CSE2016

프로그램설계방법론

상속을 활용한 프로그램 부품의 재사용

Component Reuse through Inheritance

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Starter

PuzzleStarter

main

종속 관계로 클래스 독립 개별 구현 불가

Controller

Model

PuzzleController

SlidePuzzleBoard board
PuzzleWriter writer

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

SlidePuzzleBoard

PuzzlePiece[][] board
int empty_row
int empty_col

PuzzlePiece[][] contents()
boolean move(int w)
boolean found(int v, int row, int col)

1

*

Output View

PuzzleWriter

SlidePuzzleBoard board
final int SIZE

PuzzleWriter(SlidePuzzleBoard b)
void displayPuzzle()
void printError(String s)

has
JPanel

uses
javax.swing
java.awt

PuzzlePiece

int face_value

int faceValue()

specification

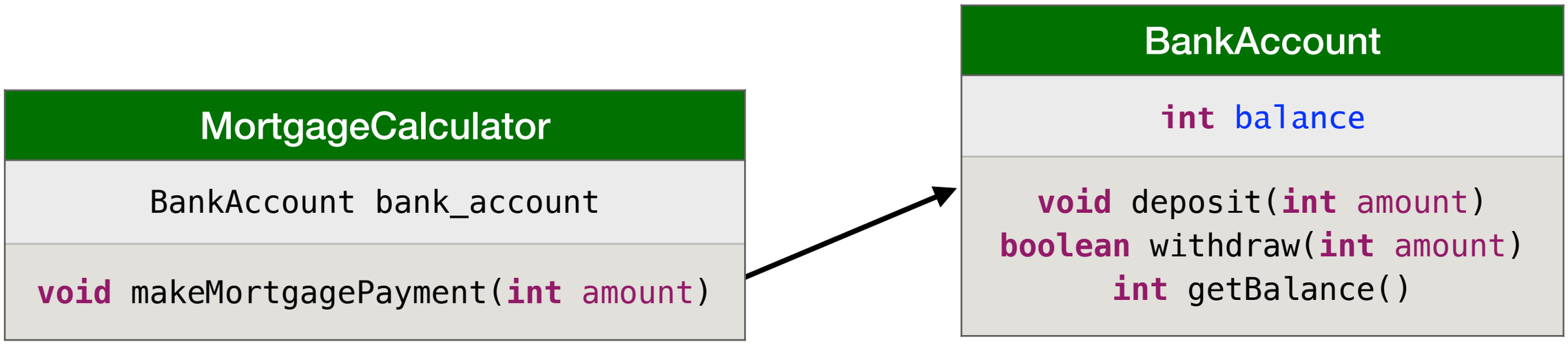
Programming to the interface,

not the implementation

class

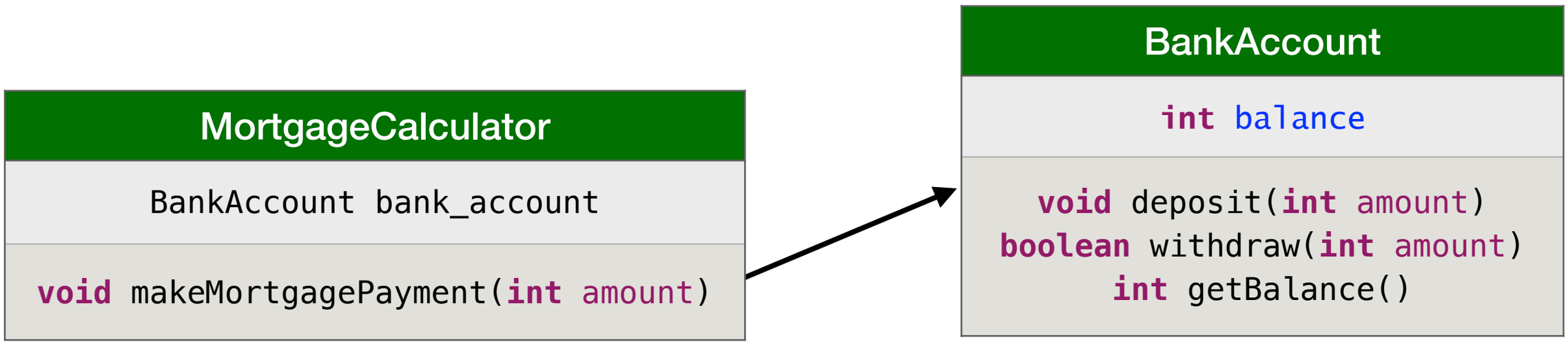
프로그래밍 작업 분업 가능

클래스 다이어그램


MortgageCalculator
BankAccount bank_account
void makeMortgagePayment(int amount)
BankAccount
int balance
void deposit(int amount)
boolean withdraw(int amount)
int getBalance()

클래스 다이어그램

구현 분업?



클래스 다이어그램

구현 분업 가능!

class

MortgageCalculator

BankAccountSpecification bank_account

void makeMortgagePayment(**int** amount)

class

BankAccount

int balance

void deposit(**int** amount)
boolean withdraw(**int** amount)
int getBalance()

implements

BankAccountSpecification

void *deposit(**int** amount)*
boolean *withdraw(**int** amount)*

interface

```java
public interface BankAccountSpecification {

    /** deposit - 입금
     * @param amount - 입금액 (0이상의 정수) */
    public void deposit(int amount);

    /** withdraw - 출금 (잔고가 충분하면)
     * @param amount - 출금액 (0이상의 정수)
     * @return true - 출금 성공, false - 출금 실패 */
    public boolean withdraw(int amount);

}
```

```java
public class MortgagePaymentCalculator {

    private BankAccountSpecification bank_account;

    /** Constructor
     * @param account - 사용 계좌 */
    public MortgagePaymentCalculator(BankAccountSpecification account) {
        bank_account = account;
    }

    /** */
    public void makeMortgagePayment(int amount) {
        if (bank_account.withdraw(amount))
            System.out.println(amount + "원 지불");
        else
            System.out.println("잔고 부족");
    }
}
```

```java
public class BankAccount implements BankAccountSpecification {

    private int balance;

    public BankAccount() {
        balance = 0;
    }

    /** deposit - 입금
     * @param amount - 입금액 (0이상의 정수) */
    public void deposit(int amount) {
        balance = balance + amount;
    }

    /** withdraw - 출금 (잔고가 충분하면)
     * @param amount - 출금액 (0이상의 정수)
     * @return true - 출금 성공, false - 출금 실패 */
    public boolean withdraw(int amount) {
        if (amount <=  balance) {
            balance -= amount;
            return true;
        }
        else
            return false;
    }

    /** getBalance - 잔액 리턴
     * @return - 잔액 */
    public int getBalance() {
        return balance;
    }
}
```

```java
public interface BankAccountSpecification {

    /** deposit - 입금
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    public boolean withdraw(int amount);

}
```
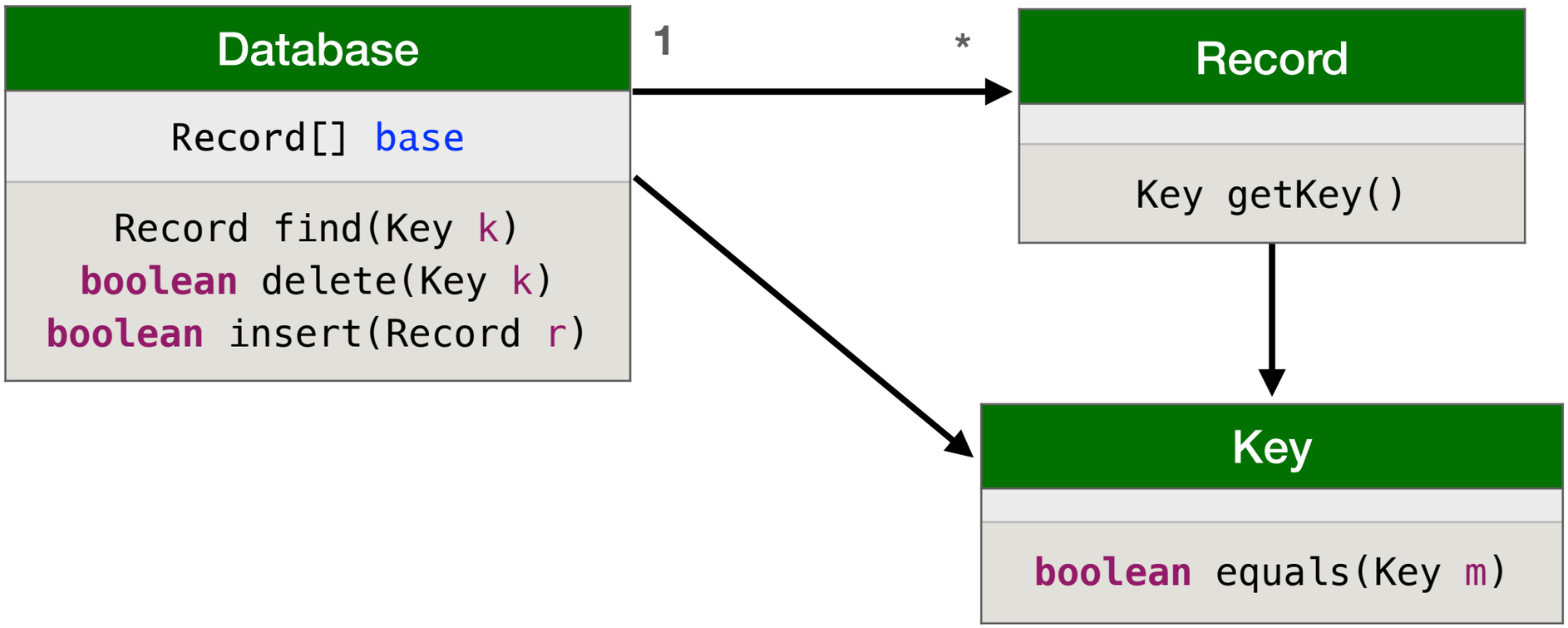

Arhitecture for a Database



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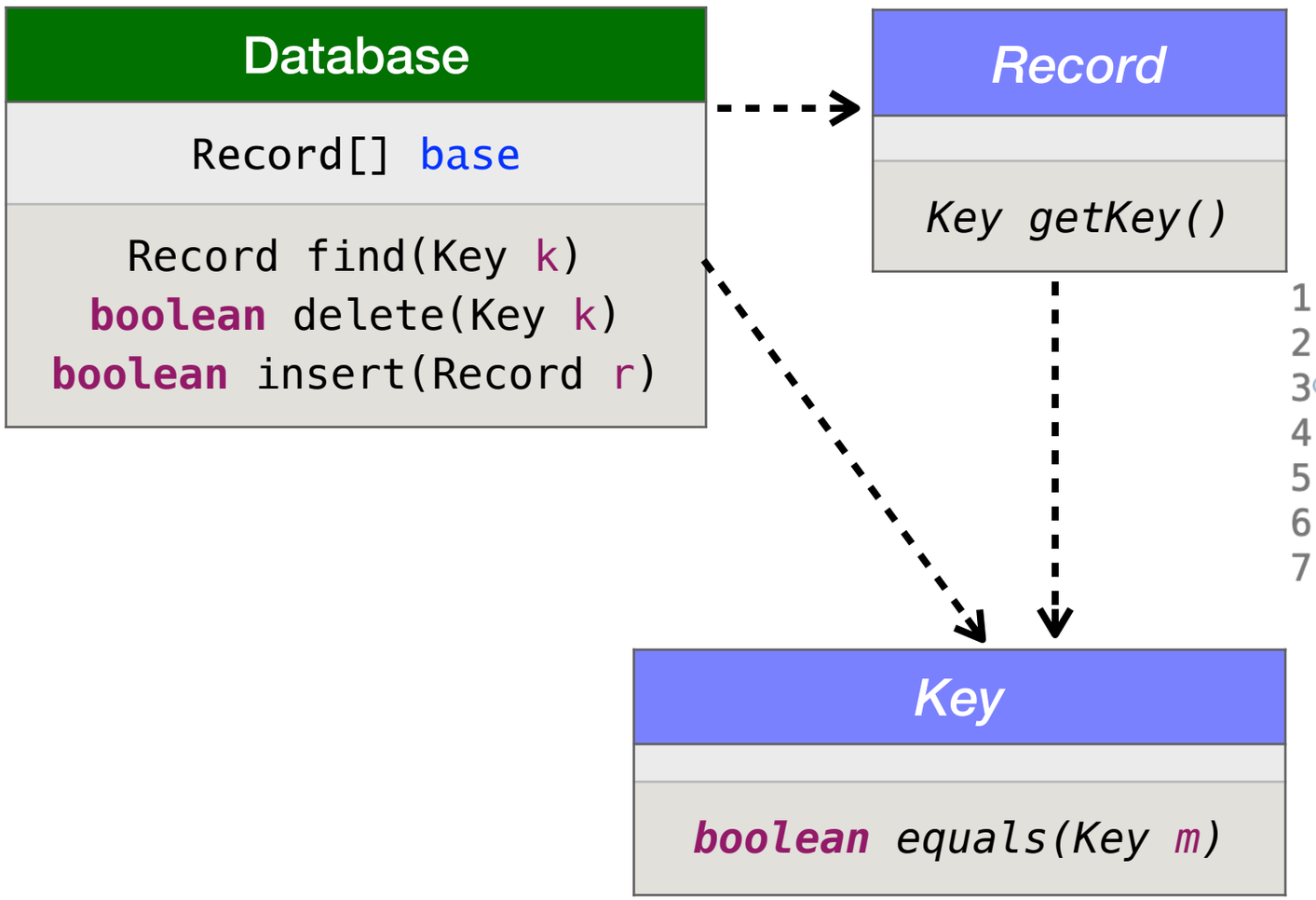
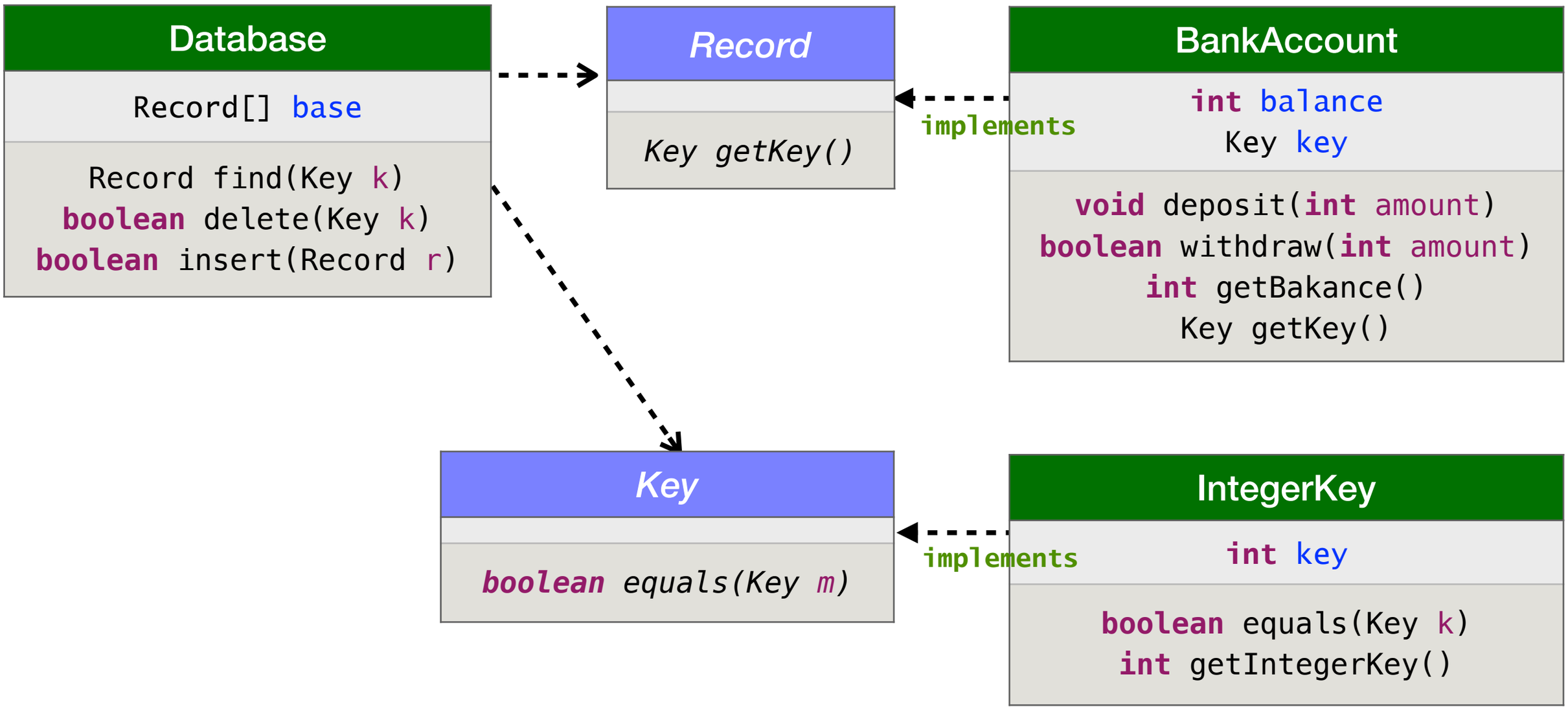



```java
public interface Record {

    /** 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);
}
```

Architecture for Bank Database Application



상속을 활용한 프로그램 부품의 재사용

```java
public interface Record {

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

}
```

```java
public class BankAccount implements Record {

    private int balance;
    private Key key;

    /** Constructor - 계좌 개설
     * @param initial_amount - 개설 예금액
     * @param id - 계좌의 키 */
    public BankAccount(int initial_amount, Key id) {
        balance = initial_amount;
        key = id;
    }

    /** deposit - 입금
     * @param amount - 입금액 (0이상의 정수) */
    public void deposit(int amount) {
        balance = balance + amount;
    }

    /** withdraw - 출금 (잔고가 충분하면)
     * @param amount - 출금액 (0이상의 정수)
     * @return true - 출금 성공, false - 출금 실패 */
    public boolean withdraw(int amount) {
        if (amount <=  balance) {
            balance -= amount;
            return true;
        }
        else
            return false;
    }

    /** getBalance - 잔액 리턴
     * @return - 잔액 */
    public int getBalance() {
        return balance;
    }

    /** getKey - 계좌 키 리턴
     * @return - 키 */
    public Key getKey() {
        return key;
    }
}
```

```java
public class IntegerKey implements Key {

    private int k;

    public IntegerKey(int i) {
        k = i;
    }

    public boolean equals(Key c) {
        return k == ((IntegerKey)c).getInt();
    }

    public int getInt() {
        return k;
    }

}
```

```java
public interface Key {

    /** equals - 인수로 제공된 키와 자신과 같은지 비교
     * @param - 비교 대상 키
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    public boolean equals(Key m);
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```

상속 Inheritance	구현 Implementation
`class Sub extends Super`	`class C implements S`
• 클래스 Super를 상속 받아 클래스 Sub를 구현 • 클래스 Super의 코드를 클래스 Sub에서 재사용 • Sub: 하위 클래스 • Super: 상위 클래스	• 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 getName() {
        return name;
    }

    ……
}
```

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

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

    public String getCity() {
        return city;
    }

    ……
}
```

```
PersonFrom x = new PersonFrom("마음", "안산");
System.out.println("이름: " + x.getName());
System.out.println("출신: " + x.getCity());
```

상속을 활용한 프로그램 부품의 재사용

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

- `System.out.println(p.getCity());`
- `System.out.println(q.getName());`
- `System.out.println(p.sameName(p));`
- `System.out.println(q.sameName(p));`
- `System.out.println(q.same(p));`

기본 타입 Primitive Types

`byte`, `int`, `long`, `float`, `double`, `boolean`

Subtyping

`int <= double`

`int`는 `double`의 서브타입 이다.

`double` 값을 쓸 수 있는 곳에서 `int` 값도 쓸 수 있다.

예:

```
double d = 4.5 / 2;
```

```
public double inverseOf(double d) {
    return 1.0 / d
}
```

```
System.out.println(inverseOf(3));
```

`byte <= int <= long <= float <= double`

객체 타입 Object/Reference Types

Subtyping

상속
inheritance

```
public class MyPanel extends JPanel { . . . }
```

MyPanel <= JPanel

MyPanel는 **JPanel**의 서브타입 이다.

JPanel 객체을 쓸 수 있는 곳에서 **MyPanel** 객체도 쓸 수 있다.

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

JPanel의 서브 타입 객체를 모두 수용

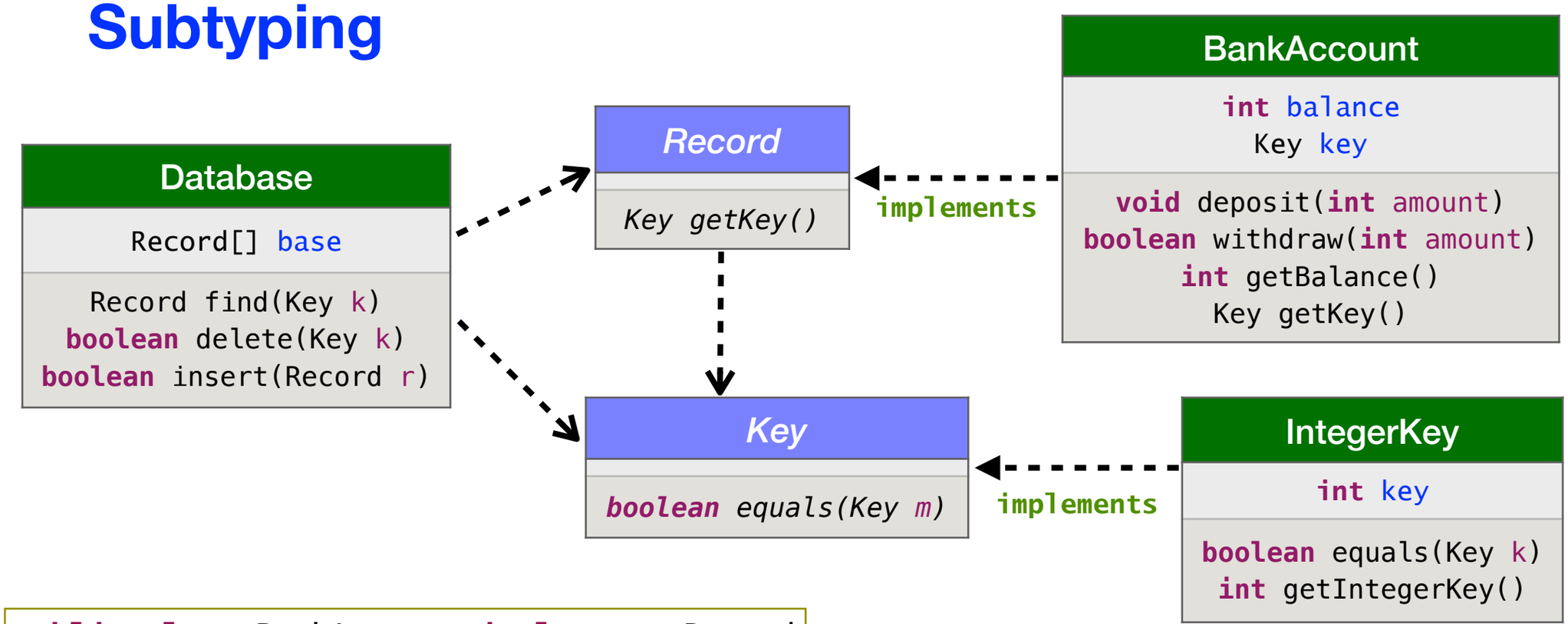
Subtyping

```
public class BankAccount implements Record
```

BankAccount <= 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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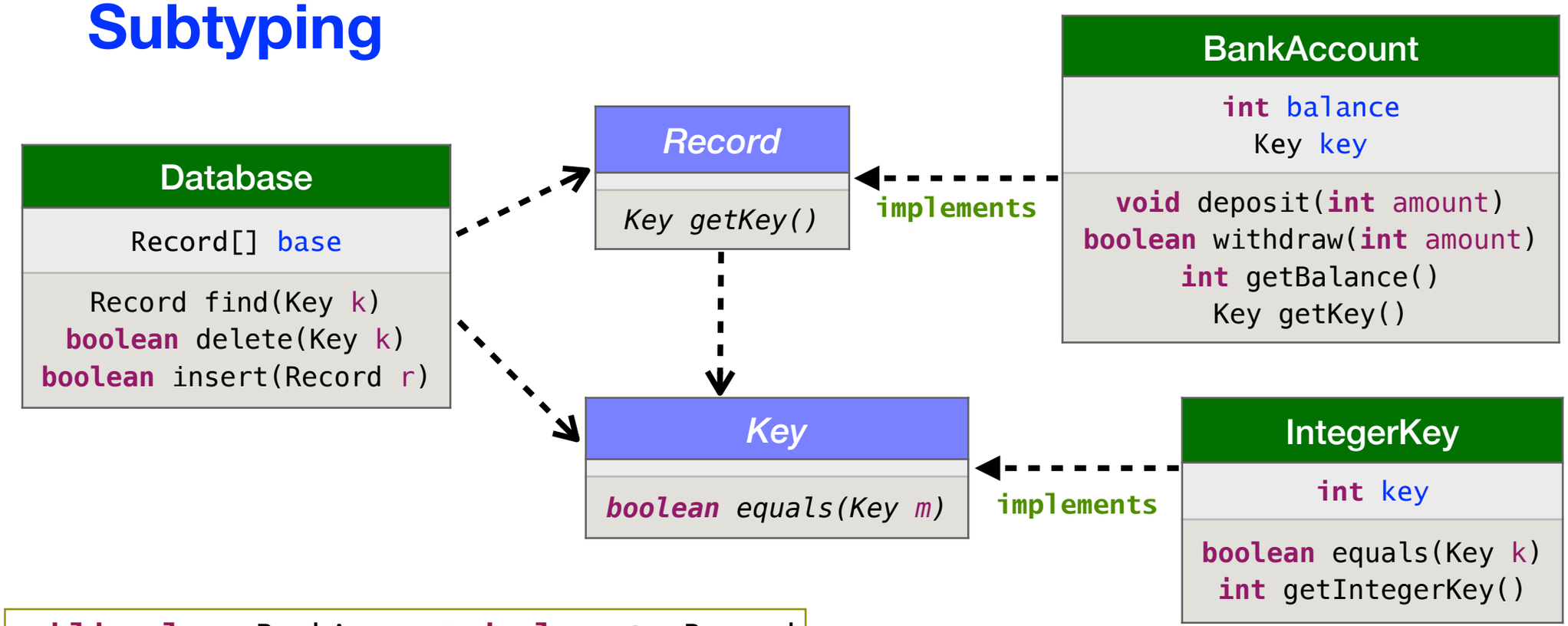


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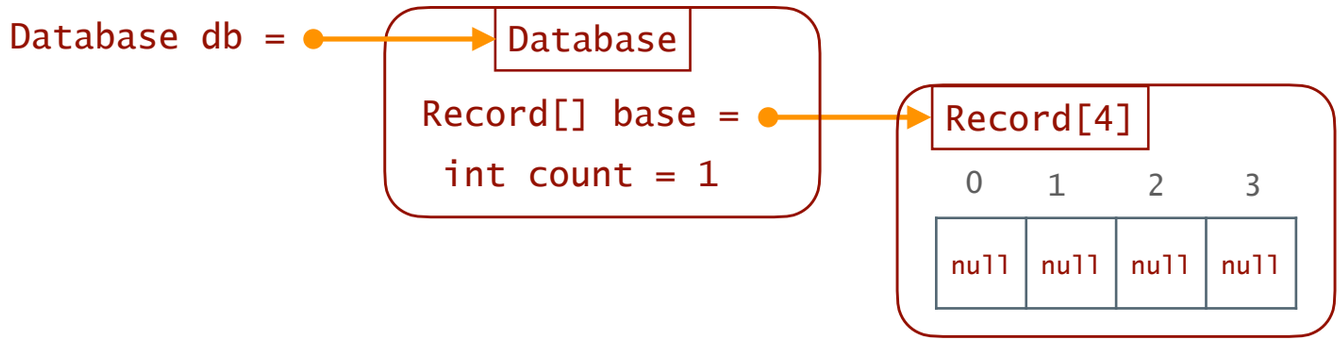

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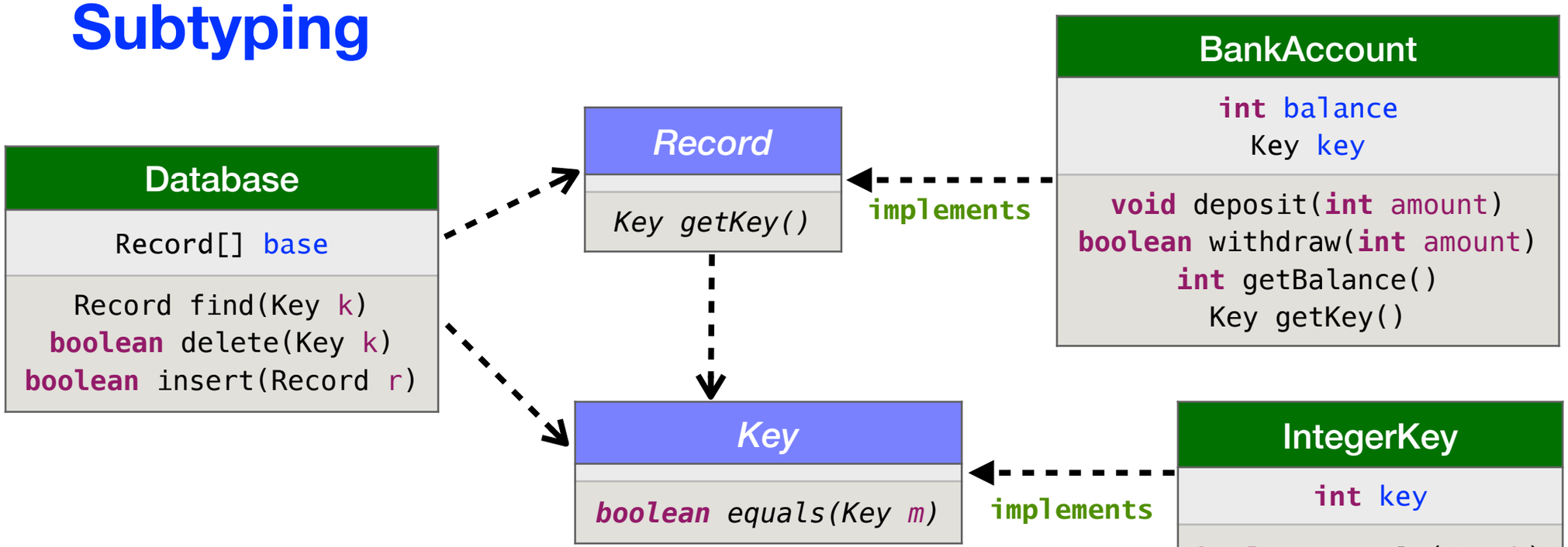


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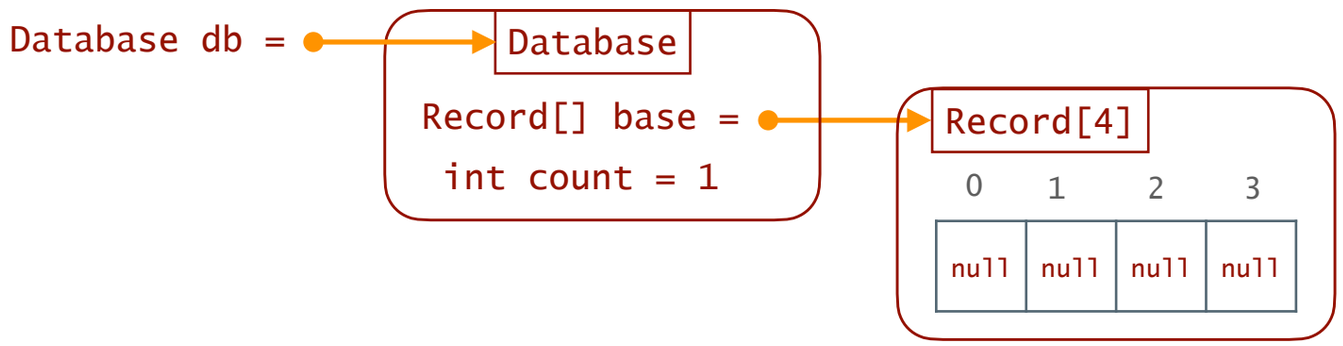

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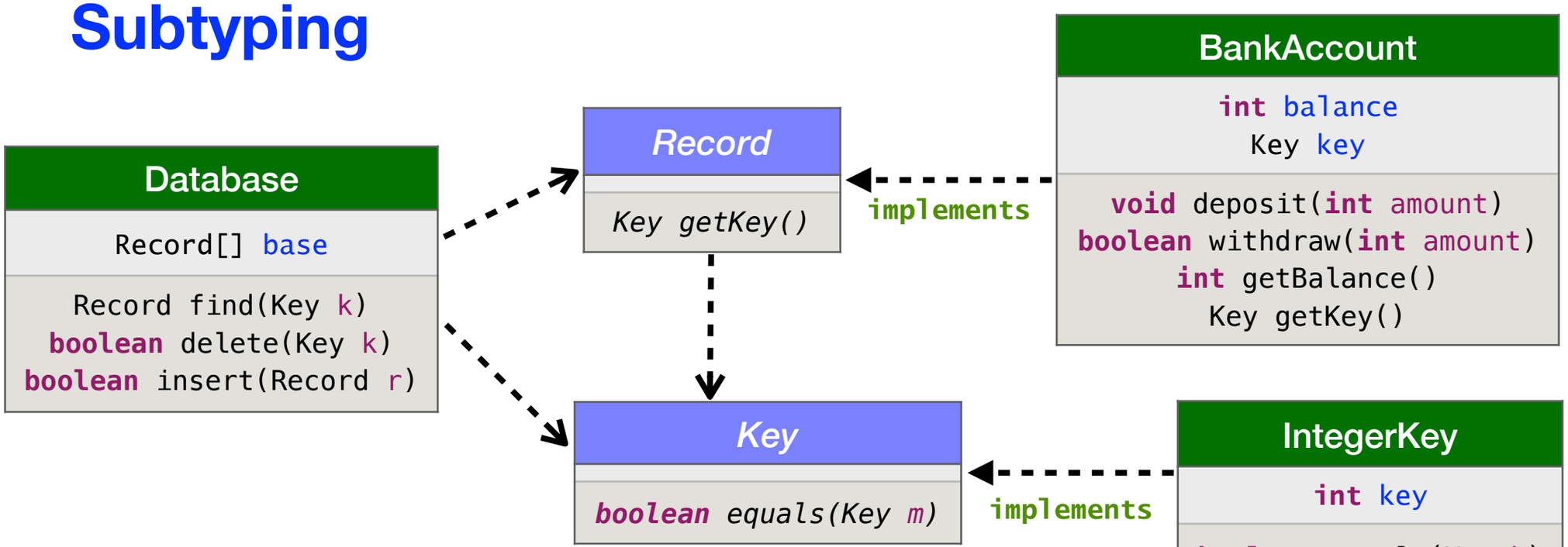


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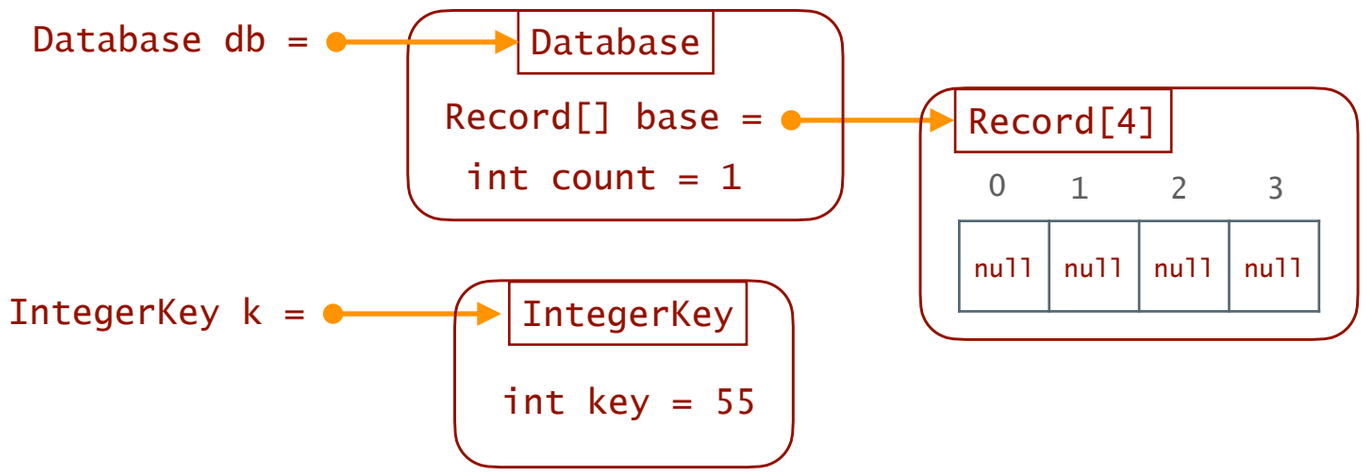

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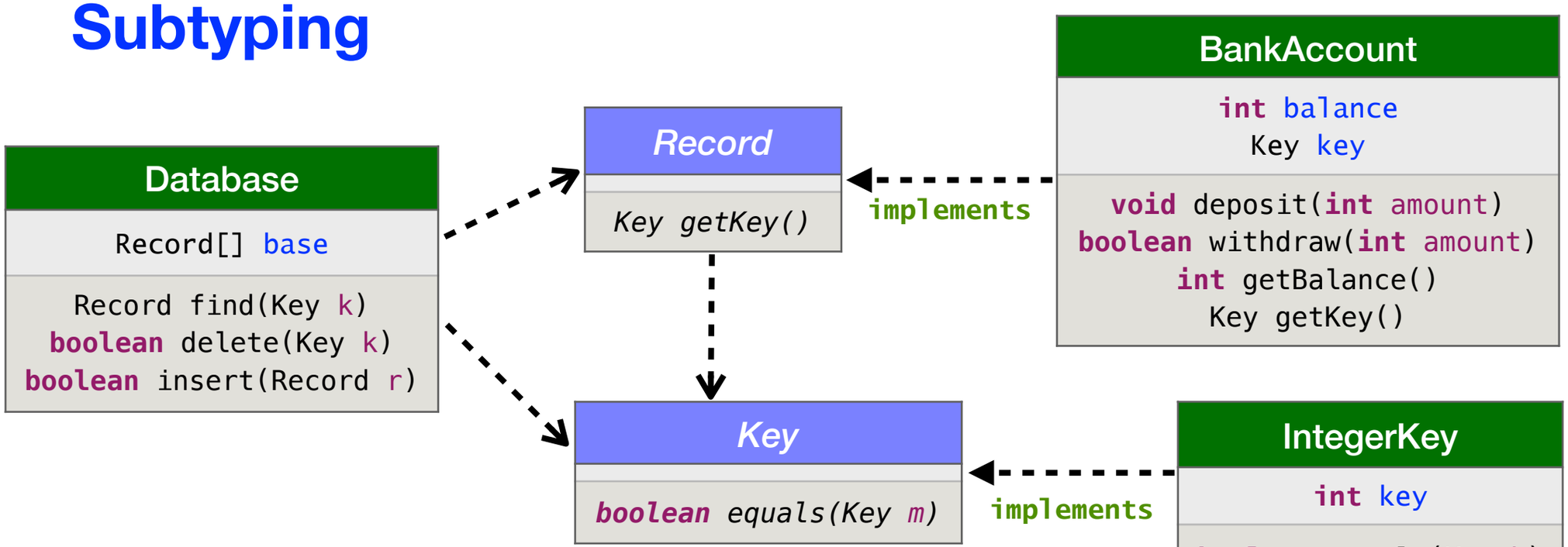


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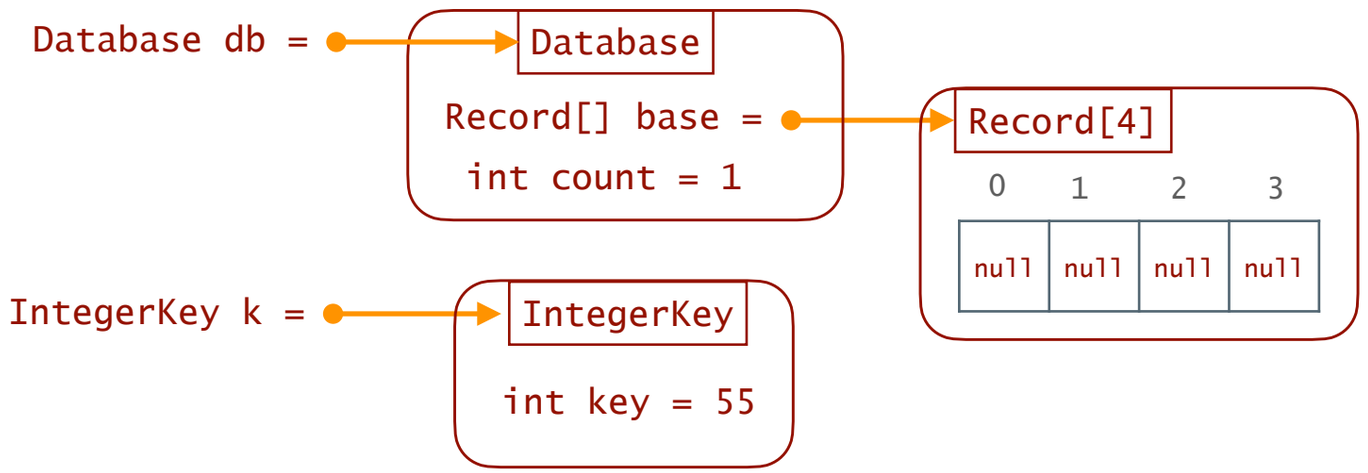

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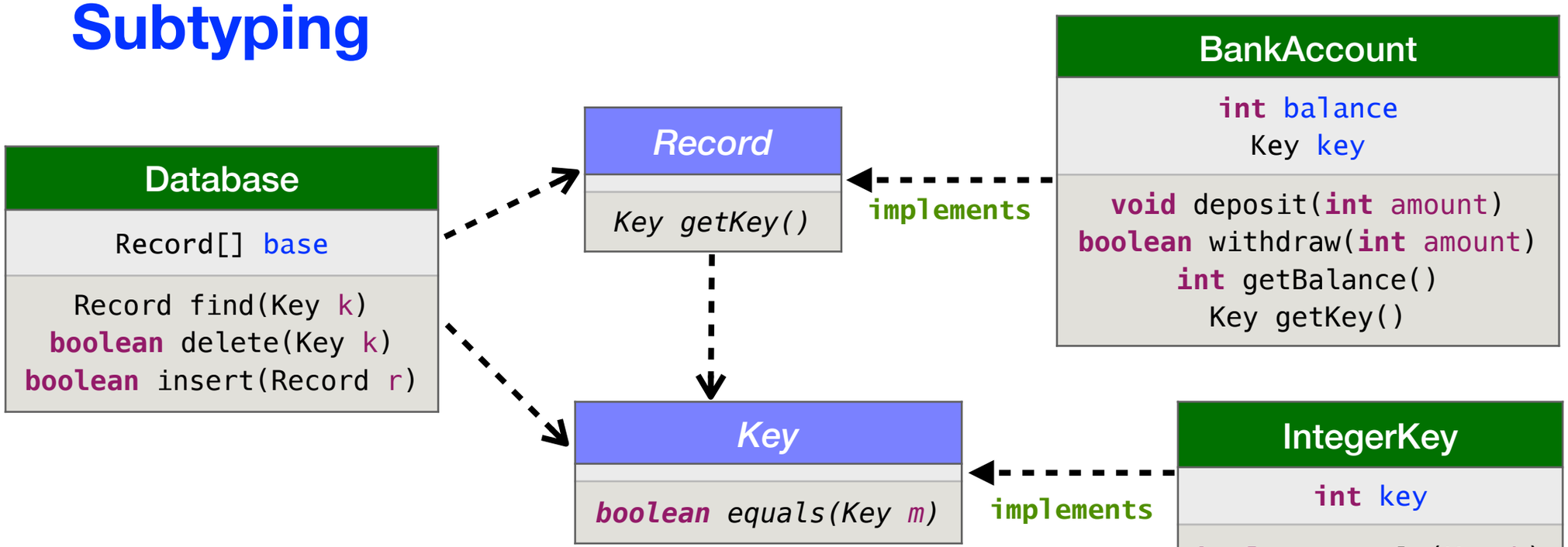


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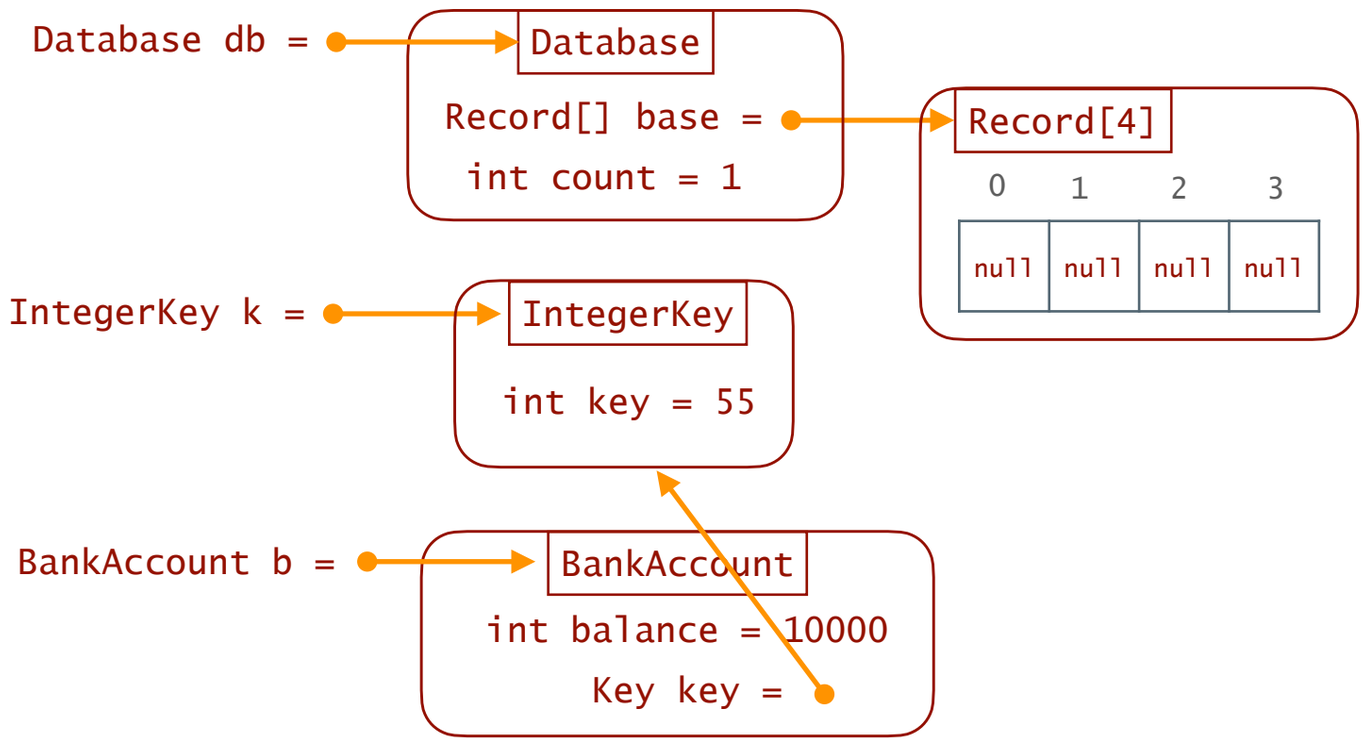

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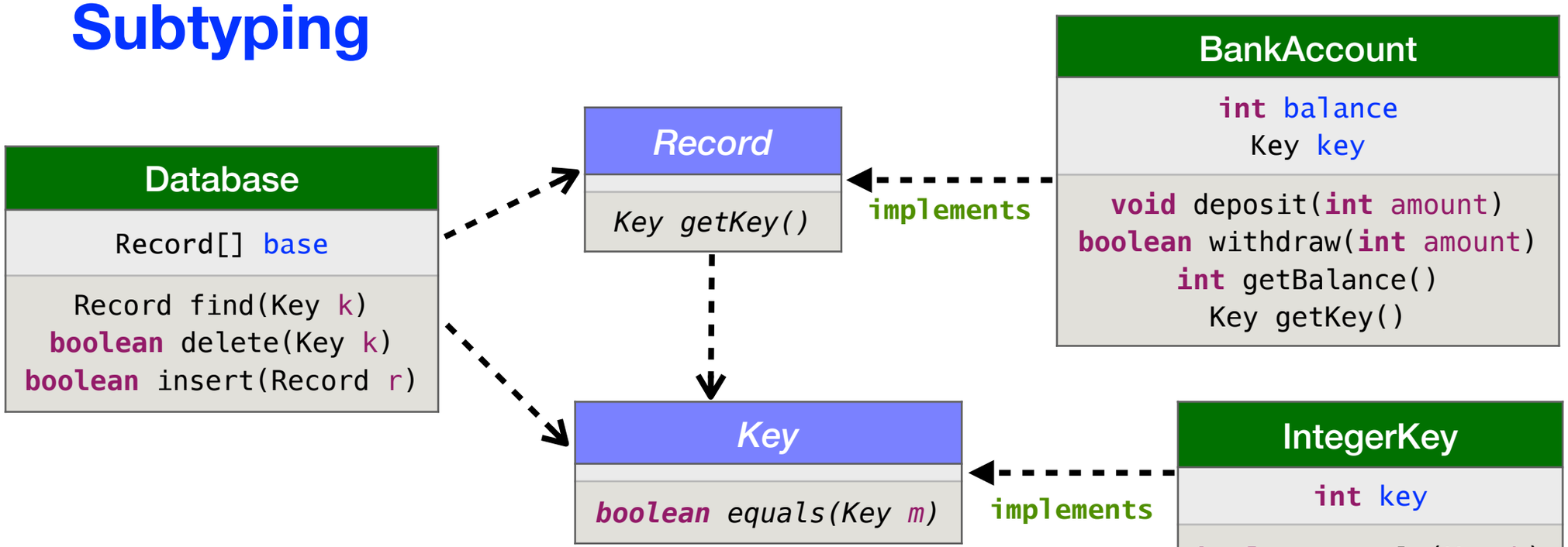


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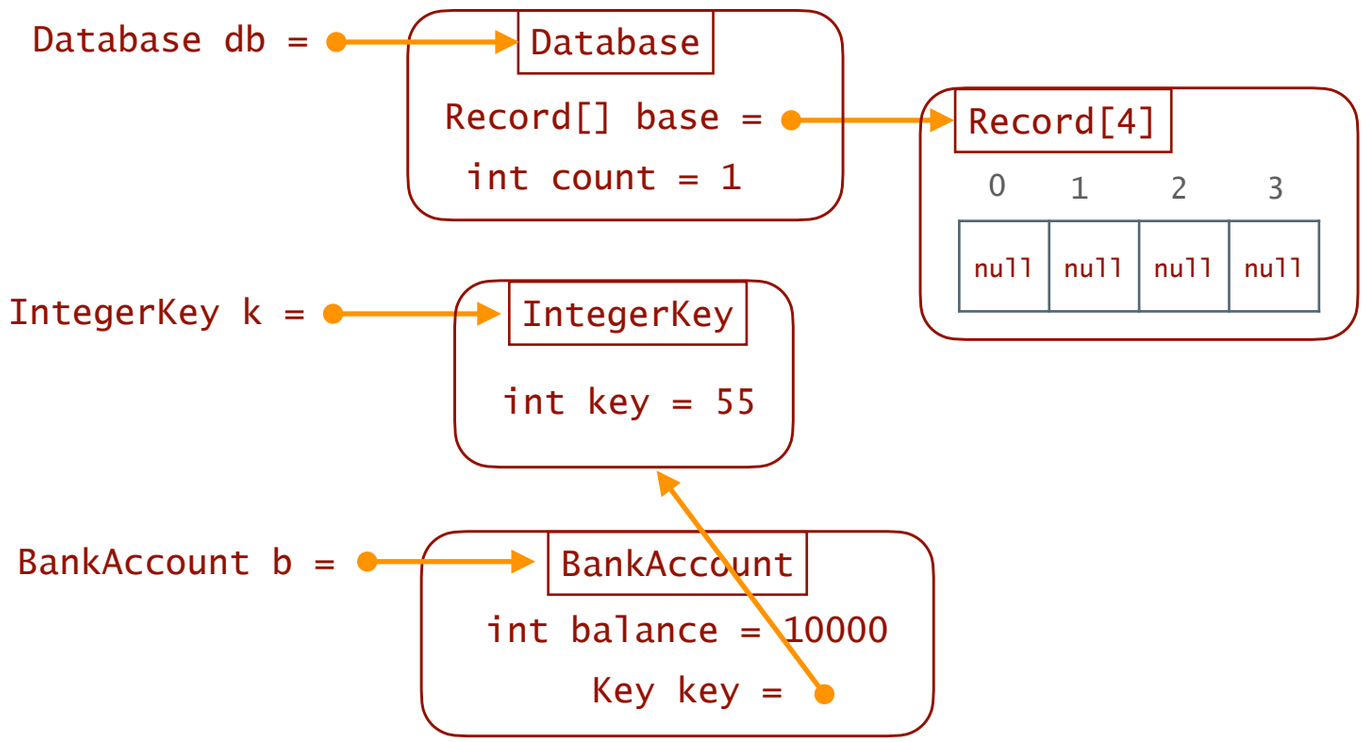

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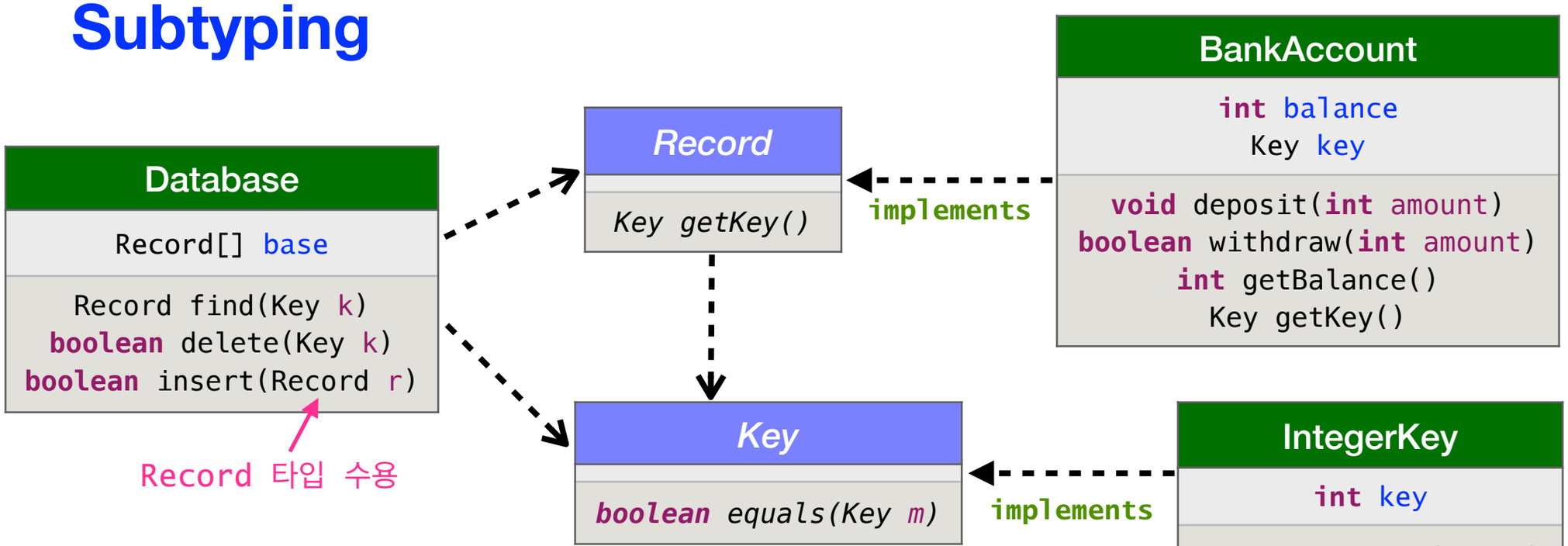


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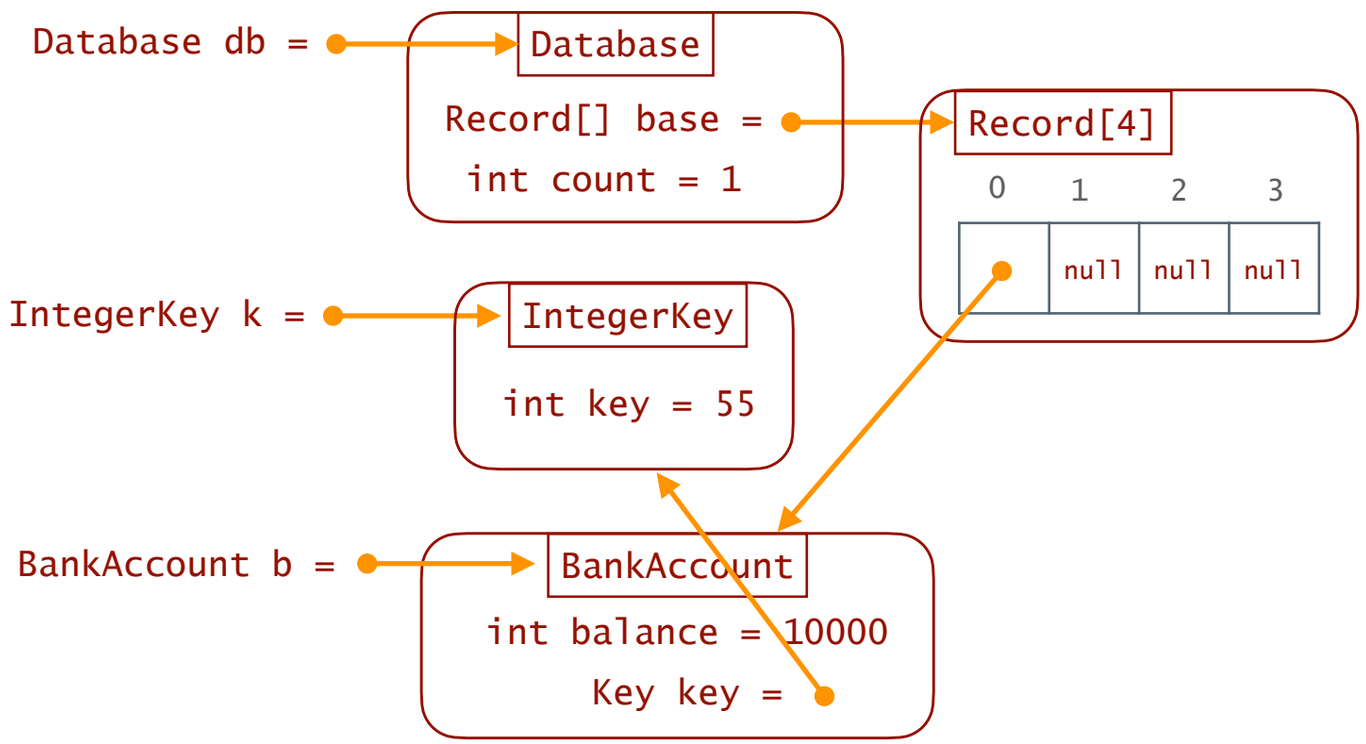
BankAccount 타입



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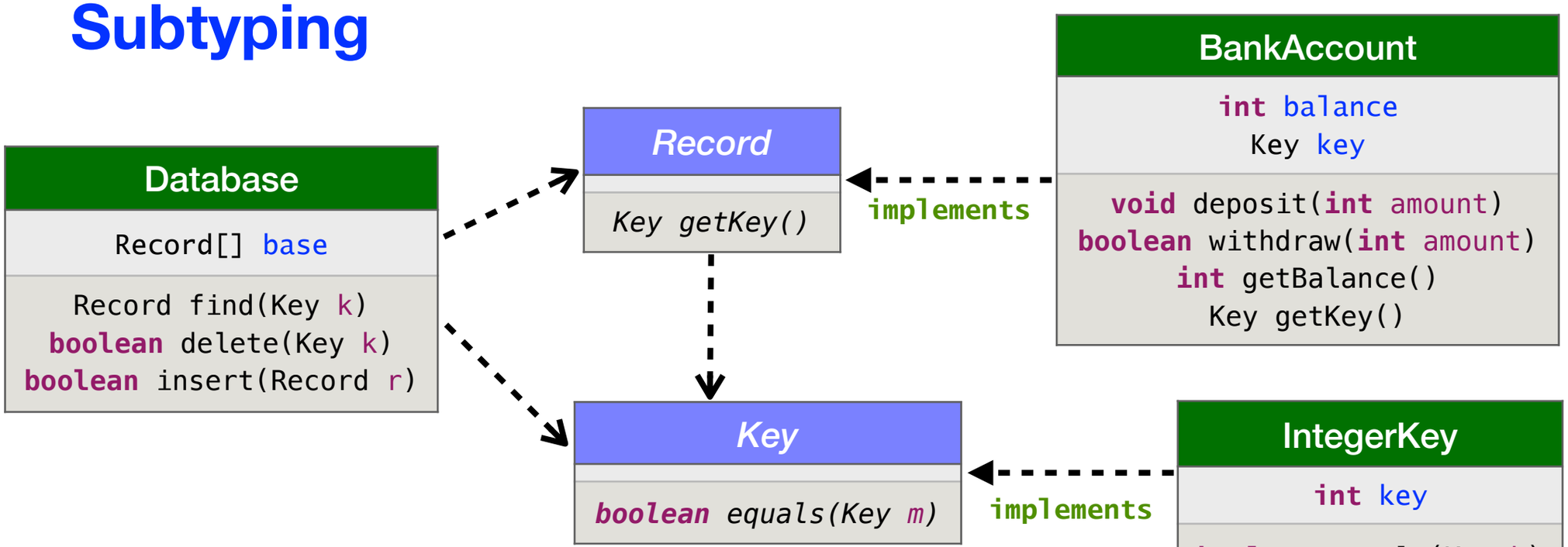


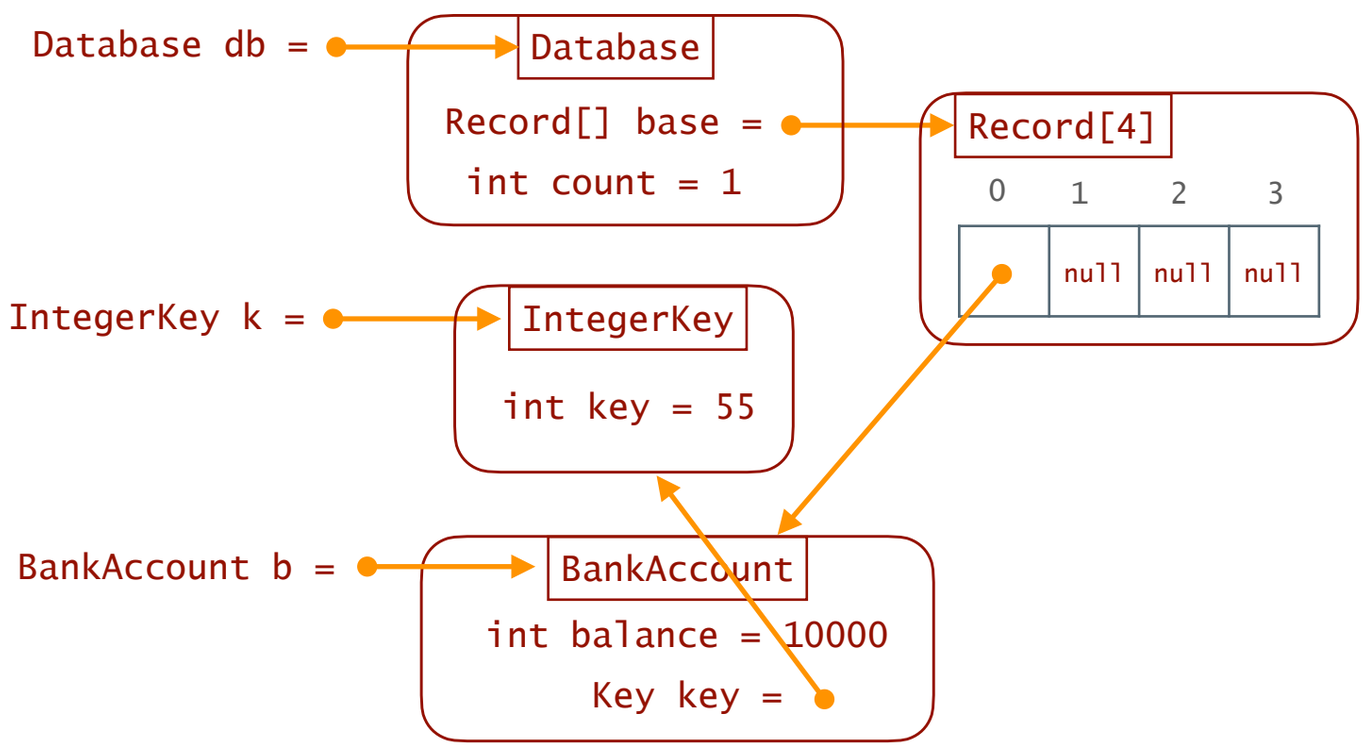

```
public class IntegerKey implements Key
```

IntegerKey <= Key

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

… r.getBalance() …

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



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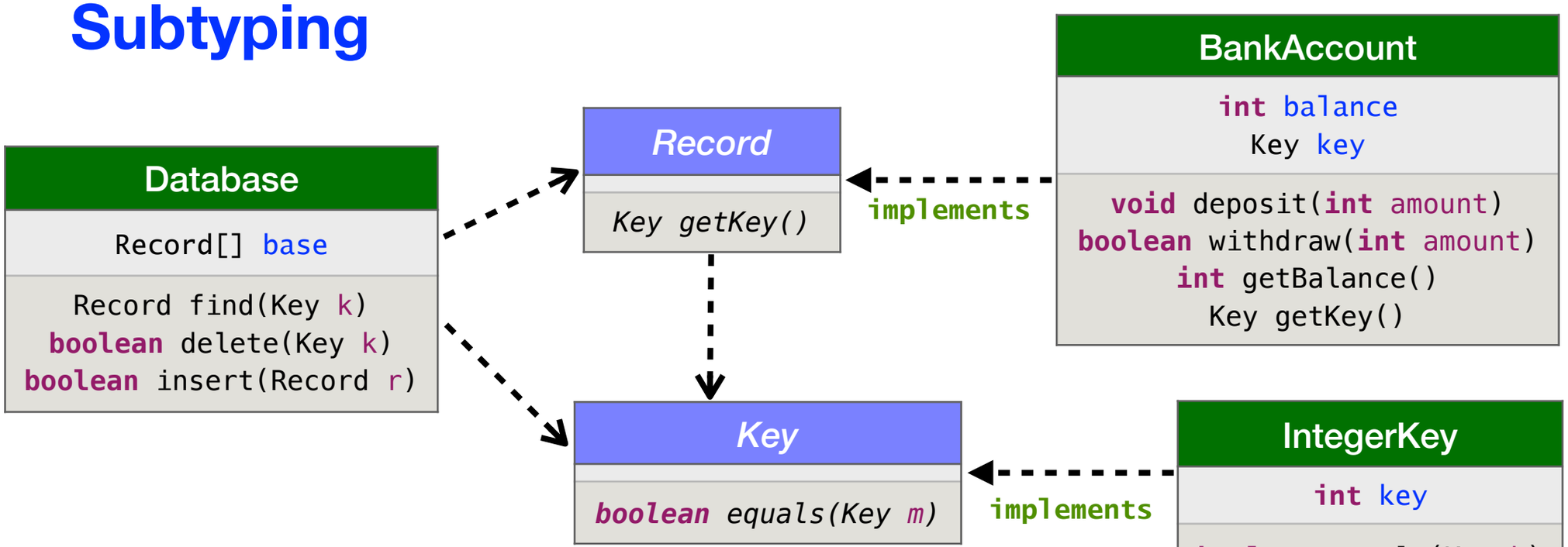


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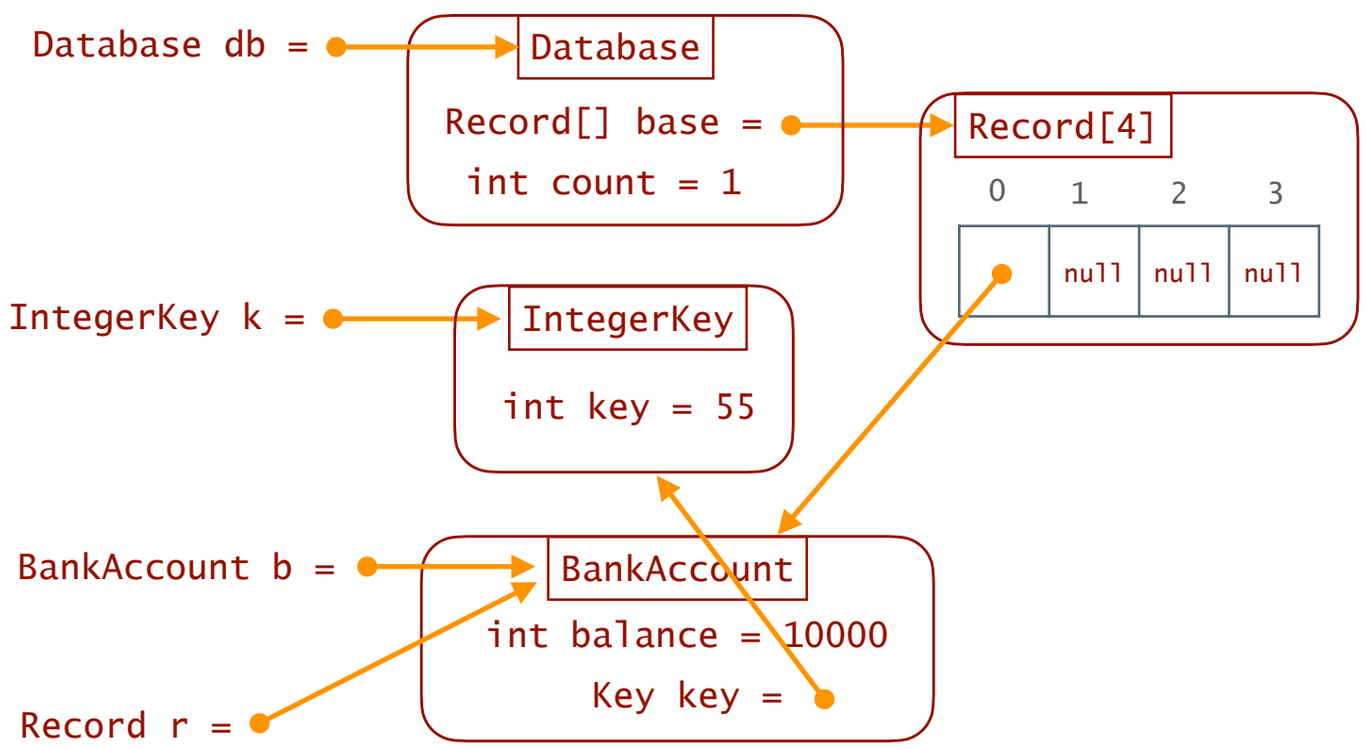

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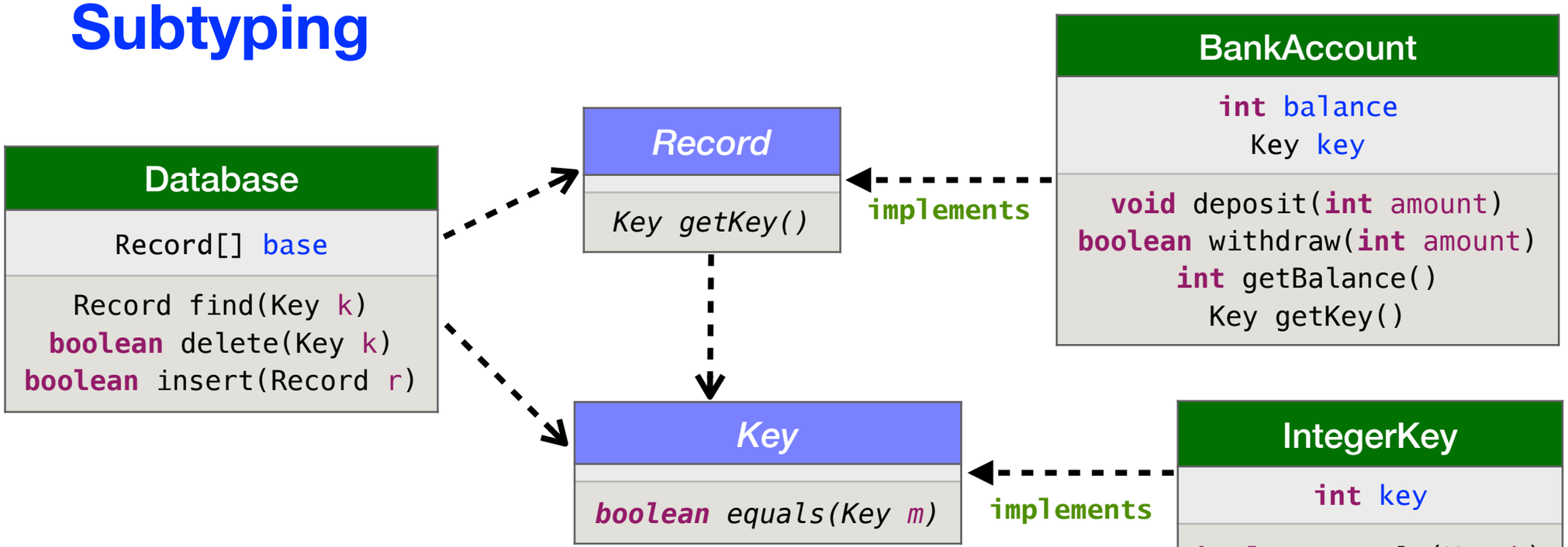


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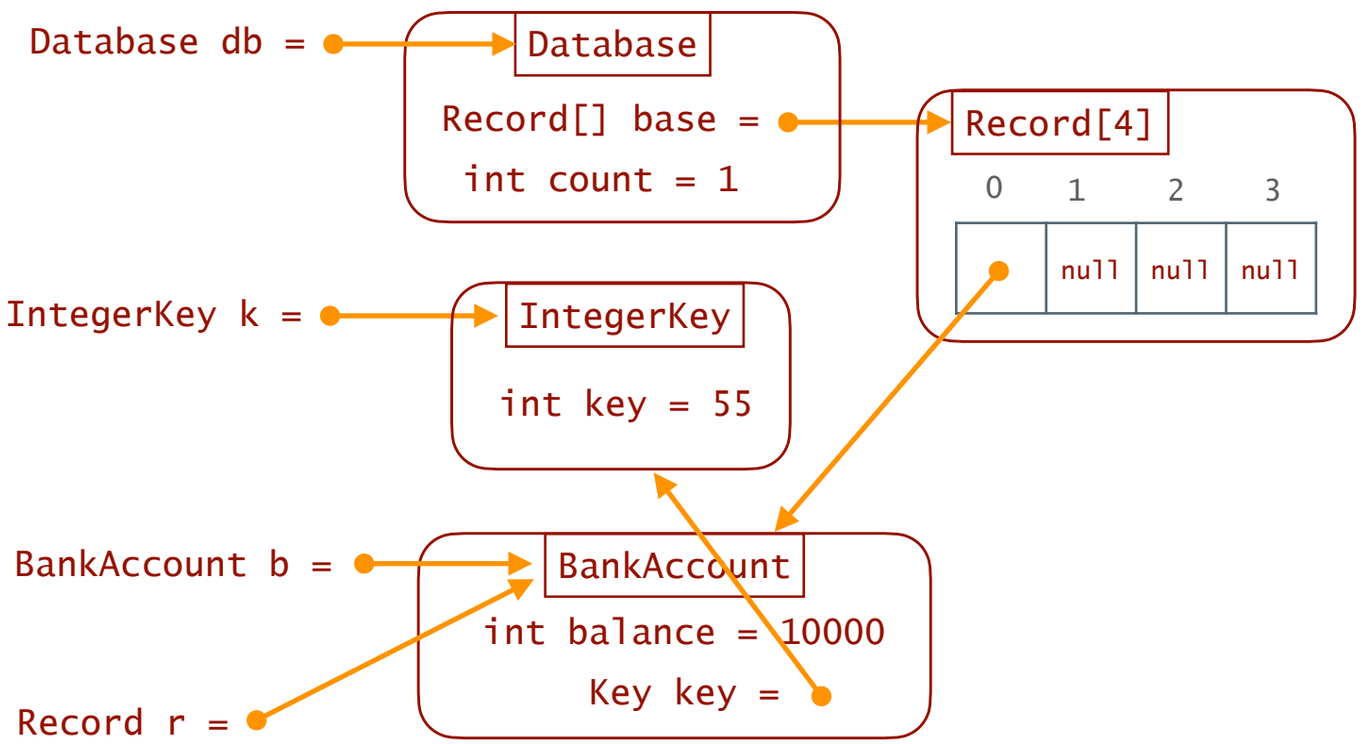
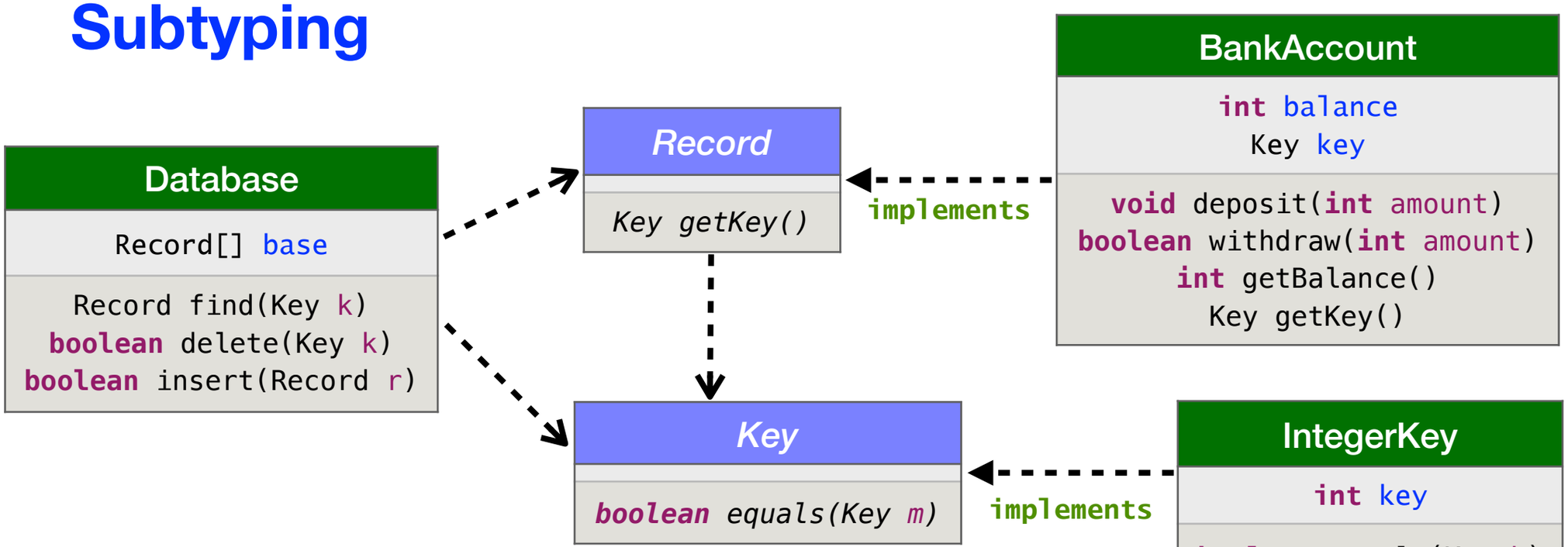


Subtyping

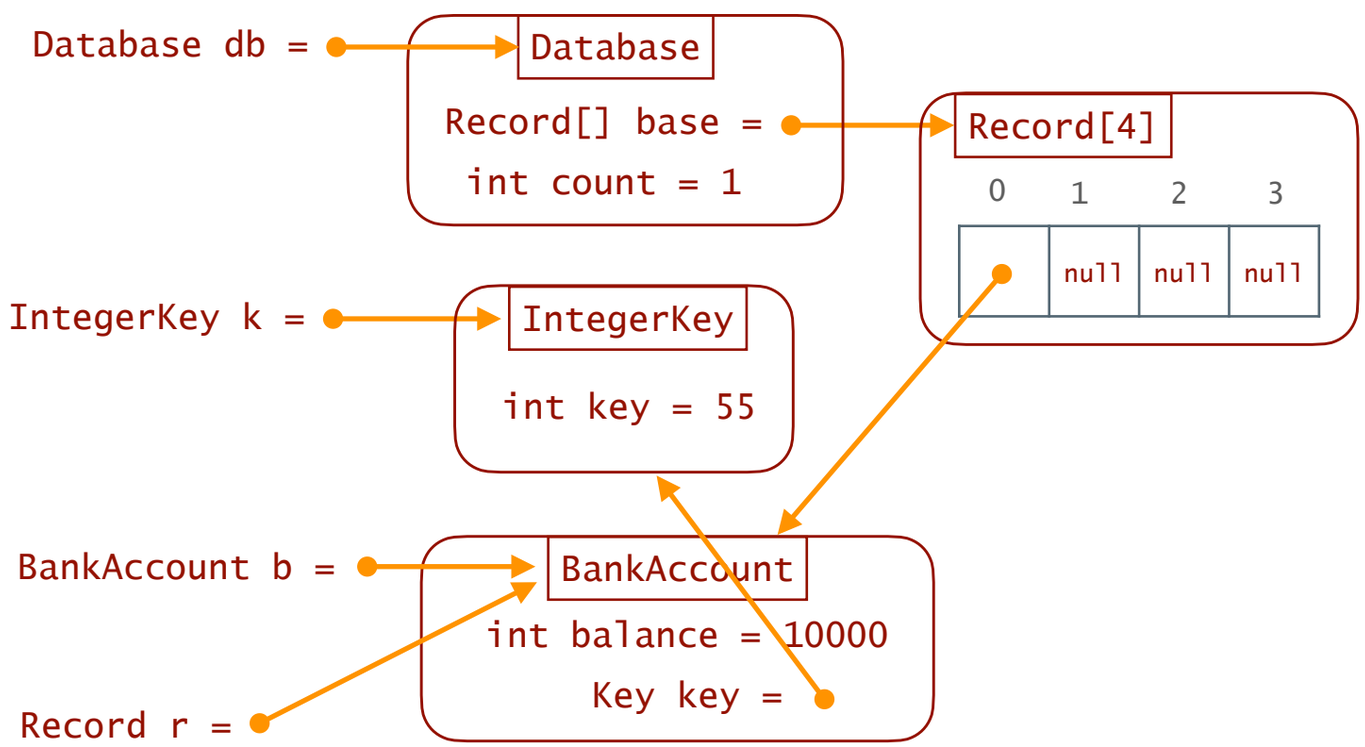



```
public class IntegerKey implements Key
```

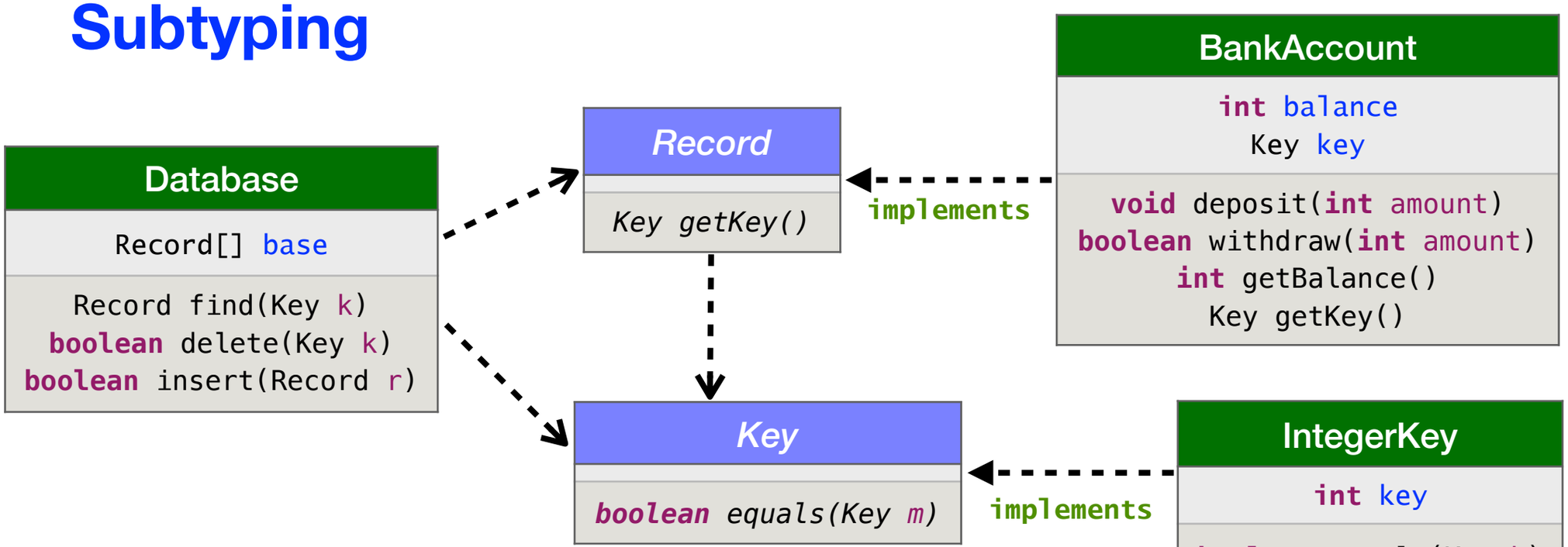
IntegerKey <= Key

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

… r.getBalance() …

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

타입오류! - Record 인터페이스는
getBalance() 메소드를 모른다.



Subtyping

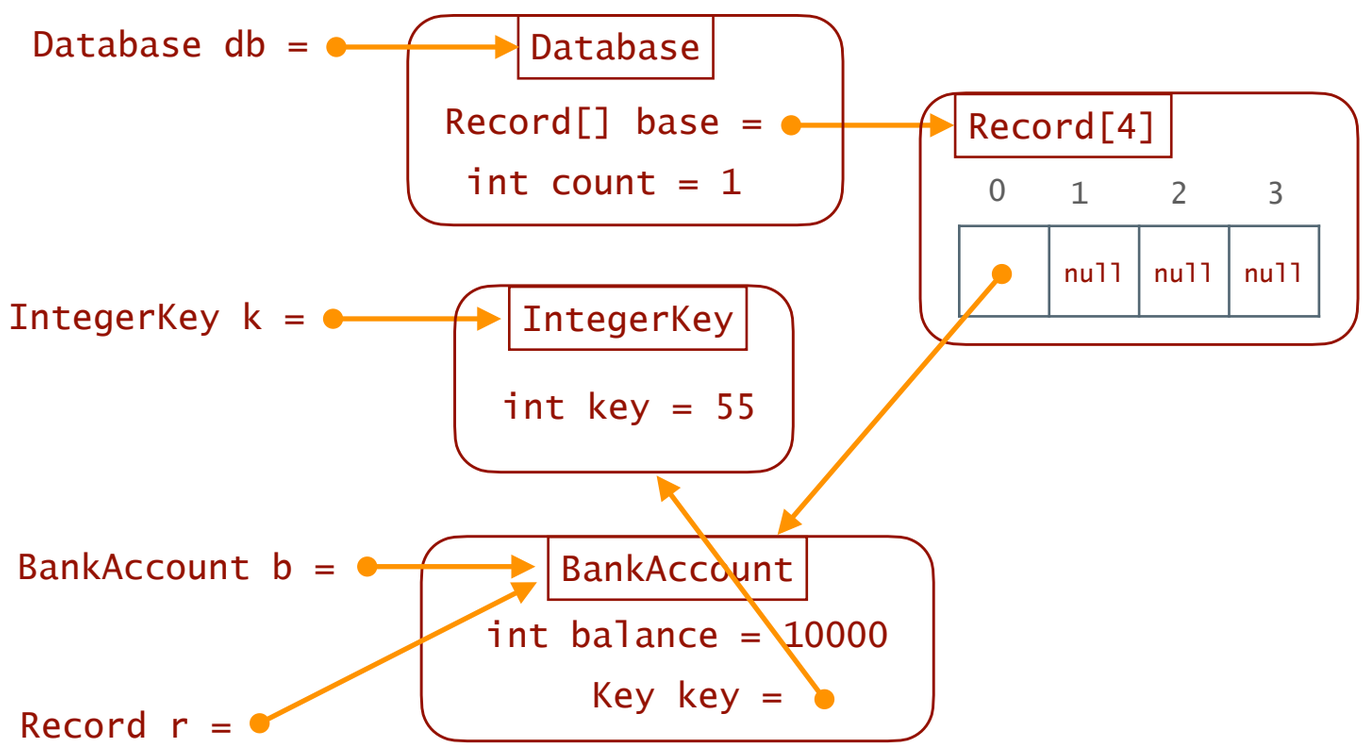



```
public class IntegerKey implements Key
```

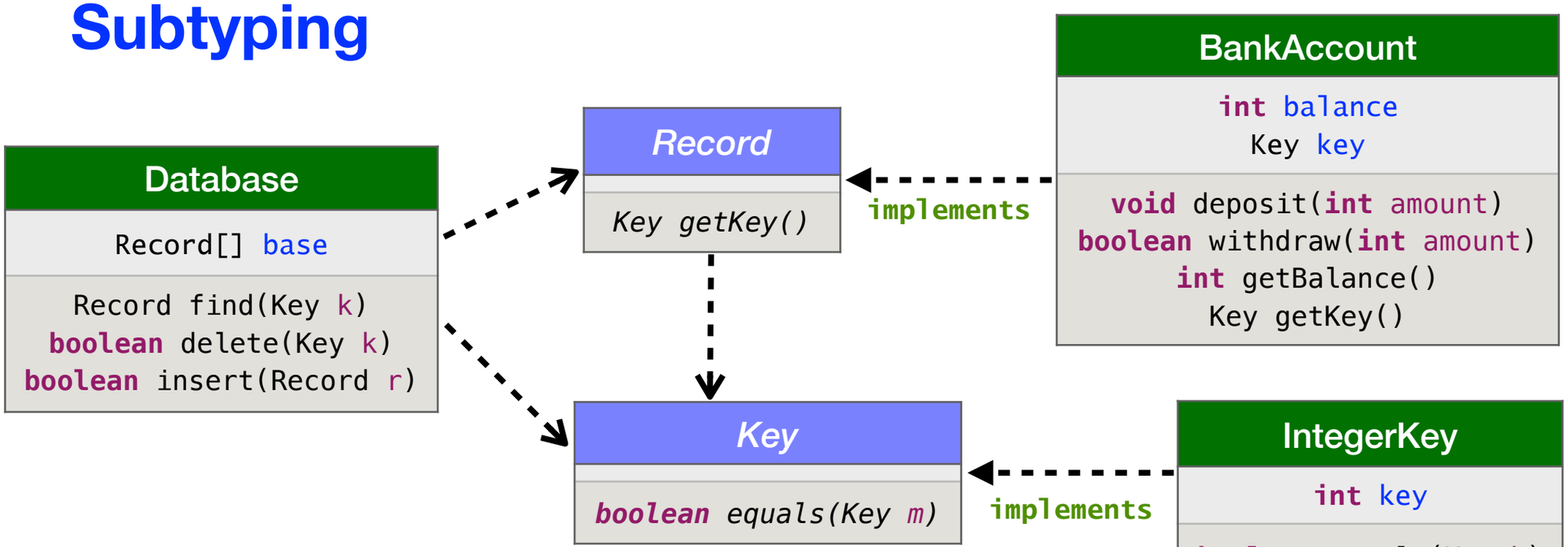
IntegerKey <= Key

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

… r.getBalance() …

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

타입 캐스트하여 컴파일러 통과



Subtyping




```
public class IntegerKey implements Key
```

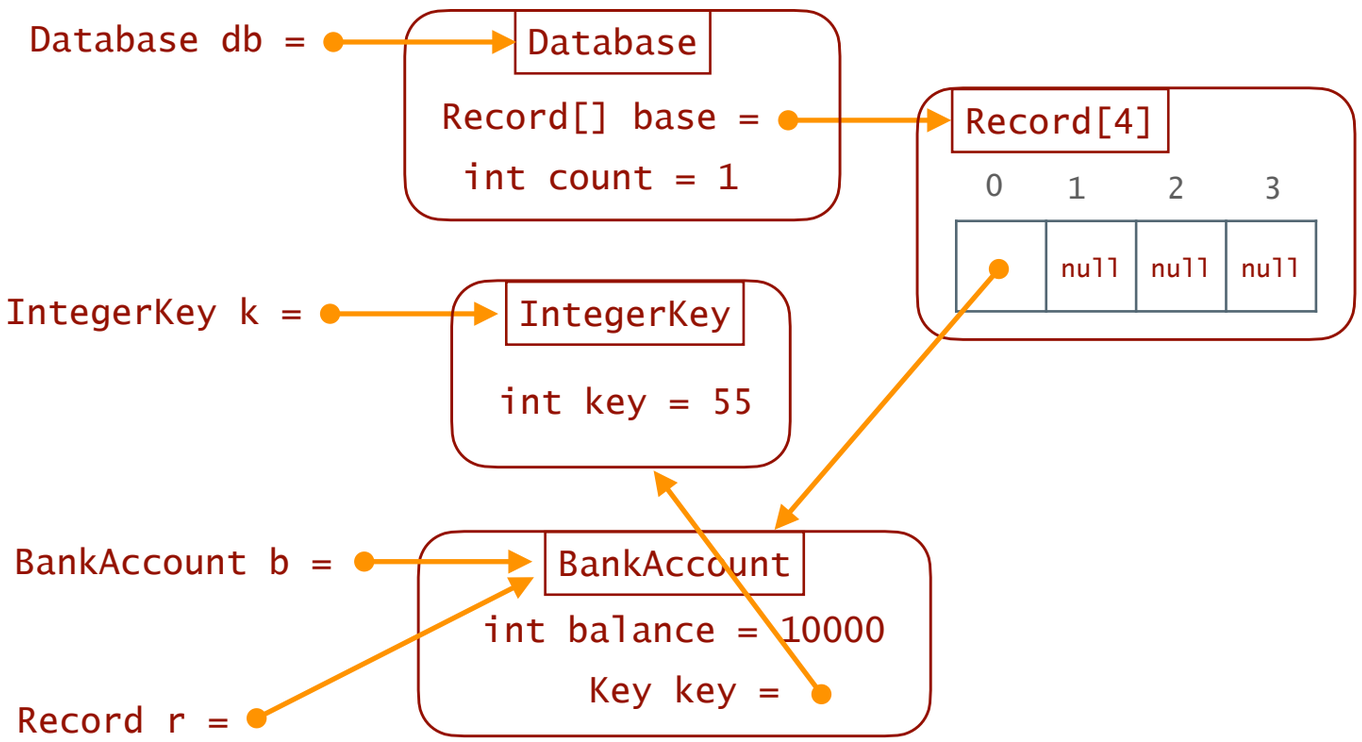
IntegerKey <= Key

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

… r.getBalance() …

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

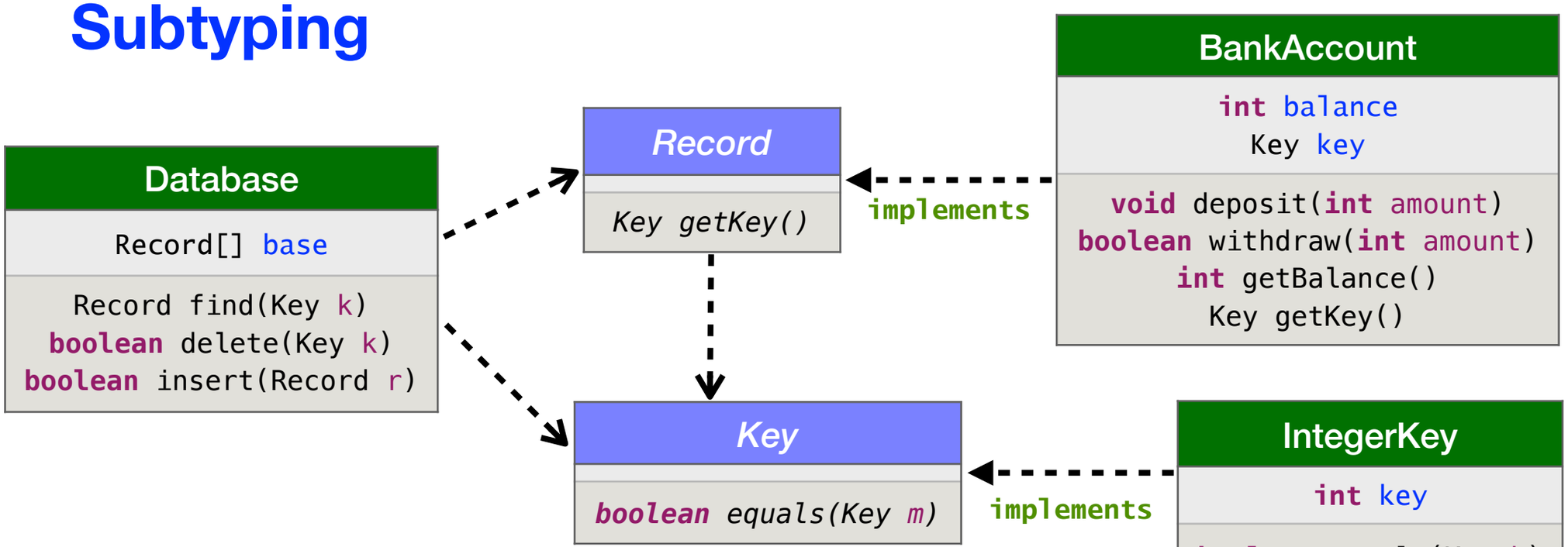
BankAccount 아님 IntegerKey 아님

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

컴파일러 통과,
하지만 실행 오류 발생



Subtyping



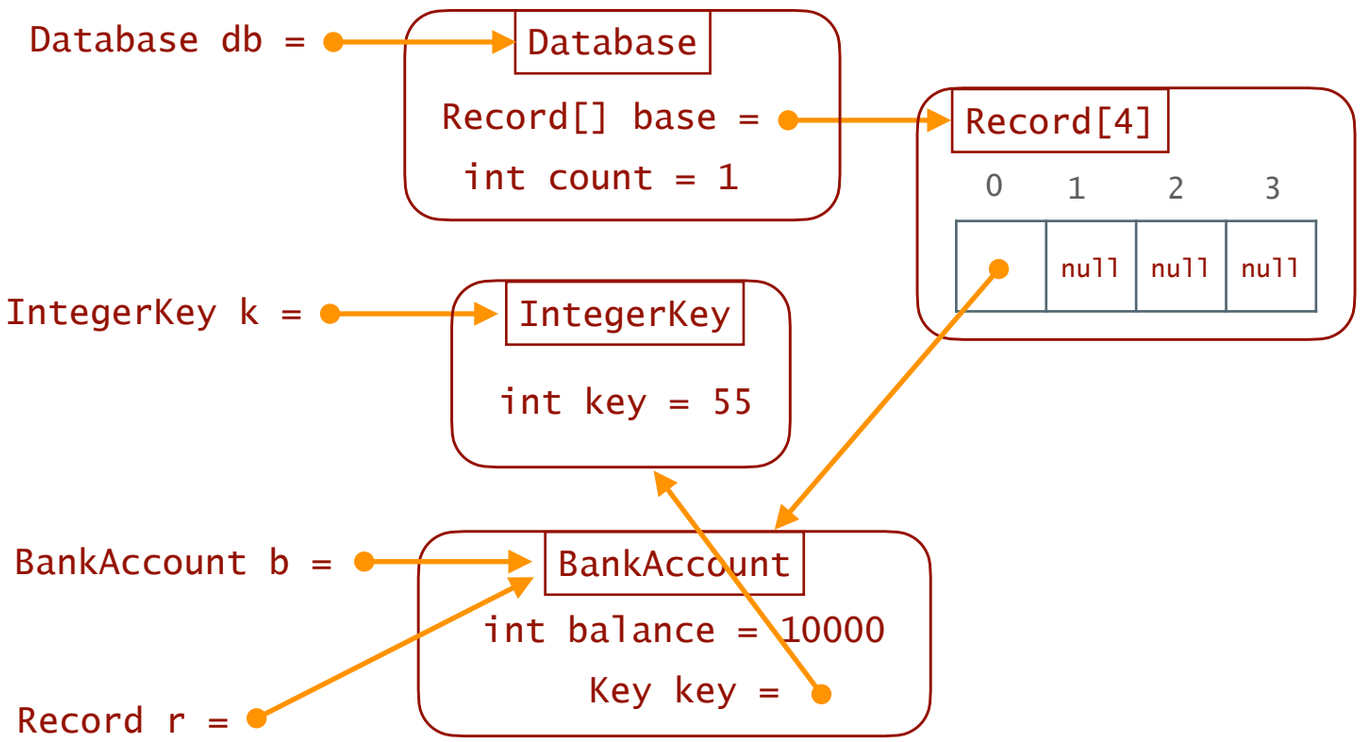

```
public class IntegerKey implements Key
```

IntegerKey <= Key

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

… r.getBalance() …

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

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

r이 BankAccount 인지 사전 확인 하여 실행 오류 방지



컴파일러가 잡아내지 못하는 타입 오류

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

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

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

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

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

컴파일 OK,
그러나 실행중 오류 발생

컴파일러가 타입 오류를 찾을 수 없음 => 프로그래머가 챙겨야 할 몫!

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

Lab#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));`

Lab#2. instanceof

1. 앞에서 구현한 IntegerKey와 같은 요령으로 StringKey를 구현하자.
2. 다음 코드를 실행하면 어떤 결과가 실행창에 프린트될까?

```
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");
```

Lab#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();

    ……
}
```

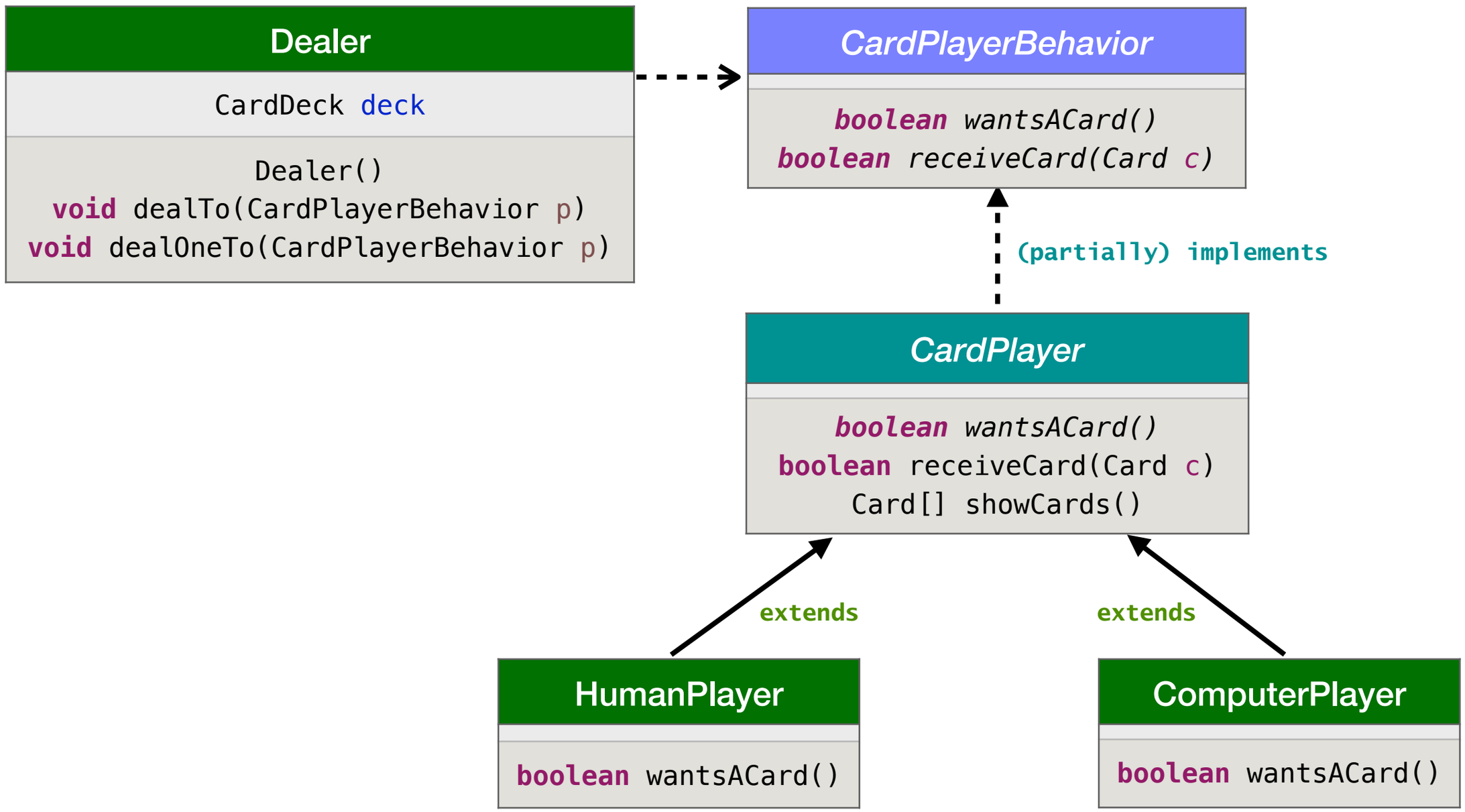
- new Person() 불가!
- extends 가능

```
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;
    }

    ……
}
```

Lab#4. Card Players 구현

Arhitecture 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() { . . . }
```

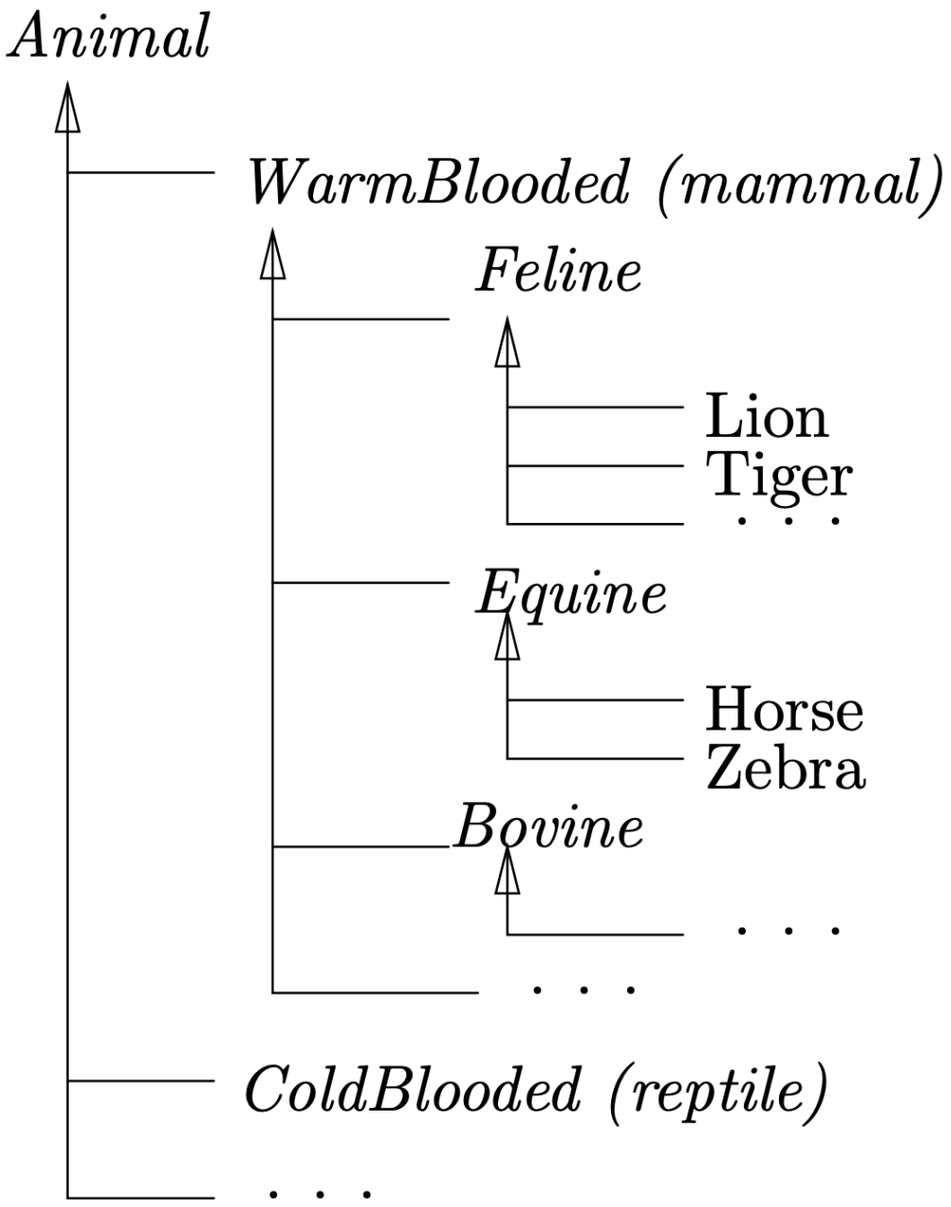
HumanPlayer

```
public boolean wantsACard { . . . }

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

Card[3]

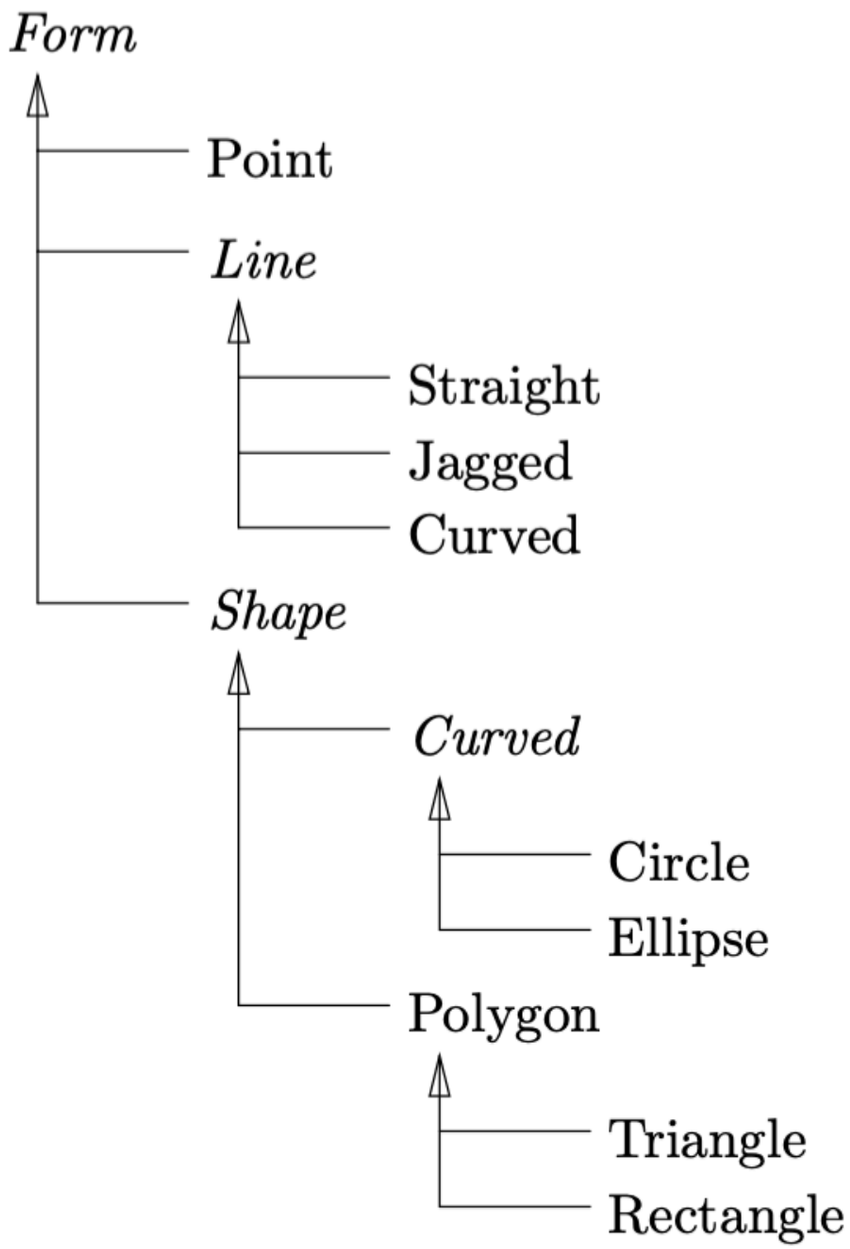
```
ComputerPlayer
<= CardPlayer
<= CardPlayerBehavior

HumanPlayer
<= CardPlayer
<= CardPlayerBehavior
```

Taxonomy of Animals




```
public abstract class Animal
{
  // fields and methods that describe an animal
}

public abstract class WarmBlooded extends Animal
{
  // additional fields and methods specific to warm-blooded animals
}

public abstract class Equine extends WarmBlooded
{
  // fields and methods specific to equines
}

public class Horse extends Equine
{
  // fields and completed methods specific to horses
}
```

Hierarchy of Forms for Drawing



Frameworks

- 프레임워크는 특정 애프리케이션 제작에 특화한 아키텍처 구축용으로 미리 준비하여 모아놓은 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 모아놓은 클래스와 인터페이스를 통틀어 패키지라고 한다.
  - java.util
  - java.awt
  - javax.swing
- import <패키지이름> 의 형식으로 불러쓴다.

class Object

소속 패키지: java.lang

모든 클래스 C에 대해서, C <= Object

Object는 존재하는 모든 클래스의 최상위 객체

```
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 Class Diagram