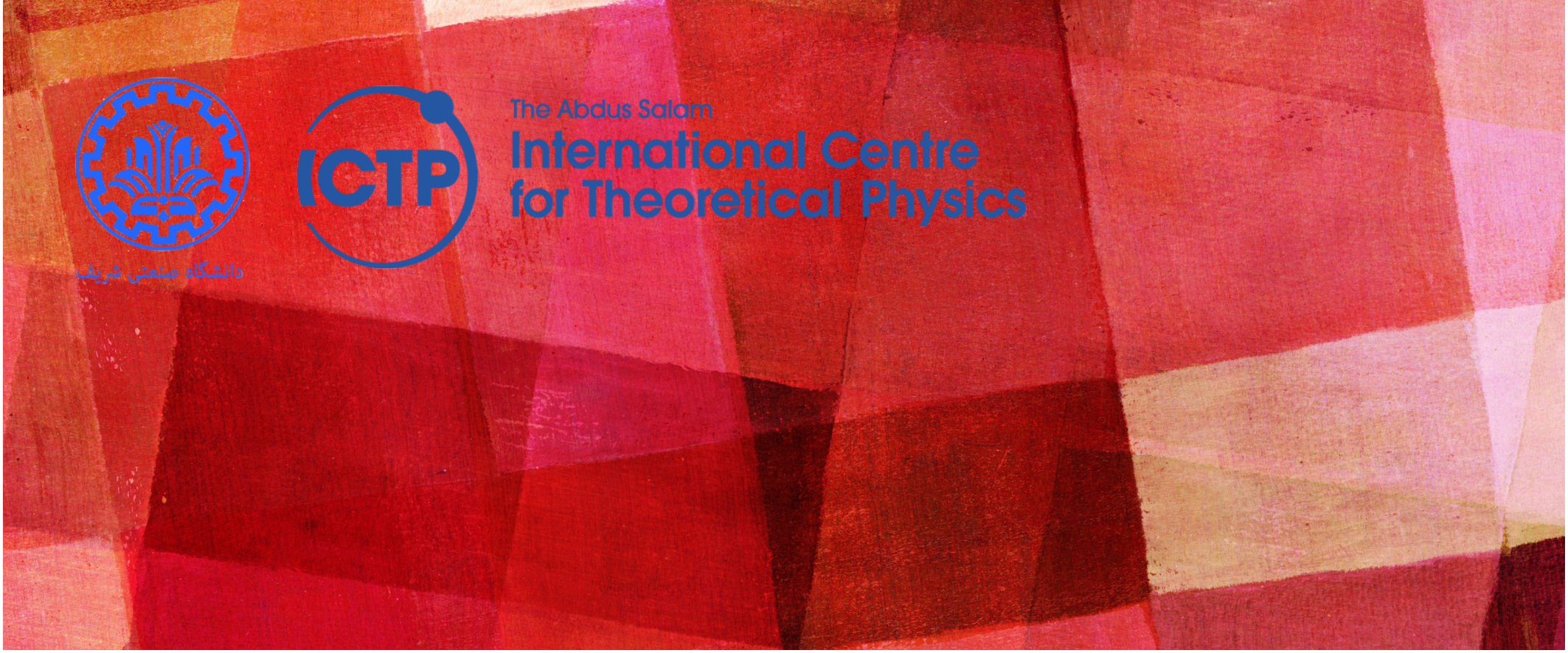

THE MAKEFILE UTILITY

Ali Farnudi

MOTIVATION

small programme

MOTIVATION

small programme

Small file

'Not so small' programme

MOTIVATION

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Small file

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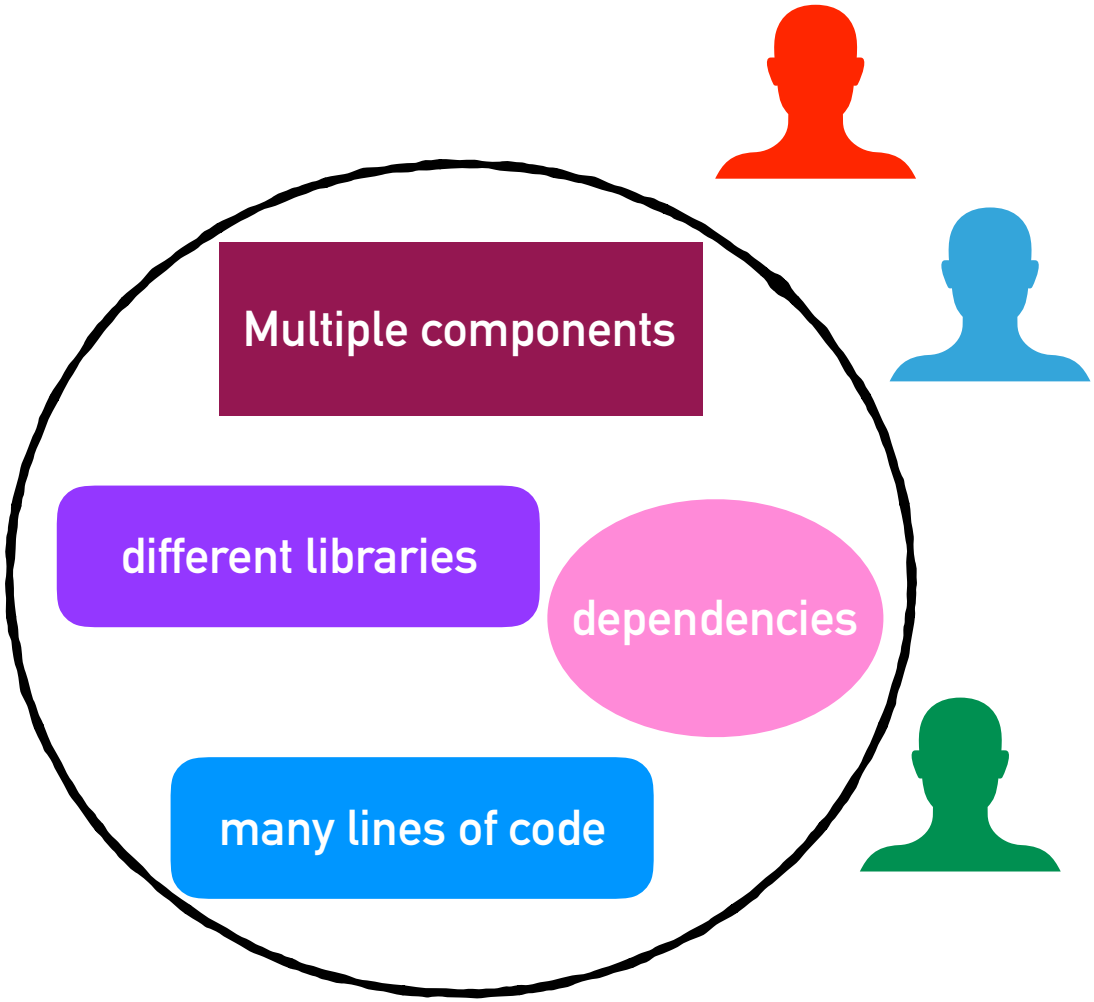

MOTIVATION

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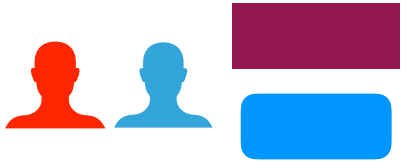


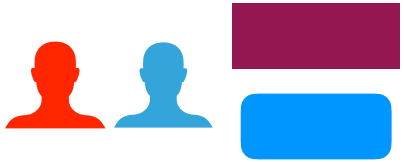
PROBLEMS

- long files are harder to manage for **both** programmer and the machine
- A **big file** means long compilation for a small change
- If possible, its **very confusing** for several programmers to simultaneously modify a file.

MOTIVATION

small programme

'Not so small' programme



SOLUTION: DIVIDE PROJECT TO MULTIPLE FILES (TARGETS)

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small programme

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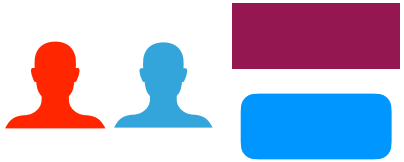


SOLUTION: DIVIDE PROJECT TO MULTIPLE FILES (TARGETS)

- **Divide** the code to **components**
- **Minimum compilation** when **something is changed**
- **Easy maintenance** of project **structure**, **dependencies** and **creation**

PROJECT MAINTENANCE

- Done in Unix by the **Makefile** mechanism
- A makefile is a **file** (**script**) containing:
  - The project **structure** (**files**, **dependencies**)
  - **Instructions** for files **creation**
- The **make** command reads a **makefile**, understands the **project structure** and makes up the **executable**
- It is **not limited** to **C programs**

PROJECT MAINTENANCE

Project ***structure*** *and* ***dependencies*** *can be represented as a '**Directed Acyclic Graph**'*

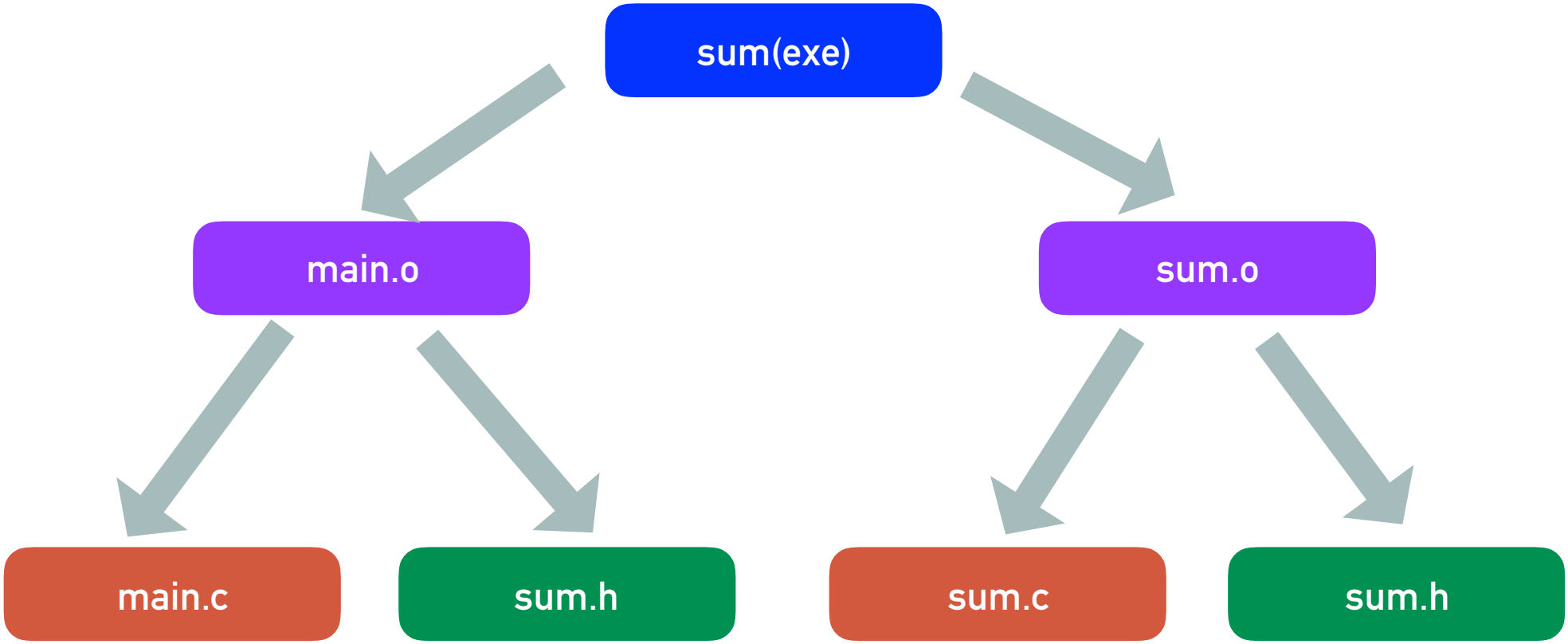
PROJECT MAINTENANCE

*Project **structure** and **dependencies** can be represented as a '**Directed Acyclic Graph**'*

- Example :
  - Program contains **3 files**
  - **main.c**, **sum.c**, **sum.h**
  - **sum.h** is included in **both** '**.c**' files
  - Executable should be the file '**sum**'

PROJECT MAINTENANCE

Directed Acyclic Graph



MAKEFILE

filename: makefile

Target: Dependancie

←tab→ rules

Target02: Dependancie

←tab→ rules

> cd ‘dir’ of makefile
> make

MAKEFILE

```
sum: main.o sum.o
    gcc –o sum main.o sum.o

main.o: main.c sum.h
    gcc –c main.c

sum.o: sum.c sum.h
    gcc –c sum.c
```

Target: Dependancie

←tab→ rules

MAKEFILE

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sum: main.o sum.o
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main.o: main.c sum.h
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EQUIVALENT MAKEFILES

- **‘.o’** depends (**by default**) on corresponding **‘.c’** file.

We may **rewrite** the **makefile** in this **equivalent** format:

EQUIVALENT MAKEFILES

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We may **rewrite** the **makefile** in this **equivalent** format:

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sum: main.o sum.o
    gcc –o sum main.o sum.o

main.o: sum.h
    gcc –c main.c

sum.o: sum.h
    gcc –c sum.c
```

EQUIVALENT MAKEFILES

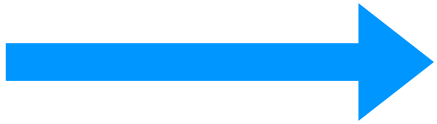
- We can compress **identical dependencies** and use **built-in macros** to get another (shorter) **equivalent makefile**:

```
sum: main.o sum.o
    gcc –o sum main.o sum.o
```

```
sum: main.o sum.o
    gcc –o $@ main.o sum.o
```

```
main.o: sum.h
    gcc –c main.c

sum.o: sum.h
    gcc –c sum.c
```



```
main.o sum.o: sum.h
    gcc –c $*.c
```

MAKE OPERATION

- Project **dependencies tree** is **constructed**
- Target of the **first** rule should be created

- We go **down the tree** to see if there is a **target** that should be **recreated**.
  - This is required when the **target** file is **older** than **one of its dependencies**
  - In this case we **recreate** the **target file** according to the action specified, **on our way up the tree**. Consequently, **more files may need to be recreated**

- If something was changed, **linking is performed**

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PROJECT MAINTENANCE

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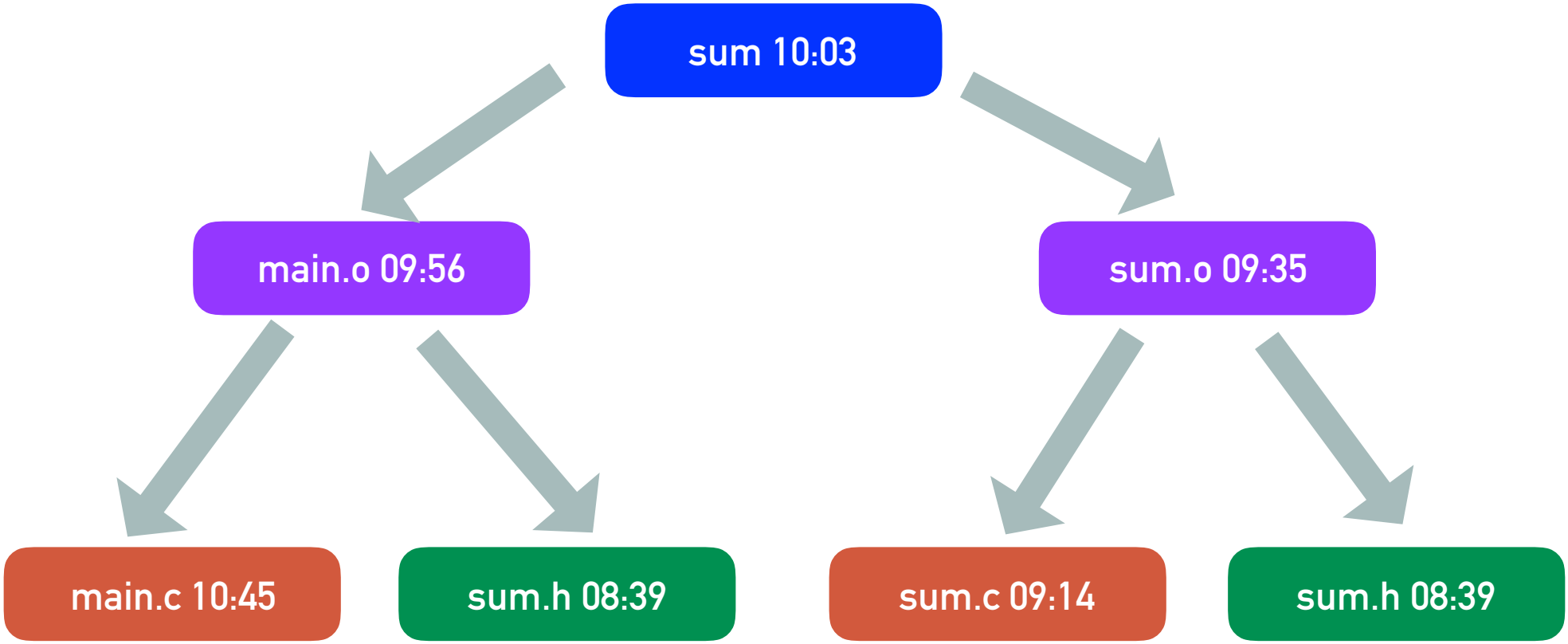
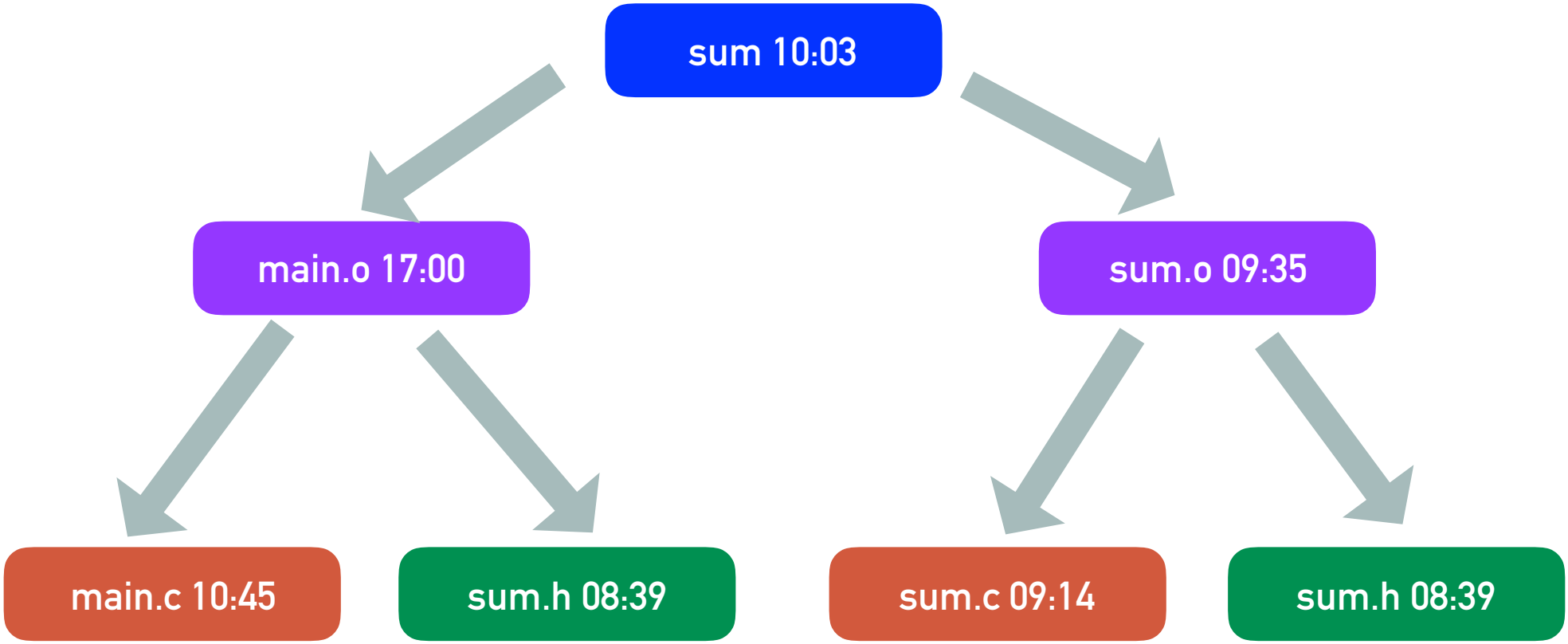


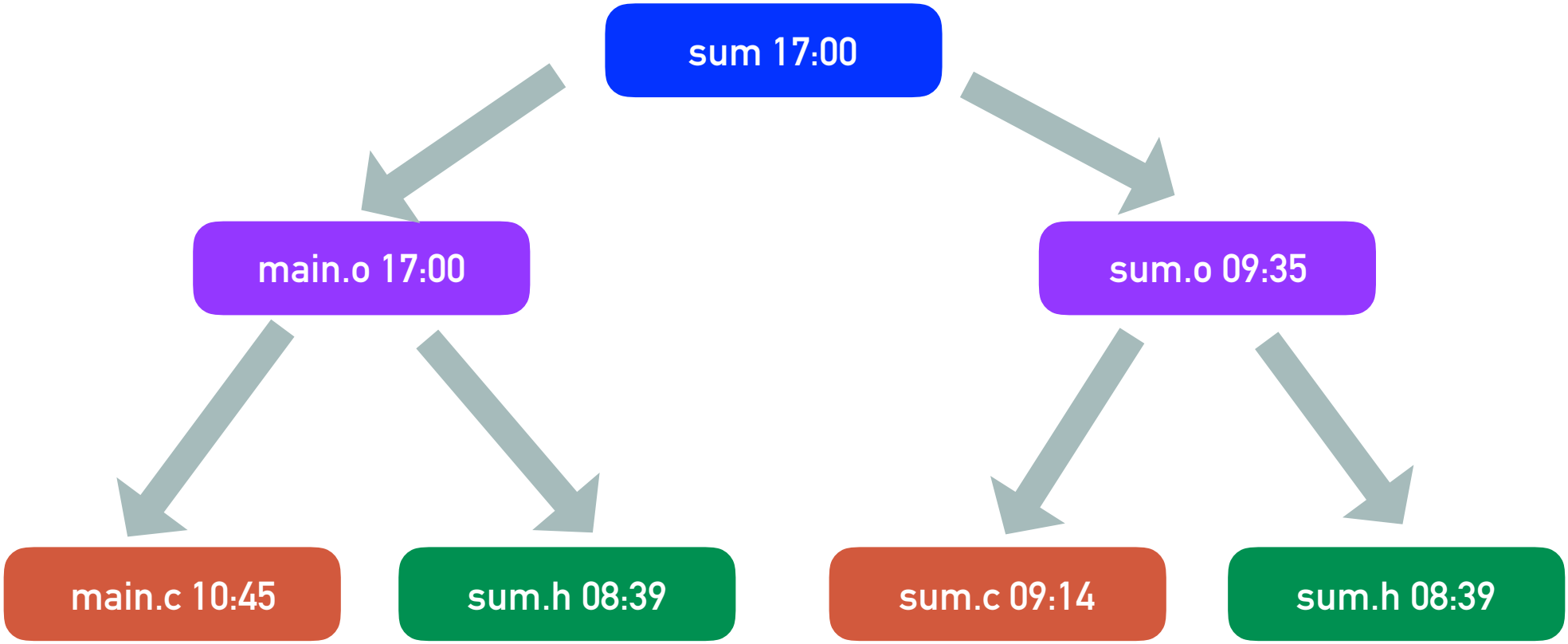
PROJECT MAINTENANCE

Directed Acyclic Graph



PROJECT MAINTENANCE

Directed Acyclic Graph



MAKE OPERATION

- '**make**' operation can be used to ensure **minimum compilation**, when the project structure is **written properly**

- **Do not write this at home**:

```
prog: main.c sum1.c sum2.c
    gcc –o prog main.c sum1.c sum2.c
```

USEFUL GCC OPTIONS

- Include: -I<path>
- Define: -D<identifier>
- Optimization: -O<level>

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Example:

gcc –DDEBUG –O2 –I/usr/include example.c –o example -lm

ANOTHER EXAMPLE

```
# Makefile to compare sorting routines
BASE    = /home/blufox/base
CC      =  gcc
CFLAGS  =  -O –Wall
EFILE   =  $(BASE)/bin/compare_sorts
INCLS   =  -I$(LOC)/include
LIBS    =  $(LOC)/lib/g_lib.a \
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LOC      =  /usr/local
OBJS = main.o   another_qsort.o   chk_order.o \
       compare.o   quicksort.o

$(EFILE): $(OBJS)
    @echo “linking …”
    @$(CC) $(CFLAGS) –o $@ $(OBJS) $(LIBS)

$(OBJS): compare_sorts.h
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# Clean intermediate files
clean:
    rm *~ $(OBJS)
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- We can define **multiple targets** in a makefile
- Target **clean** – has an empty set of dependencies. Used to clean intermediate files.
- **make clean** will remove intermediate files
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GET MORE OUT OF MAKEFILE

http://www.gnu.org/software/make/manual/make.html