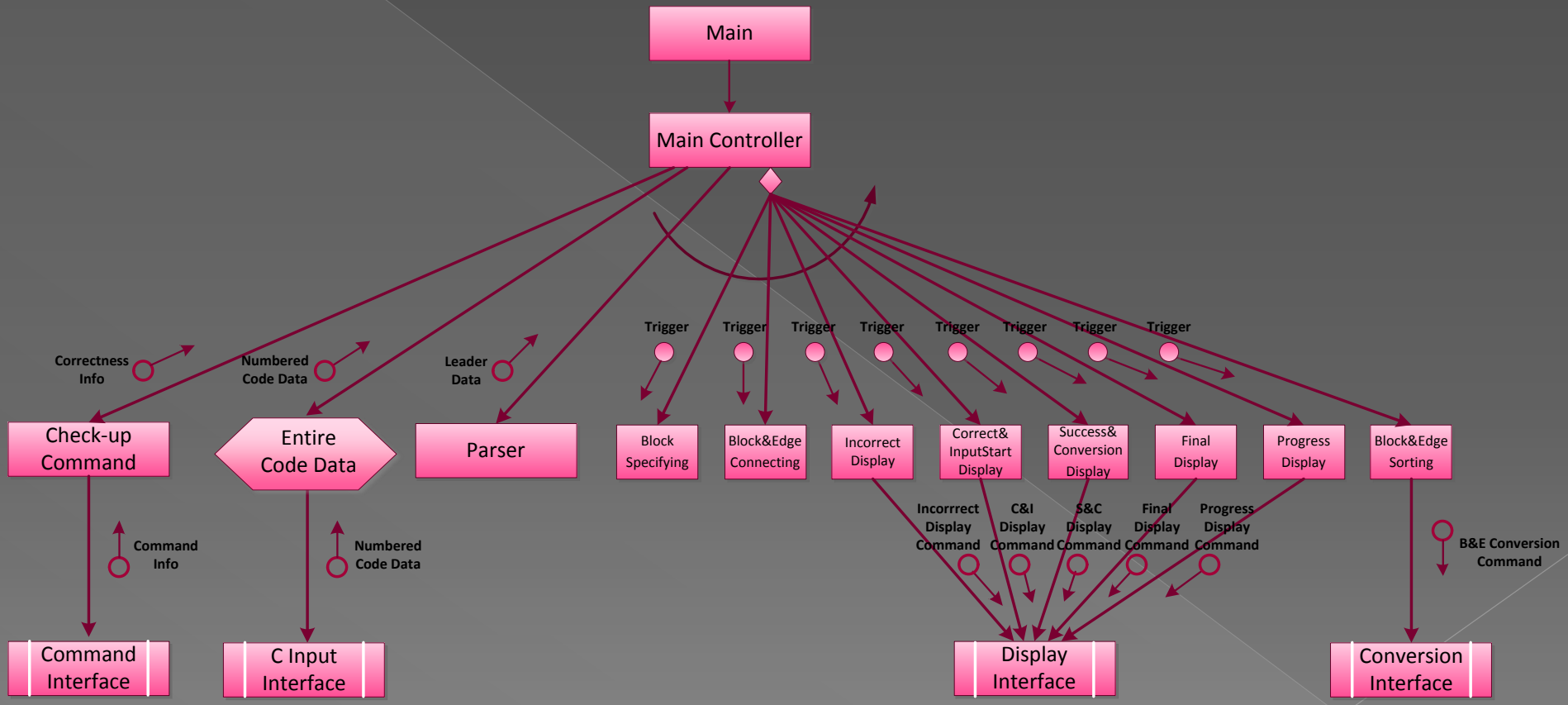
Structured Chart – CFG Generator



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Structured Chart – Data Definition [1/2]

Data name	Description
Command Info	It is a processed ***Command Input*** for ***Check-up Command*** to check correctness of received command.
Correctness Info	A boolean value meaning correctness of received command. (True/False)
Numbered Code Data	It consists of ***C Source Code File Input*** and each corresponding line number.
Leader Data	It is a structure data { Raw Block Data, Raw Edge Group Data }
Incorrect Display Command	A command data that contains error message meaning input of incorrect command and help message.

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Structured Chart – Data Definition [2/2]

Data name	Description
C&I Display Command	A command data that contains correct message meaning input of correct command and input start message meaning system will start to input of C source code file at once.
S&C Display Command	A command data that contains success message meaning system received input file successfully and conversion message meaning system will start to convert file to CFG at once.
Final Display Command	A command data that contains completion message meaning end of CFG converting and the name of report file.
Progress Display Command	A command data that contains execution order of C source code and progress.
B&E Conversion Command	A command data being sent to ***Conversion Interface*** to convert ***Parsed Data*** to final CFG.

Source Code

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Development Environment

- Windows 7 Home edition K
- cygwin 1.7.9
- visual studio 2010 professional

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Project Structure

- **Header**
  - data.h
  - input.h
  - output.h
  - _mingw.h / conio.h / tc.h / windows.h
- **Source**
  - input.c
  - output.c
  - main.c
  - tc.c

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Proje

- Dat

```
11 enum
l_else_
l_break
12 enum
13 enum
15 // C
16 enum
PROGRES
```

```
lo_while, l_if,
l_root,

t_b };

&Conversion.
AND_C, FINAL,
```

- st
- st
- st
- st
- st
- st

```
18 struct command_info
19 {
20 int command_count;
21 char** command_input;
22 };
24 struct entire_code_data
25 {
26 int line;
27 char** numbered_code_data;
28 };
30 struct leader_data {
31 enum leader keyword;
32 int block_start, block_end;
34 char* edge_condition; };
36 struct leader_data* parent;
37 int child_num;
39 struct leader_data** children;
40 int children_cap;
41 int children_size;
42 };
44 struct block_data {
45 enum block_type type;
46 int id;
47 int block_start, block_end;
48 enum leader keyword;
49 char* description;
50 };
52 struct edge_data {
53 enum edge_type type;
54 int id;
55 int source_block, destination_block;
56 char* description;
57 };
59 struct display_command {
60 enum display_command_type type;
61 char* message1;
62 char* message2;
64 char* block;
65 char** edge;
67 int edge_size;
68 int* edge_start;
69 int* edge_end;
71 int block_id;
72 };
```

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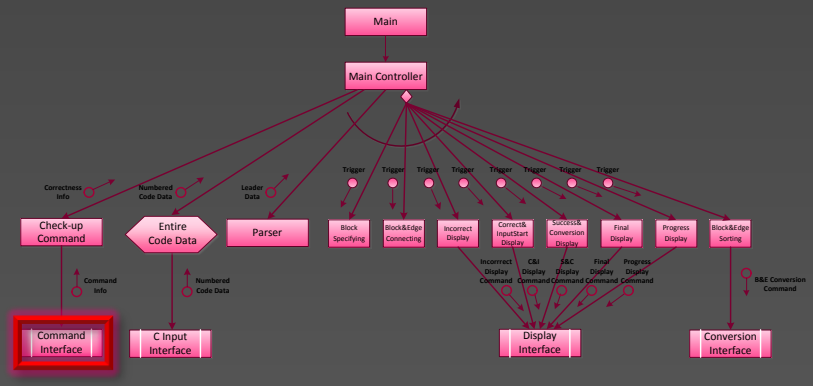
Major Procedure



Reference No.	1.1
Name	Command Interface
Input	Command Input
Output	Command Info
Description	Receiving a ***Command Input*** of the ***User's Command***, converts it to ***Command Info*** that the system can make use of.

```
5 void command_interface(int argc, char **argv, struct command_info* c_info)
6 {
7 c_info->command_count = argc;
// 명령어 인자 개수 설정
8 c_info->command_input = argv;
// 명령어 인자 설정
9 }
```

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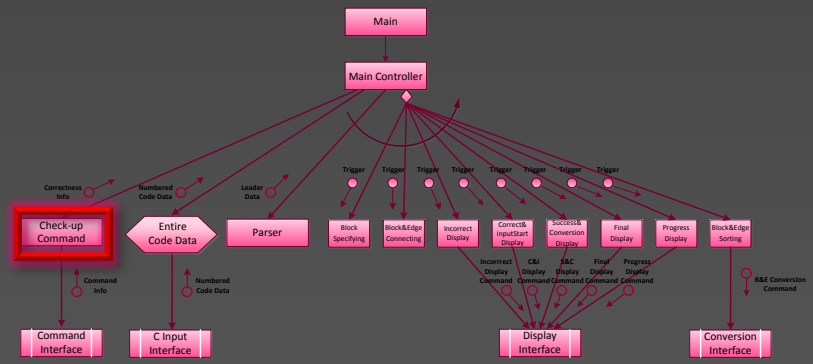
Major Procedure



Reference No.	1.3
Name	Check-up Command
Input	Command Info
Output	Correctness Info
Description	Checking correctness of ***Command Info***, assigns an boolean value and sends ***Correctness Info*** to ***Command Data***.

```
86 if(c_info->command_count != 3) // 명령어 옵션 개
수 오류
87 return 0;
89 temp = strstr(c_info->command_input[1],".c");
// 소스파일 확장자 검사
91 if(NULL == temp) // 소스파일 확장자 오류
92 {
93 return 0;
94 }
95 else if(c_info->command_input[1] +
strlen(c_info->command_input[1]) - 2 != temp)
96 {
97 return 0; // ".c"는 찾았지만 맨 끝에 있지 않을경우
ex) asdf.cAA
98 }
100 temp = strstr(c_info-
>command_input[2],".txt"); // 출력파일 확장자 검사
102 if(NULL == temp) // 출력파일 확장자 오류
103 {
104 return 0;
105 }
106 else if(c_info->command_input[2] +
strlen(c_info->command_input[2]) -
strlen(".txt") != temp)
107 {
108 return 0; // ".txt"는 찾았지만 맨 끝에 있지 않을경
우 ex) asdf.txtAA
109 }
```

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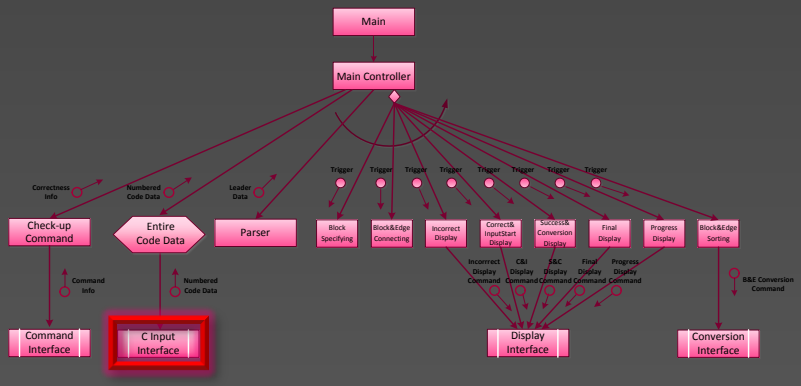
Major Procedure



Reference No.	1.2
Name	C Input Interface
Input	C Source Code File Input
Output	Numbered Code Data
Description	Receiving a ***C Source Code File Input***, numbers off in order and save it to ***Entire Code Data***.

```
29 while( (ch=fgetc(file)) != EOF ) // 라인 수 카운트
30 {
31 if(ch == '\n') 32 entire_code->line++;
33 }
44 while( (ch=fgetc(file)) != EOF ) // 라인 당 문자 수 카운트
45 {
46 if(ch == '\n') 48 i++;
50 else 52 line_characters[i]++;
54 }
59 for(i=0;i<entire_code->line;i++) // numbered_code_data 생성
60 {
61 entire_code->numbered_code_data[i] = (char*)malloc(sizeof(char)*(line_characters[i]+1));
63 fgets(entire_code->numbered_code_data[i],line_characters[i]+2,file);
66 entire_code->numbered_code_data[i][(int)strlen(entire_code->numbered_code_data[i])] = '\0';
67 }
70 entire_code->numbered_code_data[entire_code->line] = (char*)malloc(sizeof(char)*4)
71 entire_code->numbered_code_data[entire_code->line] = "EOF";
```

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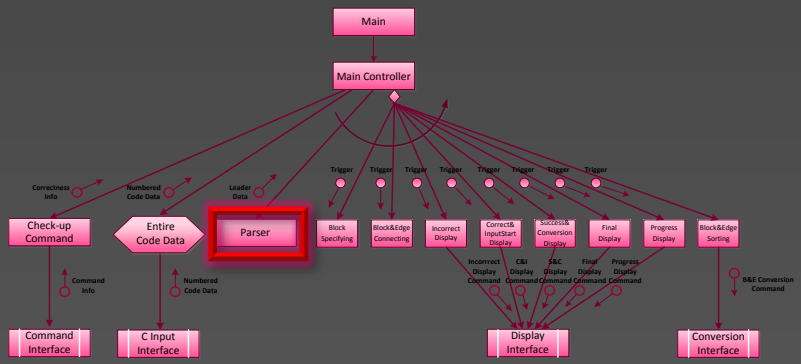
Major Procedure



Reference No.	2.1.2
Name	Parser
Input	Numbered Code Data, Trigger
Output	Leader Data
Description	Converting ***Numbered Code Data*** into ***Raw Block Data*** and ***Raw Edge Group Data***, stores them in the ***Leader Data***.

```
129 static int cur_line = 0; //어디까지 읽었는지를 저장하는 코드
130 static struct leader_data* scope = NULL;
131 static char* block_in_condition = NULL;
//case문에 대한 조건을 저장하는 변수 - switch문에서만 쓰인다. 132 int type;
133 struct leader_data* rbd = NULL;
134 do
135 {
136 type = check_line(codeinfo[cur_line++]);
137 }
138 while(type == 0); //블록이 생성될때까지 체크한다. - 주석이나 중괄호를 무시한다.
141 //타입에 따른 구조체 동적할당 및 초기화와 트리구조를 구현한다.
142 switch(type)
143 {
144 case 1:
...
...중략
...
326 case -1: //파일의 끝일경우이다.
327 rbd = NULL;
328 break;
329 }
```

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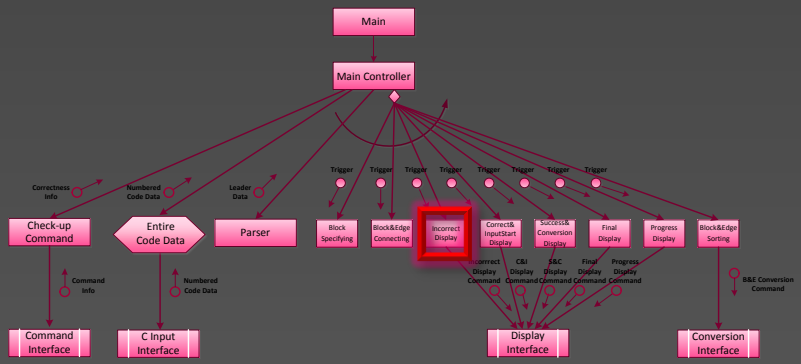
Major Procedure



Reference No.	2.1.3
Name	Incorrect Display
Input	Trigger
Output	Incorrect Display Command
Description	When a user input incorrect command, sends ***Incorrect Display Command*** which consists of error message and help message to ***Display Interface***. Afterward, terminates program.

```
8 void
incorrect_display(struct
display_command* d_command)
9 {
10 d_command->type =
INCORRECT;
11 d_command->message1 =
"\n>> error : incorrect
command";
12 d_command->message2 =
"\n>> command syntax :
$ ./program Inputcode.c
Result.txt";
13 }
```

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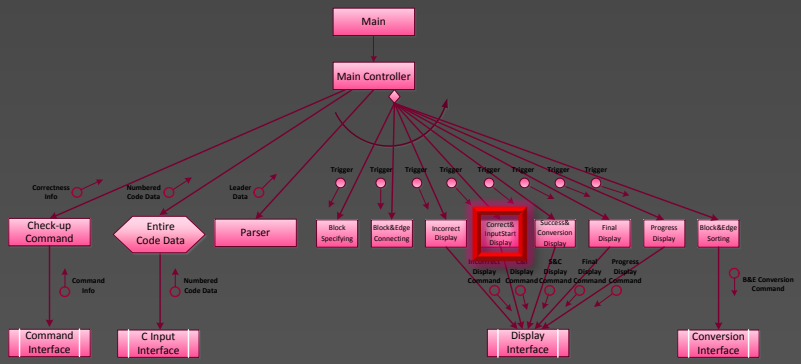
Major Procedure



Reference No.	2.1.4
Name	Correct&InputStart Display
Input	Trigger
Output	C&I Display Command
Description	When a user input correct command, sends ***C&I Display Command*** which consists of correct message and input start message to ***Display Interface***.

```
18 void
correct_and_inputstart_disp
lay(struct display_command*
d_command)
19 {
20 d_command->type =
C_AND_I;
21 d_command->message1 =
"\n>> system : received
correct command";
22 d_command->message2 =
"\n>> system : start to
input";
23 }
```

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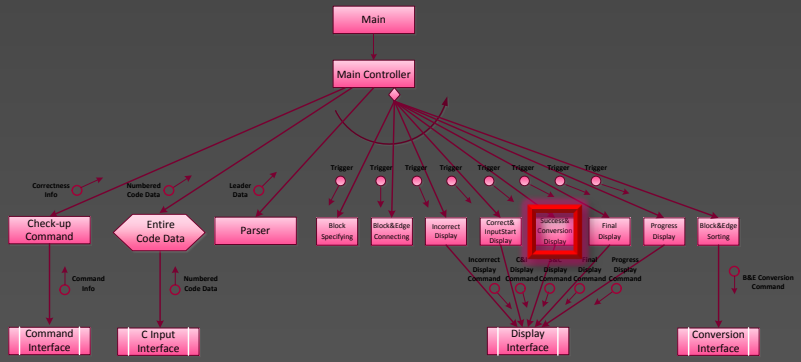
Major Procedure



Reference No.	2.1.5
Name	Success&Conversion Display
Input	Trigger
Output	S&C Display Command
Description	When system receives input file successfully and ***Numbered Code Data*** is created, it sends ***S&C Display Command*** which consists of success message and conversion message to ***Display Interface***.

```
28 void success_and_conversion_display(struct display_command* d_command)
29 {
30 d_command->type = S_AND_C;
31 d_command->message1 = "\n>> system : received input file successfully";
32 d_command->message2 = "\n>> system : start to convert";
33 }
```

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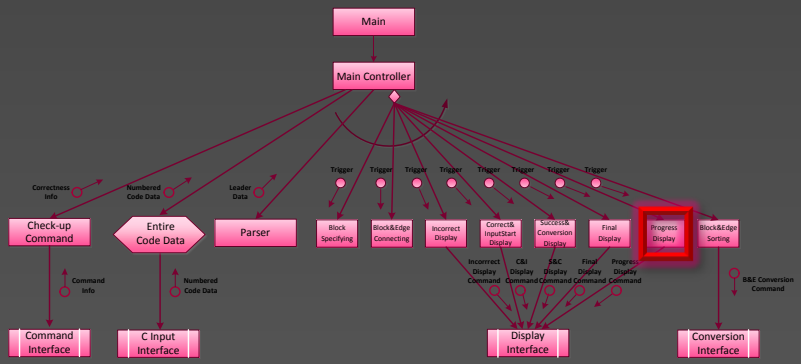
Major Procedure



Reference No.	2.1.7
Name	Progress Display
Input	Parsed Data, Trigger
Output	Progress Display Command
Description	Receiving ***Parsed Data***, it sends ***Progress Display Command*** which shows execution order of C source code and progress to ***Display Interface***.

```
48 void progress_display(struct
display_command* d_command)
49 {
50 int i,j;
51 static int pre_size =0;
52 d_command->type = PROGRESS;
53 d_command->block = block_list[blist_size-1]-
>description;
54 d_command->block_id = block_list[blist_size-
1]->id;
56 for(i=pre_size,j=0; i<elist_size; i++,j++)
57 {
58 d_command->edge_start[j] = edge_list[i]-
>source_block;
59 d_command->edge_end[j] = edge_list[i]-
>destination_block;
60 d_command->edge[j] = edge_list[i]-
>description;
61 }
62 d_command->edge_size = j;
63 pre_size = elist_size;
64 }
```

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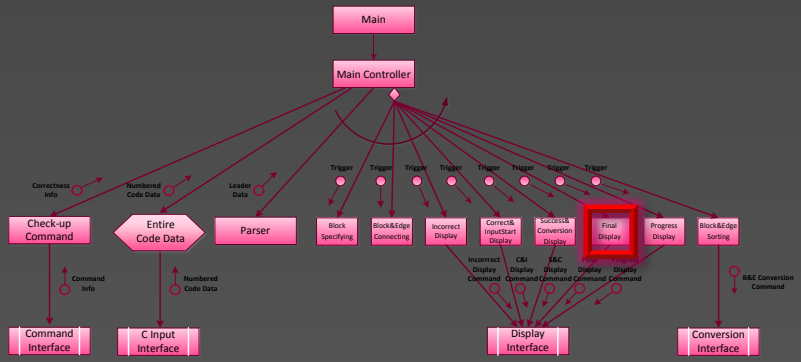
Major Procedure



Reference No.	2.1.6
Name	Final Display
Input	Trigger
Output	Final Display Command
Description	After finishing parsing and sorting, sends ***Final Display Command*** which consists of completion message and the name of report file to ***Display Interface***. Afterward, terminates program.

```
38 void
final_display(struct
display_command* d_command,
char* filename)
39 {
40 d_command->type = FINAL;
41 d_command->message1 =
"\n>> system : complete
conversion. report filename
is";
42 d_command->message2 =
filename;
43 }
```

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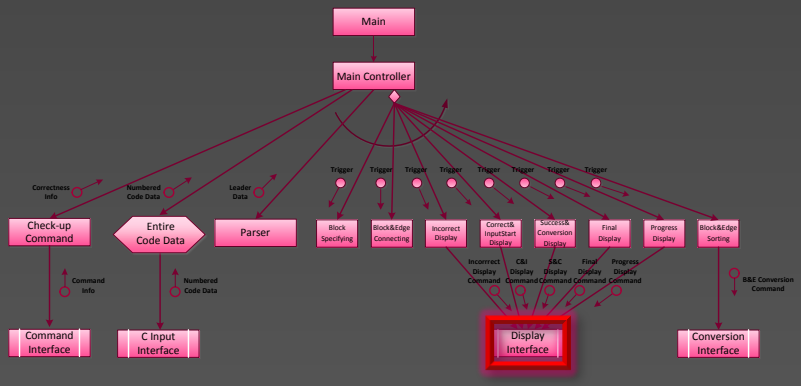
Major Procedure



Reference No.	2.2
Name	Display Interface
Input	Display Commands
Output	Display
Description	Receiving all sorts of ***Display Commands*** from sub processes, sends a ***Display*** converted from them to ***Monitor*** to be printed.

```
72 if(d_command->type != PROGRESS) // 나머지 Display Command
처리
73 {
74 setcolor(YELLOW); 75 printf("%s\n", d_command->message1);
76 printf("%s\n", d_command->message2); 77 setcolor(WHITE);
78 printf("\n");
79 }
80 else // Progress Display Command 처리
81 {
82 for(i=0; i<d_command->edge_size; i++)
83 {
85 if(d_command->edge_start[i] < d_command->edge_end[i])
86 {
87 setcolor(LIGHTMAGENTA); printf("+[edge] ");
setcolor(WHITE); printf("source : ");
88 setcolor(LIGHTCYAN); printf("%d", d_command-
>edge_start[i]+1); setcolor(WHITE); printf(", destination :
");
89 setcolor(LIGHTRED); printf("%d", d_command-
>edge_end[i]+1); setcolor(WHITE);
90 }
91 else
… 중략
98 printf(", description : %s \n\n", d_command->edge[i]);
99 }
101 setcolor(LIGHTGREEN); printf("+[block] ");
setcolor(WHITE);
102 printf("id : %d, description : %s \n",d_command-
>block_id+1, d_command->block);
```

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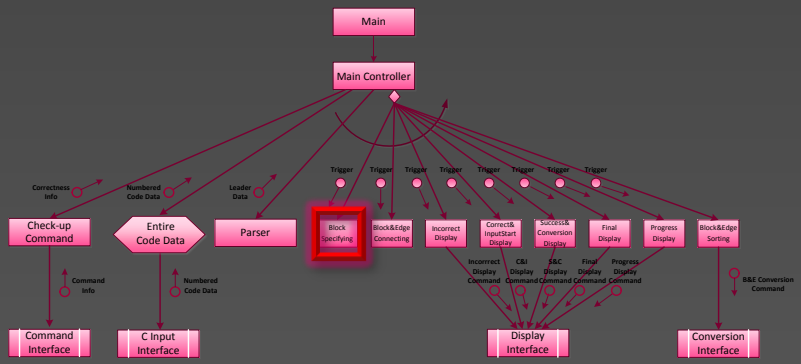
Major Procedure



Reference No.	2.1.8
Name	Block Specifying
Input	Leader Data, Trigger
Output	Block Data
Description	Receiving incomplete ***Leader Data***, outputs ***Block Data*** specifying each block's concrete information.

```
112 block->block_start = input-
>block_start;
113 block->block_end = input->block_end;
114 block->keyword = input->keyword;
115 block->id = bid++;
116 block->description = codeinfo[input-
>block_start];
118 switch(block->keyword)
119 {
120 case l_function:
121 block->type = entry_b;
122 break;
123 case l_return:
124 block->type = exit_b;
125 break;
126 case l_while:
127 case l_for:
128 case l_do_while:
129 block->type = loop_header;
130 break;
131 default:
132 block->type = basic;
133 break;
134 }
```

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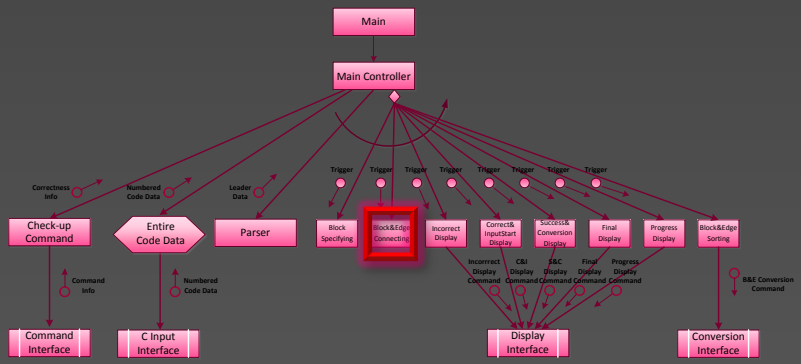
Major Procedure



Reference No.	2.1.9
Name	Block&Edge Connection
Input	Leader Data, Trigger
Output	Edge Group Data
Description	Receiving incomplete ***Leader Data***, outputs ***Edge Group Data*** whose each edge data corresponds with involved blocks.

```
143 struct leader_data* parent =
input->parent;
144 struct leader_data*
brother=NULL;
147 //부모와연결
148 if(input->parent->keyword !=
l_root)
149 {
150
link_parent2(parent,block,input-
>child_num,input->edge_condition);
151 }
152 if(input->child_num != 0)
153 {
154 brother = input->parent-
>children[input->child_num-1];
155 //형제와연결
156 link_brother(brother,block);
158 //형제가 반복문일 경우 백엣지 연결
159 add_back(brother);
160 }
```

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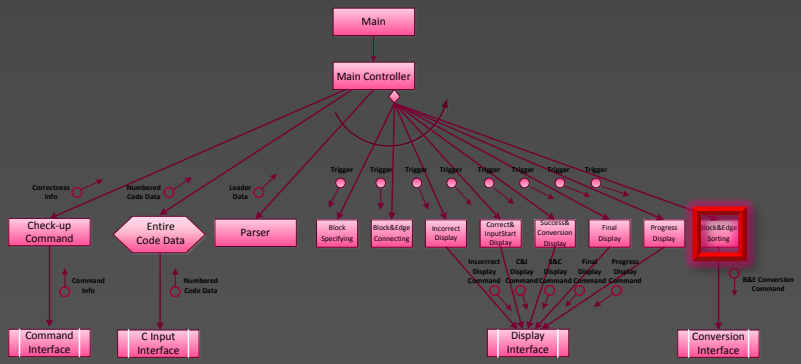
Major Procedure



Reference No.	2.1.10
Name	Block&Edge Sorting
Input	Parsed Data, Trigger
Output	B&E Conversion Command
Description	Receiving ***Parsed Data***, outputs ***B&E Conversion Command*** to be converted into final CFG in sorted text form according to each block's level.

```
207 while(temp[index] != NULL)
208 {
209 for(i=0;i<temp[index]->children_size;i++)
210 {
211 j=0;
212 while(temp[j++]!=0);
213 temp[--j] = temp[index]->children[i];
215 }
216 if(temp[index]->keyword != l_root)
217 {
218 result = search_block(temp[index]-
>block_start, temp[index]->block_end);
219 result_block_list[rblist_size++] =
block_list[result];
220 }
221 for(i=0;i<elist_size;i++)
222 {
223 if(edge_list[i]->source_block == result)
224 {
225 result_edge_list[relist_size++] =
edge_list[i];
226 }
227 }
228 index++;
229 }
```

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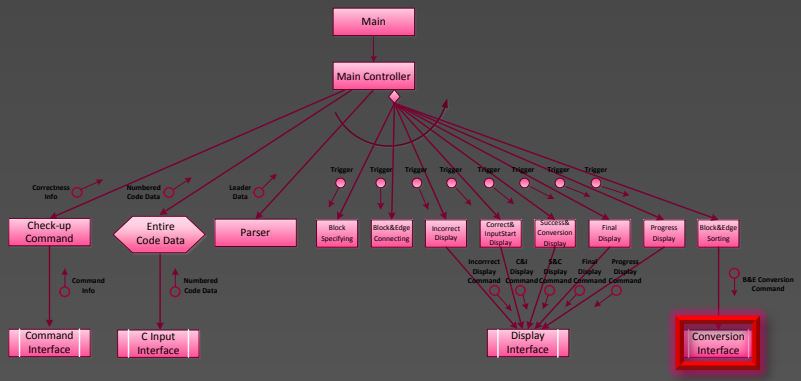
Major Procedure



Reference No.	2.3
Name	Conversion Interface
Input	Conversion Command
Output	CFG Info
Description	Receiving ***Conversion Command***, converts it to final output ***CFG Info***. It enables CFG Generator to report with a text file by sending ***CFG Info*** to ***CFG Text File***.

```
253 for(i=0; i<rblist_size; i++)
254 {
255 fprintf(report," %d / ",
result_block_list[i]->id+1);
257 switch(result_block_list[i]->type)
258 {
259 case basic:
260 fprintf(report,"Basic block / ");
261 break;
262 case loop_header:
263 fprintf(report,"Loop header / ");
264 break;
265 case entry_b:
266 fprintf(report,"Entry block / ");
267 break;
268 case exit_b:
269 fprintf(report,"Exit block / ");
270 break;
271 }
273 fprintf(report,"%d / %d / ",
result_block_list[i]->block_start+1,
result_block_list[i]->block_end+1);
274 fprintf(report,"%s\r\n",
result_block_list[i]->description);
275 }
```

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Converting Algorithm

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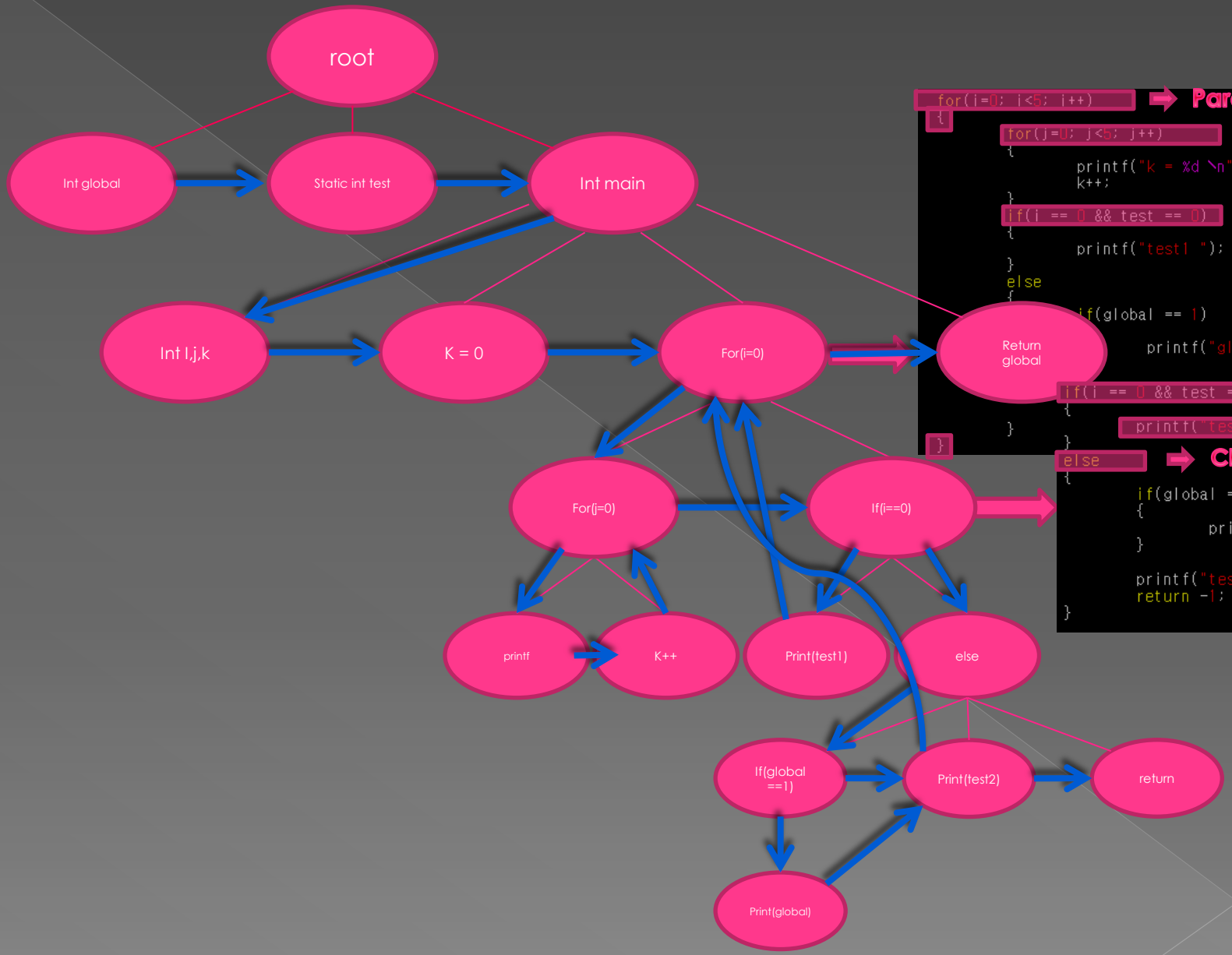
```c
#include <stdio.h>
#include <stdlib.h>

int global = 1;
static int test = 0;

int main(int argc)
{
        int i, j, k;
        k = 0;

        for(i=0; i<5; i++)
        {
                for(j=0; j<5; j++)
                {
                        printf("k = %d \n", k);
                        k++;
                }
                if(i == 0 && test == 0)
                {
                        printf("test1 ");
                }
                else
                {
                        if(global == 1)
                        {
                                printf("global 1!!!!\n");
                        }

                        printf("test2 ");
                        return -1;
                }
        }
        return global;
}
```

Block !!!
Block !!!
Block !!!
Block !!!
Block !!!
Block !!!
Block !!!
Block !!!
Block !!!
Block !!!
Block !!!
Block !!!
Block !!!
Block !!!
Block !!!



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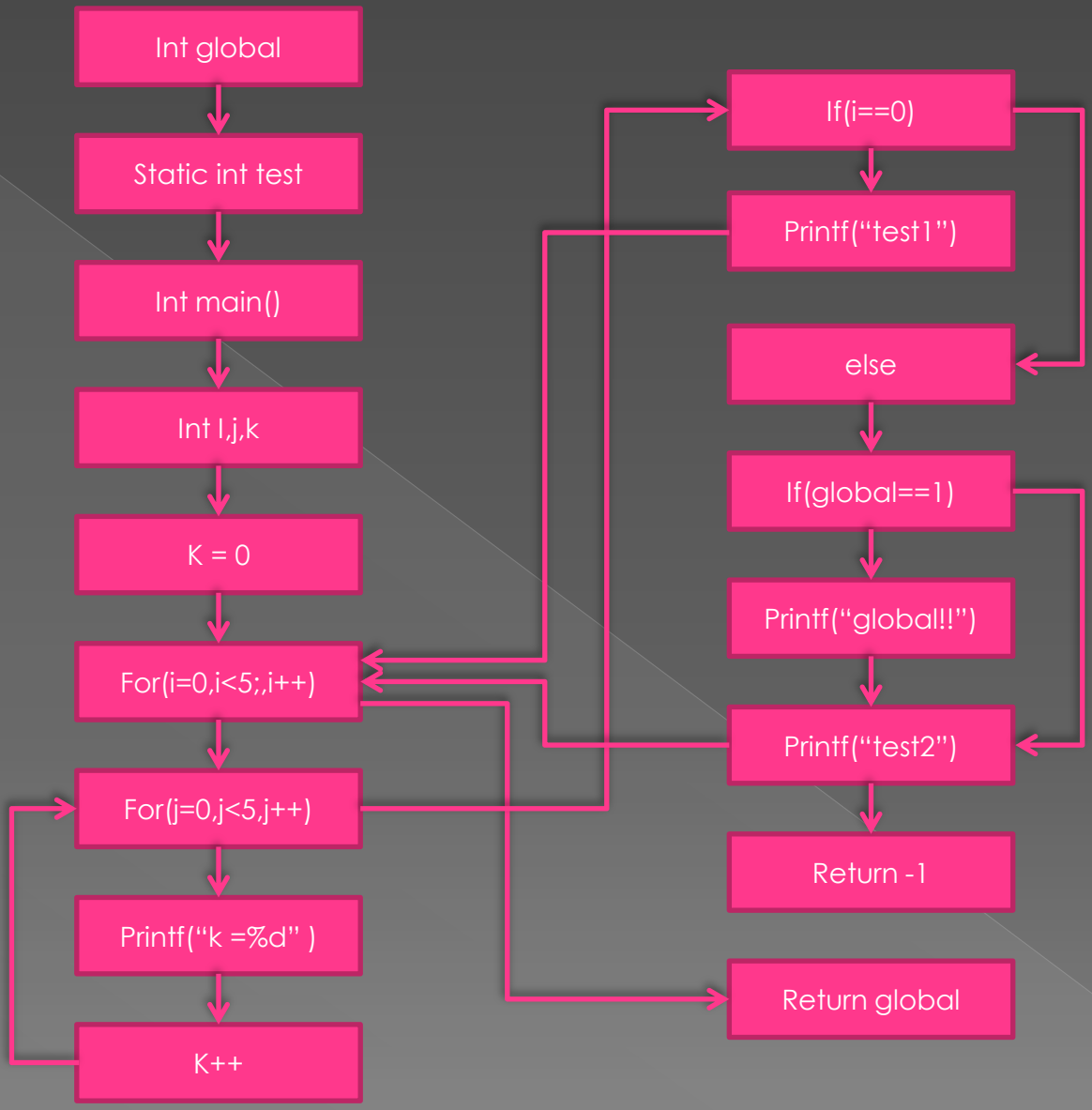

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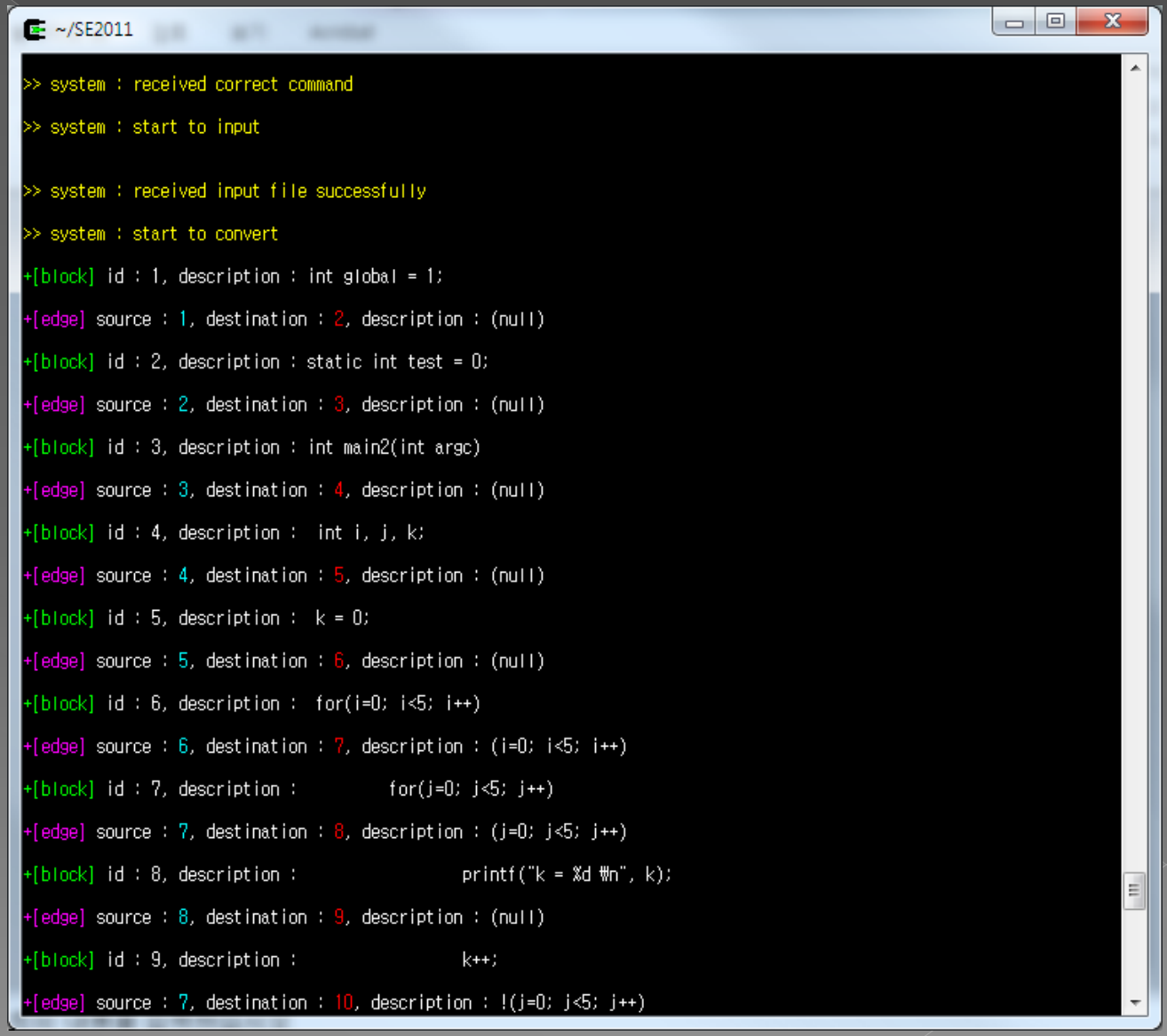
Program Screenshot



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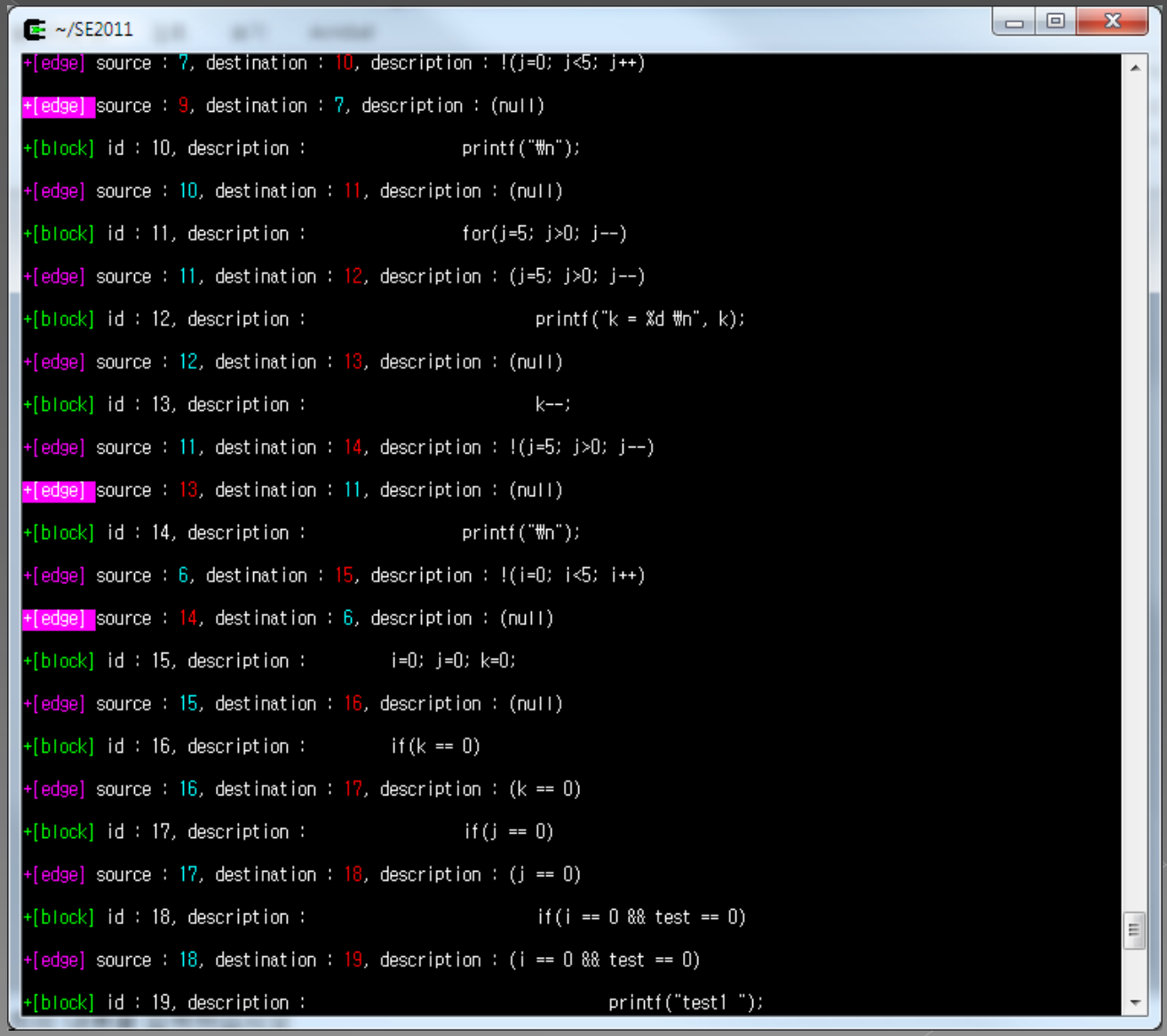
Program Screenshot



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Program Screenshot

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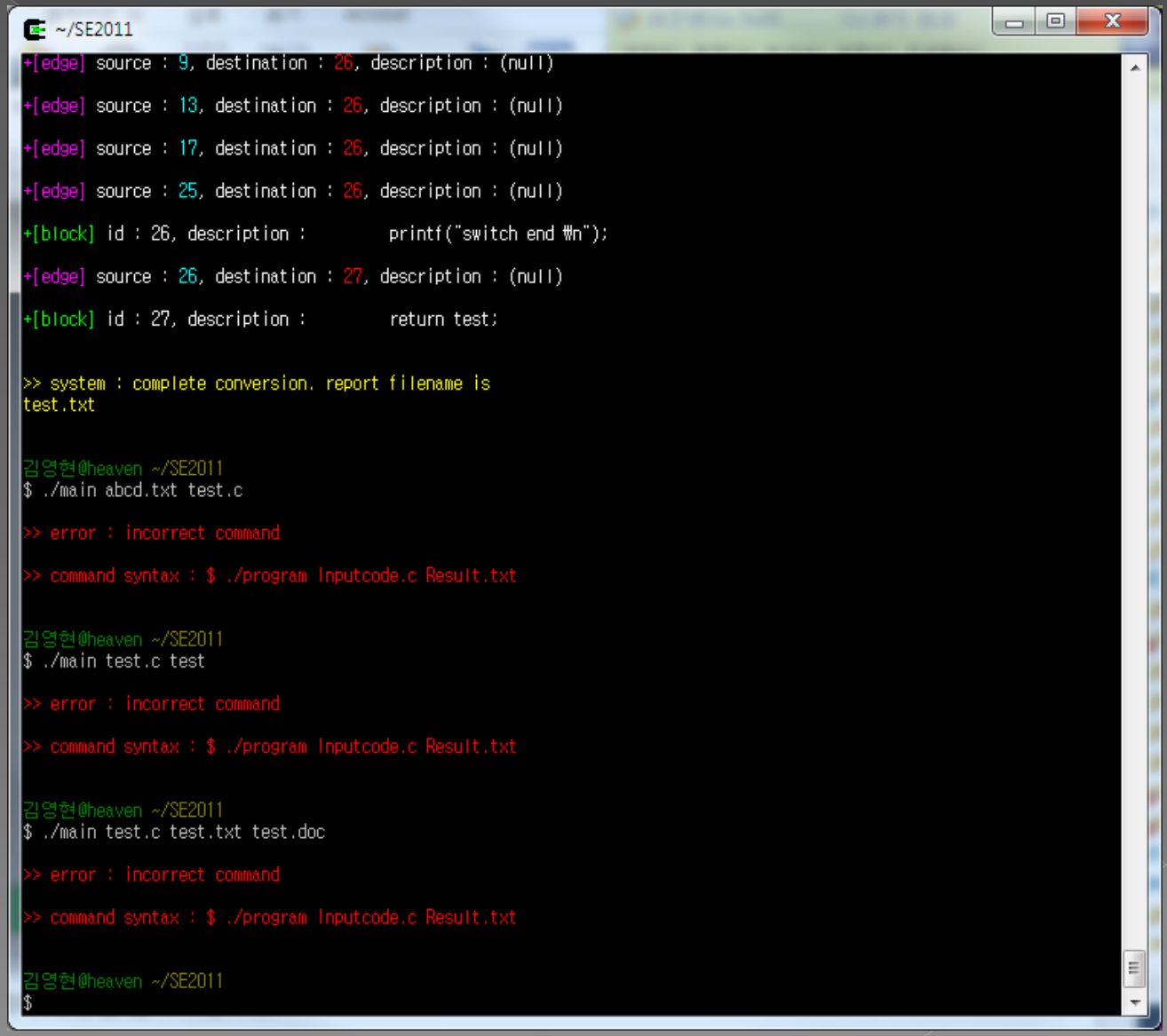
Program Screenshot



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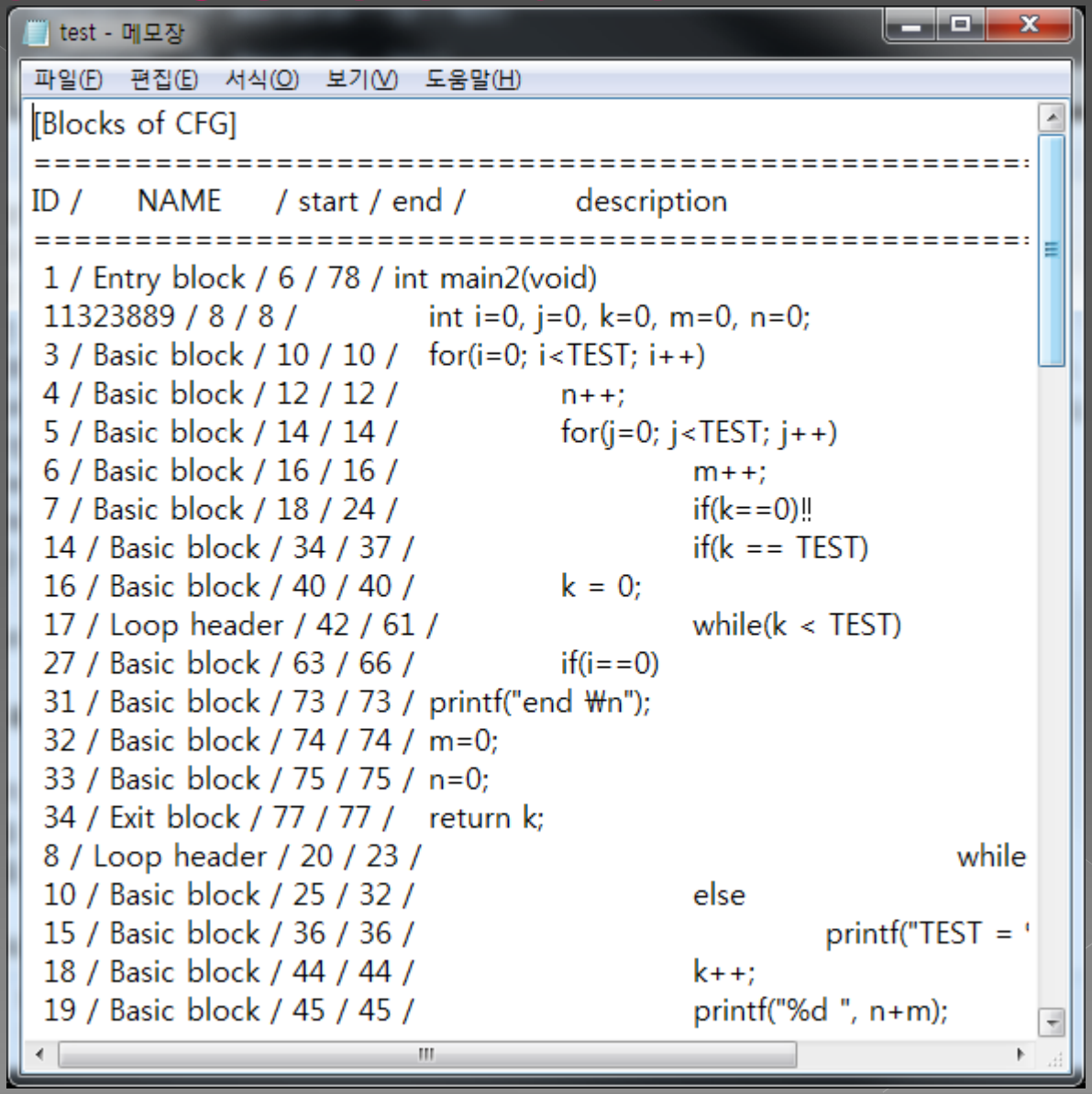
Program Screenshot



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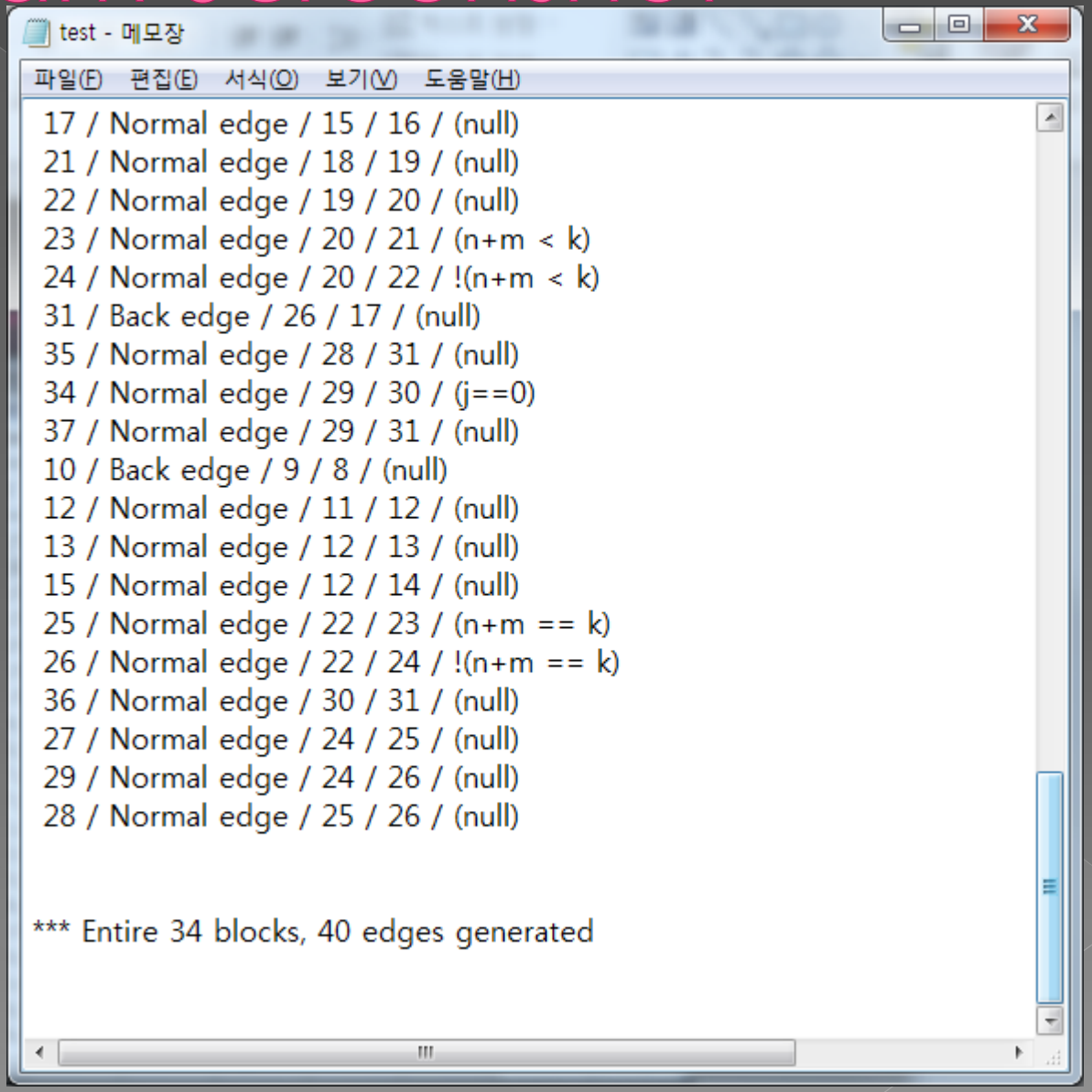
Program Screenshot



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Demonstration

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Demonstration

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Question?

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