인터페이스와
클래스 계층 구조

Interfaces and Class Hierarchy

슬라이드 퍼즐 게임

Starter

PuzzleStarter

`static void main(String[] args)`

Controller

PuzzleController

`SlidePuzzleBoard board`
`PuzzleWriter writer`

`PuzzleController(SlidePuzzleBoard b, PuzzleWriter w)`
`void play()`

Model

SlidePuzzleBoard

`PuzzlePiece[][] board`
`int empty_row`
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`SlidePuzzleBoard()`
`boolean move(int w)`

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PuzzlePiece

`int face`

`PuzzlePiece(int n)`

Output View

PuzzleWriter extends JPanel

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`PuzzleWriter(SlidePuzzleBoard b)`
`void paintComponent(Graphics g)`
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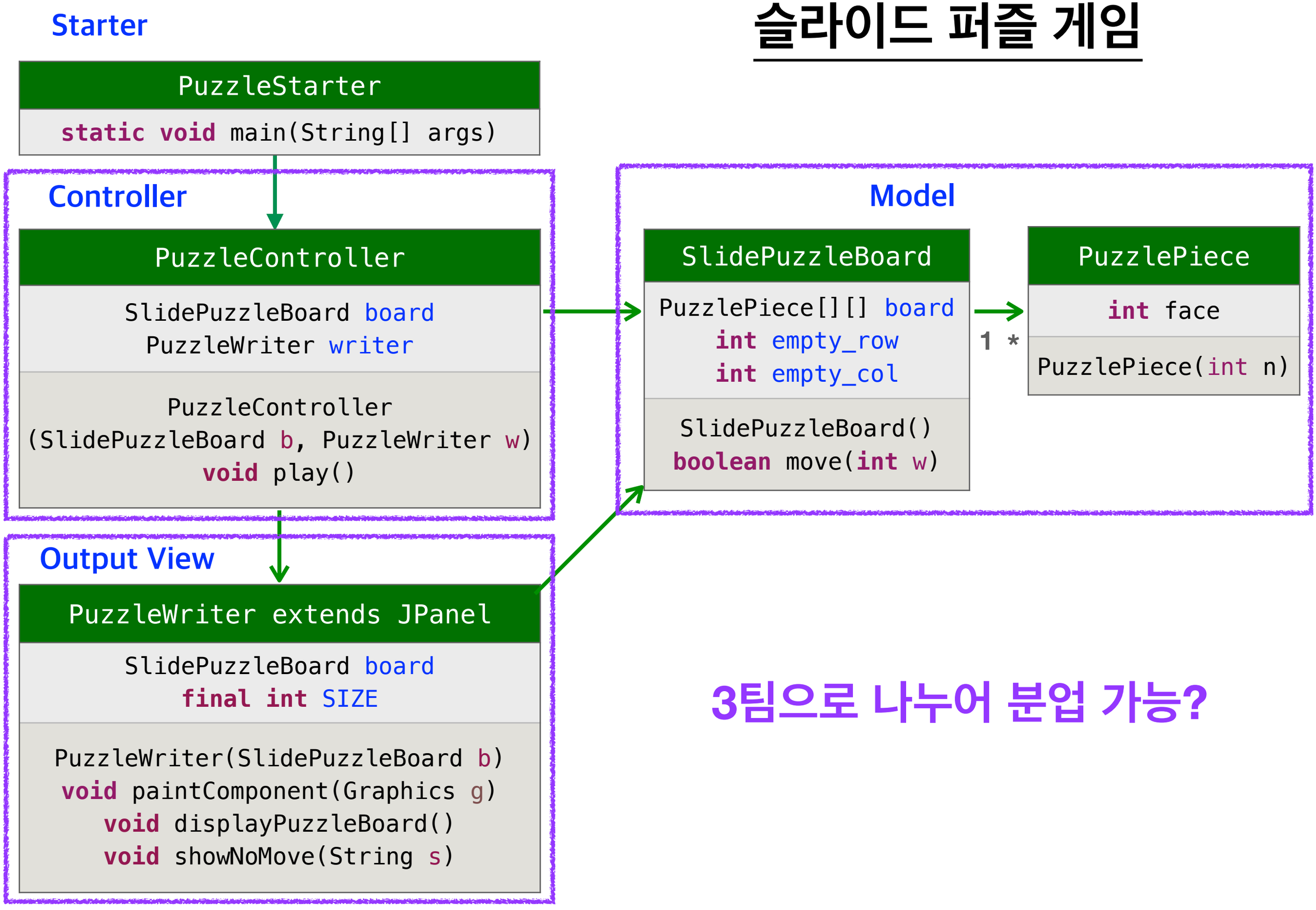

3팀으로 나누어 분업 가능?

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클래스 끼리 종속 관계가 있어
구현의 분업이 어려움!

specification

Programming to the interface,

not the implementation

class

프로그래밍 작업 분업 가능

종속 클래스 대신 인터페이스만 있어도 컴파일 가능

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SlidePuzzleBoardInterface

`boolean move(int w)`
`PuzzlePiece[][] board();`

```java
public interface SlidePuzzleBoardInterface {

    public boolean move(int w);

    public PuzzlePiece[][] board();

}
```

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`boolean move(int w)`
`PuzzlePiece[][] board();`

```java
public interface SlidePuzzleBoardInterface {

    public boolean move(int w);

    public PuzzlePiece[][] board();

}
```

```java
public class SlidePuzzleBoard implements SlidePuzzleBoardInterface {

    private PuzzlePiece[][] board;
    private int empty_row;
    private int empty_col;

    public PuzzlePiece[][] board() { return board; }

    public SlidePuzzleBoard() {
        board = new PuzzlePiece[4][4];
        int number = 15;
        for (int i = 0; i < 4; i++)
            for (int j = 0; j < 4; j++) {
                board[i][j] = new PuzzlePiece(number);
                number -= 1;
            }
        board[3][3] = null;
        empty_row = 3;
        empty_col = 3;
    }

    public boolean move(int n) {
        int row, col;
        if (found(n,empty_row-1, empty_col)) {
            row = empty_row-1;
```

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public interface SlidePuzzleBoardInterface {

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}
```

```java
import javax.swing.*;

public class PuzzleController {

    private SlidePuzzleBoard puzzle;
    private PuzzleWriterInterface writer;

    public PuzzleController(SlidePuzzleBoard p, PuzzleWriter w) {
        puzzle = p;
        writer = w;
    }

    public void play() {
        while (true) {
            writer.displayPuzzleBoard();
            String input = JOptionPane.showInputDialog("Your move:");
            int n = Integer.parseInt(input);
            if (! puzzle.move(n))
                writer.showNoMove("Cannot move.");
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    }

}
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SlidePuzzleBoardInterface

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public interface SlidePuzzleBoardInterface {

    public boolean move(int w);

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}
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```java
import java.awt.*;
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public class PuzzleWriter extends JPanel {
    private SlidePuzzleBoard puzzle;
    private final int SIZE; // the size of a puzzle piece in pixel

    public PuzzleWriter(SlidePuzzleBoard p) {
        puzzle = p;
        SIZE = 30;
        JFrame f = new JFrame();
        f.getContentPane().add(this);
        f.setLocation(550,100);
        f.setTitle("Slide Puzzle");
        f.setSize(SIZE*6, SIZE*6+28);
        f.setVisible(true);
        f.setDefaultCloseOperation(WindowConstants.EXIT_ON_CLOSE);
    }

    public void paintComponent(Graphics g) {
        g.setColor(Color.YELLOW);
        g.fillRect(0, 0, SIZE*6, SIZE*6);
        PuzzlePiece[][] r = puzzle.board();
        for (int i = 0; i < 4; i = i + 1) {
            for (int j = 0; j < 4; j = j + 1) {
```

SlidePuzzleBoardInterface

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PuzzleWriterInterface

```
void displayPuzzleBoard()
void showNoMove(String s)
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```java
public interface PuzzleWriterInterface {

    public void displayPuzzleBoard();

    public void showNoMove(String s);

}
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void displayPuzzleBoard()
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```java
public interface PuzzleWriterInterface {

    public void displayPuzzleBoard();

    public void showNoMove(String s);

}
```

```java
import java.awt.*;
import javax.swing.*;

public class PuzzleWriter extends JPanel implements PuzzleWriterInterface {
    private SlidePuzzleBoardInterface puzzle;
    private final int SIZE; // the size of a puzzle piece in pixel

    public PuzzleWriter(SlidePuzzleBoardInterface p) {
        puzzle = p;
        SIZE = 30;
        JFrame f = new JFrame();
        f.getContentPane().add(this);
        f.setLocation(550,100);
        f.setTitle("Slide Puzzle");
        f.setSize(SIZE*6, SIZE*6+28);
        f.setVisible(true);
        f.setDefaultCloseOperation(WindowConstants.EXIT_ON_CLOSE);
    }

    public void paintComponent(Graphics g) {
        g.setColor(Color.YELLOW);
        g.fillRect(0, 0, SIZE*6, SIZE*6);
        PuzzlePiece[][] r = puzzle.board();
        for (int i = 0; i < 4; i = i + 1) {
            for (int j = 0; j < 4; j = j + 1) {
                paintPiece(g, r[i][j], i, j);
```

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void displayPuzzleBoard()
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implements

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public interface PuzzleWriterInterface {

    public void displayPuzzleBoard();

    public void showNoMove(String s);

}
```

```java
import javax.swing.*;

public class PuzzleController {

    private SlidePuzzleBoardInterface puzzle;
    private PuzzleWriter writer;

    public PuzzleController(SlidePuzzleBoardInterface p, PuzzleWriter w) {
        puzzle = p;
        writer = w;
    }

    public void play() {
        while (true) {
            writer.displayPuzzleBoard();
            String input = JOptionPane.showInputDialog("Your move:");
            int n = Integer.parseInt(input);
            if (! puzzle.move(n))
                writer.showNoMove("Cannot move.");
        }
    }

}
```

PuzzleWriterInterface

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상속 Inheritance	구현 Implementation
`class Sub extends Super`	`class C implements S`
• Sub = 하위 클래스 • Super = 상위 클래스 • 클래스 Super를 상속 받아 클래스 Sub를 구현 • 클래스 Super의 코드를 클래스 Sub에서 재사용	• 명세(interface) S를 만족하는 클래스 C 구현 • `S x = new C();`

사례 학습 : 상속 Inheritance 이해하기

```
public class Person {

    private String name;

    public Person(String n) {
        name = n;
    }

    public String name() {
        return name;
    }

    . . . . . .
}
```

```
public class PersonFrom extends Person {

    private String city;

    public PersonFrom(String n, String c) {
        super(n);
        city = c;
    }

    public String city() {
        return city;
    }

    . . . . . .
}
```

```
PersonFrom x = new PersonFrom("마음", “서울");
System.out.println("이름: " + x.name());
System.out.println("출신: " + x.city());
```

```java
public class Person {
    private String name;

    public Person(String n) {
        name = n;
    }

    public String name() {
        return name;
    }

    public boolean sameName(Person other) {
        return name.equals(other.name());
    }
}
```

```java
public class PersonFrom extends Person {
    private String city;

    public PersonFrom(String n, String c) {
        super(n);
        city = c;
    }

    public String city() {
        return city;
    }

    public boolean same(PersonFrom other) {
        return sameName(other) &&
               city.equals(other.city());
    }
}
```

```java
Person p = new Person("마음");
Person q = new PersonFrom("소리","서울");
```

다음 중에서 어떤 문장이 Java 컴파일러를 통과할까?
통과하여 실행하면, 무엇을 프린트할까?

- `System.out.println(p.city());`
- `System.out.println(q.name());`
- `System.out.println(p.sameName(p));`
- `System.out.println(q.sameName(p));`
- `System.out.println(q.same(p));`

Subtyping

기본 타입

byte **int** **long** **float** **double** **boolean**

byte <= **int** <= **long** <= **float** <= **double**
int는 **double**의 서브타입 이다. **double** 값을 담을 수 있는 변수에 **int** 값도 담을 수 있다.

예:

```
double d = 3;
```

```
public double inverseOf(double d) {
    return 1.0 / d
}
System.out.println(inverseOf(3));
```

Subtyping

객체 타입

Object Types

Reference Types

```
public class MyPanel extends JPanel
```

MyPanel <= JPanel

MyPanel은 **JPanel**의 서브타입 이다.

JPanel 객체을 담을 수 있는 변수에 **MyPanel** 객체도 담을 수 있다.

상속

inheritance

예:

```
JFrame f = new JFrame();
f.getContentPane().add(new MyPanel());
```

JFrame
Container getContentPane()

Container
Component add(Component comp)

MyPanel <= JPanel <= JComponent <= Container <= Component <= Object

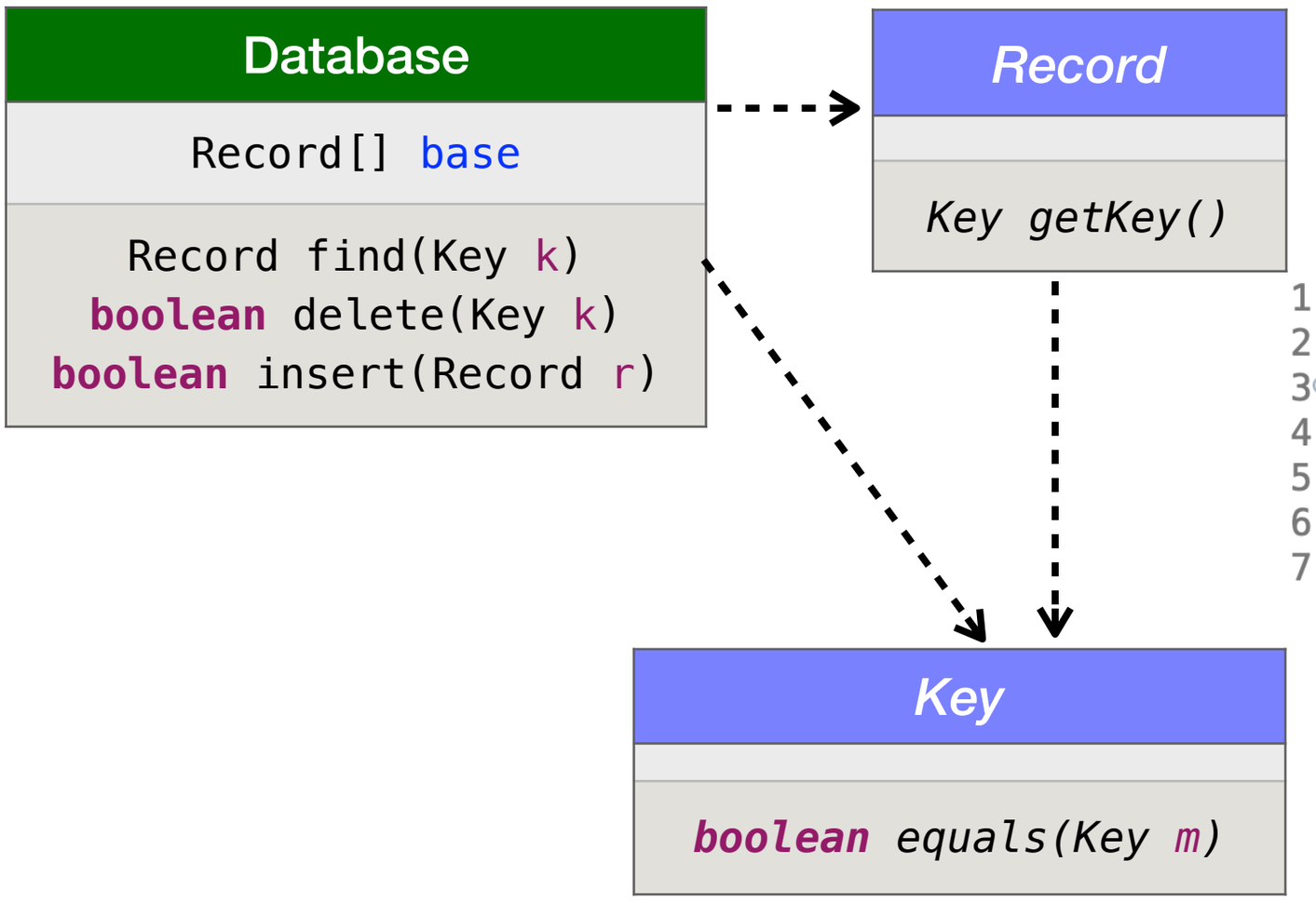
```java
public class PuzzleStarter {

    public static void main(String[] args) {
        SlidePuzzleBoard puzzle = new SlidePuzzleBoard();
        PuzzleWriter writer = new PuzzleWriter(puzzle);
        new PuzzleController(puzzle, writer).play();
    }

}
```

SlidePuzzleBoard <= SlidePuzzleBoardInterface

PuzzleWriter <= PuzzleWriterInterface

```java
import javax.swing.*;

public class PuzzleController {

    private SlidePuzzleBoardInterface puzzle;
    private PuzzleWriterInterface writer;

    public PuzzleController(SlidePuzzleBoardInterface p, PuzzleWriterInterface w) {
        puzzle = p;
        writer = w;
    }

    public void play() {
        while (true) {
            writer.displayPuzzleBoard();
            String input = JOptionPane.showInputDialog("Your move:");
            int n = Integer.parseInt(input);
            if (! puzzle.move(n))
                writer.showNoMove("Cannot move.");
        }
    }

}
```

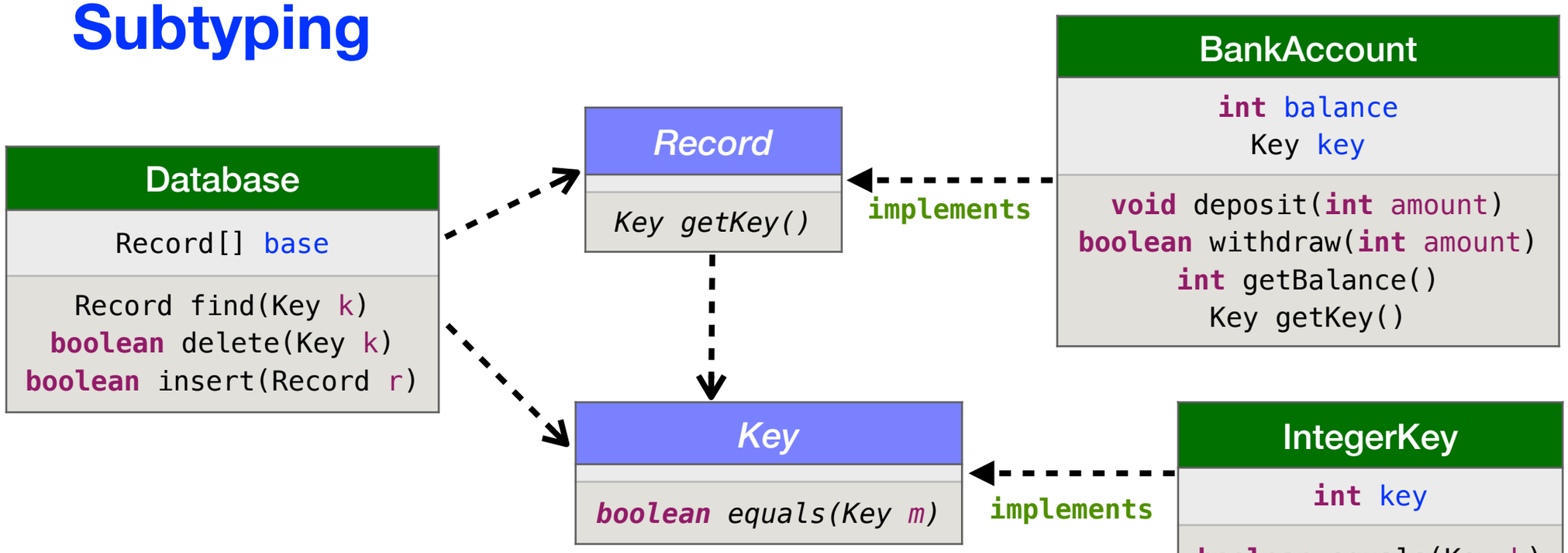
Architecture for a Database




```java
public interface Record {

    /** getKey - 레코드를 유일하게 식별하는 키를 리턴
     * @return - 키 */
    public Key getKey();

}
```

```java
public interface Key {

    /** equals - 인수로 제공된 키와 자신과 같은지 비교
     * @param - 비교 대상 키
     * @return - 같으면 true, 다르면 false */
    public boolean equals(Key m);
}
```

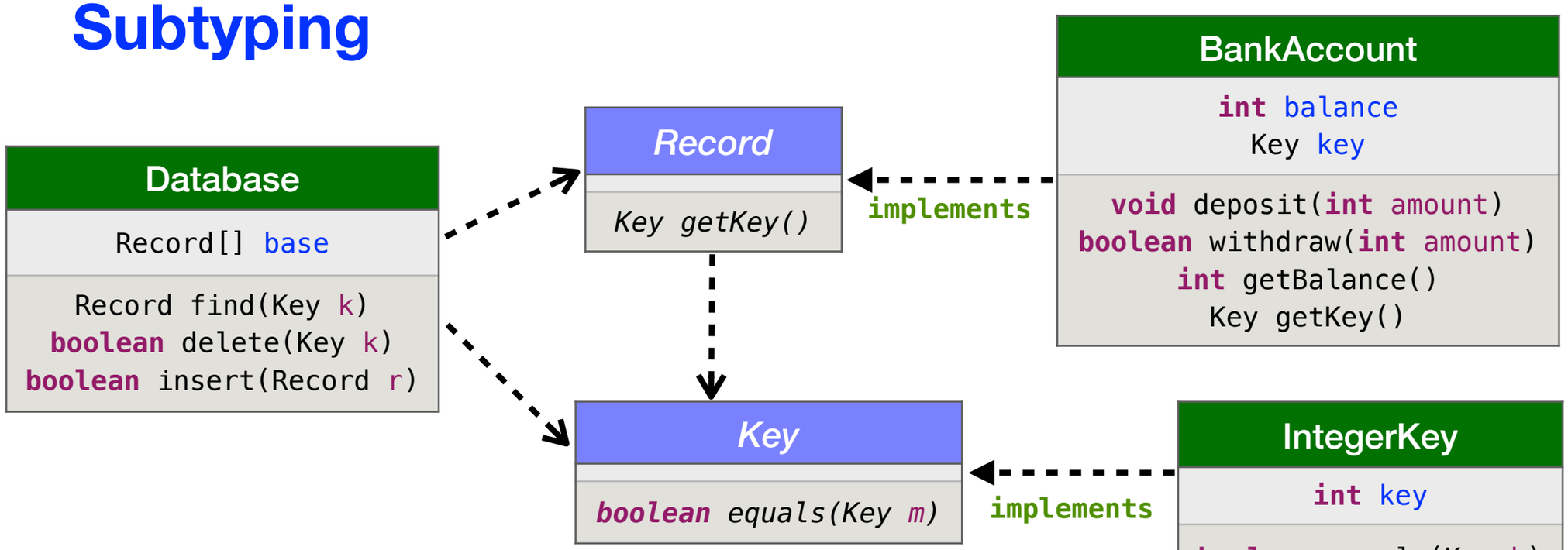
Subtyping




```
public class BankAccount implements Record
```

```
Database db = new Database(4);
IntegerKey k = new IntegerKey(55);
BankAccount b = new BankAccount(10000, k);
boolean success = db.insert(b);
```

Subtyping

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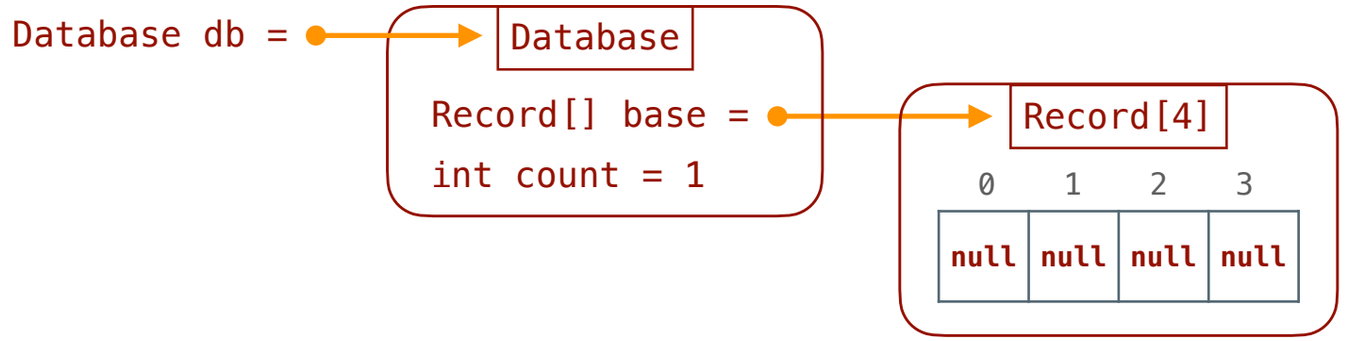

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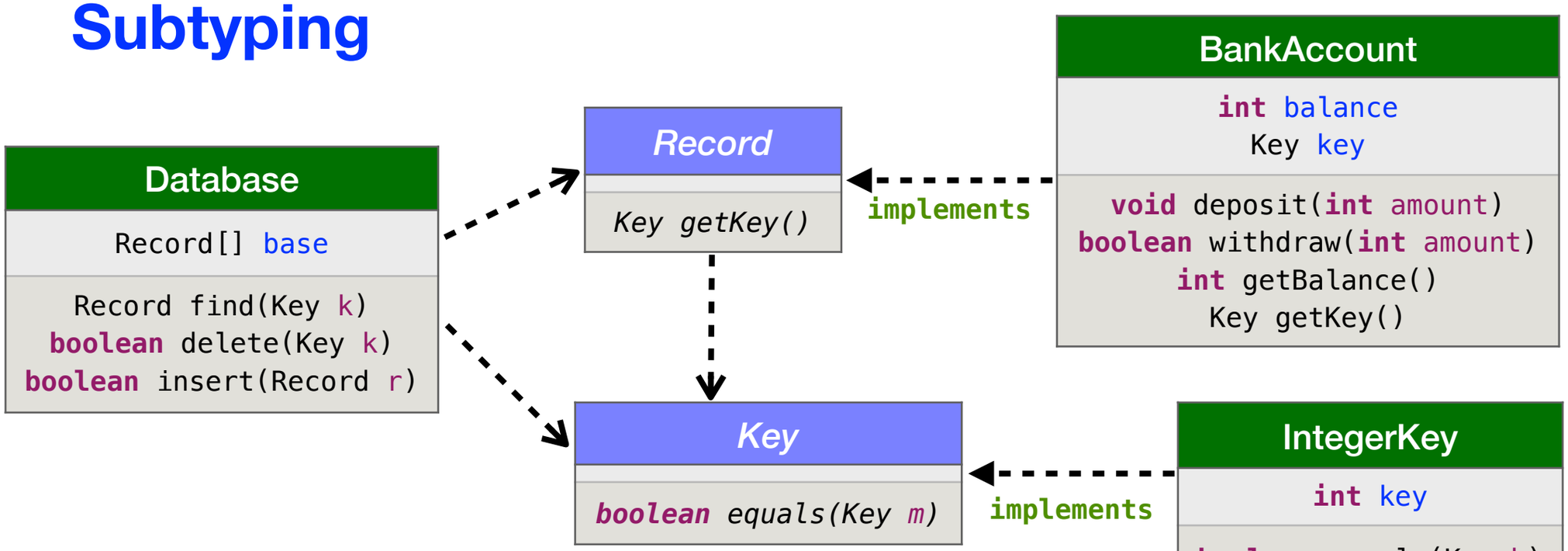


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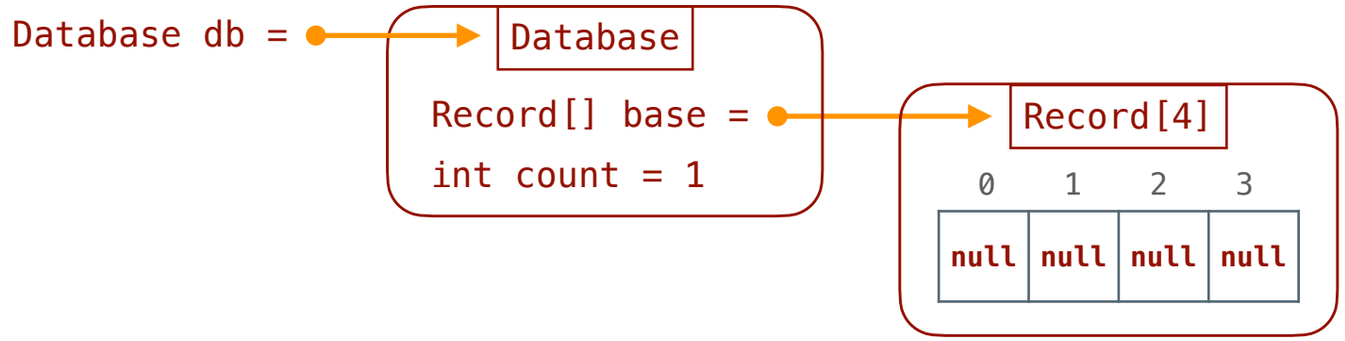
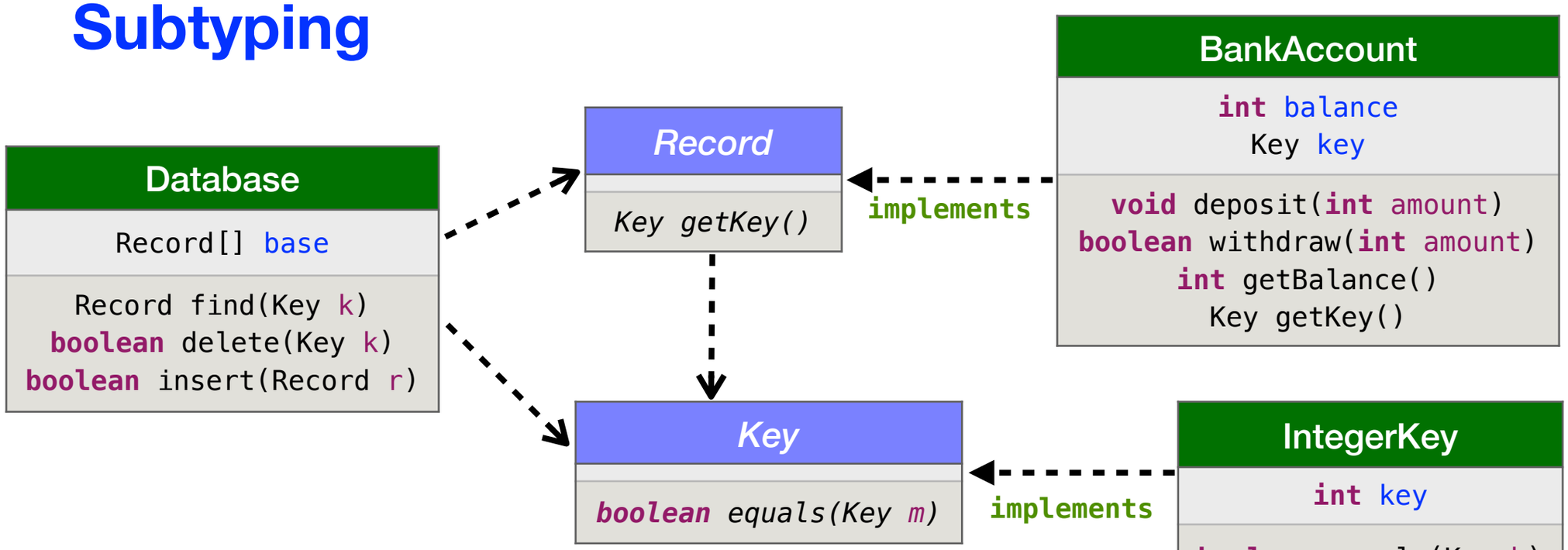
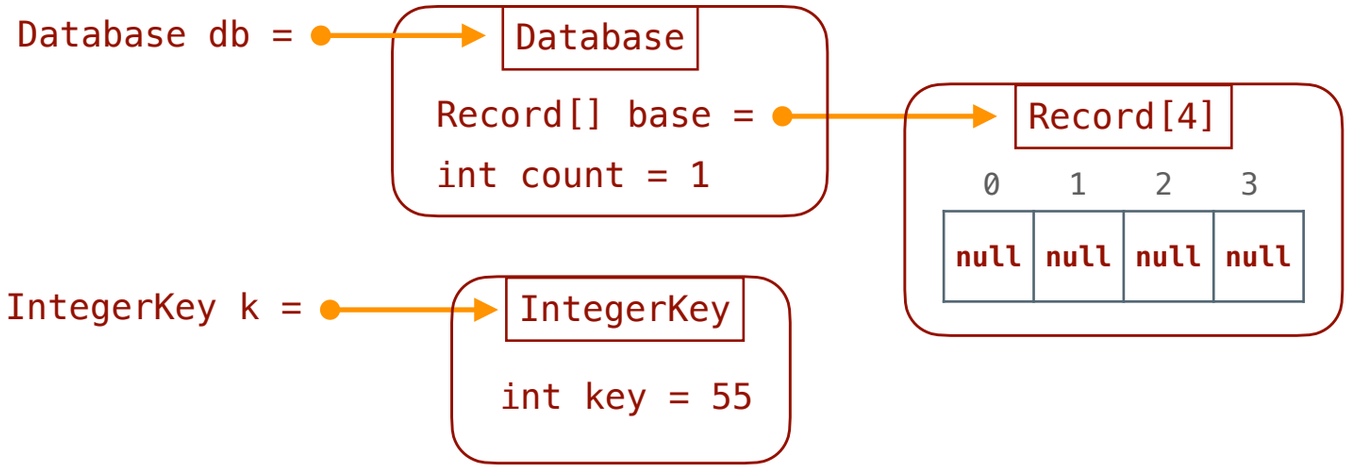


Subtyping

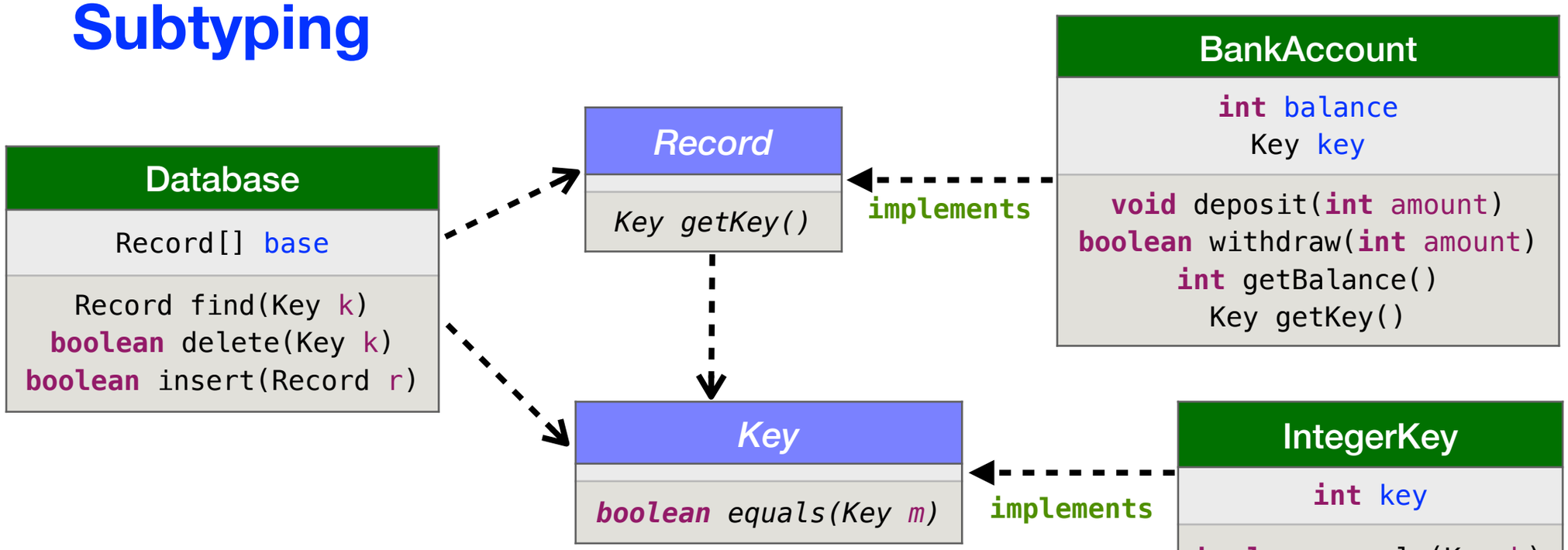



```
public class BankAccount implements Record
```

```
Database db = new Database(4);
IntegerKey k = new IntegerKey(55);
BankAccount b = new BankAccount(10000, k);
boolean success = db.insert(b);
```



Subtyping

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IntegerKey k = new IntegerKey(55);
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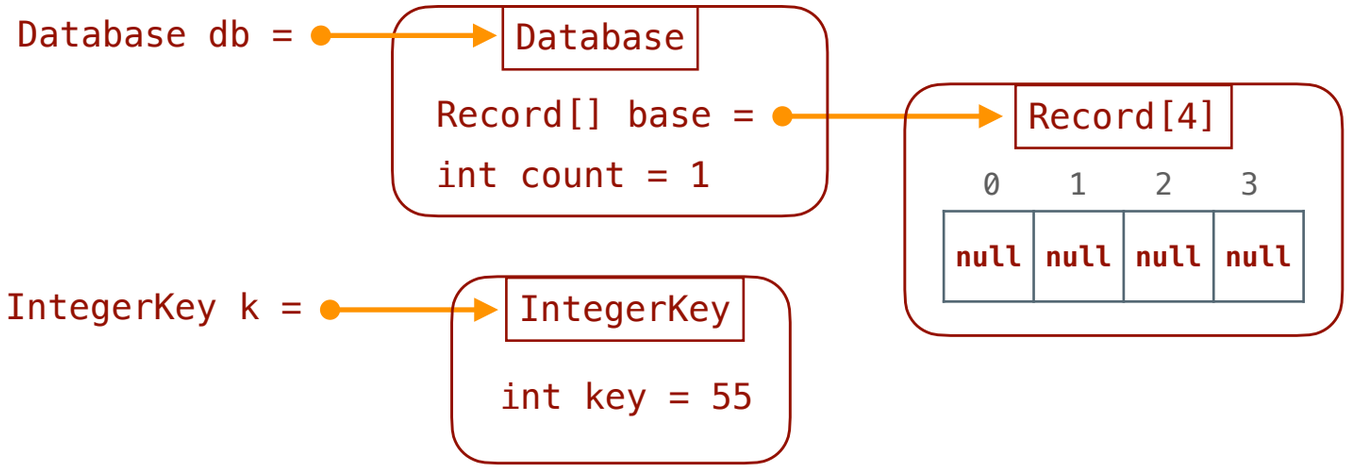
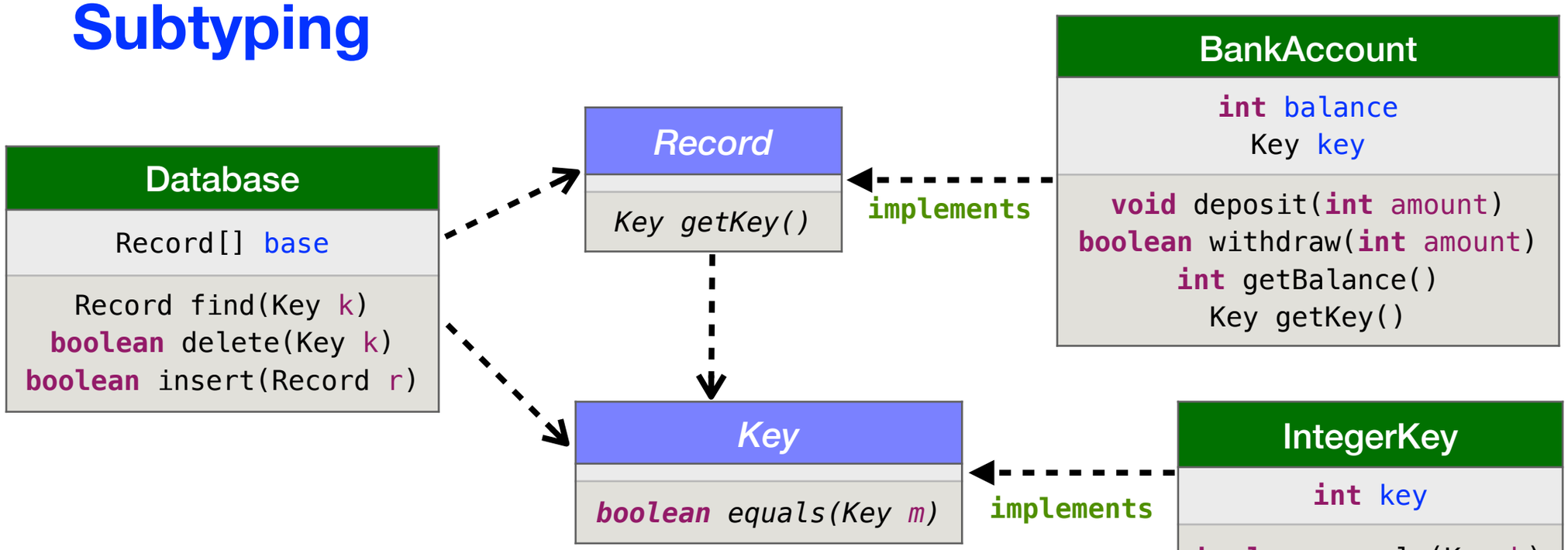
boolean success = db.insert(b);
```



Subtyping

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public class BankAccount implements Record
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IntegerKey k = new IntegerKey(55);
BankAccount b = new BankAccount(10000, k);
boolean success = db.insert(b);
```
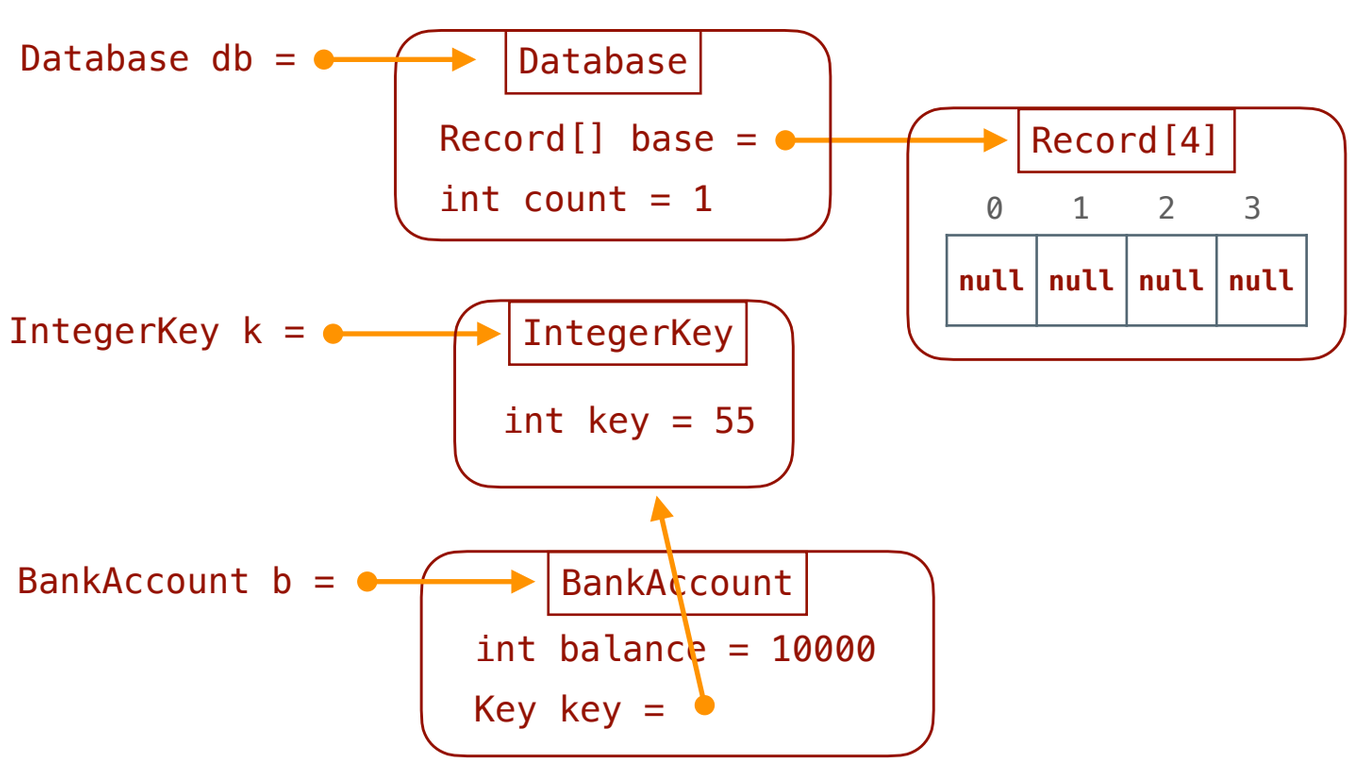
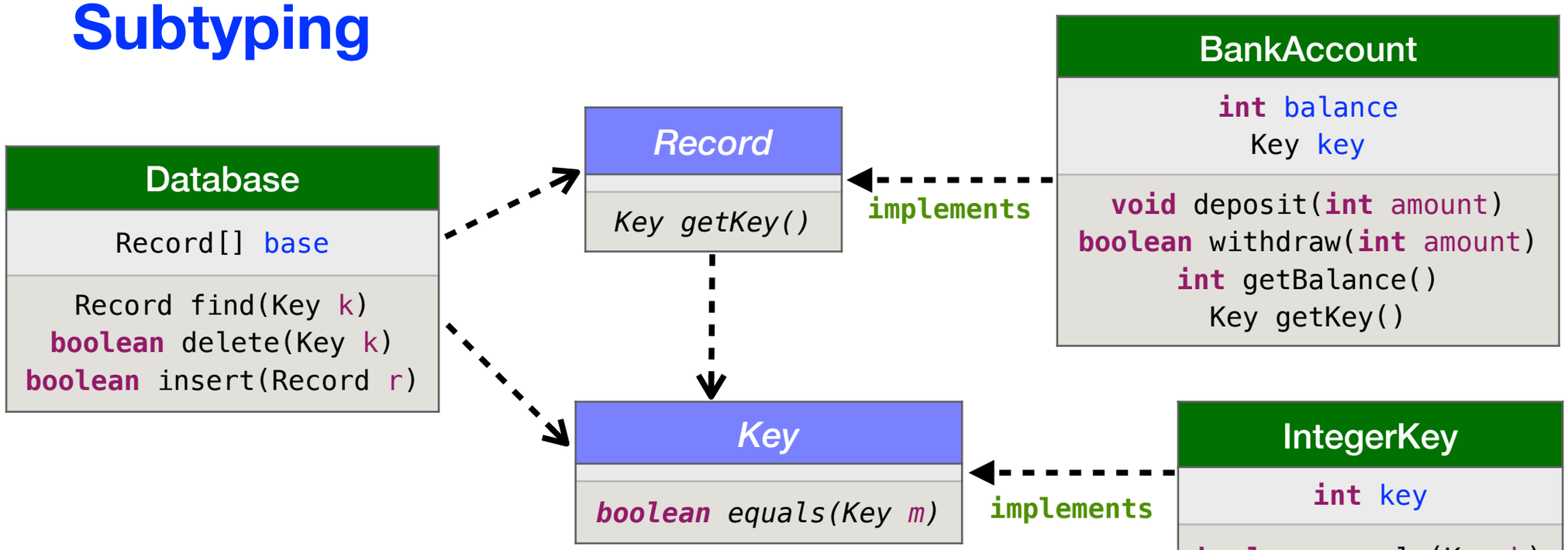
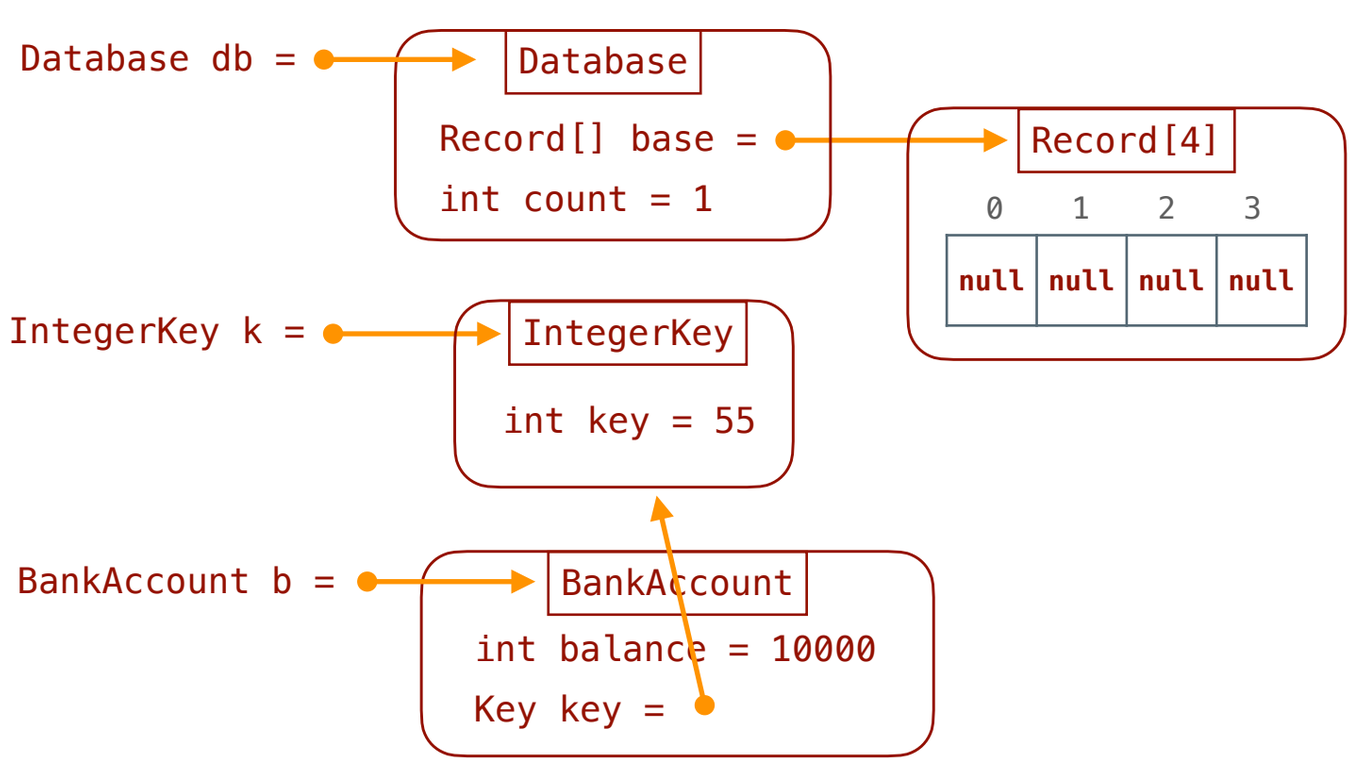



Subtyping

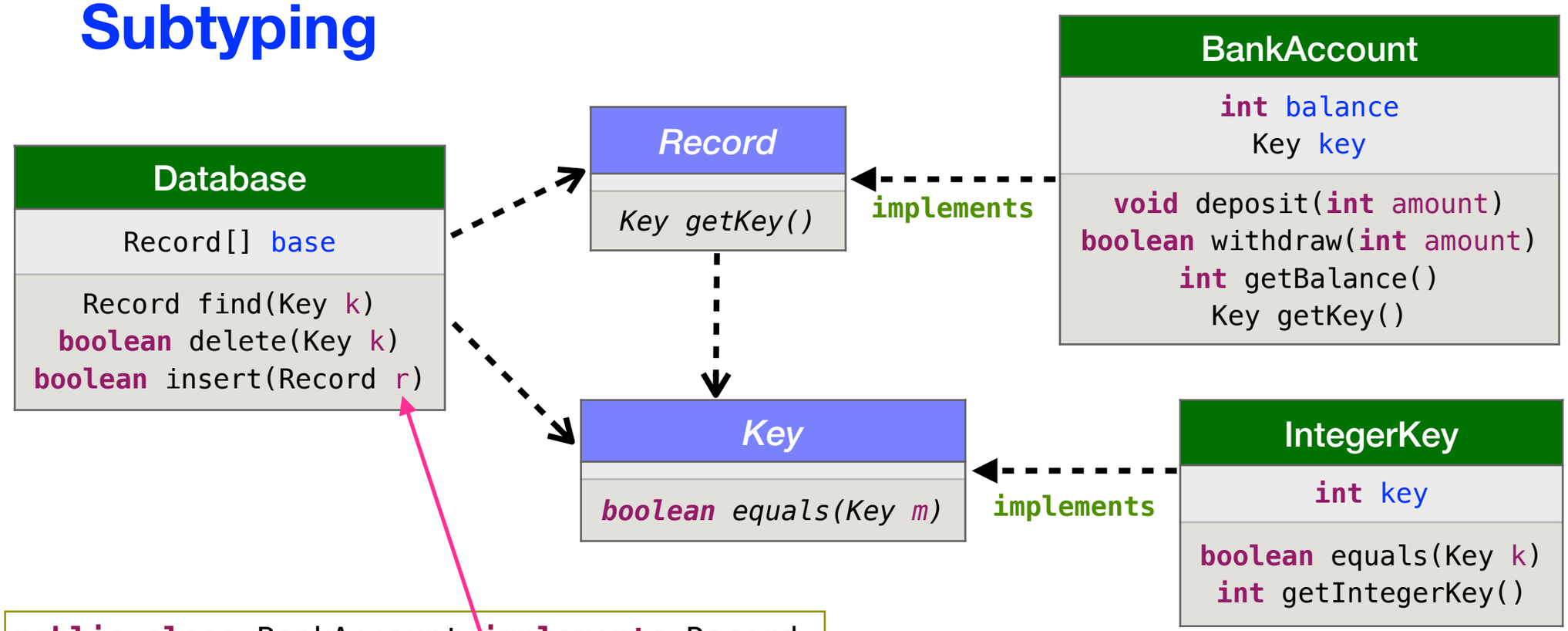



```
public class BankAccount implements Record
```

```
Database db = new Database(4);
IntegerKey k = new IntegerKey(55);
BankAccount b = new BankAccount(10000, k);
boolean success = db.insert(b);
```



Subtyping

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```

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Database db = new Database(4);
IntegerKey k = new IntegerKey(55);
BankAccount b = new BankAccount(10000, k);
boolean success = db.insert(b);
```

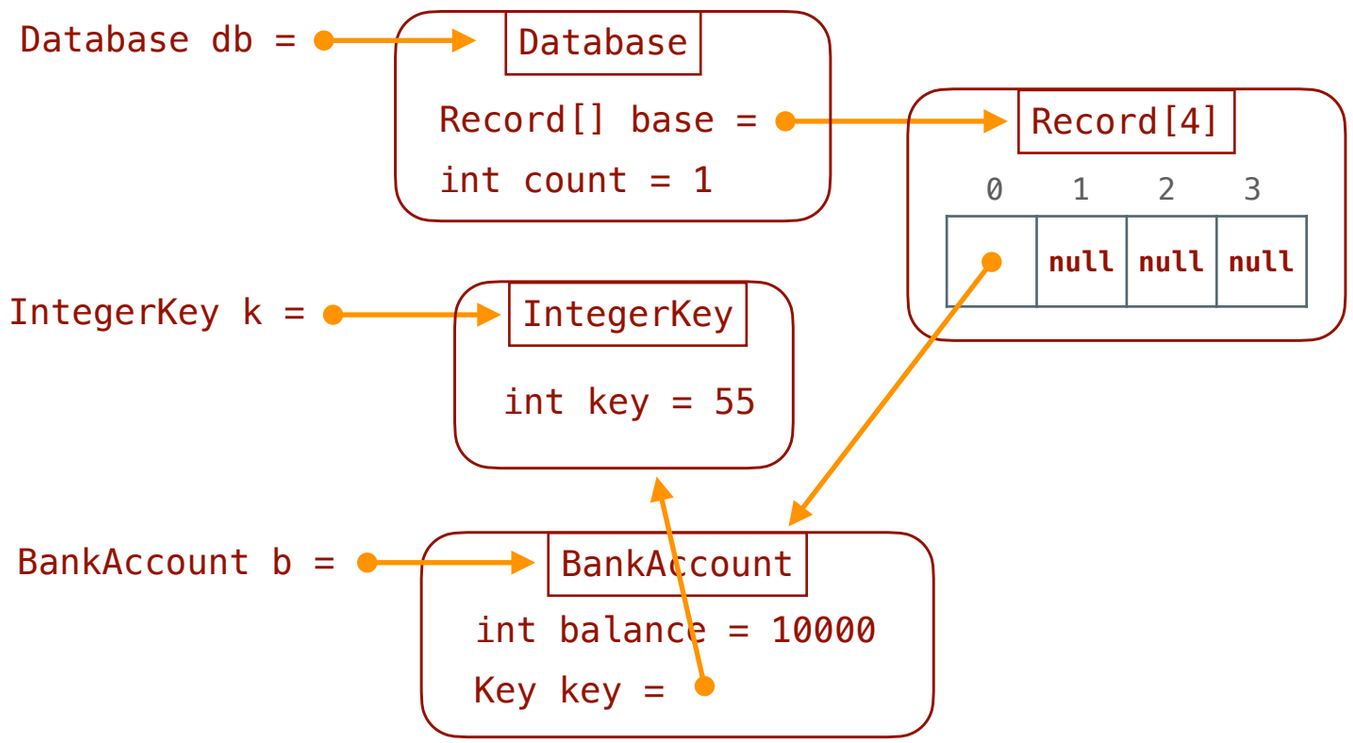

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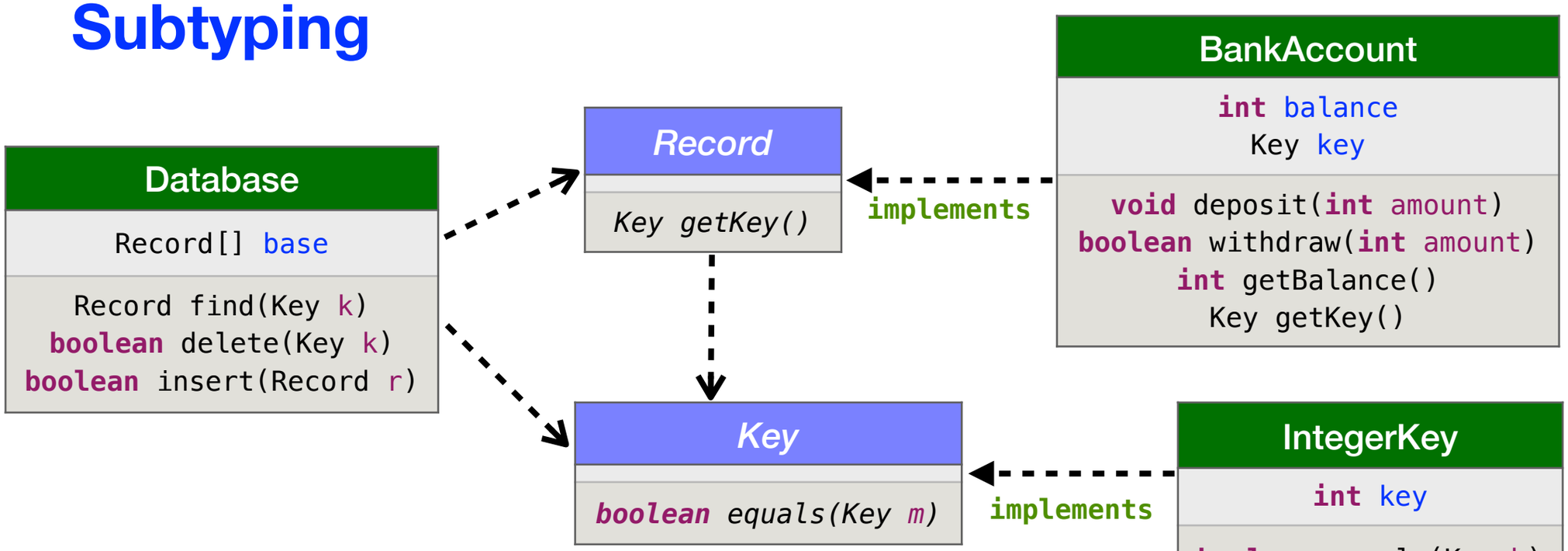
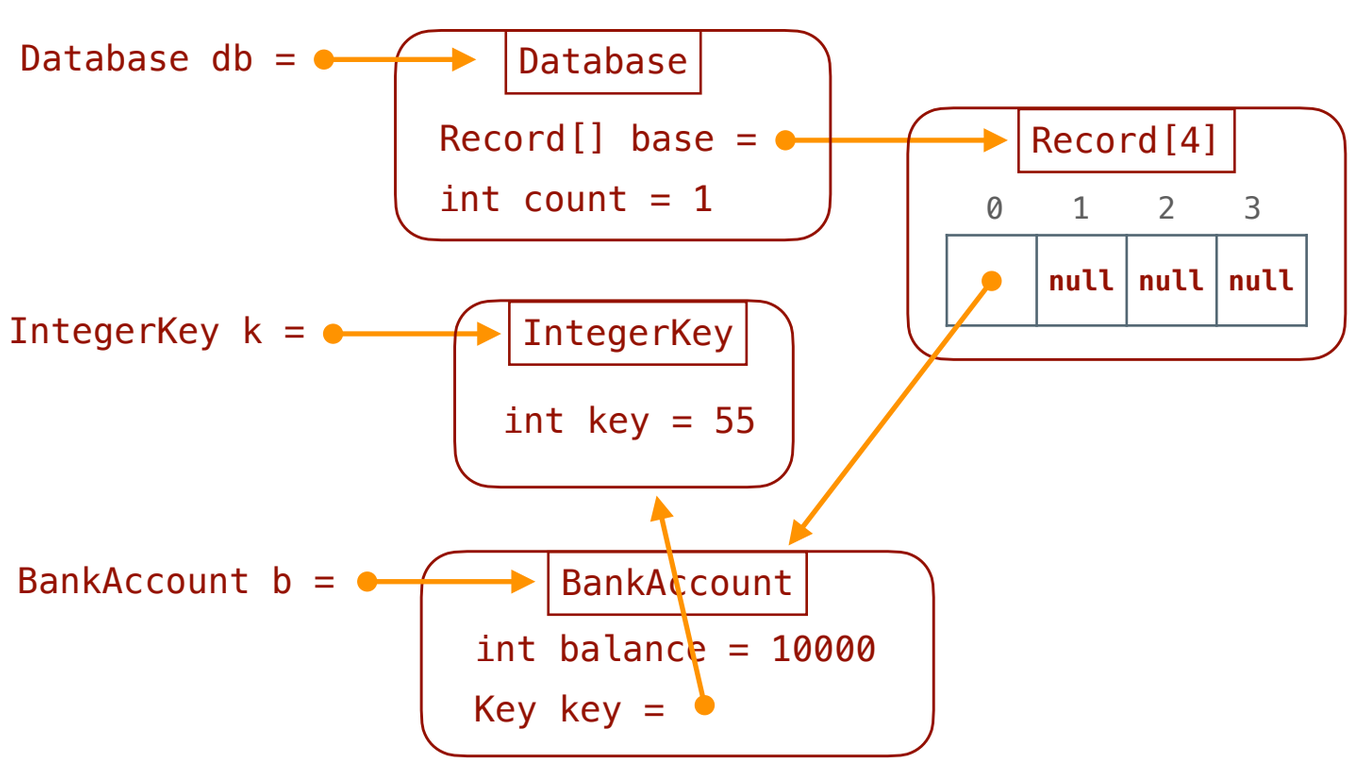



```
public class IntegerKey implements Key
```

```
Record r = db.find(k);

… r.getBalance() …

… ((BankAccount)r).getBalance() …;
```



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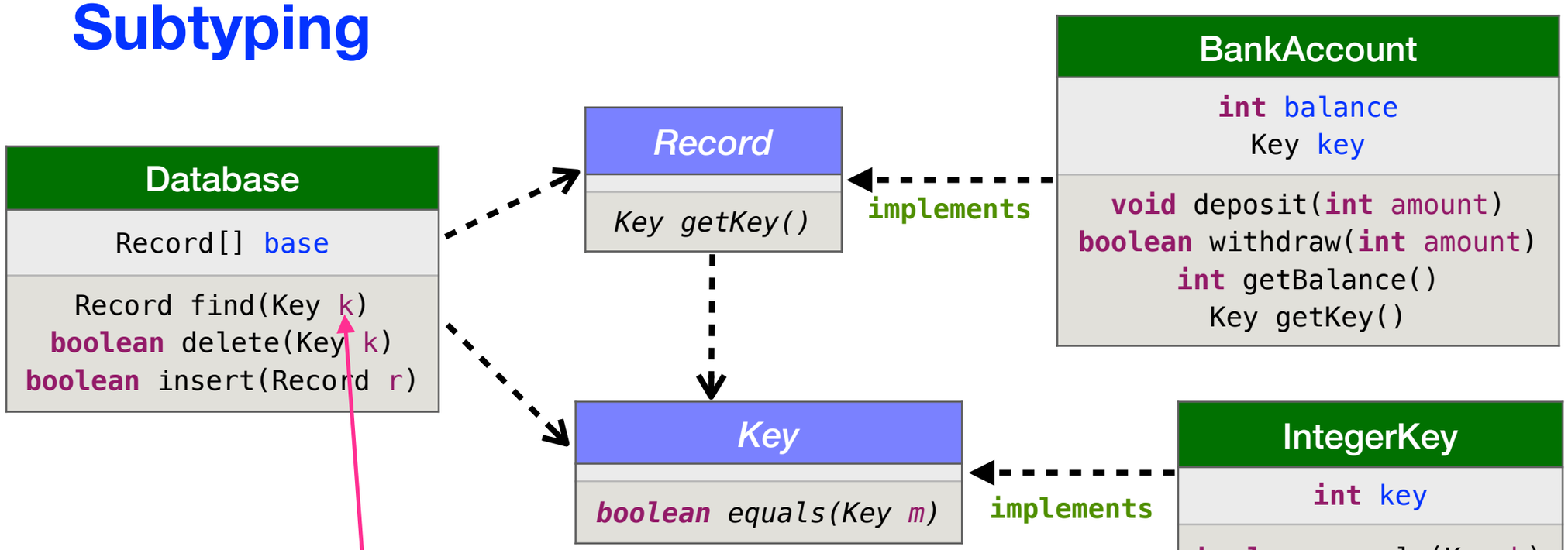


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public class IntegerKey implements Key
```

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Record r = db.find(k);

… r.getBalance() …

… ((BankAccount)r).getBalance() …;
```
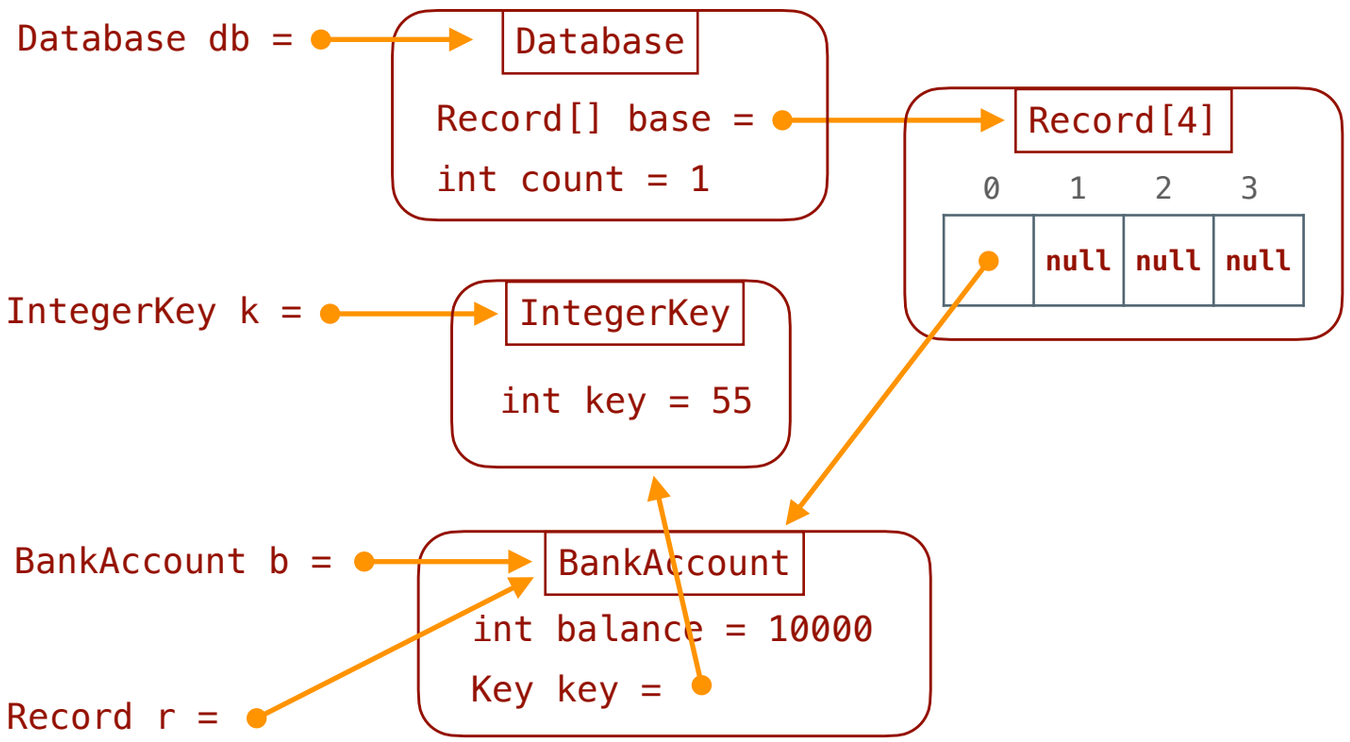
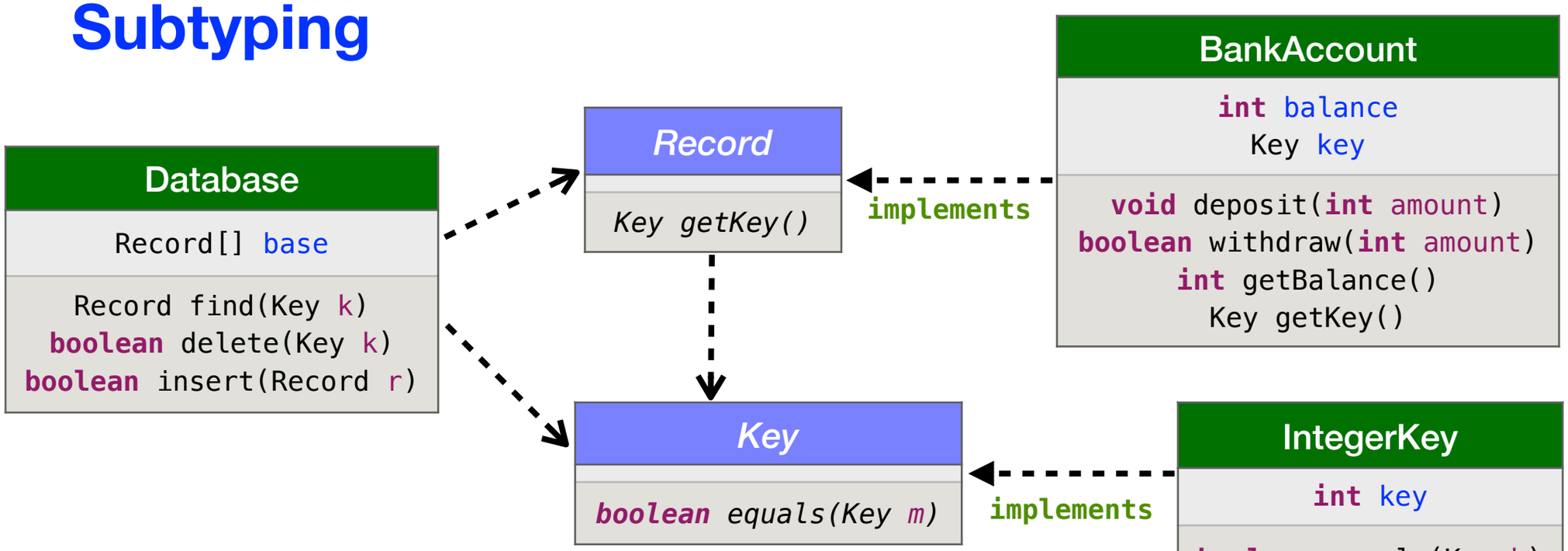



Subtyping

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… r.getBalance() …

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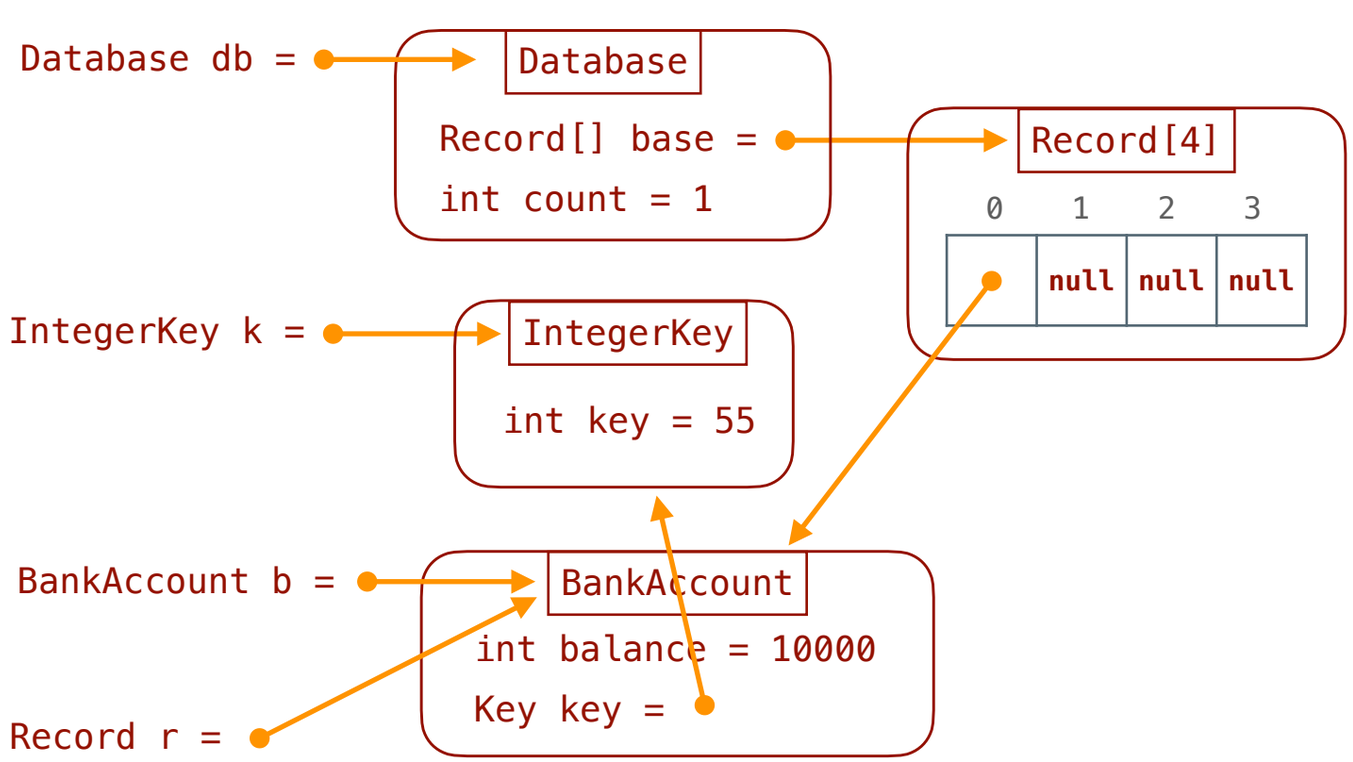
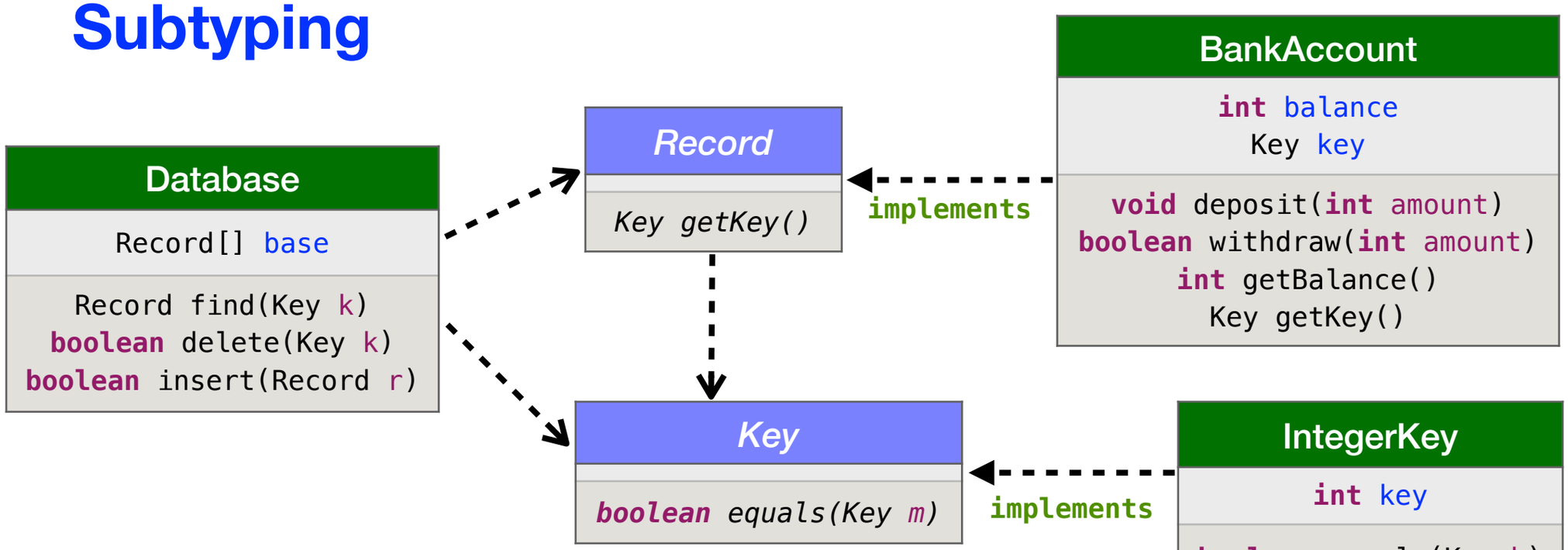


Subtyping




```
public class IntegerKey implements Key
```

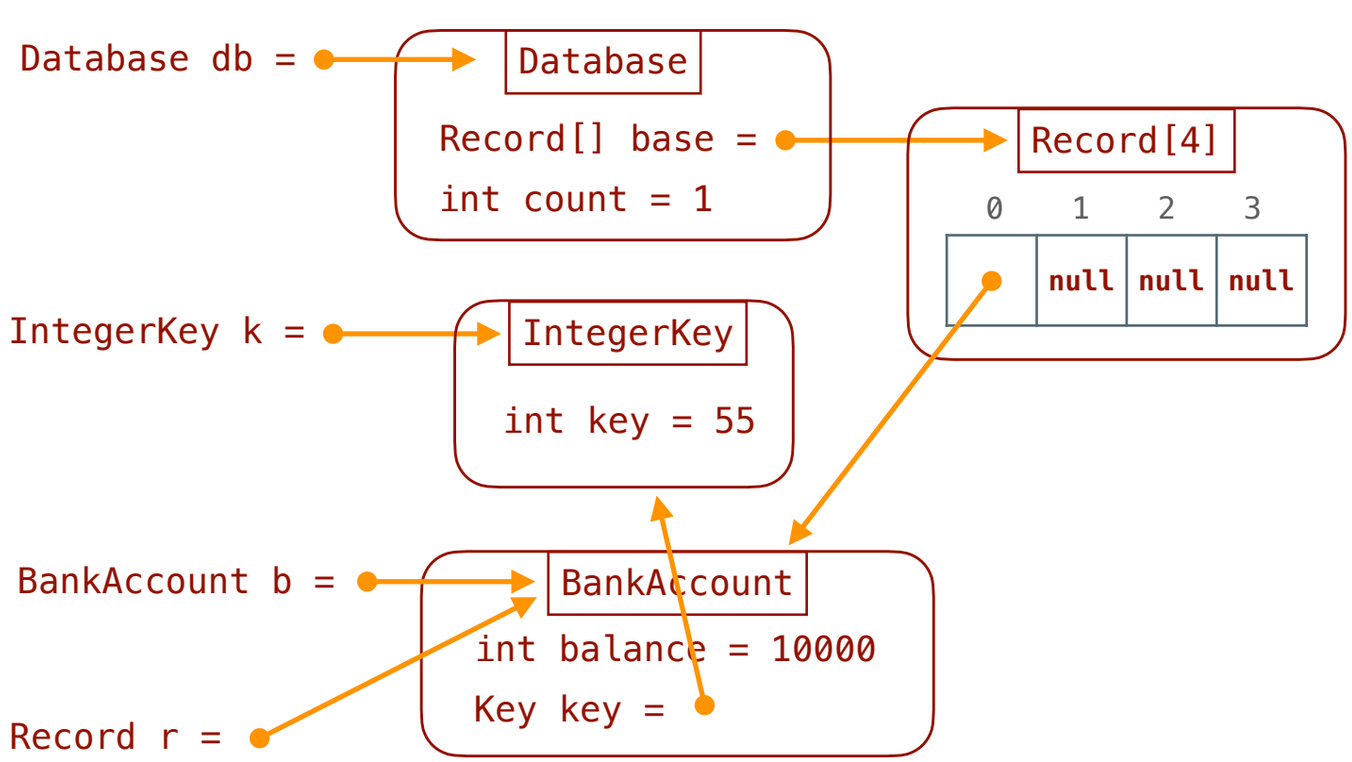
```
Record r = db.find(k);

… r.getBalance() …

… ((BankAccount)r).getBalance() …;
```

컴파일 실패!

타입오류 – Record 인터페이스는 getBalance() 메소드를 모른다.



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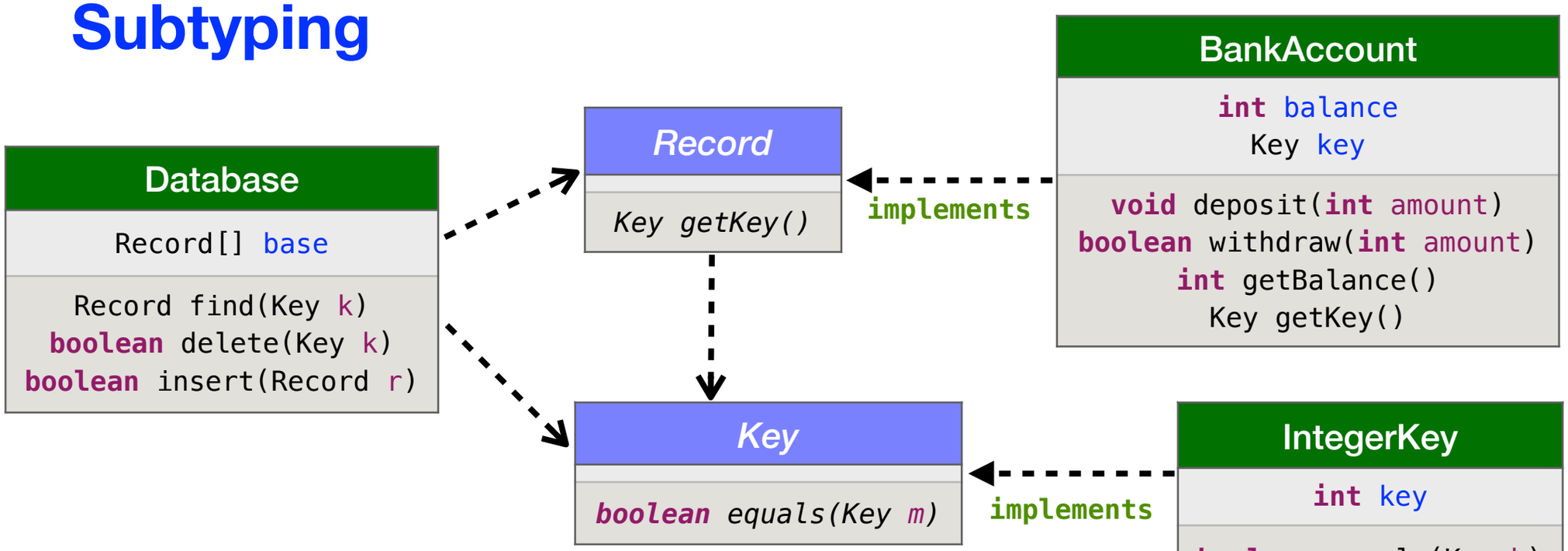


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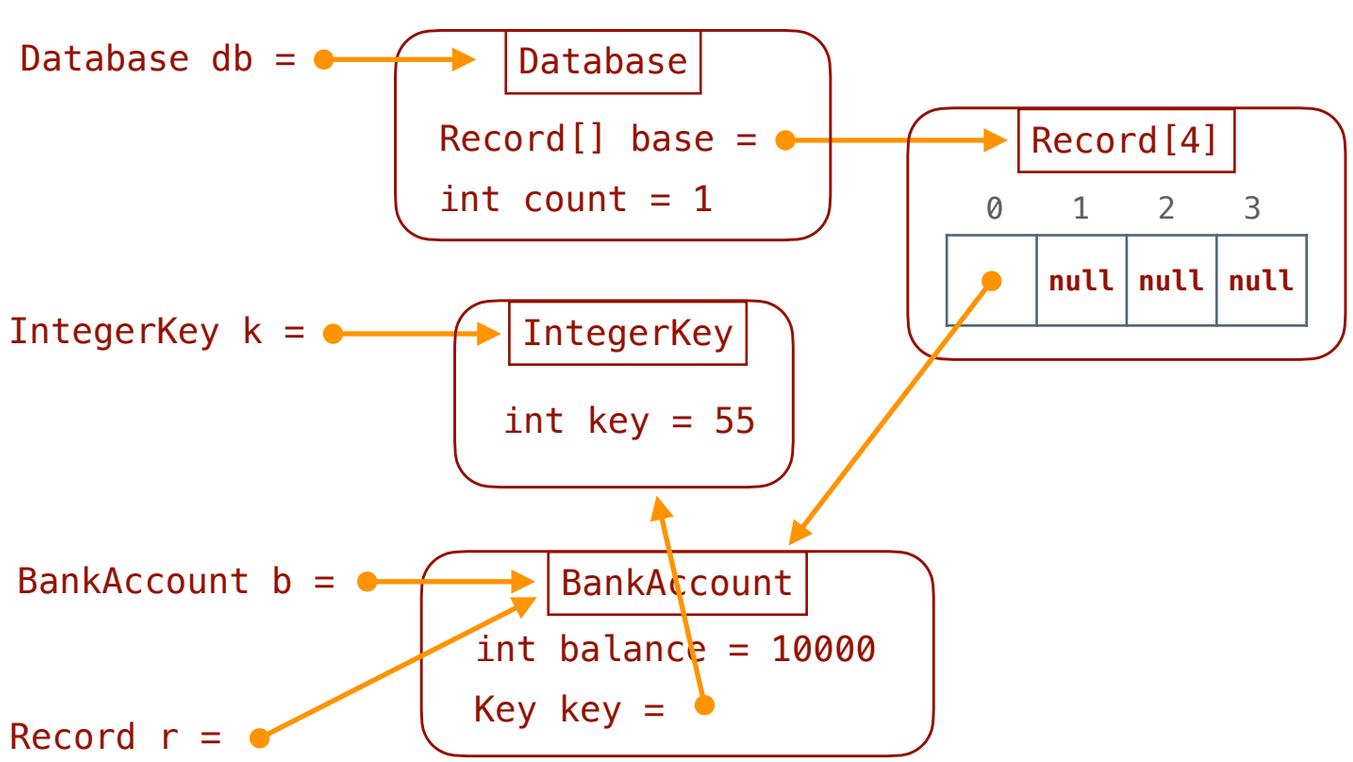
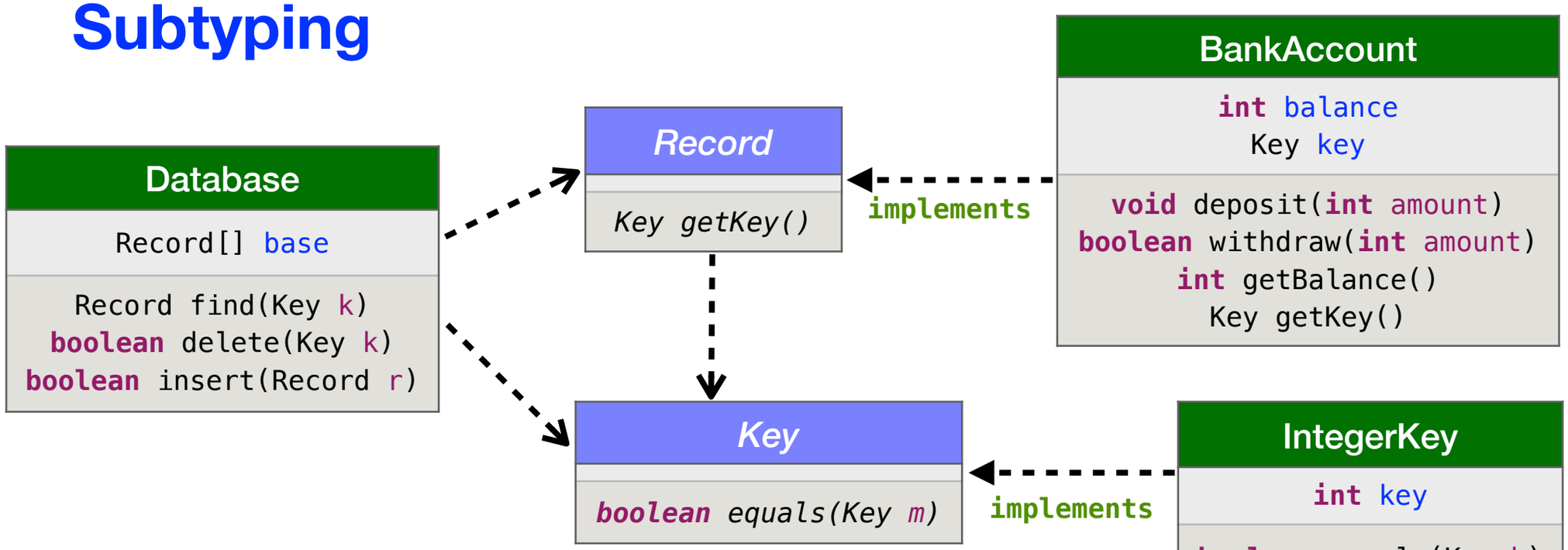


Subtyping



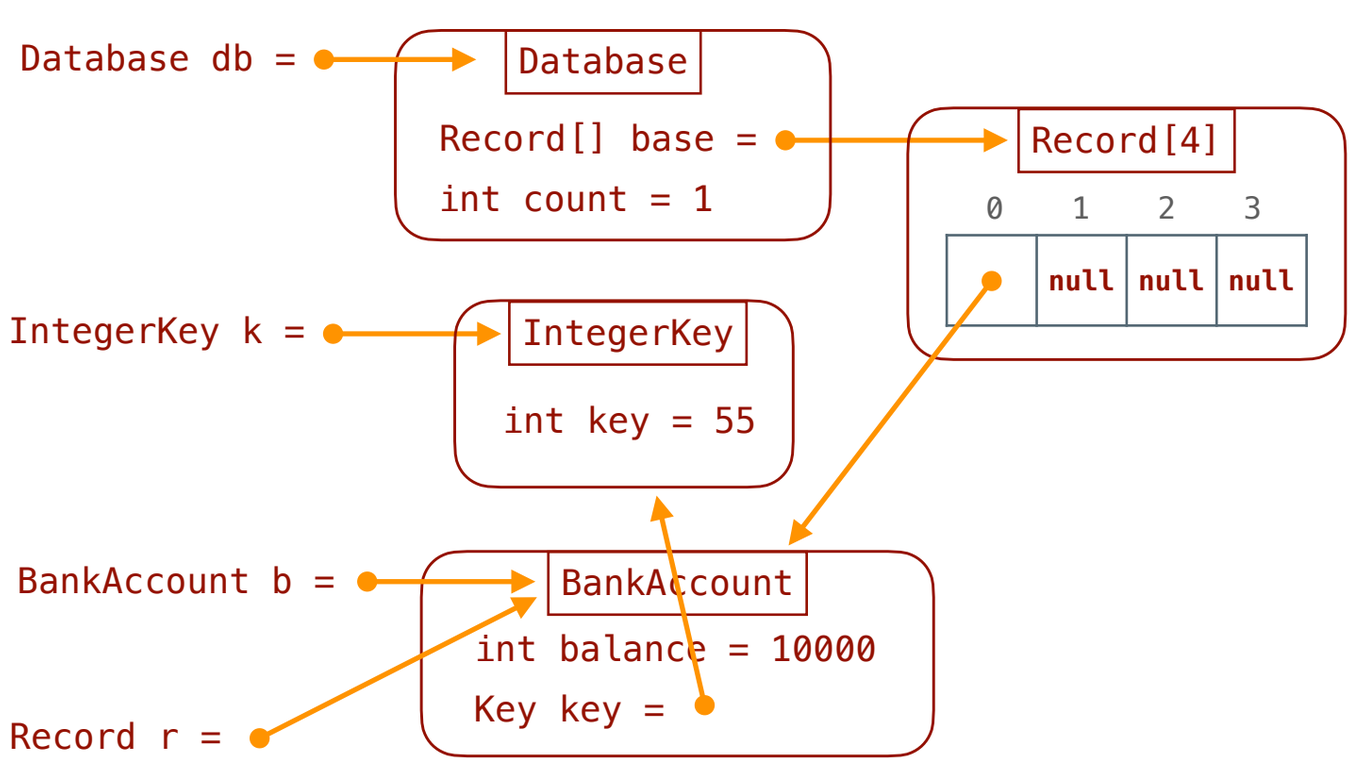

```
public class IntegerKey implements Key
```

```
Record r = db.find(k);

… r.getBalance() …

… ((BankAccount)r).getBalance() …;
```

타입 캐스트하여 컴파일 성공



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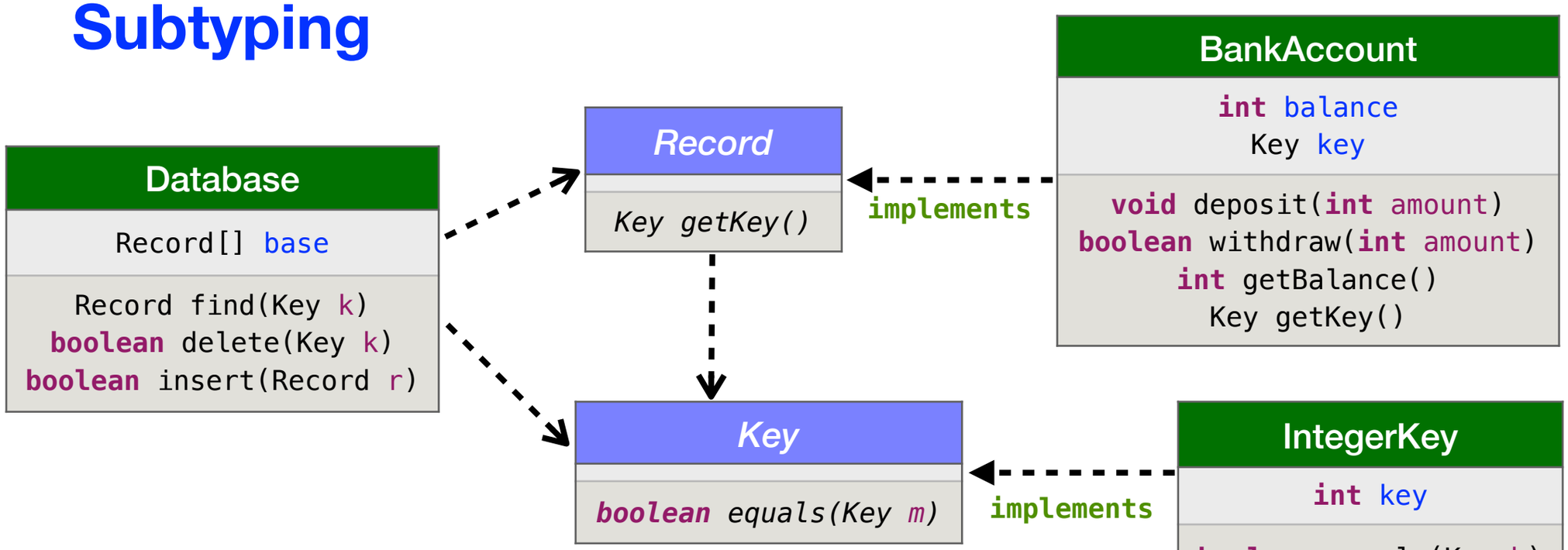


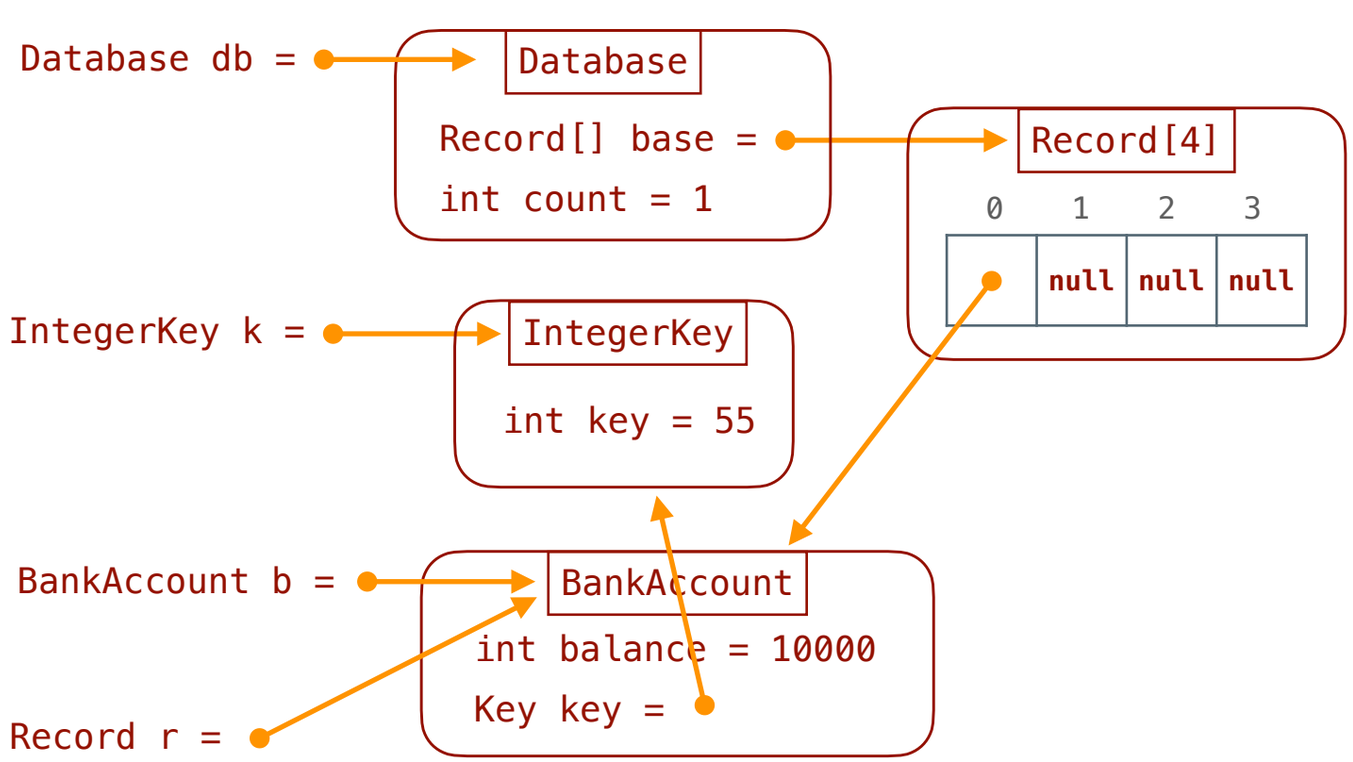

```
public class IntegerKey implements Key
```

BankAccount가 아니라면?

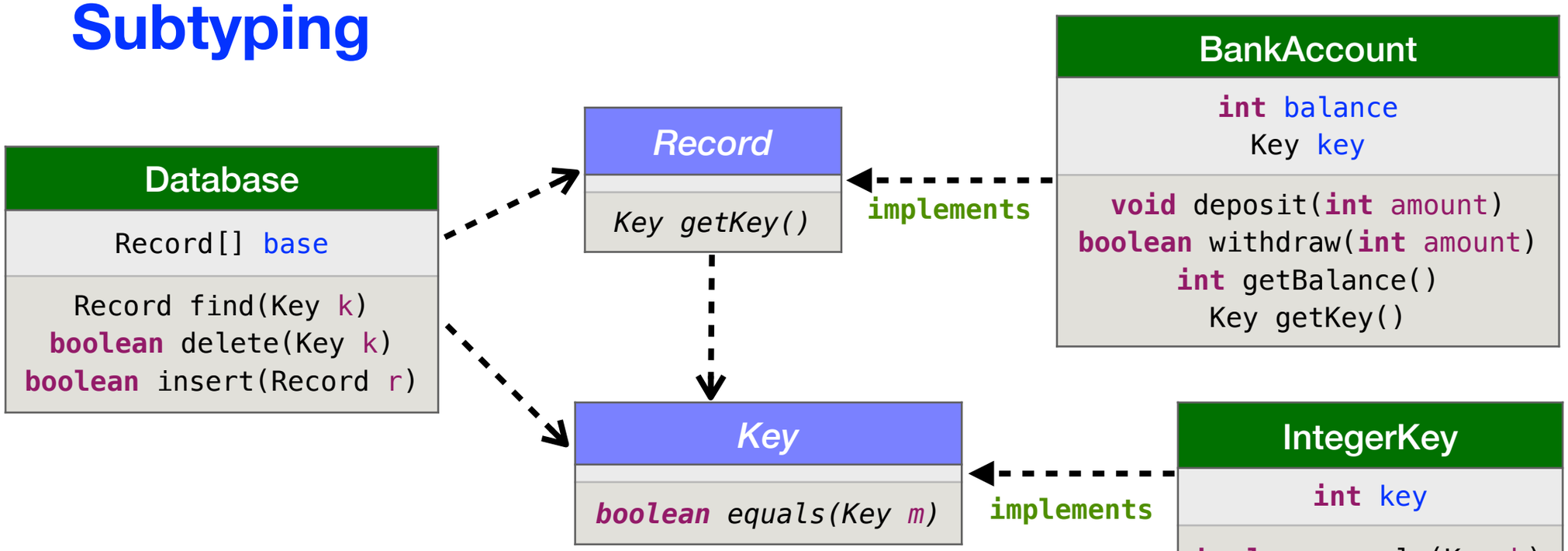
IntegerKey 아니라면?

```
Record r = db.find(some_key);
… ((BankAccount)r).getBalance() … ;
```

컴파일러 통과,
하지만 실행 오류 발생



Subtyping

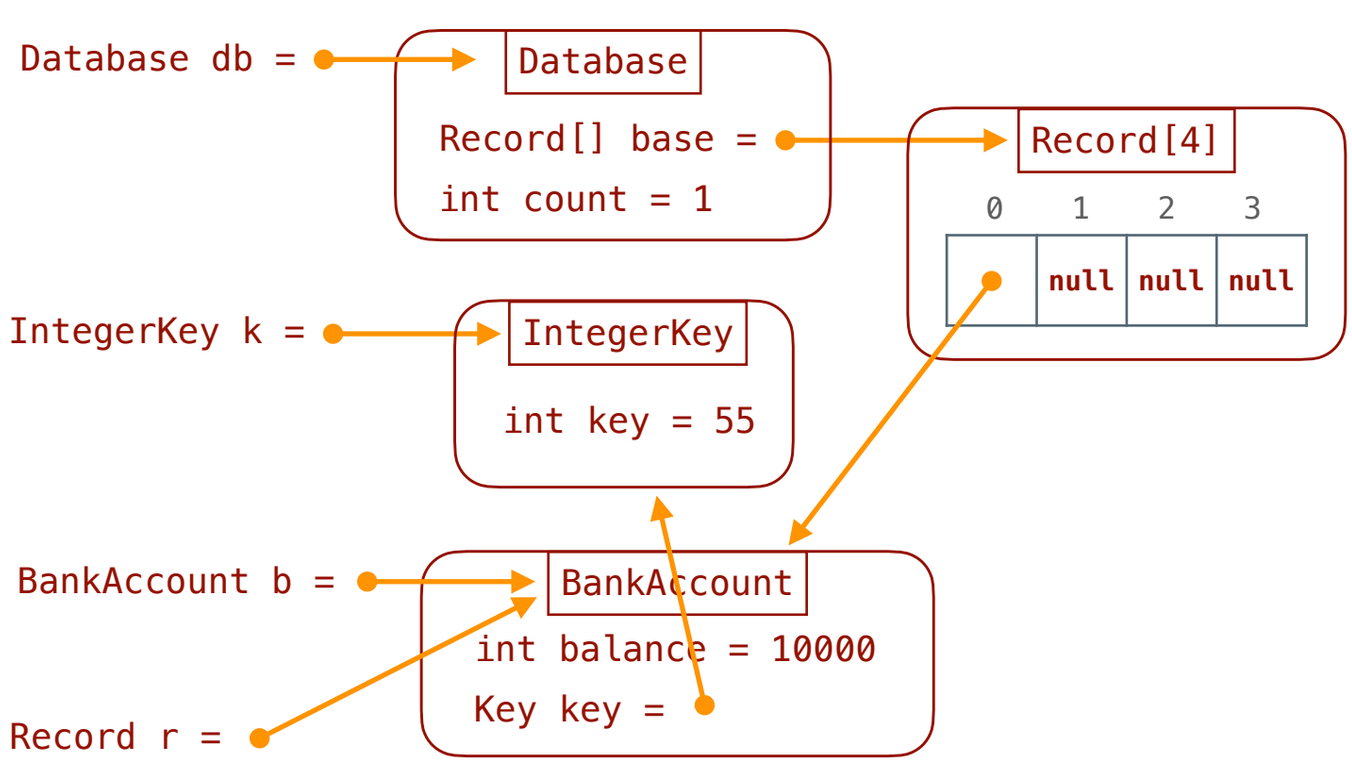



```
public class IntegerKey implements Key
```

```
Record r = db.find(k);

… r.getBalance() …

… ((BankAccount)r).getBalance() …;
```

```
Record r = db.find(some_key);
… ((BankAccount)r).getBalance() … ;
if (r instanceof BankAccount)
    … ((BankAccount)r).getBalance() … ;
else
    System.out.println("취급 불가 Record");
```

r이 BankAccount 인지 사전 확인해야 함



추가 예제

```java
public interface Key {

    /** equals - 인수로 제공된 키와 자신과 같은지 비교
     * @param - 비교 대상 키
     * @return - 같으면 true, 다르면 false */
    public boolean equals(Key m);
}
```

```java
public class StringKey implements Key {
    private String s;

    public StringKey(String s0) {
        s = s0;
    }

    public boolean equals(Key m) {
        return s == ((StringKey)m).getString();
    }

    public String getString() {
        return s;
    }
}
```

```java
IntegerKey k1 = new IntegerKey(3);
StringKey k2 = new StringKey("three");
boolean answer = k2.equals(k1);
```

컴파일러 무사 통과, 그러나 실행중 오류 발생 !

IntegerKey 객체는 getString() 메소드가 없음

수리 방법

```
public class StringKey implements Key {
    private String s;

    public StringKey(String j) {
        s = j;
    }

    public boolean equals(Key m) {
        if (m instanceof StringKey)
           return s.equals(((StringKey)m).getString());
        else
           return false;
    }

    public String getString() {
        return s;
    }
}
```

```
IntegerKey k1 = new IntegerKey(3);
StringKey k2 = new StringKey(“three”);
boolean answer = k2.equals(k1);
```

컴파일 OK,
실행 OK - false 리턴

실습#1. 서브 타입 이해하기

```java
public class Person {
    private String name;

    public Person(String n) {
        name = n;
    }

    public String getName() {
        return name;
    }

    public boolean sameName(Person other) {
        return getName().equals(other.getName();
    }
}
```

```java
public class PersonFrom extends Person {
    private String city;

    public PersonFrom(String n, String c) {
        super(n);
        city = c;
    }

    public String getCity() {
        return city;
    }

    public boolean same(PersonFrom other) {
        return sameName(other) &&
                city.equals(other.getCity());
    }
}
```

```java
Person p = new Person("마음");
Person q = new PersonFrom("소리","서울");
```

다음 각 문장을 이해하고, Java 컴파일러를 통과하는 문장을 고르고, 그 문장이 무엇을 프린트할지 예측해보자.

- `System.out.println(p.sameName(q));`
- `Person x = q; System.out.println(x.getName());`
- `PersonFrom x = p; System.out.println(x.getCity());`
- `Person x = q; System.out.println(x.getCity());`
- `System.out.println(q.same(p));`

실습#2. instanceof

1. IntegerKey를 구현하자.
2. 다음 코드를 실행하면 어떤 결과가 실행창에 프린트 될까?

```
Database db = new Database(4);

BankAccount a1 = new BankAccount(50000, new IntegerKey(55));
Key k = new StringKey("열려라");
BankAccount a2 = new BankAccount(10000, k);
boolean transaction1 = db.insert(a1);
boolean transaction2 = db.insert(a2);


Record p = db.find(k);
BankAccount q = (BankAccount)p;
System.out.println(q.getBalance());

Key k = q.getKey();
if (k instanceof IntegerKey)
    System.out.println(((IntegerKey)k).getInt());
else if (k instanceof StringKey)
    System.out.println(((StringKey)k).getString());
else
    System.out.println("모르는 Key 출현 오류");
```

실습#3. Dealer 클래스 구현

```
1  public interface CardPlayerBehavior {
2
3      /** wantsACard - 카드 한 장을 받겠는지 답한다.
4       * @return 카드를 받고 싶으면 true, 아니면 false */
5      public boolean wantsACard();
6
7      /** receiveCard - 카드 한 장을 받아서 손에 넣는다.
8       * @return 카드 수령 성공이면 true, 실패이면 false */
9      public boolean receiveCard(Card c);
10 }
```

class	Dealer	카드 딜러
method	`void dealTo(CardPlayerBehavior p)`	카드를 한 장씩 매번 물어보면서 원하는 만큼 p에게 준다.
	`void dealOneTo(CardPlayerBehavior p)`	카드를 한 장 p에게 준다.
collaborators	CardPlayerBehavior, CardDeck, Card	

Abstract Class

일부 메소드의 몸체가 비어있는 클래스

```
public abstract class Person {
    private String name;

    public Person(String n) {
        name = n;
    }

    public String getName() {
        return name;
    }

    public abstract String getAddress();

    ……
}
```

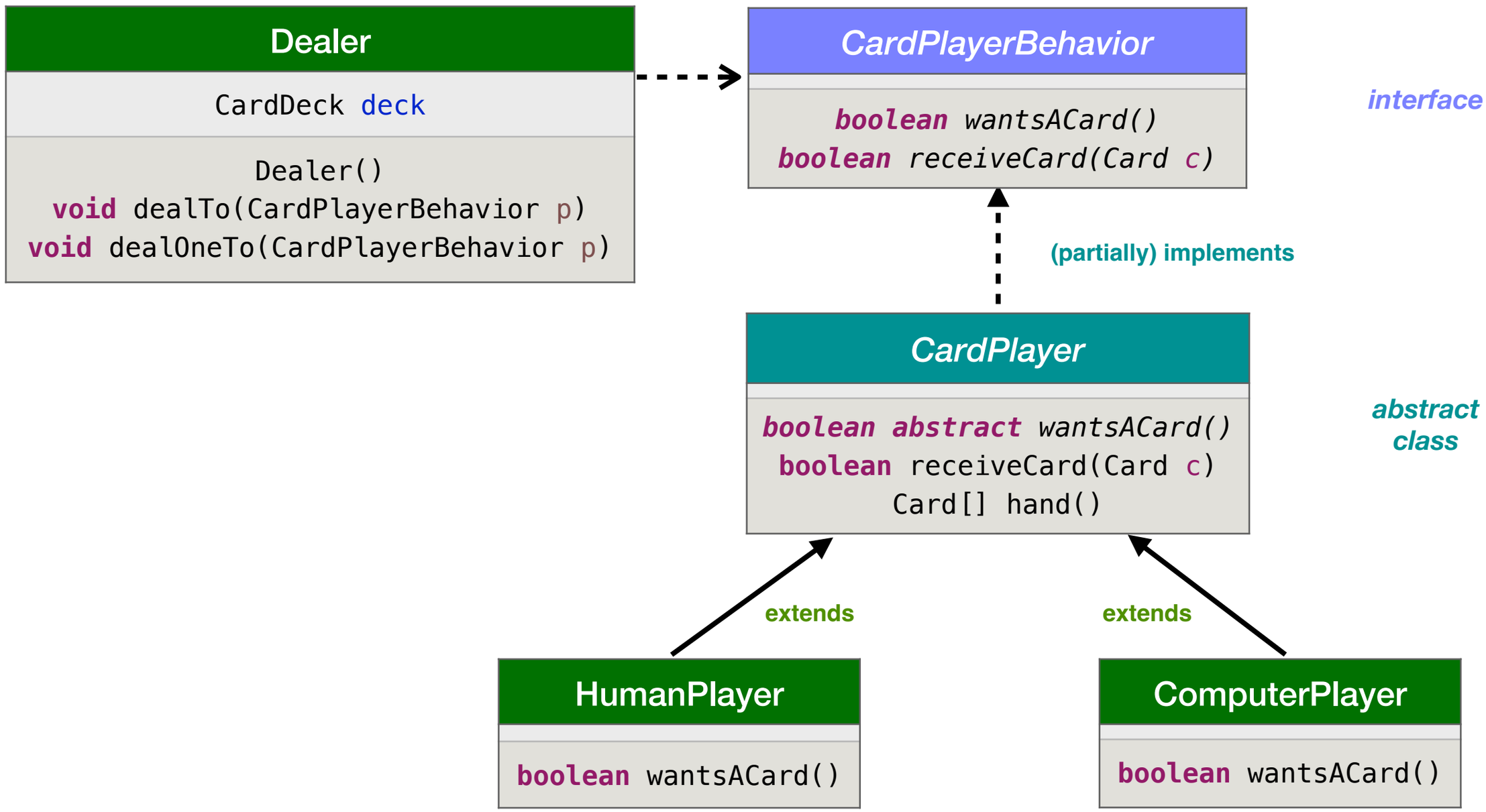
- `new Person()` 불가!
- `extends` 가능

```
public class PersonAddress extends Person {
    private String address;

    public PersonAddress(String n, String a) {
        super(n);
        address = a;
    }

    public String getAddress() {
        return address;
    }

    ……
}
```

```
public class PersonAddrInt extends Person {
    private int address;

    public PersonAddrInt(String n, int a) {
        super(n);
        address = a;
    }

    public String getAddress() {
        return "" + address;
    }

    ……
}
```

실습#4. Card Players 구현

Architecture for Dealer and Card Players



```
ComputerPlayer p = new ComputerPlayer(3);
HumanPlayer h = new HumanPlayer(3);
CardPlayer player1 = p;
CardPlayerBehavior player2 = player1;
```

```
if (player2 instanceof CardPlayer) {
    ((CardPlayer)player2).showcards();
}
```

ComputerPlayer p ==

HumanPlayer h ==

CardPlayer player1 ==

CardPlayerBehavior player2 ==

Card[3]

ComputerPlayer

```
public boolean wantsACard { . . . }

// from CardPlayer
Card[] hand ==
int card_count == 0
public boolean receiveCard(Card c) { . . . }
public Card[] showCards() { . . . }
```

HumanPlayer

```
public boolean wantsACard { . . . }

// from CardPlayer
Card[] hand ==
int card_count == 0
public boolean receiveCard(Card c) { . . . }
public Card[] showCards() { . . . }
```

Card[3]

```
ComputerPlayer
<= CardPlayer
<= CardPlayerBehavior

HumanPlayer
<= CardPlayer
<= CardPlayerBehavior
```

Frameworks

- 프레임워크는 특정 애프리케이션 제작에 특화한 아키텍처 구축용으로 미리 준비하여 모아 놓은 클래스와 인터페이스의 집합체
  - 그래픽 윈도우 구축용 프레임워크
  - 애니메이션 제작용 프레임워크
  - 스프레드쉬트 개발용 프레임워크
  - 음악 작곡용 프레임워크
  - 카드게임 개발용 프레임워크
- 프레임워크의 일부는 `abstract class` 로 비워 둠
- 사례
  - Java’s Abstract Window Toolkit (`java.awt`) package
  - Java’s Swing (`javax.swing`) package

Packages

- 폴더 안에 모아 놓은 클래스와 인터페이스를 통틀어 패키지라고 한다.
  - `java.util`
  - `java.awt`
  - `javax.swing`
- `import <패키지이름>` 의 형식으로 불러쓴다.

class Object

Object는 존재하는 모든 클래스의 최상위 객체

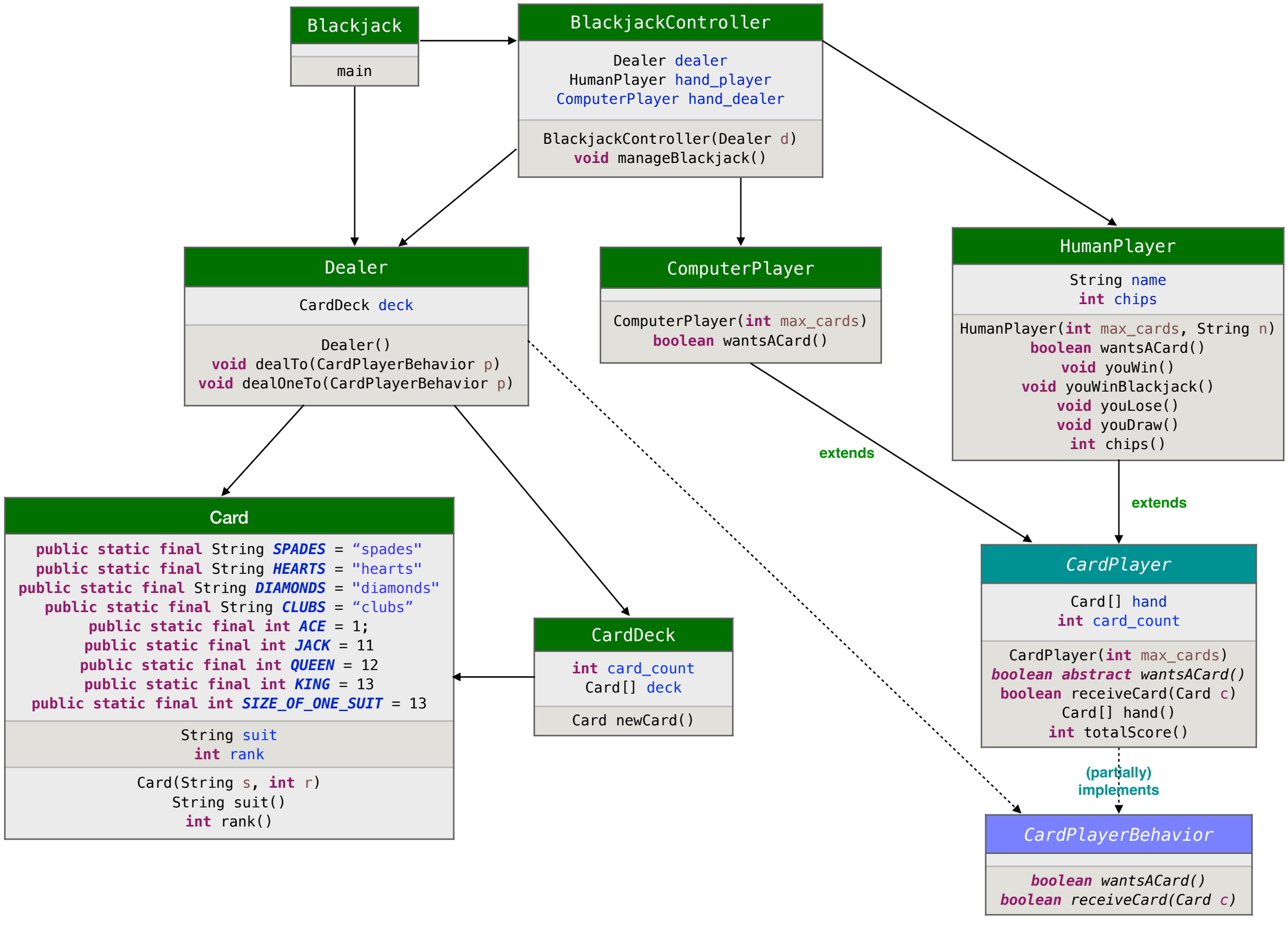
모든 클래스 C에 대해서, C <= Object

소속 패키지: java.lang

```
public class Pair {
    Object[] r = new Object[2];

    public Pair(Object ob1, Object ob2) {
        r[0] = ob1;
        r[1] = ob2;
    }

    public Object get1st(){
        return r[0];
    }

    public Object get2nd(){
        return r[1];
    }
}
```

```
Pair p = new Pair("abc", 7);

Object item1 = p.get1st();
System.out.println((String)item1 + (String)item1);

Object item2 = p.get2nd();
System.out.println((int)item2 + 2);
```

Blackjack


Blackjack
main
BlackjackController
Dealer dealer
HumanPlayer hand_player
ComputerPlayer hand_dealer
BlackjackController(Dealer d)
void manageBlackjack()
Dealer
CardDeck deck
Dealer()
void dealTo(CardPlayerBehavior p)
void dealOneTo(CardPlayerBehavior p)
ComputerPlayer
ComputerPlayer(int max_cards)
boolean wantsACard()
HumanPlayer
String name
int chips
HumanPlayer(int max_cards, String n)
boolean wantsACard()
void youWin()
void youWinBlackjack()
void youLose()
void youDraw()
int chips()
extends
extends
Card
public static final String SPADES = “spades"
public static final String HEARTS = "hearts"
public static final String DIAMONDS = "diamonds"
public static final String CLUBS = “clubs”
public static final int ACE = 1;
public static final int JACK = 11
public static final int QUEEN = 12
public static final int KING = 13
public static final int SIZE_OF_ONE_SUIT = 13
String suit
int rank
Card(String s, int r)
String suit()
int rank()
CardDeck
int card_count
Card[] deck
Card newCard()
CardPlayer
Card[] hand
int card_count
CardPlayer(int max_cards)
boolean abstract wantsACard()
boolean receiveCard(Card c)
Card[] hand()
int totalScore()
(partially) implements
CardPlayerBehavior
boolean wantsACard()
boolean receiveCard(Card c)