So you want to add variants to Go?

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Prior art

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        Square Double |           -- side
        Rectangle Double Double -- width, height
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type Circle = { radius: number };
type Square = { side: number };
type Rectangle = { length: number; height: number };

type Shape = Circle | Square | Rectangle;
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```python
class Circle(NamedTuple):
        radius: float

class Square(NamedTuple):
        side: float

class Rectangle(NamedTuple):
        length: float
        height: float

Shape = Circle | Square | Rectangle
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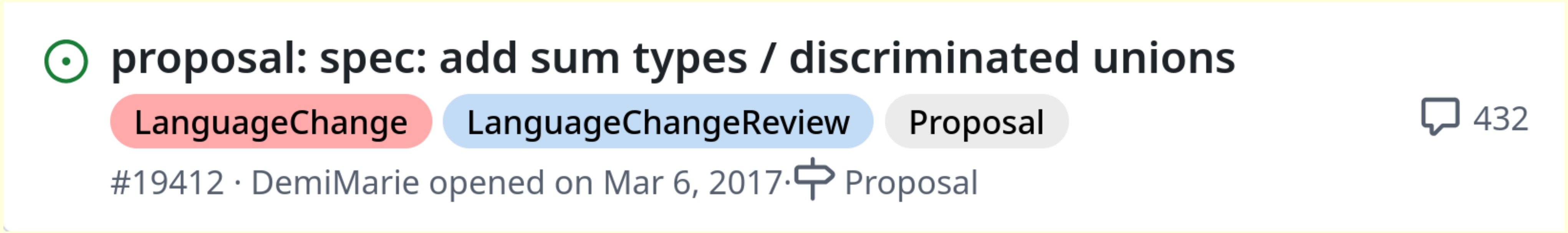
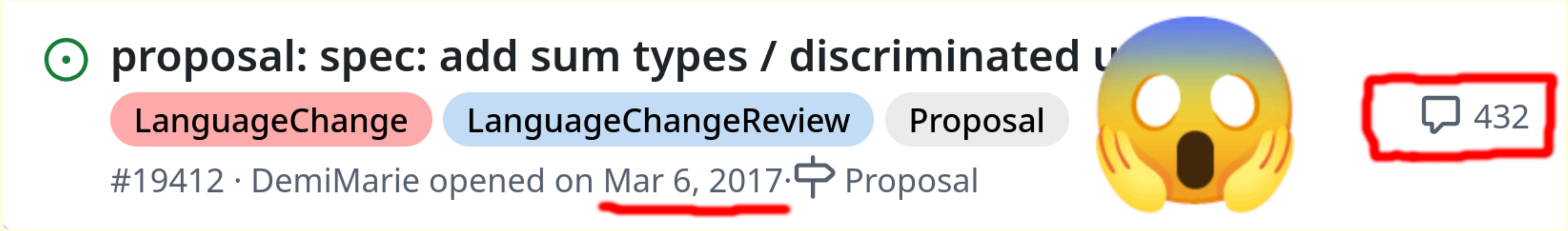


proposal: spec: add sum types / discriminated unions

LanguageChange LanguageChangeReview Proposal

432

#19412 · DemiMarie opened on Mar 6, 2017 · Proposal



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What people want

What people want: closed list

```
type Circle struct { Radius float64 }
type Square struct { Side float64 }
type Rectangle struct { Height, Width float64 }

type Shape enum {
  Circle
  Square
  Rectangle
}

// Type error: Ellipsis is not in Shape
var s Shape = Ellipsis{}
```

What people want: closed list

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type Shape enum {
  Circle
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// Type error: Ellipsis is not in Shape
var s Shape = Ellipsis{}
```

Note: in this talk, I will **not worry** about specific syntax.

What people want: exhaustiveness check

```
func F(s Shape) {
  switch s := s.(type) {
  case Circle:
    DoCircleThing(s)
  case Square:
    DoSquareThing(s)
  // compiler error: missing case Rectangle
  }
}
```

What people want: well-defined state

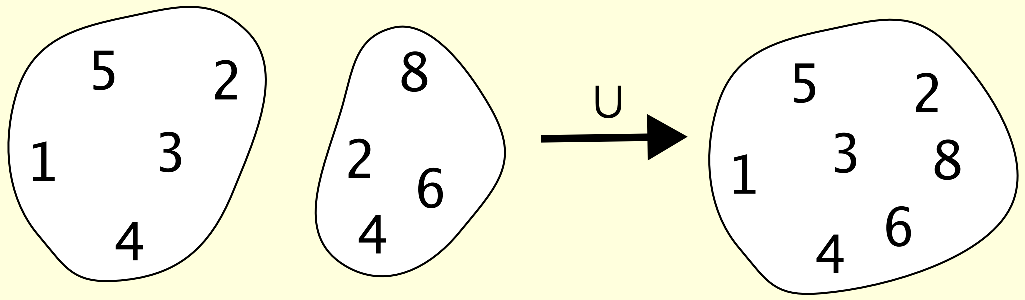
```
type Result[T any] enum {
  T
  error
}

// GetThing returns either a Thing, or an error;
// never both and never neither.
func GetThing() Result[Thing]
```

Design space

Unions and Sums

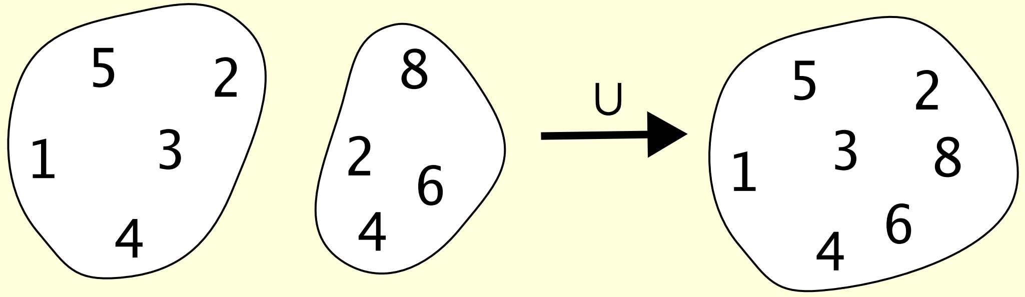
Unions and Sums

Union:

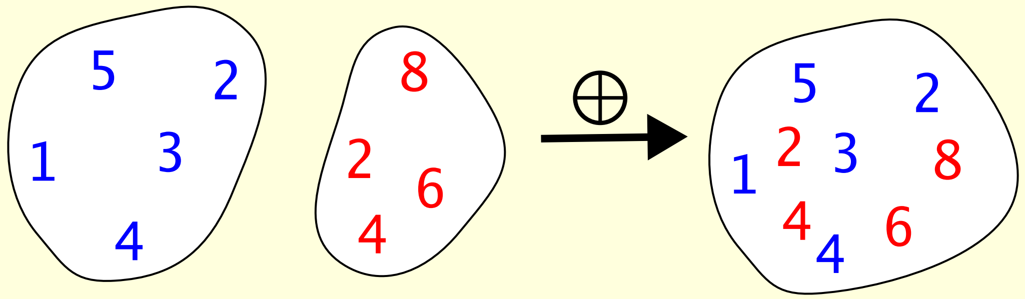


Unions and Sums

Union:



Sum:



Unions and Sums (concretely)

Typescript has unions:

```typescript
type MyUnion = number | string;
let x: MyUnion;
x = 42;
x = "Hello, world";
```

Rust has sums:

```rust
enum MySum {
    Int(i64),
    String(&'static str),
}


fn main() {
    let mut x: MySum;
    x = MySum::Int(42);
    x = MySum::String("Hello, world");
}
```

Unions and Sums (concretely)

Pretending go had unions:

```go
type MyUnion union {
  int,
  string,
}


func main() {
  var x MyUnion
  x = 42;
  x = "Hello, world";
}
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Unions and Sums (concretely)

Pretending go had unions:

```
type MyUnion union {
  int,
  string,
  time.Duration,
}

func main() {
  var x MyUnion
  x = 42; // int or time.Duration?
  x = "Hello, world";
}
```

Rust has sums:

```
enum MySum {
    Int(i64),
    String(&'static str),
    Duration(i64),
}

fn main() {
    let mut x: MySum;
    x = MySum::Int(42); // clearly Int
    x = MySum::String("Hello, world");
}
```

Unpacking

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```
fn degenerate(s: &Shape) -> bool {
  match s {
    Shape::Circle(0.0) => true,
    Shape::Square(0.0) => true,
    Shape::Rectangle(0.0, _) => true,
    Shape::Rectangle(_, 0.0) => true,
    _ => false,
  }
}
```

Gradual code repair

Principle: APIs should be interoperable, when moved from one package to another.

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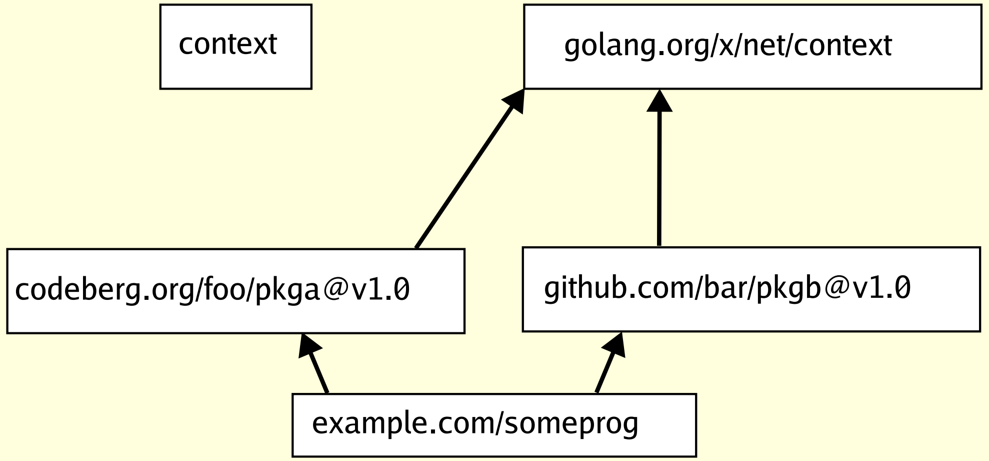

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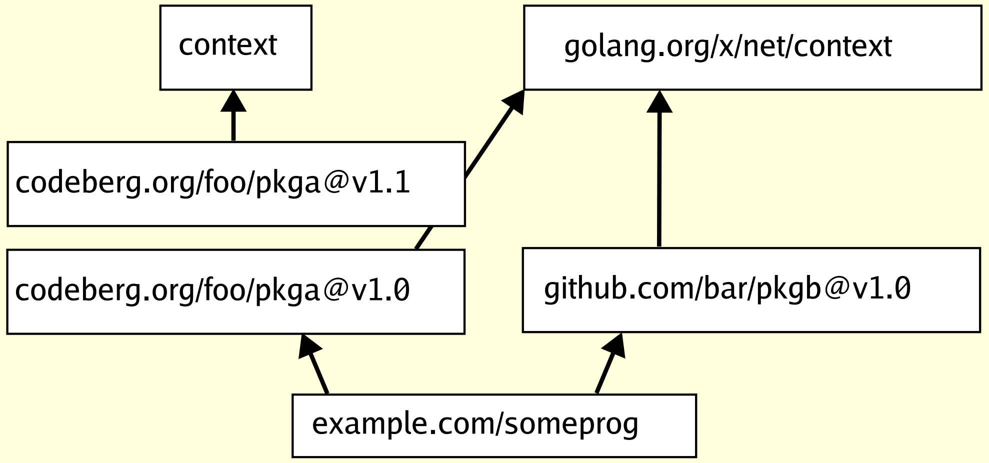

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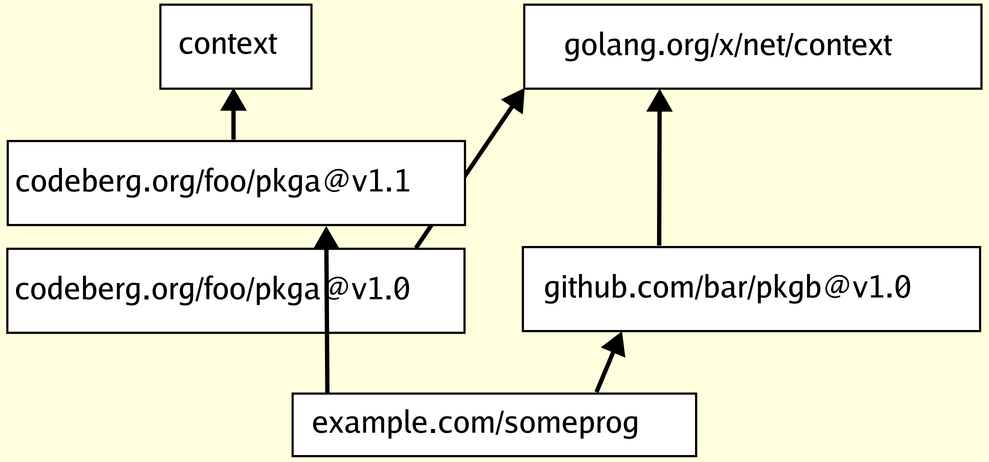

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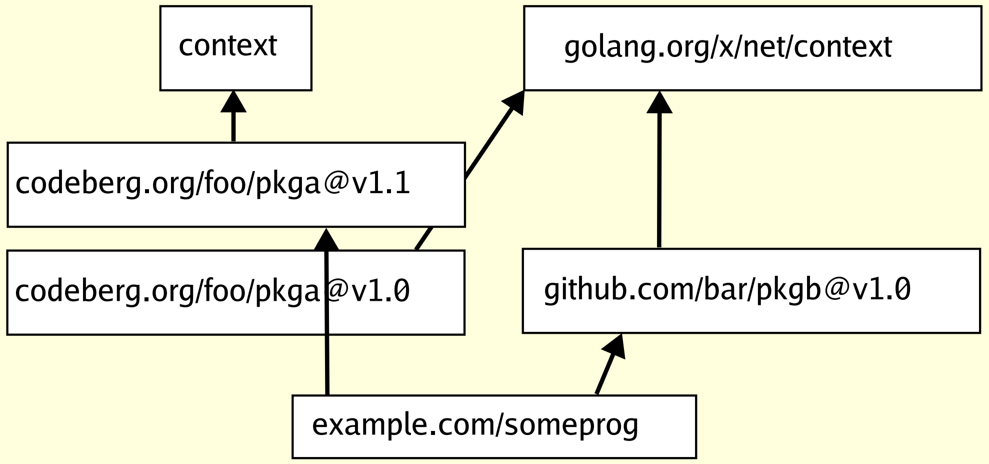

Exhaustive switch checking breaks gradual repair!

Zero values

Every Go type needs a **zero value**, which should be represented by `0` bytes

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1. Use zero value of “default term”
   - Default is explicitly marked
   - Default is implied by order (usually the first term)
2. Use sentinel for “no value”

Variants in Go

Union elements

```
type Shape interface{ Circle | Square | Rectangle }

func F[S Shape](v S) {}
// cannot use type Shape outside a type constraint:
//   interface contains type constraints
func G(v Shape) {}
```

Union elements

```go
type Shape interface{ Circle | Square | Rectangle }

func F[S Shape](v S) {}


func G(v Shape) {
  // unpacking via type switch:
  switch v := v.(type) {
  case Circle:
  case Square:
  case Rectangle:
  }
}
```

Proposal: #57644

Consequence: nested unions

```
type Signed interface { int8 | … | int64 }
type Unsigned interface{ uint8 | … | uint64 }

type Integer interface { Signed | Unsigned }
```

Consequence: nested unions

```
type Signed interface { int8 | … | int64 }
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type Integer interface { Signed | Unsigned }
type Integer2 interface{ int8 | … | int64 | uint8 | … | uint64 }
```

Should remain the same ⇒ no nested unions.

Consequence: interface terms

```
type Result[T] interface{ T | error }
```

Consequence: interface terms

```go
// error: term cannot be a type parameter
// error: cannot use error in union (error contains methods)
type Result[T] interface{ T | error }
```

Interfaces with methods disallowed $\Longrightarrow$ no interfaces in unions.

More details: blog post and talk “Constraining Complexity in the Generics Design”

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type Union interface{ int | string }
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Must remain valid ⇒ cannot require explicit default.

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Must remain valid ⇒ cannot require explicit default.

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Should remain the same as `Union` ⇒ cannot use order for default.

⇒ We must make the zero value `nil`.

Consequence: type switch

```
type Reader interface{ *bytes.Reader | *strings.Reader | int }
func F(r Reader) {
  switch r := r.(type) {
  case io.Reader:
  case *bytes.Reader: // never taken
  // case int not handled
  }
}
```

Consistency:

- No exhaustiveness check
- No forced default
- Overlapping cases allowed (choose first match)

Sum types

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$\Longrightarrow$ Probably too confusing and hard to learn.

Conclusion

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1. Use existing union–elements: relatively low benefit, likely disappointing.
2. Add proper sum types: too redundant with union elements.
3. Do nothing and leave Go without variants.

As the first two options are not clearly good, we are so far stuck with the third.

Thank you